An Empirical Analysis of the Stay-at-Home Behaviors During COVID-19 Pandemic of China

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Abstract

Background

The spread of the Coronavirus Disease 2019(COVID-19) pandemic has a great impact on people's life, study, and work. People must stay at home and cannot go out for a long time, especially when the number of infected people increases rapidly. In order to explore the changes in the behavior of people at home during the COVID-19 pandemic in March, 2020, a national survey in China was conducted on people’s anxiety, sleep quality, study/work status, daily activities and family communication with the window opening and overlooking behavior.

Methods

The survey was carried out by online questionnaires of SMS service. A total of 3401 valid questionnaires were received. Chi-square analysis was used to establish the relationship model of the human behavior and activities during the stay-home of the COVID-19 pandemic.

Results

The survey results showed that due to the influence of the COVID-19, more than 74.92% participants had anxiety. Compared with the pre-outbreak period, the sleep quality of people become worse. There was a tendency for people to study/work less, exercise less, play more game, and watch the TV. On the other hand, the family communication has been increased, and people have tried to open windows and look outside through windows to alleviate the human anxiety.

Conclusions

This paper has revealed COVID-19 has had a great impact on people's behavior in all sorts of ways. The response of people affected by the pandemic should be constantly identified and monitored, to assist policy formulation for future short-term or long-term pandemic.

Background

The COVID-19 outbreak in China was upgraded to a public health emergency on January 21, 2020. More than 1 billion people in China have been restricted in varying degrees, such as bans on public transportation, restriction on movement, and quarantine for 14 days after travel[1, 2]. During the nationwide stay-home, Chinese people were more sedentary and less physically active. They spent more time watching electronic device’s screen and suffered from poor emotional state, which could pose considerable health risks.

There have been studies on the effects of COVID-19 on different aspects of human behavior. 93.6% of the participants' outdoor time and 70.2% of the participants' physical activities have undergone significant changes [3]. 22% of the participants' physical exercise habits were affected [4], 58.6% participants did little or no exercise [5], and the participation rate of moderate intensity aerobic exercise decreased from 50.5% before the COVID-19 to 38.5% during the COVID-19[6]. Extended periods at home lead to increased screen time and decreased outdoor time, which in turn increased sedentary behaviors. These behaviors may have unforeseen consequences for physical and mental health [7, 8]. In addition, long periods at home and repetitive routines may affect sleep patterns and sleep quality. People spent more time in bed and the sleep quality decreased. People with more severe symptoms of depression, anxiety, and stress had more difficulty sleeping [9]. In the context of stay-home for COVID-19, the lack of physical activities and direct contact with nature contributed to increased anxiety among residents [10], which also adversely affected mental health [11–13]. Studies have shown that 40% participants experienced an overall increase in stress and anxiety levels [14]. 34% participants had moderate anxiety, 71.8% and 24.7% had feelings of fear and depression and 64.9% said their lives had been affected during the COVID-19 pandemic [15].Long-term home quarantine affected people's physical and mental health [16], and people who cannot contact the outdoor environment for a long time would have certain psychological pressure [17]. The psychological pressure of people affected by the COVID-19 pandemic became more serious.

The effects of home quarantine on people during the COVID-19 pandemic mentioned above focused on psychological problems, such as stress-related symptoms, and less social support and stress management. In contrast, few studies have looked at specific changes in home behaviors before and during the COVID-19 pandemic. Therefore, some key questions need to be investigated, such as which home behaviors were affected, how much the COVID-19 pandemic influenced home behaviors, and what were the reasons for these changes. Considering these questions, we conducted this study to assess the overall impact of COVID-19 on behavioral changes in the stay-at-home population.

The study conducted a national survey on anxiety, sleep quality, study/work status, entertainment status, sports status, communication with families, window opening and overlooking behavior of people quarantined at home. This study compared the changes of people's behavioral patterns before and during the COVID-19 pandemic and then investigates the impact of behavioral differences on people's lives and physical and mental health. Suggestions should be made on the behavior patterns and healthy behaviors and lifestyles should be promoted for people in long-term stay-home during the COVID-19 pandemic.

Methods

Time and scope of questionnaire survey

The questionnaire used in this study was based on the Questionnaire Design Platform of SMS(WeChat), and the surveying time was from March 8, 2020 to March 19, 2020 (Fig. 1a), that more than a month has

passed since people have been isolated at home, and the COVID-19 was still spreading, with the confirmation rate at its peak. During that period, a total of 3516 WeChat answers were received from people in 34 provincial administrative regions (Fig. 1b). There were 3401 valid questionnaires, with a validity rate of 96.73%

Questionnaire survey contents

The questionnaire is a comprehensive survey of people's anxiety and home behavioral factors before and during COVID-19 pandemic. It contains three parts: basic information, sleep quality and anxiety of the participants before and during the pandemic, daily working/studying hours, the frequency of entertainment, exercise, overlooking, opening windows and communicating with family members before and during the pandemic. Table 1 showed the questionnaire.

Table 1. Questionnaire for the assessment of occupants' behavioral factors during the COVID-19 pandemic

Questionnaire for the assessment of occupants' behavioral factors during the COVID-19 pandemic

Hello! Thank you for participating in this questionnaire on the assessment of occupant behavioral factors during the COVID-19 pandemic. Your opinion is very important to us. We hope you can actively participate in and we will keep your answer completely confidential. Thank you for your support and cooperation.

——————————————— The basic information———————————————

1. What's your gender?

□ Male □ Female

2. What's your age?

□ Under 18 □ 18-25 □ 26-35 □ 36-45 □ 46-60 □ Over 60

————————————The status of the COVID-19 pandemic at home——————————

1. How well did you sleep before the COVID-19 pandemic?

□ Very poor(0) □ Poor(1) □ Fair(2) □ Good(3) □ Very good(4)

4.How well did you sleep during the COVID-19 pandemic?

□ Very poor(0) □ Poor(1) □ Fair(2) □ Good(3) □ Very good(4)

5.How anxious were you during the COVID-19 pandemic?

□ As usual(0) □ A little anxious(1) □ Anxious(2) Special anxiety(3)

————————Behavioral factors at home during the COVID-19 pandemic————————

6.What was the average working/studying day before the COVID-19 pandemic?

□ Less than 3h □ 4-6h □ 7-9h □ 10-12h □ More than 12h

7.What is the average working/studying day during the COVID-19 pandemic?

□ Less than 3h □ 4-6h □ 7-9h □ 10-12h □ More than 12h

8.What was the average recreational time per day before the COVID-19 pandemic?

□ Less than 1h □ 1-2h □ 3-4h □ 5-6h □ More than 7h

9.What is the average recreational time per day during the COVID-19 pandemic?

□ Less than 1h □ 1-2h □ 3-4h □ 5-6h □ More than 7h

10.What was the average amount of physical activity per day before the COVID-19 pandemic?

□ Zero □ Less than 0.5h □ 0.5-1h □ 1-2h □ More than 2h

11.What is the average amount of physical activity per day during the COVID-19 pandemic?

□ Zero □ Less than 0.5h □ 0.5-1h □ 1-2h □ More than 2h

12.What was the average daily frequency of communication with family members before the COVID-19 pandemic?

□ Zero □ 1-2 times □ 3-4 times □ 5-6 times □ More than 7 times

13.What is the average daily frequency of communication with family members during the COVID-19 pandemic?

□ Zero □ 1-2 times □ 3-4 times □ 5-6 times □ More than 7 times

14.What was the average number of overlooking per day before the COVID-19 pandemic?

□ Zero □ 1 time □ 2 times □ 3 times □ 4 times □ 5 times □ 6 times □ 7 or more times

15.What is the average number of overlooking per day during the COVID-19 pandemic?

□ Zero □ 1 time □ 2 times □ 3 times □ 4 times □ 5 times □ 6 times □ 7 or more times

16.What was the average number of opening windows per day before the COVID-19 pandemic?

□ Zero □ 1 time □ 2 times □ 3 times □ 4 times □ 5 or more times

17.What is the average number of opening windows per day during the COVID-19 pandemic?

□ Zero □ 1 time □ 2 times □ 3 times □ 4 times □ 5 or more times

Research method

The data used in this study was the questionnaire for the assessment of occupants' behavioral factors during the COVID-19 pandemic. Chi-square analysis was used to establish the relationship model of the behavioral difference of the homebound during the COVID-19 pandemic, and the influence relationship was specifically studied.

Results

Table 2 showed the gender, age distribution and proportion of the participants. Participants were mainly aged 18–35 years old, and the proportion of males was 17.9% higher than females. In this survey, people have been quarantined about 2 months after the outbreak of the pandemic, which indicated that the data

could truly reflected the specific conditions of people's behavior under the long-term stay-home. The results of the questionnaires were summarized and analyzed as follows.

Table 2
The basic characteristics of stay- home population. N (%)

Predictor variables	Study population	Number	Percentage (%)
Gender	A.Female	1396	41.05
	B.Male	2005	58.95
Age	A.Less than 18 years old	236	6.94
	B.18–25 years old	1019	29.96
	C.26–35 years old	1049	30.84
	D.36–45 years old	377	11.08
	E.46–60 years old	479	14.08
	F.More than 60 years old	241	7.09
Summation		3401	100.0

Statistical analysis of personnel anxiety

Figure 2 showed the probability density of anxiety levels during stay-home. Due to the influence of COVID-19, 74.92% participants had anxiety, and the overall anxiety level was 1.536(between "Slight anxiety" and "anxiety"), indicating that COVID-19 has created the certain anxiety. Existing studies have shown that stress and anxiety generally increased during the period of self-quarantine at home. According to the study [18], 53.8% participants considered the psychological impact of the COVID-19 pandemic to be moderate or severe. And 16.5% experienced moderate to severe depression, 28.8% experienced moderate to severe anxiety, and 8.1% experienced moderate to severe stress.

Figure 3 showed the anxiety levels of genders and ages during the COVID-19 pandemic. From the variation of anxiety levels with genders in Fig. 3(a), the average anxiety level of women was 1.88, which is 0.58 higher than that of men of 1.30. Gender differences are common in mental illnesses, particularly in major depression (MDD) and anxiety disorders (AD). In fact, both conditions were more common in females than males [19, 20]. Similarly, Narayanan L et al. suggested that anxiety levels were higher in females (89%) than in males (77%) [21] during the COVID-19 pandemic. From the variation of anxiety levels with ages in Fig. 3(b), the anxiety levels of 26–35 years old and 36–45 years old are the highest with an average of 1.73, while the anxiety levels of people of under 18 years old and 18–25 years old are the lowest with an average of 1.42. This phenomenon is due to that those aged lower than 25 years old are usually in the school or the collage, while those aged between 26 and 45 years old are the main income source, which had been largely affected by the COVID-19.

Roy D et al. suggested that 12.5% of participants had difficulty sleeping as a result of the COVID-19 pandemic [22]. Figure 4 showed the sleep quality of people before and during the pandemic. The sleep quality was 2.158 (between moderate and good, close to good) before the pandemic, while it was 1.534(between poor and moderate, near moderate) during the pandemic, and the difference was 0.624, indicating that people's sleep quality generally decreased due to the pandemic.

Behavioral factors at home during the pandemic

In the survey by Stephen X. Zhang et al., 27% participants worked in office, 38% chose to work at home, and 25% stopped working due to the COVID-19 pandemic [23]. This showed that the COVID-19 pandemic has an impact on people's working conditions. According to Smith et al., people watched screens for an average of 3.8 hour per day [24]. Home quarantine could reduce outdoor activities and increase indoor screens entertainment time during the COVID-19 pandemic[25]. Figure 5 showed people's working/studying hours and entertainment hours before and during the COVID-19 pandemic. As seen in Fig. 5(a), People who worked/studied 7–9 hours accounted for 50.51% before the pandemic and 41.75% during the pandemic, while worked/studied less than 6 hours accounted for 11.41% before the pandemic and 45.16% during the pandemic. It could be concluded that people's working/studying hours generally decrease during the pandemic, which would have a direct impact on people's income and students' learning progress. This might further increase the anxiety of people. As seen in Fig. 5(b), before the COVID-19 pandemic, 41.87% participants spent 3–4 hours for entertainment, and 31.96% spent 1–2 hours, while during the COVID-19 pandemic, 47.63% participants spent 5–6 hours for entertainment, and 18.16% spent 3–4 hours. This proved that people's entertainment time increased during the COVID-19 pandemic, which would lead to people's emptiness.

Figure 6 showed the exercise time and communication times between participants and their families before and during COVID-19. From the variation of exercise time in Fig. 6(a), inactive population increased from 21.05% before the pandemic to 33.49% during the pandemic. The highest proportion of exercise time was 0.5-1 hour (44.72%) and 0-0.5 hour (48.96%) before and during the epidemic, respectively. It proved that most exercise was confined indoors, and people's exercise time was generally reduced when people could not go outside. From the variation of communication times between participants and their families in Fig. 6(b), before the COVID-19 pandemic, 54.78% of the participants communicated with their families 3–4 times per day and only 21.02% communicated with their families more than 5 times per day, while during the COVID-19 pandemic, 75.68% participants communicated with their families more than 5 times per day. It could be inferred that anxiety and fear caused people to communicate more closely with their families.

Figure 7 showed the frequency of overlooking and opening windows per day before and during the COVID-19 pandemic. As seen in Fig. 7(a), the frequency of overlooking was 2.41 times before the pandemic and 3.90 times during the pandemic, increasing significantly by 1.49 times. This phenomenon was because people were kept indoors for a long time. And it also proved that people liked to interact with the outside through looking into the distance during stay-home. As seen in Fig. 7(b), the frequency of opening windows was 1.76 times before the pandemic and 2.18 times during the pandemic, increasing

by 0.42 times. The main function of opening windows is to adjust indoor air flow, increase fresh air, and regulate indoor thermal environment. The results indicated that the awareness of ventilation was enhanced, and the frequency of opening windows was increased during the COVID-19 pandemic. People were used to opening and closing the window to change the indoor environment[26], which could adjust indoor temperature and humidity[27].

Discussion

Summary and implications of the studies

The results showed that because of COVID-19, people quarantined at home showed behavioral changes different from those before COVID-19. These changes would undoubtedly have an impact on physical and mental health. The COVID-19 pandemic will not be fully resolved in the short term. If the population is not properly guided, these behavioral changes will even have a negative impact on economic development and social stability. It is necessary to understand the behavioral factors of people in home quarantine to inform policy formulation during future short-term or long-term pandemic. Therefore, our study foresees this long-term impact, and the research results have guiding significance for the introduction of various industries and policies.

Among the study results, 74.92% of the participants showed varying degrees of anxiety and overall decreased sleep quality. In May 2020, the United Nations warned that COVID-19 was causing a mental health crisis and that countries were likely to face more and more severe mental health problems, and urged countries to include mental health in their COVID-19 response [28]. The World Health Organization recommended that countries develop national plans and allocate funds to shift mental health care from social institutions to community services. The National Health Commission of China issued psychological counseling guidelines for different groups of people in February 2020 after the outbreak of the pandemic, and guide is popularized online and offline in various forms, especially through new media [29]. In addition, studies have shown that anxiety can have a detrimental effect on sleep[30]. Depression, anxiety and the damage they cause should be monitored to predict the long-term impact of this crisis. This will help ensure that future policies consider the protection of human physical and mental health.

The results of the questionnaire showed that people spend less time working/studying, less time exercising and more time on entertainment because of stay-home. During the pandemic, telecommuting/online learning was the only option for many companies/schools. Online learning has proven to be an effective and dynamic way to deliver course content [31]. By 2017, more than 80% businesses in the United States had introduced telecommuting, and 30 million people telecommute from home, representing 16–19% of the working population in the United States. Telecommuting is on the rise in China and has broad space for development [32]. In light of study results, new office/learning models may emerge, and stakeholders will have to evaluate online work/learning from different perspectives. Similarly, the movement of people in public places needs to be monitored. Zhou et al. [33] propose that governments should collaborate with other private companies to use big data (such as mobile phone

data, Google navigation data, Yelp login, geotagged tweets, etc.) to monitor public mobility patterns and social distance behaviors, so as to jointly provide information for policy making. In addition, the maximum amount of entertainment time for the population was 3–4 hours (41.87%) before the pandemic and 5–6 hours (47.63%) during the pandemic. In order to guide healthy entertainment activities and positive public response, more positive content should be reported online, and relevant policies should be introduced for various industries. Too much negative information on social media could affect people's mood, and people quarantined at home relied too much on electronic devices. A study in Thailand showed that social media is a major source of information about the pandemic and a potential source of anxiety during the pandemic [34]. Therefore, people should arrange their time they spend on social media reasonably and treat the pandemic information correctly. Finally, the finding of less time spent exercising had implications for health awareness in the general population. The pandemic has caused a heavy burden on national medical care and countries will vigorously promote fitness and health. Combined with relevant policy guidance, people's health awareness will gradually be improved. Some health clubs have started online training courses to help people in quarantine exercise at home so that relives their stress and spend time effectively to improve their health. Lemay China launched its online video teaching course at the end of 2019, including a shape-shaping course using home props. And the number of registrations to the course increased by 25000 during the Spring Festival in 2020, with cumulative views of more than 500000 [35]. During the pandemic, people were limited to go out and spent more time at home. Therefore, how to bring better convenience to people and remind people to find joy of life should be considered.

Enthusiastic, empathetic communication combined with positive expectations can significantly reduce anxiety [36]. The study results showed that the frequency of communication increased. It is possibly because people were feeling anxious and afraid with the pandemic, so there was an urgent need for communication to reduce anxiety. This requires great attention. The results particularly noted that the frequency of overlooking and opening windows have frequency increased, which indicated that people have realized the importance of landscaping and the natural environment. Due to home quarantine and community closed management, people's activity space is limited, and in such situation, good landscape greening can relieve mood and improve air quality. Several studies have explained how and why natural landscapes reduce stress and improve mood, from the perspectives of environmental psychology [37], horticultural therapy [38], and others. After the pandemic, there may be demand for commercial housing with sufficient replacement landscaping and beautiful residential environment. This is important information for the real-estate industry and the landscape design industry.

The pandemic has had a huge impact on the world. Interestingly, individual subjective behavior change has not received enough attention in public health management and prevention The behavioral factors of people affected by the pandemic should be constantly identified and monitored, and psychological services should be raised to the same important status as livelihood security and medical treatment. Emphasize the importance of policy intervention and guidance, and formulate targeted measures for the population to avoid the occurrence of security risks, which is related to the maintenance of social stability.

Limitations of our studies and further research

We recognize a number of limitations. The research was a cross-sectional study, and the data were collected only for a short period of time after the COVID-19 outbreak, reflecting only the association during the survey period. Future research should carry out longitudinal analyses to investigate other important behaviors that may have changed beyond the time limit, so as to fully reflect behavioral changes because of the pandemic. In addition, the COVID-19 pandemic has an impact on people around the world, but we studied only Chinese people. Due to different policies, people in other countries and regions may make different behavioral changes. Most importantly, while online questionnaires can lead to good response rates, the inability to collect data face-to-face means that we cannot collect other indicators. The questionnaire only reflects the subjective answers of the participants. In the future, we will combine the measurement of physiological indicators, such as heart rate, blood pressure, blood oxygen saturation, brain wave, skin electricity, etc., to comprehensively understand the physiological changes of behavior.

Conclusions

In the context of stay-home for COVID-19, this study investigated the behavioral factors of 3401 residents at home from 34 provinces of China. By analyzing the factors of anxiety, sleep quality, study/work status, entertainment status, sports status, communication with families, window opening, and overlooking behavior, it was found that people's behaviors changed significantly before and after the COVID-19 pandemic. Targeted policy responses and guidance for people are necessary and urgent, for the prevention and control of the epidemic, and for people's physical and mental health. The specific conclusions are as follows.

1. 74.92% participants had anxiety under the influence of the COVID-19 pandemic. The overall anxiety level was 1.536(between "Slight anxiety" and "anxiety"). Females reported an average of 0.44 more anxiety than males. The anxiety level in the age group of 26–35 years old and 36–45 years old was the highest, and the average level of anxiety is above 1.70. Depression, anxiety, and the harm they develop should be monitored, and mental health guidance policies should be implemented.
2. People's sleep quality generally decreased under the influence of the pandemic. The sleep quality was 2.158 (between moderate and good, close to good) before the pandemic while was 1.534(between poor and moderate, near moderate) during the pandemic, and the difference was 0.624
3. The working/studying hours of most people generally decreased due to stay-home during the COVID-19 pandemic. People worked more than 7 hours were 88.59% before the pandemic and 54.84% during the pandemic. In addition, the entertainment time increased significantly. People spent more than 3 hours for entertainment were 19.05% before the pandemic and 59.48% during the pandemic. The exercise time generally decreased during epidemics, and the possible reason was that people could not go out and most sports were confined indoors. The number of people who did not exercise increased from 21.05% before the pandemic to 33.49% during the pandemic, and who exercised for

0.5 hours decreased from 61.87% before the pandemic to 17.55% during the pandemic. Changes in work, entertainment, and exercise may give rise to new ways of telecommuting/online learning and entertainment to cope with the future of irregular in-home quarantine. Therefore, various measures should lead to a healthy lifestyle and a positive public response.

4. Before the pandemic, 54.78% participants communicated with their families 3–4 times a day, while during the pandemic, 75.68% communicated with their families more than 5 times a day. The possible reason is that communication can reduce anxiety. People in long-term quarantine preferred to interact with the outside world by looking into the distance, and the daily overlooking frequency increased by 61.8%. The possible reason was that people were quarantined indoors for a long time and could not go out. During the pandemic, the window opening frequency increased by 23.9%, indicating that people's awareness of ventilation enhanced. This indicated that people have realized the importance of landscaping and the natural environment.

The research results showed that during long-term stay-home, people would have anxiety, irritability, and other negative emotions. Great changes have taken place in people's behavior factors at the same time. It is necessary to understand the behavioral factors of people in home quarantine to inform policy formulation during future short-term or long-term pandemic. Therefore, our study foresees this long-term impact, and the research results have guiding significance for the introduction of various industries and policies. As for people themselves, they should adjust a good state of mind, enhance their physical exercise, plan their work, study and entertainment time rationally, and improve their efficiency. It is suggested that people look at the distance often to relax, open the window frequently to promote indoor air circulation, and communicate with family members to maintain physical and mental health. Future studies will further analyze the changes of people with long-term stay-home through the measurement of blood pressure, heart rate, brain wave, and other indicators, so as to put forward reasonable planning and suggestions for the physical and mental health of people with long-term home quarantine.

Abbreviations

COVID-19: Coronavirus disease 2019.

Declarations

Ethics approval and consent to participate

The respondents were anonymous, voluntary and consent for participation. All study procedures were approved

by the Ethics Committee of Qingdao University of Technology.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Conceptualization, C.L. and W.G.; methodology, C.L.; software, X.J. and Z.L.; validation, C.L. and L.S. ; formal analysis, L.S. and Y.T.; investigation, C.L.; resources, W.G.; data curation, C.L.; writing—original draft preparation, C.L. and X.J.; writing—review and editing, C.L. and G.C.; supervision, W.G.; project administration, Y.W.; funding acquisition, W.G. All authors have read and agreed to the published version of the manuscript.

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Figures

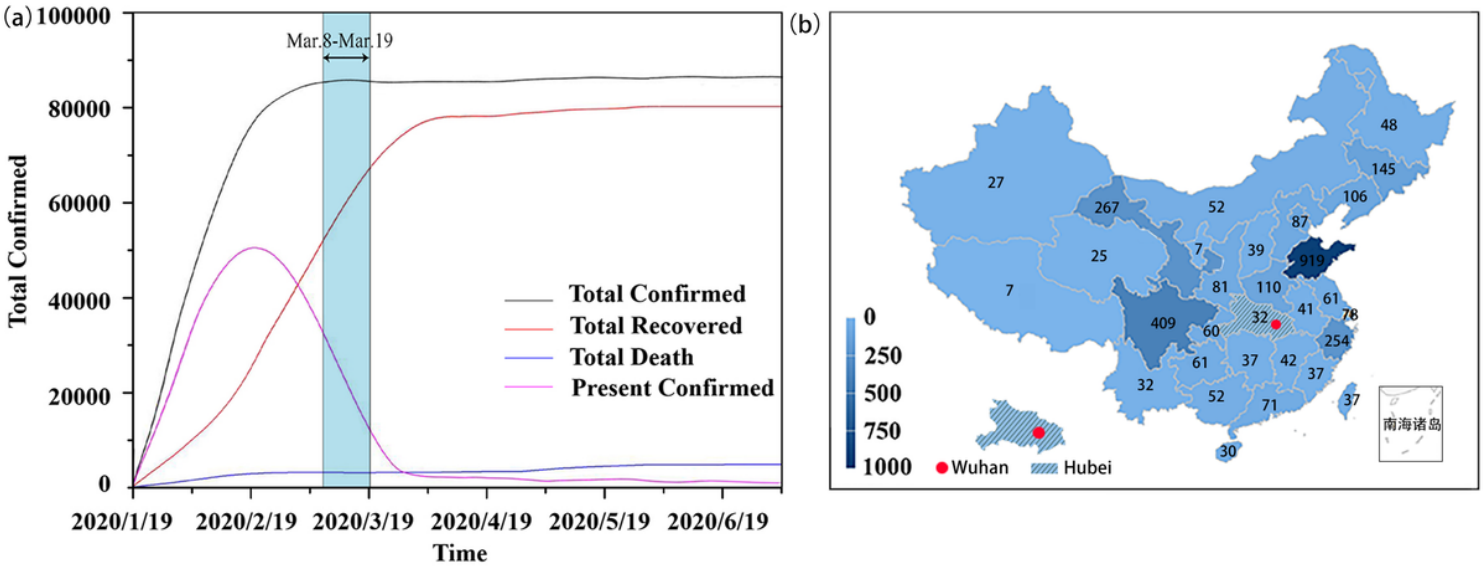

Figure 1

(a)Covid-19 development trend and questionnaire survey time period and (b)the distribution of questionnaires in each province of China Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research

Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

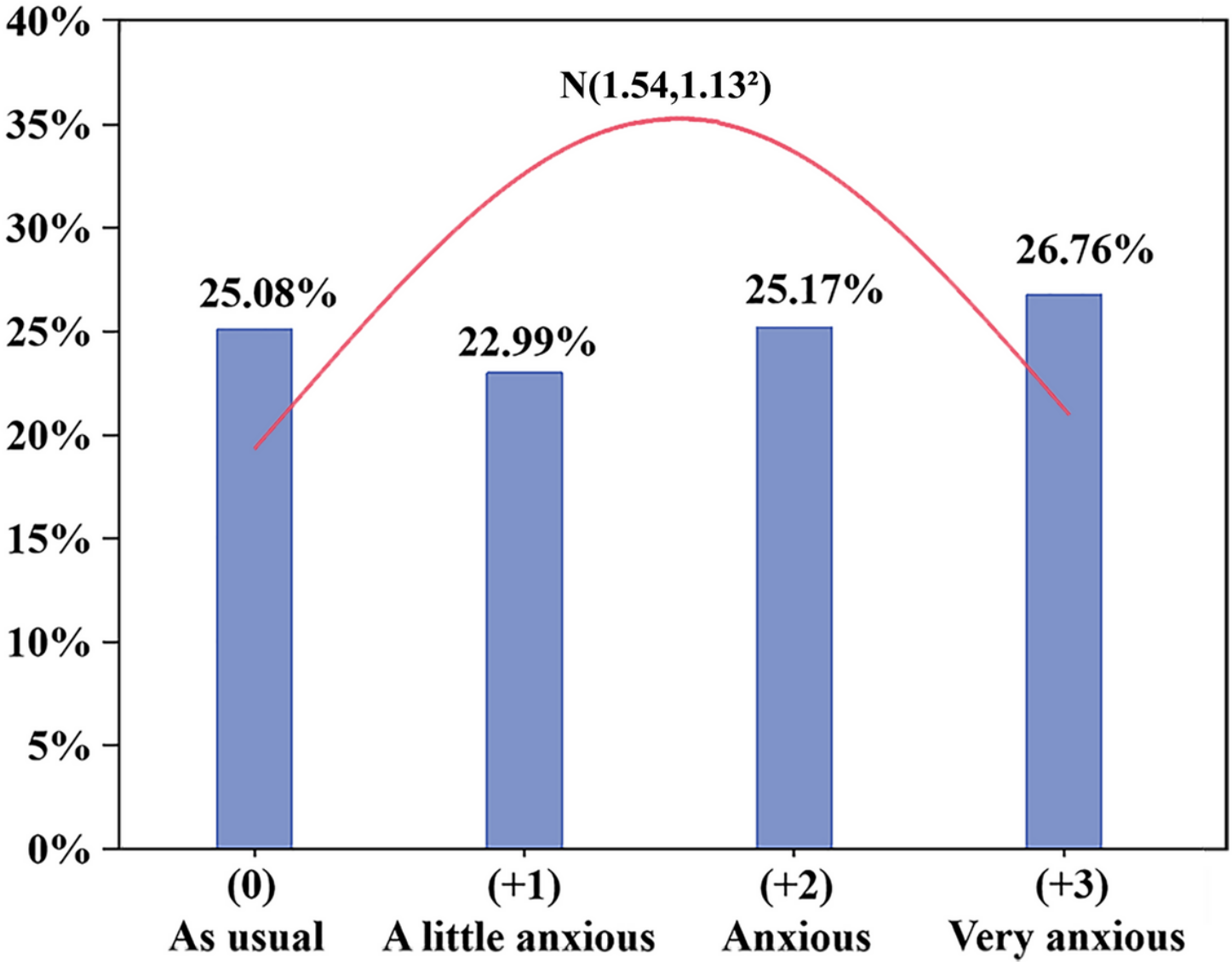

Figure 2

Probability density of anxiety levels

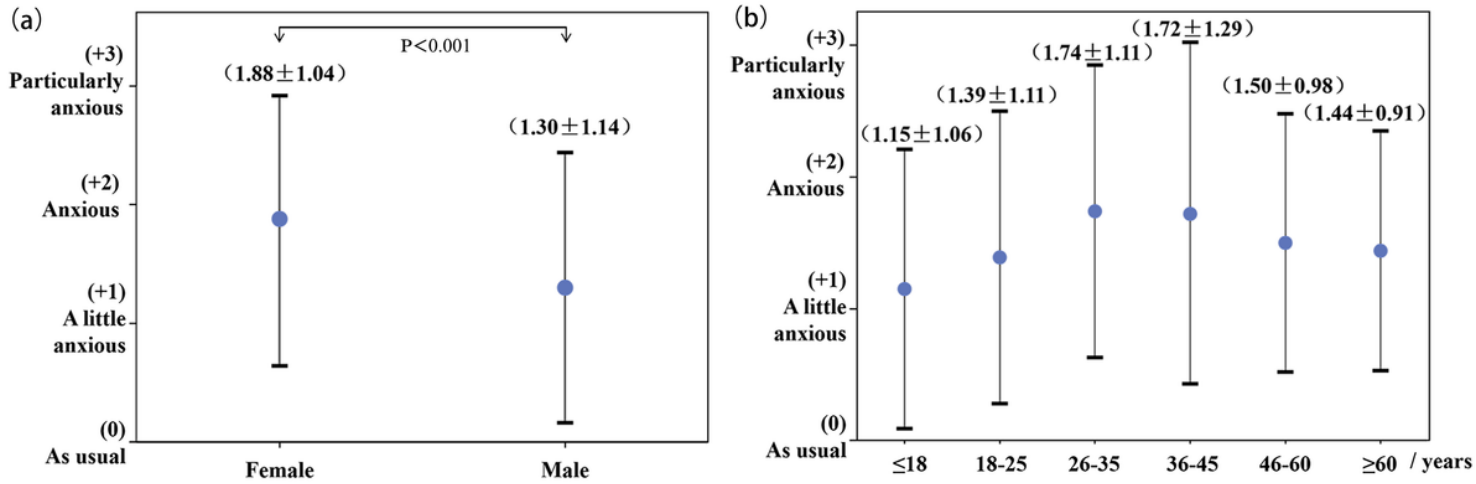

Figure 3

Anxiety levels of with (a)genders and (b)ages

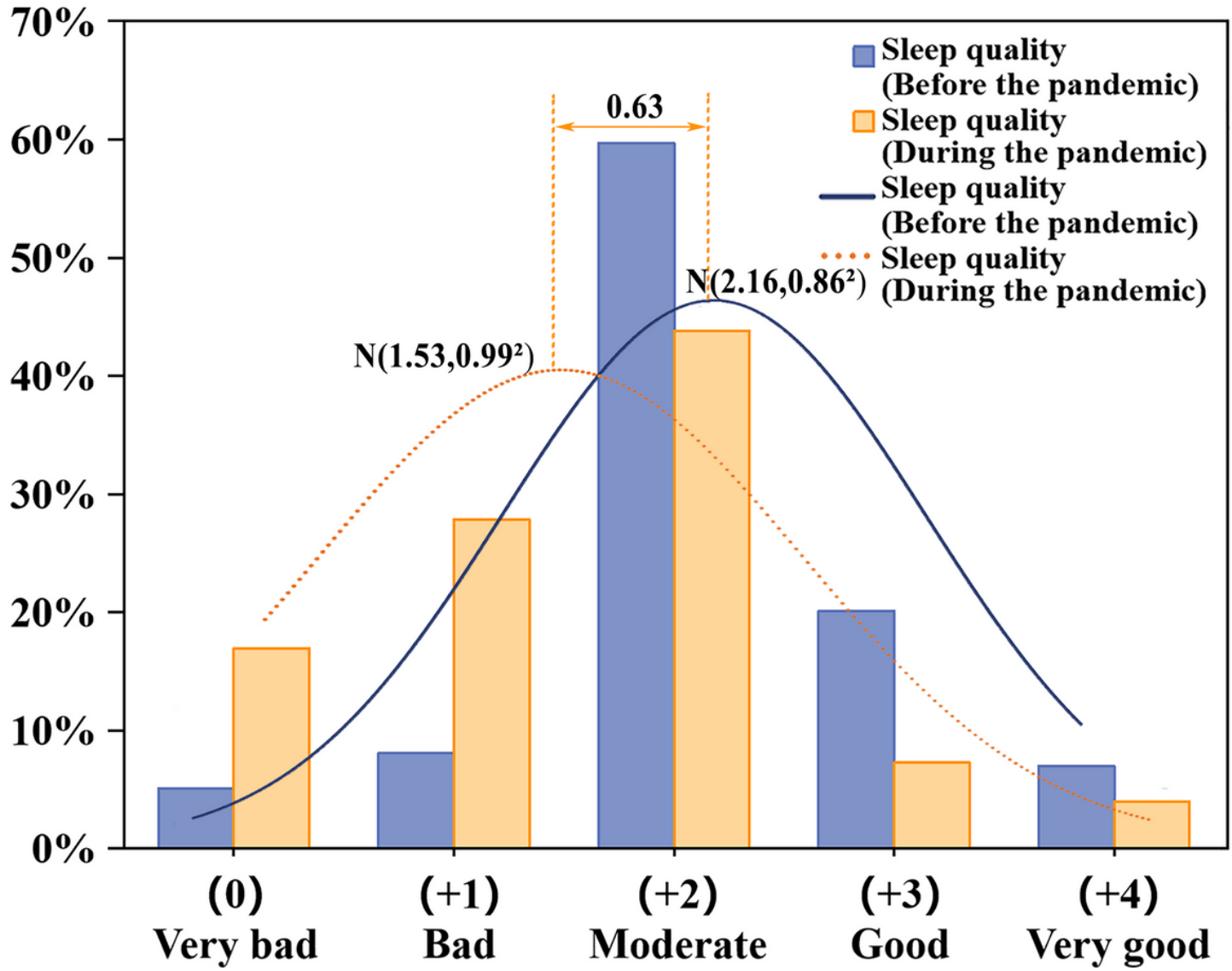

Figure 4

People's sleep quality before and during the pandemic

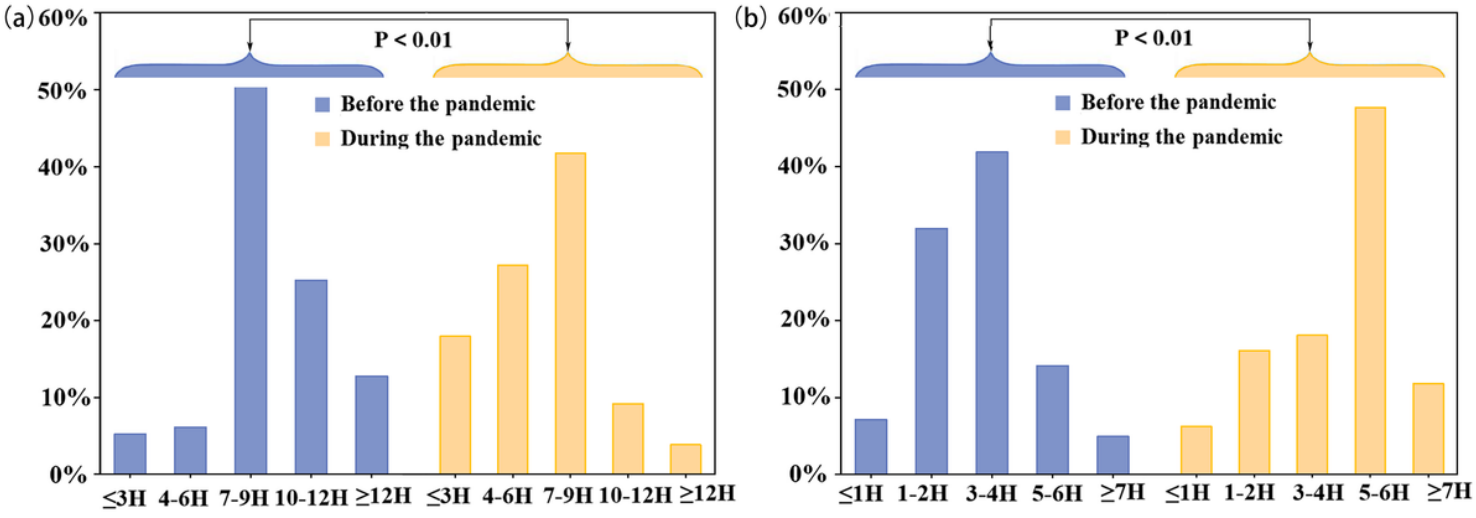

Figure 5

(a)People's working/studying hours and (b)entertainment hours before and during the pandemic

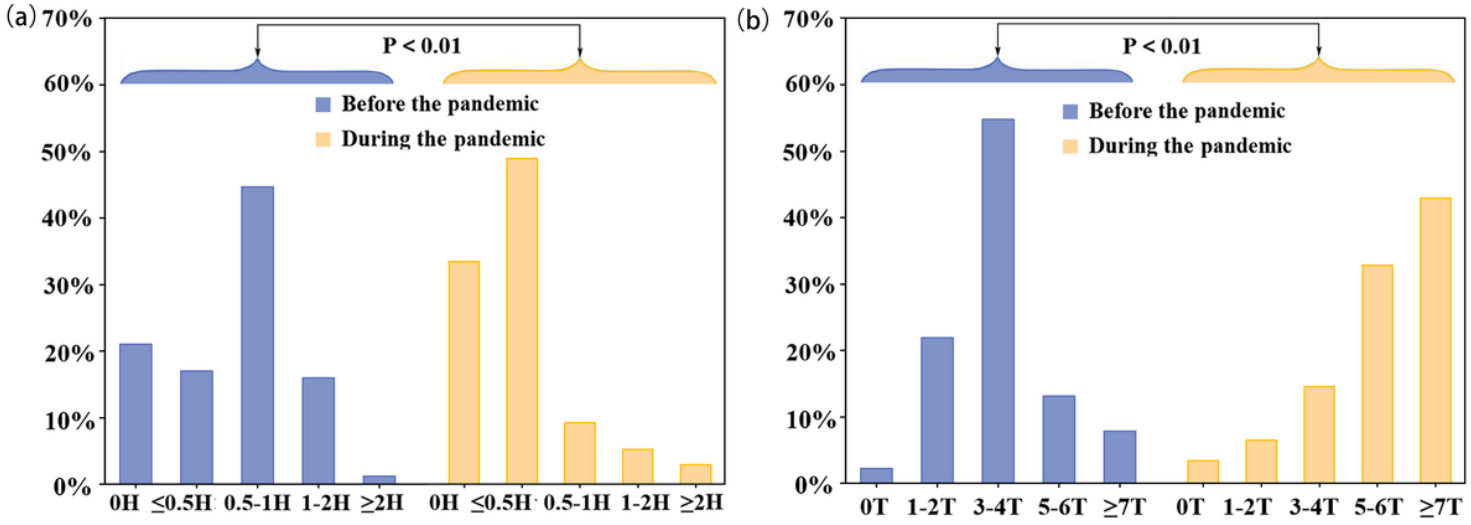

Figure 6

(a)Exercise time and (b)communication times between participants and their families per day before and during the pandemic

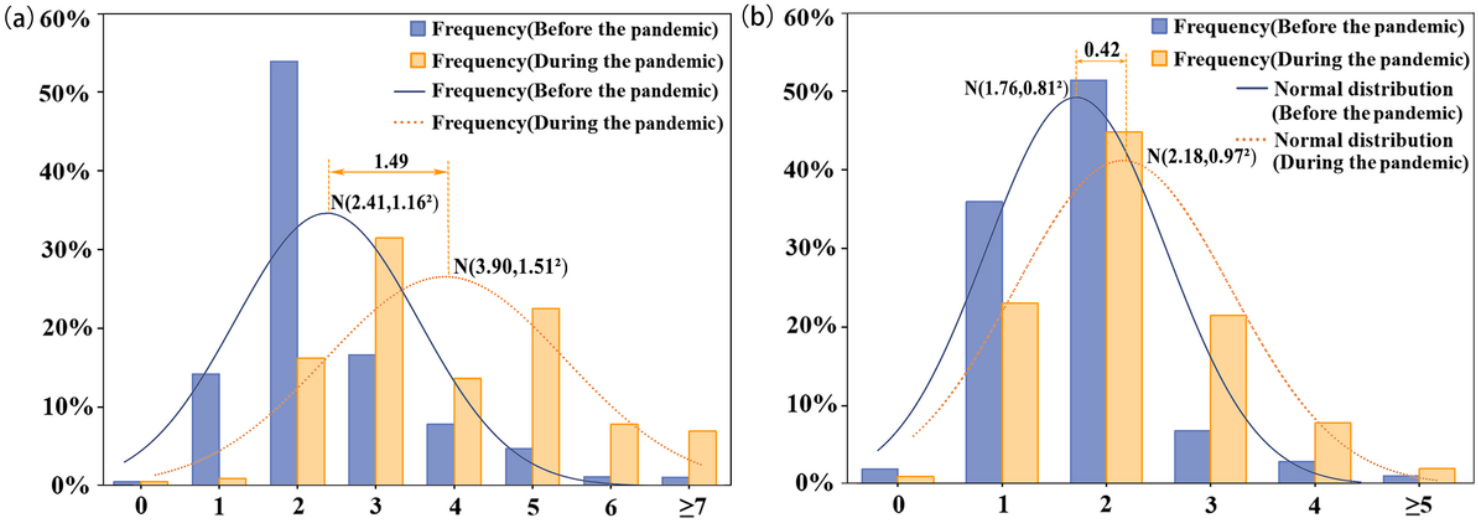

Figure 7

The frequency of (a)overlooking and (b)opening windows per day before and during the pandemic