Relationship between infection, physical and mental health and exercise habits of some Chinese residents after recovery from COVID-19

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Abstract

Objective The purpose of this study was to obtain the infection status, exercise, anxiety and sleep quality of some Chinese residents who recovered from infection during the COVID-19 pandemic, explore the influencing factors of recovery status, and help improve the intervention measures for COVID-19 recovery. **Methods** This study is a sub-study, nested within a cross-sectional study, investigating the infection and physical and mental health of partially recovered residents in all 34 provincial areas of China during the COVID-19 epidemic. **Results** There were 1013 participants in this study, including 374 males and 639 females. The cardiopulmonary endurance after infection was significantly lower than that before infection ($P<0.01$). Among all participants, women (3.92 ± 4.97) had more anxiety than men (3.33 ± 4.54, $P<0.01$); The sleep score after infection (8.27 ± 7.05) was significantly higher than that before infection (4.17 ± 4.97, $P<0.01$). The days of fever remission in regular exercise and sedentary group were significantly shorter than those in irregular exercise and sedentary group ($P<0.05$). The days of fever remission in regular exercise group (1.81 ± 1.91) was significantly shorter than that in irregular exercise group (2.02 ± 1.95, $P<0.05$). The number of negative days in the non-sedentary group (7.32 ± 3.24) was significantly lower than that in the sedentary group (7.66 ± 3.06, $P<0.05$). **Conclusions** In this study, it was observed that the recovery time of symptoms after COVID-19 recovery was related to age, and the more symptoms there were, the worse cardiopulmonary fitness and sleep quality would be. Sedentary people and irregular exercise people generally took a longer time to turn negative. Therefore, appropriate exercise, psychological and sleep hygiene and other health interventions should be considered in COVID-19 recovery measures.

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Keywords: COVID-19 infection; Post-recovery of COVID-19; Recovery status; Cardiopulmonary endurance; Anxiety; Sleep quality.11Authors: Zhou Ai-yi, Postgraduate,Exercise Intervention for Chronic Diseases and Health Promotion; Xia Yun-can,Postgraduate, exercise prescription. Corresponding author: Wang Yan, Email:wyweiwei@126.com Zhou Ai-yi and Xia Yun-can are both the first authors

Introduction

The COVID-19 pandemic is a highly infectious disease caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and has seriously affected human life and the global economy. Initially detected in Wuhan, China, in December 2019, the outbreak has spread rapidly around the world, with 8.98 million confirmed cases as of February 8, 2023. Coronavirus is a multi-system disease, common respiratory system problems, but also accompanied by musculoskeletal, endocrine, gastrointestinal problems,[1] similarly, symptoms such as fever, fatigue, loss or change to your sense of smell or taste are also associated with the coronavirus infection, COVID-19 affects all age groups, but it can be more serious[2, 3] in elderly patients or those with other medical conditions, and symptoms are mostly mild in children[4] or people under the age of 18. A meta-analysis of respiratory diseases such as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) showed that anxiety and depression persisted even after six months of decline in exercise and quality of life among infected survivors,[5] Stephen et al. point out that COVID-19 has a similar effect on the human body after infection.[6] Research has found that sleep has a protective effect on immunity, people will get sick[7] easily if they don't get enough sleep, and when people are infected with COVID-19, they may develop a range of symptoms that can also lead to poor sleep quality, so it is crucial to carry out recovery after COVID-19 infection.

The purpose of this study was to understand the infection status, recovery situation, anxiety and sleep quality of some Chinese residents who recovered from COVID-19 during the pandemic, to explore the factors affecting recovery status and physical and mental health, to help people who turned negative after infection develop scientific exercise prescriptions, and timely sort out the possible psychological and sleep problems of these people.

Materials and methods

Sample size calculations

This study was a secondary data analysis of a cross-sectional study of a subset of Chinese people who turned negative after infection from December 19, 2022 to January 17, 2023. Before the investigation, G*power was used to estimate the minimum sample size, test efficacy (1-β) was set to 0.80, Class I error rate (α) was set to 0.05, and the final sample size was at least 568.

Study design

It was conducted in the form of online survey. Questionnaires were distributed through wechat and other social platforms, and respondents completed the questionnaires anonymously through wjx.cn. The respon-

dents completed a five-part questionnaire, including basic information (gender, age, education, height and weight), health status (vaccination status, COVID-19 infection status, basic diseases, sedentary time), exercise status (exercise intensity, exercise frequency, exercise time, cardiopulmonary endurance self-assessment), psychological status and sleep status. It takes about 3-5 minutes to complete the entire survey. In previous studies, the sleep and anxiety scales have been well applied, and their reliability and validity have been fully verified. This study has been approved by the Ethics Committee of Beijing Sport University with the approval number 2023013H.

Measures

The assessment of cardiopulmonary endurance was adapted from the upstairs experiment,[8] and the cardiopulmonary endurance before COVID-19 infection was divided into five levels, from "very relaxed, not panting at all, basically no feeling" to "feeling very tired, short of breath and some difficulty, and needing a long time to rest to calm down". The degree increased step by step, and the cardiopulmonary endurance also got worse. After infection, the expression "unable to walk up five floors at a normal pace" was added to the cardiorespiratory endurance evaluation, considering the elderly population and some people with poor physical fitness.

The evaluation of psychological state adopts 7 Generalized anxiety disorder scale (generalized Anxiexy Disorde-7, GAD-7),[9] the scale has been verified and tested in clinical environment, the problem is short and has a certain recognition rate on anxiety, easy to diagnose and treatment. GAD-7 is a self-rating scale, which assesses the psychological state in the recent two weeks, score range is 0-21. According to the score of the scale, anxiety can be divided into no anxiety (0-4 points), mild anxiety (5-9 points), moderate anxiety (10-14 points) and severe anxiety (15-21 points). Higher scores indicate more severe anxiety.

Sleep quality was assessed from a module of the Pittsburgh Sleep Quality Index[10] (PSQI), focusing as much as possible on sleep disturbances caused by COVID-19 infection, such as going to the bathroom at night and feeling cold or hot, in order to reduce the burden on respondents. Each component was rated on a 0-3 scale, with higher scores indicating poorer sleep quality.

Statistical Analysis

Continuous variables were expressed as Mean ± standard deviation, and categorical variables were expressed as cases or percentage. In univariate analysis, if continuous variables conform to normal distribution, the T-test or one-way analysis of variance will be used for data analysis; if not, the rank sum test will be used for data analysis; when independent variables are in two groups, the Mann-Whitney U test will be used for analysis; when independent variables are in more than two groups, the Kruskal-Wallis test will be used for analysis. Spearman correlation analysis was used for the correlation between rank variables or data that did not conform to normal distribution. $P<0.05$ was considered to be statistically significant. SPSS 26.0 statistical software was used for statistical analysis of all data, and GraphPad Prism 9.0 and Excel were used for plotting.

Results

Patient Characteristics

A total of 1039 questionnaires were distributed in this study. After eliminating 26 invalid questionnaires, 1013 valid questionnaires were finally collected, with an effective rate of 97.50%. Among 1013 respondents, male and female accounted for 36.92% and 63.08%, respectively. The age group was concentrated between 18 and 25 years old (45.90%), 201 subjects (19.84%) turned negative for 7 days, 91.21% had fever symptoms, 30.21% had fever symptoms for 2 days, 45.21% had fever concentrated in 38.1-39, as shown in Table 1 for details.

Table 1 The basic distribution table COVID-19 positive to negative population

Characteristic	Total (N=1013)	Male (N=374)	Female (N=639)
Age(y) [?]18 18-59 [?]60	31(3.06) 960(94.77) 22(2.17)	16(4.28) 347(92.78) 11(2.94)	15(2.35) 613(95.93) 11(1.72)
BMI underweight normal overweight obesity	95(9.38) 627(61.90) 223(22.01) 68(6.71)	16(4.28) 193(51.60) 129(34.49) 36(9.63)	79(12.36) 434(67.92) 94(14.71) 32(5.01)
Education Below undergraduate Bachelor or above	160(15.79) 853(84.21)	66(17.65) 308(82.35)	94(14.71) 545(85.29)
Vaccination	19(1.88) 10(0.99)	9(2.41) 7(1.87)	10(1.56) 3(0.47)
Unvaccinated One dose Two doses Three doses Four doses	155(15.30) 803(79.27) 26(2.57)	57(15.24) 291(77.81) 10(2.67)	98(15.34) 512(80.13) 16(2.50)
Underlying disease Yes No	148(14.61) 891(87.96)	55(14.71) 319(85.29)	67(10.49) 572(89.51)
Tobacco use Yes No	109(10.76) 904(89.24)	88(23.53) 286(76.47)	21(3.29) 618(96.71)
Number of symptoms [?] four ¿four	525(51.83) 488(48.17)	221(59.09) 153(40.91)	304(47.57) 335(52.43)
Regular exercise Yes No Sedentary	319(31.49) 694(68.51)	151(40.37) 223(59.63)	168(26.29) 471(73.71)
Yes	319(31.49)	151(40.37)	168(26.29)
No	694(68.51)	223(59.63)	471(73.71)
GAD-7 score 0-4 5-9 10-14 15-21	685(67.62) 211(20.83) 72(7.11) 45(4.44)	258(68.98) 78(20.86) 27(7.22) 11(2.94)	427(66.82) 133(20.81) 45(7.04) 34(5.32)

Infection situation

Among 1013 respondents who had positive negative conversion, the symptoms they had during the infection were investigated. 785 had general fatigue, 636 had muscle and joint pain, 646 had sore throat, 739 had nasal congestion and runny nose, 862 had cough and phlegm symptoms, and 473 had changes in taste and smell. 270 people developed symptoms of diarrhea and vomiting. The infection of different genders is shown in Fig 1.

There were significant differences in the recovery time of general fatigue and pharyngeal pain by gender stratification ($P<0.05$). There were significant differences between nasal congestion, runny nose and changes in taste and smell ($P<0.05$), and there were significant correlations between general fatigue, muscle and joint pain, cough and sputum ($P<0.01$). Recovery time of general fatigue and changes in taste and smell also gradually extended with the increase of age.

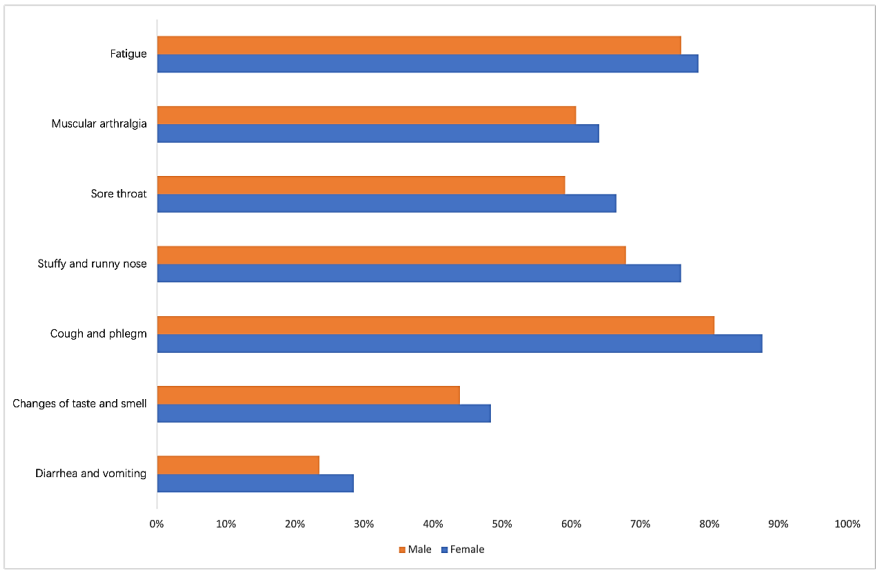

Fig 1 Symptoms of infection between the sexes

In all respondents, the average time of overcast was 7.46±3.18 days, with a minimum of 2 days and a maximum of 39 days. 924 people (91.21%) had fever during infection, 15.91% had fever temperature of 37.3-38,49.57% had fever temperature of 38.1-39, 30.74% had fever temperature of 39.1-40, 3.46% had fever temperature of 40.1-41, and 0.32% had fever temperature above 41. The average number of days from fever to fever was 2.43+-1.24. Eighty-nine people (8.79%) did not develop fever during infection. Taking age as an independent variable, it was observed that the duration of symptoms in the population after COVID-19 turned negative was significantly correlated with age, and had statistical significance with the duration of some symptoms (Table 2).

Table 2 Persistence days of post-recovery of COVD-19 recorded symptoms in studied subjects

	Avg days	Standard deviation	Number (%)	P value
Fatigue	5.80	4.48	696(68.71)	¡0.01**
Muscular arthralgia	3.56	3.07	617(60.91)	¡0.01**
Sore throat	5.10	3.59	618(61.01)	0.319
Stuffy and runny nose	5.66	3.60	635(62.69)	0.002**
Cough and phlegm	8.75	5.22	574(56.66)	¡0.01**
Changes of taste and smell	7.23	5.32	390(38.50)	0.014*
Diarrhea and vomiting	3.33	3.66	251(24.78)	¡0.01**

*p<0.05 considered statistically significant, **p<0.01 considered extremely significant.

Physical and mental health

The cardiopulmonary endurance level after infection was significantly lower than that before infection (P<0.01), and that of males before and after infection was significantly higher than that of females (P<0.01). The better the cardiopulmonary endurance level after infection, the shorter the conversion time, and the cardiopulmonary endurance level after infection was significantly positively correlated with the conversion time (r=0.64, P<0.05).

Among all the interviewees who recovered from infection, 67.62% had no anxiety, 20.83% had mild anxiety,

7.11% had moderate anxiety, and 4.44% had severe anxiety. The GAD-7 score during infection was 3.70±4.82. The anxiety of women (3.92±4.97) was more serious than that of men (3.33±4.54, P<0.01). There was a significant difference between the number of symptoms and the score of GAD-7. The more symptoms during infection, the higher the score of GAD-7, that is, the more anxious the infected person was (r=0.224, P<0.01).

The sleep score after infection (8.27±7.05) was significantly higher than that before infection (4.17±4.97, P < 0.01), and there was no gender difference before infection (P=0.465). After infection, the sleep score of female (8.87±7.02) was significantly higher than that of male (7.25±7.00, P<0.01). There was a significant positive correlation between the number of symptoms and sleep quality of the infected (r=0.306, P<0.01). The more symptoms the infected showed, the worse the sleep quality (Fig 2).

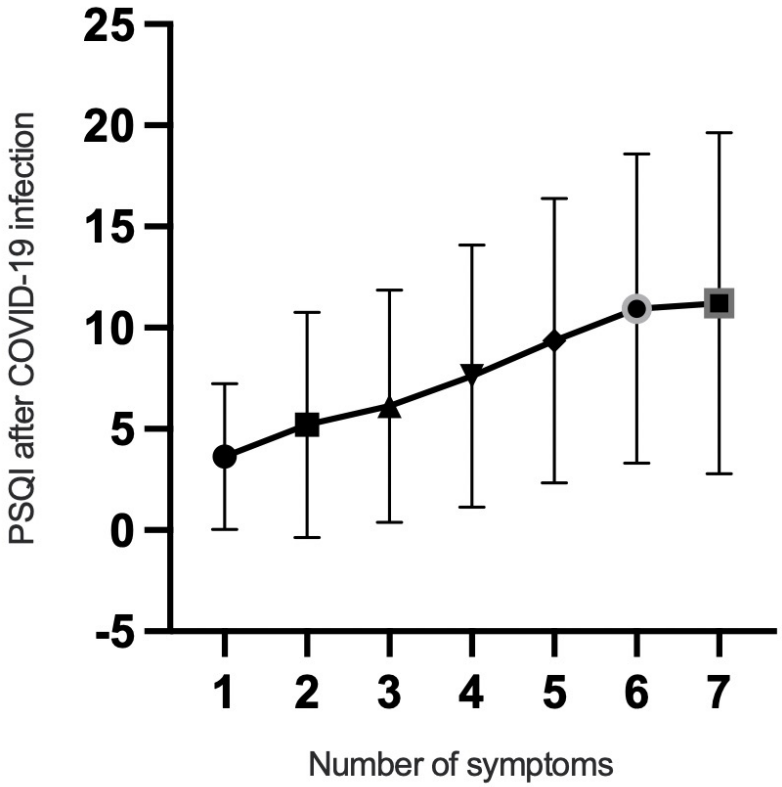

Fig 2 The number of different symptoms and sleep after infection

Recovery and movement

Exercise habits before infection, including exercise frequency, exercise intensity and exercise duration, were investigated among all positive trans positive interviewees. 269 (26.55%) never exercised before infection, 345 (34.06%) exercised 1-2 times a week, and 399 (39.39%) exercised 3 times a week or more. Those who exercise three or more times a week, 30min or more each time, lasting for more than three months are called regular exercise.[11] 319 people (31.49%) have regular exercise habits, and 694 people (68.51%) have irregular exercise habits. 763 people, or 75.32 percent, stopped exercising after contracting COVID-19.

The symptoms of general fatigue, diarrhea or vomiting during infection were significantly correlated with regular exercise. The duration of general fatigue in regular exercise group (5.27±4.37) was significantly less

than that in irregular exercise group (6.02±4.50, P<0.05). The duration of diarrhea or vomiting in exercise group was shorter than that in no exercise group (P<0.05).

According to the 24h exercise guidelines for adults issued by the Canadian Health Authority, people who sit more than 8h are defined as sedentary.[12] The sedentary of all respondents is 6.5±2.77h, and 402 people (39.68%) are sedentary group.

According to the exercise conditions, there was no significant difference between the fever temperature during infection and regular exercise or not, and there was no significant difference between the regular exercise group (7.18±3.04) and the irregular exercise group (7.54±3.23, P=0.171). However, the days of fever remission in regular exercise group (1.81±1.91) was significantly shorter than that in irregular exercise group (2.02±1.95, P<0.05). According to sedentary behavior, the number of negative days in the non-sedentary group (7.32±3.24) was significantly less than that in the sedentary group (7.66±3.06, P<0.05), and the number of fever-reducing days in the non-sedentary group (1.88±1.95) was significantly less than that in the sedentary group (2.07±1.91, P<0.05) (Fig.3).

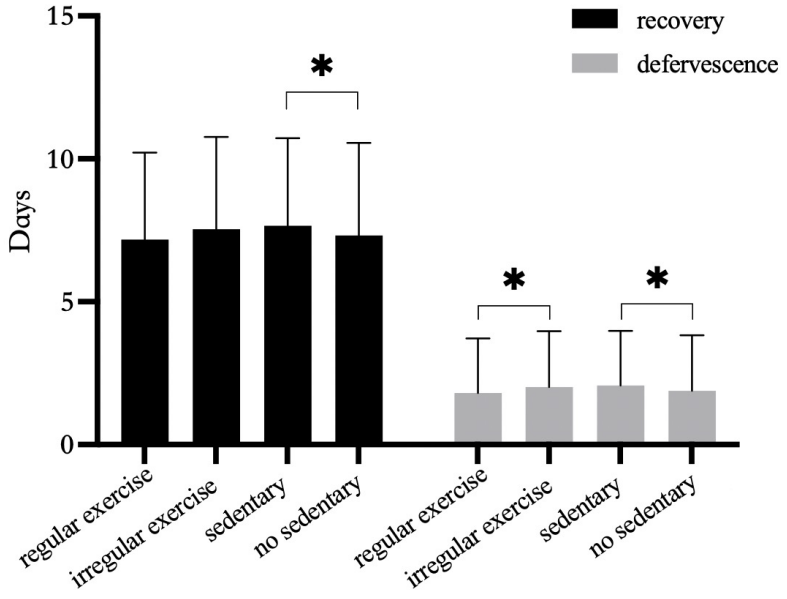

Fig 3. Exercise and sedentary behavior and post-infection recovery

*p<0.05 considered statistically significant.

Discussion

This is a survey on the recovery after COVID-19 infection, including the symptoms after infection, the impact on psychology and sleep. A total of 1013 Chinese residents were surveyed. The results showed that 91.21% had fever after infection, most respondents had fatigue, muscle and joint pain, sore throat, nasal congestion and runny nose and cough and sputum, Kessel et al. also showed that[13] the symptoms of patients infected with COVID-19 can be divided into physical, mental and social symptoms. Besides, the lingering symptoms of COVID-19 infection can have a significant impact on work and daily functioning. Previous studies have shown that it can take 60 days or longer for some infected people to recover from symptoms.[14, 15] The most common symptoms are fatigue, muscle soreness, etc., and older people, women and people with other

diseases have a higher risk of fatigue,[16]in addition, this study also found that cough, expectoration and changes in taste and smell are also the same.

In this survey, the time to turn negative after infection ranged from 2 days to 39 days, 71.27% of the infected people turned negative for about a week, and a small part of them turned negative for more than 20 days. Multiple studies showed that the time from the diagnosis of infection to the negative test was one to two weeks for more than two-thirds of the interviewees. Generally, the virus needed 1-2 weeks to disappear in the body. More severe viruses can take up to six weeks.[17] Regular physical exercise can help prevent infection and reduce infection symptoms,[18] which is consistent with the results of this study.

Cardiopulmonary endurance was significantly lower after COVID-19 infection than before infection, a finding similarly reported by Singh et al. Peak oxygen uptake (VO_2peak) was significantly lower in patients who recovered from COVID-19 compared to before infection[19] ($70\pm11\%$ vs $131\pm45\%$ $P < 0.01$), and the better the cardiopulmonary endurance level was after infection, there was a significant positive correlation between cardiopulmonary endurance level and the time of negative conversion with the shorter time of negative conversion. Clinton A. et al. found patients infected COVID-19 with poor cardiorespiratory endurance had a higher risk of hospitalization.[20] Therefore, we need to pay more attention to our cardiopulmonary function, people who have not been infected with COVID-19, we should call on them to participate in regular exercise. For people who are experiencing COVID-19 infection or have been infected, it is suggested to reduce unhealthy lifestyle and gradually recover or start their own exercise. We should all improve our awareness of cardiorespiratory endurance and the health benefits it can bring.

Surveys on anxiety show that women are more anxious than men, which may be related to women's higher psychological susceptibility.[21] Previous studies on SARS survivors have also found women have higher levels of stress, anxiety and depression.[22] There is a significant difference between the number of symptoms of infection and GAD-7 score. The more symptoms there are during infection, the higher the GAD-7 score, that is, the more anxious the infected person will be. A meta-analysis showed that among the patients surveyed, at least one symptom persists, which is a common situation.[23]Therefore, attention needs to be paid to the mental health problems caused by COVID-19 infection, especially for those at risk. Sleep quality was significantly decreased after infection, which, like anxiety, was more significant in women. In a previous survey, sleep quality is also correlated with mental health,[24]which is consistent with the results obtained in this paper.

The survey on regular exercise and sedentary situation showed that 31.49% had regular exercise habits and 39.68% were sedentary people. After COVID-19 infection, 75.32% stopped their original exercise habits, which may be related to the widespread media reports that it is not appropriate to exercise immediately after COVID-19 infection. It can be seen that people's lives will be more or less changed after COVID-19 infection, and exercise is one of the factors affected. Our research conclusion suggests that the time to turn negative and to decrease fever in sedentary people is significantly longer than that in non-sedentary people, and the time to decrease fever in people who exercise irregularly is significantly longer than that in people who exercise regularly. A study by Chen et al on physical activity and risk of hospitalization for COVID-19[25] shows that sedentary behaviors such as watching TV, this suggests that we should increase physical activity in daily life, reduce sedentary time, and exercise appropriately to improve physical fitness. Other recent studies have shown that low energy expenditure as shown by a higher BMI is highly associated with the risk of hospitalization and severe complications of COVID-19,[26] but our study did not support this view, which may be related to the fact that the population we investigated was patients with mild COVID-19 infection. The benefits of increased physical activity may not end there. Meyer et al. 's investigation[27] pointed out that maintaining and strengthening physical activity participation and reducing screen time during the COVID-19 pandemic may reduce mental health hazards, and increasing physical activity is an effective strategy to address the physical and mental health risks of the COVID-19 pandemic.[28] This has also been demonstrated at the molecular mechanism level.[29]

In order to properly evaluate the results of this paper, some limitations should be considered. First of all, this study was an anonymous online questionnaire survey, and the respondents were mostly aged 18-25 and

highly educated. Second, this survey is a cross-sectional study, lacking follow-up data and using a scale instead of face-to-face interviews, so it can only indicate that the subjects do have anxiety or sleep problems to a certain extent, but medical diagnosis cannot be made. Moreover, the long-term impact of COVID-19 on mental health may come from infection of people around them or socio-economic problems. Follow-up studies are needed to investigate psychological changes. Third, because the online questionnaire survey relies on smart phones, there are relatively few data for teenagers and the elderly. Fourth, the sample size is not large enough, and there may be some correlations between variables that cannot be observed. Fifth, the proportion of women in this survey is also higher than that of men, which makes up for the lack of female data in some previous articles. However, there may be some bias in the study due to the large sample of women. In addition, the subjects of this study were mainly asymptomatic or mildly infected Omicron variants of novel coronavirus, which did not represent the status of patients with severe/critical illness.

Conclusion

This study confirmed that some symptoms lasted for a long time in individuals who recovered from COVID-19 infection, fatigue was a common symptom of infection, and people's cardio-pulmonary endurance, psychology and sleep were affected during the infection. The symptoms of sedentary and irregular exercise people lasted for a long time, but the clearance time still needs further research. COVID-19 infection continues to be a health challenge in the 21st century, and more in-depth research is needed.

Data Availability Statement

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

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Ai-Yi Zhou, Yun-Can Xia and Peng Pi. The first draft of the manuscript was written by Ai-Yi Zhou and Yun-Can Xia, Zheng-Zhen Wang and Hong-Mei Huang revised and approved the manuscript. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Statements and Declarations

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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