Mental health status and quality of life in close contacts of COVID-19 patients in the post-COVID-19 era: a comparative study

Yan-Jie Zhao1,2,3,12, Shu-Fang Zhang4,5,12, Wen Li1,2,3,12, Ling Zhang6,12, Teris Cheung7, Yi-Lang Tang8,9, Chee H. Ng10, Bing-Xiang Yang11,15 and Yu-Tao Xiang1,2,3,15

CLOSE CONTACTS OF THOSE WITH COVID-19 (CC) may experience distress and long-lasting mental health effects. However, the mental health status and quality of life (QOL) in CC have not been adequately examined. This study examined the mental health status and QOL in CC during the post-COVID-19 period. This cross-sectional study comprised 1169 CC and 1290 who were non-close contacts (non-CC). Demographic data were collected; depression, fatigue, post-traumatic stress symptoms (PTSS) and QOL were assessed using the Patient Health Questionnaire - 9 items (PHQ-9), fatigue numeric rating scale, Post-Traumatic Stress Disorder Checklist - 17 items (PCL-17), and the World Health Organization Quality of Life Questionnaire - brief version (WHOQOL-BREF), respectively. Analysis of covariance was used to compare depressive symptoms, QOL, fatigue, and PTSS between the CC and non-CC groups. Multiple logistic regression analyses were performed to determine the independent correlates for depression, fatigue, PTSS, and QOL in the CC group. Compared to the non-CC group, the CC group reported significantly more severe depression ($F_{(1, 2458)} = 5.58$, $p = 0.018$) and fatigue ($F_{(1, 2458)} = 9.22$, $p = 0.002$) in the post-COVID-19 period. No significant differences in PTSS and QOL between the CC and non-CC groups were found ($F_{(1, 2458)} = 2.93$, $p = 0.087$ for PTSS; $F_{(1, 2458)} = 3.45$, $p = 0.064$ for QOL). In the CC group, younger age, financial loss due to COVID-19, and perception of poor or fair health status were significantly associated with depression and fatigue, while frequent use of mass media was significantly associated with fatigue. In conclusion, close contacts of COVID-19 patients experienced high levels of depression and fatigue in the post-COVID-19 period. Due to the negative effects of depression and fatigue on daily functioning, early detection and timely interventions should be provided to this neglected population.

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INTRODUCTION

At the end of 2019, coronavirus disease 2019 (COVID-19) was first reported in Wuhan, Hubei province of China and subsequently was also found in other parts of the world [1, 2]. Due to its fast transmission rate, the World Health Organization (WHO) declared the COVID-19 outbreak a pandemic on March 11, 2020 [3]. By the middle of March 2021, there were over 117 million COVID-19 cases globally with 2.6 million deaths. At the same time, over 66 million people have recovered from this disease [4].

Although research has focused on patients with COVID-19 [5, 6], few studies have reported on the close contacts of COVID-19 patients (CC hereafter). Close contacts are at high risk of contracting COVID-19 infection [7–10]. Further, restrictions imposed on them, including mandatory quarantine in designated places or at home and frequent virus testing [11, 12], can also increase the risk of physical and mental health problems.

According to previous studies, CC usually refer to people who is within 6 feet (or 2 m) of an infected person for a total of ≥15 min, or who live in the same household or shared accommodation with an infected person, or who travel in the same vehicle or an airplane with an infected person, or who have direct contact with body fluids or secretions of an infected person (e.g., was coughed or sneezed on) [13–19]. The number of CC is difficult to estimate or track; previous studies found that one confirmed COVID-19 case could have up to 44 close contacts on average [20–25].

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Given the high number of CC and the adverse impact of the pandemic on them, it is important to examine their mental health status and quality of life (QOL). In the past year, studies have found that CC had increased risk of mental health problems such as anxiety, depression, and psychological distress during the COVID-19 pandemic [26–28]. In addition, QOL has gained increasing attention as an important health outcome in clinical practice and research during the pandemic [29]. An Italian study found that the frontline healthcare staff reported lower QOL than their non-frontline counterparts [30]. Furthermore, long-term negative mental health impact of biological disasters (e.g., outbreak of infectious diseases) may occur in various populations even after the outbreak is controlled, with different clinical features compared to those during the outbreak [31–34]. A longitudinal study on severe acute respiratory syndrome (SARS) found that healthcare workers who cared for infected patients had higher stress level at the 1-year follow-up after the SARS outbreak compared to non-healthcare workers [31]. However, no studies have examined the mental health status and life quality in CC in the post COVID-19 period.

For 76 days, the city of Wuhan, the epicenter of the COVID-19 outbreak in China, was under “lockdown,” with travel restrictions and other public health and administrative measures until the 8 April 2020 [35, 36]. The “post-COVID-19 era” in this study refers to the period after the lockdown policy and related public restrictions in Wuhan were lifted on April 8, 2020 after no new cases were reported for 19 days in Wuhan [37, 38]. Additionally, during the 12-month period between April 8, 2020 and April 8, 2021, one (350) new cases were diagnosed in Hubei province [37], indicating that there was no further serious outbreak after the lockdown policy was canceled. Wuhan is not only the first epicenter of the COVID-19 outbreak globally but also the first major city where the outbreak was rapidly brought under control; therefore, Wuhan is one of the most suitable areas to conduct “post-COVID-19 era”-related research.

This study examined the mental health status, such as depression, fatigue, post-traumatic stress symptoms (PTSS), and QOL in CC during the post-COVID-19 period. Based on previous relevant findings [31–34], we hypothesized that the CC group have higher levels of depression, fatigue, PTSS, and lower QOL than the non-CC group.

**METHODS**

**Study setting and participants**

This was a cross-sectional, comparative study conducted during the post-COVID-19 period between May 25, 2020 and June 18, 2020 in Wuhan, Hubei province, China. Following previous studies [39–41], to minimize the risk of infection, participants were recruited and assessed online using the WeChat-based QuestionnaireStar program (Changsha Haoxing Information Technology Co., Ltd., Changsha, China) based on snowball sampling. A QuestionnaireStar Quick Response (QR) code linked to the invitation and assessments was disseminated by study team members, their colleagues, and friends who worked and lived in Wuhan via WeChat, which is the most popular social network application in China with around 1.2 billion monthly active users [42]. Persons who completed the assessments in this study were encouraged to invite people around them to participate in this study. The QuestionnaireStar program has been widely used in observational studies during the COVID-19 pandemic.

To be eligible, participants needed to meet the following criteria: (1) age ≥18 years; (2) able to read Chinese and understand the purpose and contents of the assessments; (3) not infected with COVID-19 during the pandemic; and (4) provided online electronic informed consent. Participants were divided into two groups: CC group and control group (non-CC hereinafter). Close contacts were defined as individuals who had family members, colleagues, close friends, or neighbors infected with COVID-19; this practical definition was widely used in clinical practice [11]. The study protocol was approved by the ethics committee of Beijing Anding Hospital, Capital Medical University.

**Assessment tools**

An electronic data collection form was designed to collect demographic and clinical data, including age, gender, education level, occupation, place of residence, living in urban or rural areas, living status (alone or with family members), frequency of mass media use, financial loss due to the COVID-19 pandemic, and perception of financial and health status. They were asked whether they had family members, colleagues, close friends, or neighbors infected with COVID-19 and whether they had previously been infected with COVID-19.

Severity of depressive symptoms (depression hereafter) was assessed using the Chinese version of the Patient Health Questionnaire - 9 items (PHQ-9), which consists of 9 items and each scored from 0 (not at all) to 3 (almost every day) [43, 44]. A higher score represents more severe depression [45]. The psychometric properties of PHQ-9 Chinese version have been validated in Chinese populations [46, 47]. Participants were classified as “having depression” if their PHQ-9 total score was ≥5 [45]. Overall QOL was assessed with the first two items of the World Health Organization Quality of Life Questionnaire - brief version (WHOQOL-BREF) [48, 49], with a higher score representing higher overall QOL [50]. Fatigue was assessed using the 11-point fatigue numeric rating scale, ranging from 0 (no fatigue) to 10 (the worst fatigue you can imagine) [51–53]. Fatigue total score ≥4 was considered as “having clinically significant fatigue” ("having fatigue" hereinafter) [54]. PTSS was assessed using the Chinese version of the Post-Traumatic Stress Disorder Checklist - 17 items (PCL-17) [55, 56]. Generally, Chinese people with psychiatric disorders tend to express their mental health problems in terms of physical symptoms [57–59]. Therefore, fatigue is not only a physical symptom but also a very common somatic symptom of psychiatric disorders. The PCL-17 is a 5-point Likert scale, with each item scoring from 1 (not at all) to 5 (extremely) in three domains: intrusion, avoidance/numbing, and hyperarousal. The Chinese version of the PCL-17 has been shown to have satisfactory psychometric properties [56].

**Statistical analysis**

All the data analyses were conducted using Statistical Analysis System (SAS), University Edition (SAS Institute Inc., Cary, NC, USA). In univariable analyses, the demographic and clinical characteristics between close contacts and non-close contacts were compared using independent two-sample t tests, Wilcoxon rank-sum tests, and chi-square tests as appropriate. Analysis of covariance (ANCOVA) was used to compare depressive symptoms, overall QOL, fatigue, and PTSS between the CC and the non-CC groups after adjusting for variables that significantly differed in univariable analysis (confounders hereafter). Multiple logistic regression was applied to determine the independent demographic and clinical correlates for depression, fatigue, PTSS, and QOL among CC if they were significantly different from non-CC. Two-sided p values <0.05 were considered as statistically significant.

Around half of participants in the CC group were medical workers. As the high proportion of medical workers might bias the results, a post hoc sensitivity analysis was conducted by excluding medical workers to examine whether this group could significantly affect the original results of logistic regression analyses. In the post hoc sensitivity analyses, similar logistic regression conducted in the whole sample were repeated, and then the results were compared with the original ones in the whole sample.

**RESULTS**

In total, 2614 were invited to participate in this study; 2459/2614 (94.1%) participants fulfilled the study entry criteria and completed the assessments, including 1169 CC and 1290 non-CC. Table 1 shows the basic demographic data of the participants. There were significant differences between the CC and non-CC groups in terms of age, occupation, place of residence, living area (urban or rural), frequency of mass media use, financial loss due to COVID-19, and perceived economic and health status (all p values <0.05). After adjusting for confounders, close contacts still had more severe depression (F(1, 2458) = 5.58, p = 0.018) and fatigue (F(1, 2458) = 9.22, p = 0.002), while no significant difference in PTSS and overall QOL between the two groups were found (F(1, 2458) = 2.93, p = 0.087) for PTSS; F(1, 2458) = 3.45, p = 0.064 for QOL).
In the CC group, 50.2% (95% CI: 47.3–53.1%) were classified as “having depression,” while the corresponding figure was 43.9% (95% CI: 41.2–46.6%) among non-CC. The prevalence of fatigue was 63.8% (95% CI: 61.1–66.6%) and 54.3% (95% CI: 51.5–57.0%) in the CC and non-CC groups, respectively. Multiple logistic regression analysis revealed that older age (odds ratio (OR) = 0.97, 95% CI: 0.96–0.98), significant financial loss during COVID-19 (OR = 2.0, 95% CI: 1.4–3.0), and perception of poor/fair health (OR = 3.9, 95% CI: 3.0–5.0) were significantly associated with depression in CC. In contrast, older age (OR = 0.97, 95% CI: 0.96–0.99), frequent use of mass media (OR = 1.4, 95% CI: 1.02–1.97), financial loss (OR = 1.6, 95% CI: 1.2–2.2 for moderate financial loss; OR = 2.6, 95% CI: 1.7–3.9 for significant financial loss), and perception of poor/fair health (OR = 3.3, 95% CI: 2.5–4.3) were significantly associated with fatigue in the CC group (Table 2).

The results of post hoc sensitivity analysis (Supplementary Table 1) were similar to the original results achieved in the CC group (Table 2), indicating that the high proportion of medical workers did not significantly affect the results.

DISCUSSION

To the best of our knowledge, this was the first study that investigated the mental health status and QOL among CC in the post-COVID-19 period. Based on this study sample recruited from the previous epicenter of COVID-19 and using validated assessment tools, we found that, after adjusting for potential confounders, CC experienced significantly higher rates of depression and fatigue symptoms compared to non-CC. As no previous studies compared mental health status between the CC and non-CC groups in the post-COVID-19 period, direct comparisons with

Table 1. Demographic and clinical characteristics of the whole study sample.

| Variables                      | Non-close contacts (N = 1290) | Close contacts (N = 1169) | Univariable analysis ANCOVA<sup>c</sup> | F df p |
|-------------------------------|-------------------------------|--------------------------|---------------------------------------|--------|
| Male gender                   | 331 (25.7)                    | 298 (25.5)               | 0.01 1 0.92                           |        |
| College and above             | 1168 (90.5)                   | 1081 (92.5)              | 2.92 1 0.09                           |        |
| Occupation                    |                               |                          |                                       |        |
| Medical workers               | 360 (27.9)                    | 598 (51.2)               |                                       |        |
| Other occupation              | 521 (40.4)                    | 324 (27.7)               |                                       |        |
| Not recorded or unemployed    | 409 (31.7)                    | 247 (21.1)               |                                       |        |
| Place of residence            |                               |                          |                                       |        |
| Wuhan city                    | 491 (38.1)                    | 967 (82.7)               |                                       |        |
| Other areas in Hubei province  | 346 (26.8)                    | 162 (13.9)               |                                       |        |
| Other provinces               | 453 (35.1)                    | 40 (3.4)                 |                                       |        |
| Living in urban (vs. rural)   | 1057 (81.9)                   | 1096 (93.8)              | 78.60 1 <0.001                        |        |
| Living with families (vs. living alone) | 1085 (84.1)                    | 1007 (86.1)               | 2.00 1 0.16                           |        |
| Financial loss due to COVID-19|                               |                          |                                       |        |
| None or minimal               | 410 (31.8)                    | 234 (20.0)               |                                       |        |
| Moderate                      | 707 (54.8)                    | 706 (60.4)               |                                       |        |
| Significant                   | 173 (13.4)                    | 229 (19.6)               |                                       |        |
| Perception of financial status|                               |                          |                                       |        |
| Poor                          | 245 (19.0)                    | 175 (15.0)               |                                       |        |
| Fair                          | 965 (74.8)                    | 936 (80.1)               |                                       |        |
| Good                          | 80 (6.2)                      | 58 (5.0)                 |                                       |        |
| Perception of health status   |                               |                          |                                       |        |
| Poor                          | 14 (1.1)                      | 19 (1.6)                 |                                       |        |
| Fair                          | 451 (35.0)                    | 536 (45.9)               |                                       |        |
| Good                          | 825 (64.0)                    | 614 (52.5)               |                                       |        |
| Age (years)                   | 33.7 (11.4)                   | 37.2 (10.1)              | 8.19 1 0.001                          |        |
| PHQ-9 total score             | 4.8 (4.9)                     | 5.5 (5.0)                | 4.52 1 <0.001                         |        |
| Overall QOL                   | 6.7 (1.3)                     | 6.4 (1.3)                | -5.59 1 <0.001                        |        |
| Fatigue score                 | 3.8 (2.3)                     | 4.4 (2.3)                | 6.29 1 <0.001                         |        |
| PCL-17 total score            | 22.7 (7.7)                    | 24.4 (8.3)               | 5.08 1 0.001                          |        |

<sup>c</sup>ANCOVA analysis of covariance, COVID-19 coronavirus disease 2019, df degree of freedom, SD standard deviation, QOL quality of life, PHQ-9 patient health questionnaire—9 items, PCL-17 post-traumatic stress disorder checklist—17 items.

aSatterthwaite corrected.

bWilcoxon rank-sum test.

*Adjusted for age, occupation, place of residence, living area (urban or rural), frequent use of mass media, financial loss due to COVID-19, health perception.
The symptoms of depression and fatigue in the CC group were significantly associated with certain demographic and clinical correlates. Previous studies found mental health problems such as depression, anxiety, and psychological distress were more common in younger people during the COVID-19 pandemic [80–85]. Quarantine and other preventive measures during the pandemic may particularly affect the social and physical activities in younger people [86, 87]; in addition, younger people may have reduced resilience and coping mechanisms [88]. Consequently, they may be more likely to have depressive and fatigue symptoms as we found in this study. Financial loss due to COVID-19 was significantly associated with higher risk of depression and fatigue among close contacts, which confirms previous findings [89–91].

In this study, more frequent use of mass media was an independent correlate of more severe fatigue (not depression) among close contacts. During the pandemic and quarantine period, close contacts facing quarantine and social isolation usually spend more time on social media such as smartphone and the Internet. This could further reduce physical exercises and social communications with others, which could increase the risk factors of chronic fatigue [92–94]. Furthermore, the proportion of medical workers in the CC group (51.2%) was much higher than that in the non-CC group (27.9%) in this study. Previous studies have found a high level of fatigue and burnout among healthcare workers during the COVID-19 outbreak [74–79], which also contributed to the higher prevalence of fatigue in the CC group.

The symptoms of depression and fatigue in the CC group were more severe than those in the non-CC group. These findings are consistent with previous studies [63–66], which found that people with close contacts of COVID-19 were more likely to experience psychological distress. Financial loss due to COVID-19 was an independent correlate of more severe fatigue (not depression) among close contacts. In this study, more frequent use of mass media was an independent correlate of more severe fatigue (not depression) among close contacts. During the pandemic and quarantine period, close contacts facing quarantine and social isolation usually spend more time on social media such as smartphone and the Internet. This could further reduce physical exercises and social communications with others, which could increase the risk factors of chronic fatigue [92–94].

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### Table 2. Independent correlates of depression and fatigue among close contacts (N = 1169).

| Variables | Non-depression (N = 582) | Depression (N = 587) | Multiple logistic regression | Non-fatigue (N = 423) | Fatigue (N = 746) | Multiple logistic regression |
|-----------|--------------------------|---------------------|-----------------------------|----------------------|------------------|-----------------------------|
|           | Mean | SD | Mean | SD | p | OR | 95% CI | Mean | SD | Mean | SD | p | OR | 95% CI |
| Age (years) | 38.4 | 10.4 | 36.1 | 9.6 | <0.001 | 0.97 | 0.96–0.98 | 38.3 | 10.7 | 36.6 | 9.6 | <0.001 | 0.97 | 0.96–0.99 |
| Female | 428 | 73.5 | 443 | 75.5 | 0.89 | 1.0 | 0.7–1.3 | 319 | 75.4 | 552 | 74.0 | 0.12 | 0.8 | 0.6–1.1 |
| Occupation | | | | | | | | | | | | | |
| Medical workers | 298 | 51.2 | 300 | 51.1 | — | — | — | 196 | 46.3 | 402 | 53.9 | — | — | — |
| Other occupations | 168 | 28.9 | 156 | 26.6 | 0.29 | 1.2 | 0.9–1.6 | 131 | 31.0 | 193 | 25.9 | 0.28 | 0.8 | 0.6–1.1 |
| Not recorded and unemployed | 116 | 19.9 | 131 | 22.3 | 0.39 | 1.2 | 0.8–1.6 | 96 | 22.7 | 151 | 20.2 | 0.43 | 0.9 | 0.6–1.2 |
| Place of residence | | | | | | | | | | | | | |
| Wuhan city | 485 | 83.3 | 482 | 82.1 | 0.96 | 1.0 | 0.5–2.0 | 332 | 78.5 | 635 | 85.1 | 0.54 | 1.2 | 0.6–2.5 |
| Other areas in Hubei province | 78 | 13.4 | 84 | 14.3 | 0.60 | 1.2 | 0.6–2.6 | 75 | 17.7 | 87 | 11.7 | 0.68 | 0.9 | 0.4–1.8 |
| Other provinces | 19 | 3.3 | 21 | 3.6 | — | — | — | 16 | 3.8 | 24 | 3.2 | — | — | — |
| Living in urban areas (vs. rural) | 548 | 94.2 | 548 | 93.4 | 0.47 | 0.8 | 0.5–1.4 | 390 | 92.2 | 706 | 94.6 | 0.18 | 1.4 | 0.9–2.4 |
| Frequent use of mass media | 475 | 81.6 | 488 | 83.1 | 0.34 | 1.2 | 0.8–1.6 | 338 | 79.9 | 625 | 83.8 | 0.038 | 1.4 | 1.02–1.97 |
| Financial loss due to COVID-19 | | | | | | | | | | | | | |
| None or minimal | 133 | 22.9 | 101 | 17.2 | — | — | — | 117 | 27.7 | 117 | 15.7 | — | — | — |
| Moderate | 361 | 62.0 | 345 | 58.8 | 0.35 | 1.2 | 0.8–1.6 | 250 | 59.1 | 456 | 61.1 | 0.002 | 1.6 | 1.2–2.2 |
| Significant | 88 | 15.1 | 141 | 24.0 | <0.001 | 2.0 | 1.4–3.0 | 56 | 13.2 | 173 | 23.2 | <0.001 | 2.6 | 1.7–3.9 |
| Poor or fair health perception (vs. good) | 189 | 32.5 | 366 | 62.4 | <0.001 | 3.9 | 3.0–5.0 | 128 | 30.3 | 427 | 57.2 | <0.001 | 3.3 | 2.5–4.3 |

SD standard deviation, OR odds ratio, CI confidential interval.
was a predictor of less severe fatigue in worn-out employees [104]. One study found that fatigue played a causal role in the subjective perception of health [105].

The strengths of this study included the large sample size and the focus on CC in the pandemic epicenter during the post-COVID-19 period. In addition, an online survey was used, which could ensure anonymity. However, there were several methodological limitations. First, due to the cross-sectional design, no causal relationships between mental health status and other variables could be established. Second, due to logistical reasons, snowball, rather than random sampling, was used, which could lead to selection bias. In addition, around half of participants in the CC group were medical workers. However, post hoc sensitivity analyses did not find that the high proportion of medical workers significantly influence the study results. Third, certain important factors related to mental health of close contacts were not collected in this study, such as different types of close contacts (e.g., household contacts, work contacts, and social contacts [106]), social supports, and quarantine history and quarantine duration of the close contacts. Fourth, information on chronic or major diseases in medical records was not collected, although this could provide more precise information on participants’ physical health than their perception of health. Fifth, the potential impact of death or post-COVID-19 disabilities of COVID-19 patients could have an important impact on the mental health status of CC, but the relevant information was not collected in this study.

In conclusion, close contacts experienced high levels of depression and fatigue in post-COVID-19 period, particularly in those who were younger, had experienced financial loss due to COVID-19, and had perception of poor or fair health status. Considering the negative effects of depression and fatigue on QOL and daily functioning, early detection and timely intervention should be provided to this neglected population.

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AUTHOR CONTRIBUTIONS
Study design: S-FZ, B-XY, Y-TX. Data collection, analysis, and interpretation: Y-JZ, WL, LZ, S-FZ, B-XY. Drafting of the manuscript: Y-JZ, TC, Y-TX. Critical revision of the manuscript: Y-LT. Approval of the final version for publication: all co-authors.

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COMPETING INTERESTS
The authors declare no competing interests.

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Correspondence and requests for materials should be addressed to Bing-Xiang Yang or Yu-Tao Xiang.

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