ISSN 2096-7071
CN 10-1629/R1

# CHINA CDC WEEKLY

Vol. 5 No. 11 Mar. 17, 2023

# CCDC weekly

中国疾病预防控制中心周报


COVID-19 ISSUE (37)

## Preplanned Studies

Cross-Sectional Online Survey on Depression and Anxiety Among the Population Infected or Non-Infected with COVID-19 — China, December 2022 235

## Vital Surveillances

Trends of SARS-CoV-2 Infection in Rural Area in Sentinel Community-Based Surveillance — China, December 2022 to January 2023 241

Trends of SARS-CoV-2 Infection Among Couriers in Risky Business After the Optimization of Prevention and Control Measures — China, December 2
022 to January 2023 248

## Notes from the Field

The First Case of Co-Infection with Omicron Subvariants BA.5.2.48 and BF.7.14 — Chongqing Municipality, China, February 2023 255

ISSN 2096-7071

Cover Image: adapted from the World Health Organization, https://www.who.int/multi-media/details/importance-of-vaccination-3.

Preplanned Studies

# Cross-Sectional Online Survey on Depression and Anxiety Among the Population Infected or Non-Infected with COVID-19 — China, December 2022

Tingting Qin[1]; Xingming Li[1,#]; Mingyu Gu[1]; Yao Wang[1]; Yutong Yang[1]; Xinyuan Bai[1]; Kun Qiao[1]

**Summary**

**What is already known about this topic?**

The psychological impact of the large-scale infection of the population resulting from the end of lockdown measures in China during the coronavirus disease 2019 (COVID-19) pandemic is unknown.

**What is added by this report?**

Among all participants, 55.7% had depression symptoms, with a significant difference between the infected and non-infected groups, and 30.1% had anxiety. Those who were young, unvaccinated, had lower incomes, and experienced chronic diseases were more likely to experience negative emotions.

**What are the implications for public health practice?**

Government officials should take into account the effect of policies on public sentiment during similar public health events and implement tailored community interventions to address any negative sentiment.

Coronavirus disease 2019 (COVID-19) is a global epidemic of infectious diseases. As of February 26, 2023, the World Health Organization (WHO) had reported 757,264,511 confirmed cases of COVID-19 (*1*). To prevent the spread of coronavirus, the Chinese government implemented the most stringent anti-COVID regimes in the world, known as the "zero-COVID" policy. This policy included strict and targeted lockdowns, mass testing, isolation or quarantine, and other measures. On December 7, 2022, the Chinese government announced the end of the policy, which came rapidly and unexpectedly, causing panic among the population due to fear of infection and shortages of medicine supplies. Therefore, it is necessary to understand the mental health status of Chinese residents after the policy adjustment. Assessing the impact of the pandemic on people's mental health has been identified as a public health research priority. Previous research has indicated that the COVID-19 epidemic has caused a rapid increase in the prevalence of anxiety and depression symptoms among the general population in China (*2*). However, there is limited research on people's mental health after China released new COVID-19 rules. This study aimed to analyze the short-term depression and anxiety symptoms of the infected and non-infected populations after the abolition of strict pandemic control measures in China. This could provide evidence and suggestions for how to improve people's mental health in the post-pandemic era.

From December 21–28, 2022, a cross-sectional online survey was conducted to investigate the symptoms of depression and anxiety among smartphone users. Convenience sampling strategies were used to recruit participants, who were electronically invited via WeChat, a Chinese social media APP. To increase the sample size, the link to the electronic questionnaire was shared to WeChat groups and Moments. Inclusion criteria: 1) Willing to participate in the study; 2) Living in Chinese mainland; 3) Able to use smartphones; 4) Knowing if he/she was infected. Exclusion criteria: 1) Participants with previously diagnosed mood disorders; 2) Incapable of completing the electronic questionnaire or unable to understand the questionnaire due to cognitive impairment or other diseases. Mature scales were used to investigate the psychological state, and data was cleaned according to the inclusion criteria and filling time (less than 120 seconds were excluded), and some data with logical errors were also excluded. A total of 5,310 electronic questionnaires were collected. According to the above criteria, 150 questionnaires were excluded, among which, 9 questionnaires had logical errors, 130 respondents were not sure whether they were infected with COVID-19, and 11 did not live in Chinese mainland. Finally, 5,160 (97.2% effective rate) valid questionnaires were included in this study. The questionnaire was composed of two parts.

The first part collected sociodemographic information, such as gender, age, education level, marital status, employment status, average monthly personal income, and residence area. Participants were also asked to report whether they had chronic diseases before COVID-19 infection, how many injections of vaccinations they had completed at most, and whether they were infected. The second part focused on evaluating the depression and anxiety status of respondents over the past two weeks using the Patient Health Questionnaire-9 (PHQ-9) and the General Anxiety Disorder-7 (GAD-7). PHQ-9 presented respondents with 9 statements, each with a four-point scale and the total score ranged from 0 to 27. The total score of PHQ-9 was divided into 5 scales: 0–4, 5–9, 10–14, 15–19, and 20–27, corresponding to none, mild, moderate, moderately severe, and severe depression symptoms, respectively. Considering the small number of respondents in the latter two scales, this study combined them into moderately severe and above depression. GAD-7 had 7 items, and each was scored 0–3 points from "Not at all" (0 points) to "Nearly every day" (3 points). According to the total score of GAD-7, anxiety symptoms were grouped into four categories. A score of 0–4 represented no anxiety, 5–9 mild anxiety, 10–14 moderate anxiety and scores greater than 14 indicated possibly severe anxiety. The Chinese versions of these scales have been demonstrated to have good reliability and validity (*3*–*4*). In this study, the Cronbach's alpha of PHQ-9 and GAD-7 were 0.899 and 0.944, respectively, indicating great internal validity. Continuous variables were summarized as mean±standard deviation or median (interquartile range). Categorical data were reported as *n* (%) and compared with Pearson's Chi-square test or Fisher's exact test. Ordinal logistic regression was used to assess the relationships between anxiety and depression symptoms and explanatory variables. PHQ-9 and GAD-7 scores were used as four-category dependent variables, and demographic information was used as independent variables. Odds ratios (*OR*s) and 95% confidence intervals (*CI*s) of independent variables were reported. All statistical analyses were performed using Stata statistical software (Version 15.0, StataCorp LLC, Lakeway Drive, College Station, Texas, USA). *P*-values <0.05 were considered statistically significant.

A total of 5,160 valid questionnaires were included in this study, of which 1,153 (22.3%) reported not being infected and 4,007 (77.7%) reported being infected. Of all participants, 1,536 (29.8%) were male and 3,624 (70.2%) were female. Most participants had an associate/bachelor degree or higher (83.8%). More than half of the participants were married (72.1%), employed (65.8%), had no history of chronic disease (83.1%), and had completed three doses of vaccination (80.8%), as shown in Table 1.

The mean PHQ-9 and GAD-7 scores were 6.1±5.3 and 3.1±3.9, respectively. The median scores of PHQ-9 and GAD-7 were 5 (2 to 9) and 2 (0 to 5), respectively. As shown in Table 2, 2,872 (55.7%) participants may have had depression symptoms and approximately one-third (30.1%) may have had anxiety symptoms. The Chi-square test revealed a significant difference in depression (*P*<0.001) between infected and non-infected participants, but no difference in anxiety (*P*=0.066) was observed.

The results of Chi-square test or Fisher's exact test of different factors of depression and anxiety symptoms among participants revealed that most factors were statistically significant in predicting the risk of depression and anxiety (*P*<0.05). Results of ordinal logistic regression of PHQ-9 showed that gender (*OR*=1.150, 95% *CI*: 1.023–1.293) was a risk factor for depressive symptoms. Age over 50 (*OR*<1), being married (*OR*=0.748, 95% *CI*: 0.602–0.931), having a personal monthly income of more than 5,000 RMB (*OR*<1), no history of chronic diseases (*OR*=0.740, 95% *CI*: 0.632–0.865), completion of four doses of vaccinations (*OR*=0.562, 95% *CI*: 0.392–0.806), and not being infected (*OR*=0.543, 95% *CI*: 0.476–0.619) were protective factors for depression, as shown in Table 3, which also displays the effect of variables on GAD-7 scores by ordinal logistic regression. Participants aged 50 or over were less likely to experience anxiety symptoms compared to those under 30 (*OR*<1). Student status (*OR*=0.653, 95% *CI*: 0.477–0.895), having a monthly personal income of more than 5,000 CNY (*OR*<1), having no history of chronic disease (*OR*=0.594, 95% *CI*: 0.497–0.711), and having completed four doses of vaccinations (*OR*=0.561, 95% *CI*: 0.371–0.848) were protective factors for anxiety.

## DISCUSSION

This study examined the prevalence of anxiety and depression among participants in China following changes to epidemic prevention and control policies during the ongoing COVID-19 pandemic. Results indicate that mental health is significantly impacted by the pandemic, and it is important to remain mindful of

TABLE 1. Demographic characteristics of participants ($n$=5,160).

| Characteristic | Self-reported not infected ($n$=1,153) | | Self-reported infected ($n$=4,007) | | $\chi^2$ | $P$-value |
|---|---|---|---|---|---|---|
| | No. of participants | Percentage (%) | No. of participants | Percentage (%) | | |
| Gender | | | | | 11.197 | 0.001 |
| Male | 389 | 33.7 | 1,147 | 28.6 | | |
| Female | 764 | 66.3 | 2,860 | 71.4 | | |
| Age (years) | | | | | 69.625 | <0.001 |
| <30 | 296 | 25.7 | 837 | 20.9 | | |
| 30–39 | 170 | 14.7 | 934 | 23.3 | | |
| 40–49 | 284 | 24.6 | 1,172 | 29.2 | | |
| 50–59 | 260 | 22.5 | 708 | 17.7 | | |
| ≥60 | 143 | 12.4 | 356 | 8.9 | | |
| Education level | | | | | 47.819 | <0.001 |
| High school education or lower | 250 | 21.7 | 586 | 14.6 | | |
| Associate/bachelor degree | 644 | 55.9 | 2,199 | 54.9 | | |
| Graduate degree | 259 | 22.5 | 1,222 | 30.5 | | |
| Marital status | | | | | 22.078 | <0.001 |
| Single | 303 | 26.3 | 881 | 22.0 | | |
| Married | 772 | 67.0 | 2,947 | 73.5 | | |
| Others* | 78 | 6.8 | 179 | 4.5 | | |
| Employment status | | | | | 75.049 | <0.001 |
| Employed | 639 | 55.4 | 2,758 | 68.8 | | |
| Retired | 209 | 18.1 | 505 | 12.6 | | |
| Students | 221 | 19.2 | 499 | 12.5 | | |
| Others | 84 | 7.3 | 245 | 6.1 | | |
| Monthly personal income (CNY†) | | | | | 94.531 | <0.001 |
| <3,000 | 362 | 31.4 | 810 | 20.2 | | |
| 3,000–5,000 | 228 | 19.8 | 697 | 17.4 | | |
| 5,000–10,000 | 296 | 25.7 | 1,076 | 26.9 | | |
| 10,000–15,000 | 152 | 13.2 | 797 | 19.9 | | |
| >15,000 | 115 | 10.0 | 627 | 15.6 | | |
| Residence area | | | | | 42.274 | <0.001 |
| Urban | 992 | 86.0 | 3,698 | 92.3 | | |
| Rural | 161 | 14.0 | 309 | 7.7 | | |
| Region | | | | | 10.346 | 0.006 |
| East | 841 | 72.9 | 3,088 | 77.1 | | |
| Central | 127 | 11.0 | 335 | 8.4 | | |
| Western | 185 | 16.0 | 584 | 14.6 | | |
| History of physical illness | | | | | 0.250 | 0.617 |
| Chronic disease | 200 | 17.3 | 670 | 16.7 | | |
| Healthy | 953 | 82.7 | 3,337 | 83.3 | | |
| Vaccination | | | | | 8.909 | 0.063 |
| 0 | 46 | 4.0 | 167 | 4.2 | | |
| 1 | 11 | 1.0 | 32 | 0.8 | | |
| 2 | 100 | 8.7 | 386 | 9.6 | | |
| 3 | 922 | 80.0 | 3,246 | 81.0 | | |
| 4 | 74 | 6.4 | 176 | 4.4 | | |

* Other marital statuses include divorced, widowed, cohabiting, and remarried.

† 10,000 Chinese Yuan≈1,476 US dollars in 2023.

TABLE 2. Symptoms of depression and anxiety among participants.

| Symptoms | Self-reported not infected | | Self-reported infected | | $X^2$ | *P*-value |
|---|---|---|---|---|---|---|
| | No. of participants | Percentage (%) | No. of participants | Percentage (%) | | |
| PHQ-9 | | | | | 99.398 | <0.001 |
| Normal | 660 | 57.2 | 1,638 | 40.9 | | |
| Mild depression | 322 | 28.0 | 1,520 | 37.9 | | |
| Moderate depression | 111 | 9.6 | 494 | 12.3 | | |
| Moderately severe and above depression | 60 | 5.2 | 355 | 8.9 | | |
| GAD-7 | | | | | 7.176 | 0.066 |
| Normal | 799 | 69.3 | 2810 | 70.1 | | |
| Mild anxiety | 285 | 24.7 | 888 | 22.2 | | |
| Moderate anxiety | 52 | 4.5 | 214 | 5.3 | | |
| Severe anxiety | 17 | 1.5 | 95 | 2.4 | | |

Abbreviation: PHQ-9=patient health questionnaire-9; GAD-7=generalized anxiety disorder-7.

the mental health of vulnerable populations, both those infected and those who remain uninfected, as the pandemic continues.

Compared to existing studies conducted when “zero-COVID” policy was implemented, the percentages of participants with depression and anxiety were slightly higher in this study (*5*). Many people were unprepared for the sudden change in the epidemic prevention and control policy, leading to worries about infection, virus mutation, and re-outbreak of COVID-19, which resulted in negative emotions for many. Compared to Australia (*6*), the percentages of respondents with depression in this study were slightly higher, while anxiety was lower. The mean score of PHQ-9 was close to the scores of four European countries, and the mean score of GAD-7 was lower than those countries (*7*). Consistent with the findings of Lei et al. (*8*), we found that participants infected with COVID-19 had significantly more depressive symptoms than the uninfected. However, a large portion of the uninfected also experienced depression symptoms.

As for influential factors of mental health, we found that respondents who were older, had higher incomes, had no history of chronic diseases, and had completed vaccinations experienced fewer symptoms of depression and anxiety. Older adults were less likely to experience symptoms of depression and anxiety compared to younger adults, which is consistent with findings from an Australian survey and a global online survey that showed younger people were more prone to stress, depression, and anxiety (*9*). This may be related to the fact that the elderly were better able to cope with stress and worried less about working and financial burdens. Higher incomes corresponded to higher anti-risk ability and the possibility of obtaining better medical resources, so participants with higher incomes were less likely to have psychological problems (*10*). People with chronic diseases were more susceptible to infection and mental illness, so attention should be paid to the health management of chronic disease patients. It is recognized that COVID-19 vaccines can effectively reduce the risk of infection, so older adults who may face a higher risk of complications from vaccine-preventable diseases should stay up to date on recommended vaccines. Valentina et al. (*11*) found that women suffered the worst short and long-term psychological problems, which was also supported by this study. Therefore, it is imperative to consider the effects of the pandemic on women’s mental health during the aftermath of COVID-19. Students were less likely to experience anxiety than employed people, which may be due to the heavy burden from work and family faced by workers.

This study has some limitations. The sample may not be representative of the broader population, as a large proportion of participants had received higher education and were employed. Additionally, since this was a cross-sectional study, it is not possible to determine the effect of epidemic prevention and control policy adjustments on people’s psychological health over time. Therefore, further longitudinal studies are needed to examine the long-term effect of the pandemic on mental health.

Following the conclusion of China’s “zero-COVID” policy, individuals continued to experience significant symptoms of depression and anxiety. Those who were young, female, unvaccinated, had low incomes, and had a history of chronic illnesses were more likely to

TABLE 3. Ordinal logistic regression of the patient health questionnaire-9 (PHQ-9) and the generalized anxiety disorder-7 (GAD-7) scales.

| Variables | PHQ-9 | | GAD-7 | |
|---|---|---|---|---|
| | ***OR* (95% *CI*)** | ***P*-value** | ***OR* (95% *CI*)** | ***P*-value** |
| Gender | | | | |
| Male | 1.00 (Ref) | | 1.00 (Ref) | |
| Female | 1.150 (1.023, 1.293) | 0.019 | 1.029 (0.898, 1.178) | 0.684 |
| Age (years) | | | | |
| <30 | 1.00 (Ref) | | 1.00 (Ref) | |
| 30–39 | 0.972 (0.765, 1.236) | 0.820 | 1.259 (0.963, 1.648) | 0.093 |
| 40–49 | 0.792 (0.617, 1.018) | 0.068 | 0.867 (0.652, 1.152) | 0.324 |
| 50–59 | 0.563 (0.427, 0.743) | <0.001 | 0.568 (0.412, 0.785) | 0.001 |
| ≥60 | 0.590 (0.408, 0.855) | 0.005 | 0.617 (0.400, 0.952) | 0.029 |
| Education level | | | | |
| High school education or lower | 1.00 (Ref) | | 1.00 (Ref) | |
| Associate/bachelor degree | 1.027 (0.858, 1.230) | 0.769 | 1.064 (0.867, 1.306) | 0.552 |
| Graduate degree | 1.079 (0.870, 1.338) | 0.488 | 1.046 (0.818, 1.338) | 0.720 |
| Marital status | | | | |
| Single | 1.00 (Ref) | | 1.00 (Ref) | |
| Married | 0.748 (0.602, 0.931) | 0.769 | 0.827 (0.647, 1.058) | 0.131 |
| Other | 0.957 (0.695, 1.318) | 0.488 | 1.017 (0.710, 1.458) | 0.925 |
| Employment status | | | | |
| Employed | 1.00 (Ref) | | 1.00 (Ref) | |
| Retired | 0.814 (0.631, 1.050) | 0.113 | 0.825 (0.606, 1.123) | 0.221 |
| Students | 0.784 (0.591, 1.039) | 0.090 | 0.653 (0.477, 0.895) | 0.008 |
| Others | 1.008 (0.788, 1.289) | 0.951 | 1.009 (0.768, 1.325) | 0.947 |
| Monthly personal income (CNY) | | | | |
| <3,000 | 1.00 (Ref) | | 1.00 (Ref) | |
| 3,000–5,000 | 0.819 (0.661, 1.015) | 0.069 | 0.791 (0.622, 1.006) | 0.056 |
| 5,000–10,000 | 0.740 (0.589, 0.931) | 0.010 | 0.671 (0.519, 0.867) | 0.002 |
| 10,000–15,000 | 0.677 (0.526, 0.872) | 0.003 | 0.571 (0.429, 0.760) | <0.001 |
| >15,000 | 0.636 (0.484, 0.835) | 0.001 | 0.488 (0.356, 0.668) | <0.001 |
| Residence area | | | | |
| Urban | 1.00 (Ref) | | 1.00 (Ref) | |
| Rural | 0.877 (0.721, 1.065) | 0.185 | 0.914 (0.733, 1.140) | 0.427 |
| Region | | | | |
| East | 1.00 (Ref) | | 1.00 (Ref) | |
| Central | 0.960 (0.795, 1.160) | 0.674 | 0.996 (0.802, 1.236) | 0.969 |
| Western | 1.105 (0.952, 1.282) | 0.188 | 1.126 (0.953, 1.331) | 0.164 |
| History of physical illness | | | | |
| Chronic disease | 1.00 (Ref) | | 1.00 (Ref) | |
| Healthy | 0.740 (0.632, 0.865) | <0.001 | 0.594 (0.497, 0.711) | <0.001 |
| Vaccination | | | | |
| 0 | 1.00 (Ref) | | 1.00 (Ref) | |
| 1 | 1.149 (0.615, 2.146) | 0.663 | 0.951 (0.477, 1.895) | 0.887 |
| 2 | 0.982 (0.720, 1.339) | 0.908 | 0.906 (0.642, 1.278) | 0.573 |
| 3 | 0.911 (0.696, 1.191) | 0.494 | 0.802 (0.597, 1.079) | 0.145 |
| 4 | 0.562 (0.392, 0.806) | 0.002 | 0.561 (0.371, 0.848) | 0.006 |
| Infection | | | | |
| Infected | 1.00 (Ref) | | 1.00 (Ref) | |
| Not infected | 0.543 (0.476, 0.619) | <0.001 | 1.030 (0.891, 1.191) | 0.688 |

Abbreviation: *OR*=odds ratio; *CI*=confidence interval; CNY=Chinese Yuan.

experience mood disorders. To protect the mental health of these vulnerable populations and promote health equity, sustainable, effective, and tailored community interventions should be implemented in the future to address these issues.

**Conflicts of interest**: No conflicts of interest.

**Acknowledgements**: The authors would like to acknowledge all the participants for their support and work for this study.

**doi:** 10.46234/ccdcw2023.043

# Corresponding author: Xingming Li, xingmingli@ccmu.edu.cn.

[1] School of Public Health, Capital Medical University, Beijing, China.

Submitted: February 28, 2023; Accepted: March 12, 2023

## REFERENCES

1. World Health Organization. WHO coronavirus (COVID-19) dashboard data. 2023. https://covid19.who.int/. [2023-2-26].
2. Li JF, Yang ZY, Qiu H, Wang Y, Jian LY, Ji JJ, et al. Anxiety and depression among general population in China at the peak of the COVID-19 epidemic. World Psychiatry 2020;19(2):249 – 50. http://dx.doi.org/10.1002/wps.20758.
3. Wang WZ, Bian Q, Zhao Y, Li X, Wang WW, Du J, et al. Reliability and validity of the Chinese version of the Patient Health Questionnaire (PHQ-9) in the general population. Gen Hosp Psychiatry 2014;36(5):539 – 44. http://dx.doi.org/10.1016/j.genhosppsych.2014.05.021.
4. Sun JG, Liang KX, Chi XL, Chen ST. Psychometric properties of the generalized anxiety disorder scale-7 item (GAD-7) in a large sample of Chinese adolescents. Healthcare (Basel) 2021;9(12):1709. http://dx.doi.org/10.3390/healthcare9121709.
5. Bareeqa SB, Ahmed SI, Samar SS, Yasin W, Zehra S, Monese GM, et al. Prevalence of depression, anxiety and stress in China during COVID-19 pandemic: a systematic review with meta-analysis. Int J Psychiatry Med 2021;56(4):210 – 27. http://dx.doi.org/10.1177/0091217420978005.
6. Stocker R, Tran T, Hammarberg K, Nguyen H, Rowe H, Fisher J. Patient Health Questionnaire 9 (PHQ-9) and General Anxiety Disorder 7 (GAD-7) data contributed by 13,829 respondents to a national survey about COVID-19 restrictions in Australia. Psychiatry Res 2021;298:113792. http://dx.doi.org/10.1016/j.psychres.2021.113792.
7. Pierce M, Hope H, Ford T, Hatch S, Hotopf M, John A, et al. Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population. Lancet Psychiatry 2020;7(10):883 – 92. http://dx.doi.org/10.1016/S2215-0366(20)30308-4.
8. Lei L, Huang XM, Zhang S, Yang JR, Yang L, Xu M. Comparison of prevalence and associated factors of anxiety and depression among people affected by versus people unaffected by quarantine during the COVID-19 epidemic in Southwestern China. Med Sci Monit 2020;26:e924609. http://dx.doi.org/10.12659/MSM.924609.
9. Varma P, Junge M, Meaklim H, Jackson ML. Younger people are more vulnerable to stress, anxiety and depression during COVID-19 pandemic: a global cross-sectional survey. Prog Neuropsychopharmacol Biol Psychiatry 2021;109:110236. http://dx.doi.org/10.1016/j.pnpbp.2020.110236.
10. Sareen J, Afifi TO, McMillan KA, Asmundson GJG. Relationship Between Household Income and Mental Disorders: Findings From a Population-Based Longitudinal Study. Arch Gen Psychiatry 2011;68(4):419 – 427. http://dx.doi.org/10.1001/archgenpsychiatry.2011.15.
11. Bucciarelli V, Nasi M, Bianco F, Seferovic J, Ivkovic V, Gallina S, et al. Depression pandemic and cardiovascular risk in the COVID-19 era and long COVID syndrome: gender makes a difference. Trends Cardiovasc Med 2022;32(1):12 – 7. http://dx.doi.org/10.1016/j.tcm.2021.09.009.

Vital Surveillances

# Trends of SARS-CoV-2 Infection in Rural Area in Sentinel Community-Based Surveillance — China, December 2022 to January 2023

Wenzhan Jing[1,&]; Fan Ding[2,&]; Yanping Zhang[2]; Guoqing Shi[2]; Jue Liu[3]; Yu Wu[3]; Fangyuan Li[2]; Wenxin Yan[3]; Chenyuan Qin[3]; Min Liu[3,#]; Qun Li[2,#]; Wannian Liang[1,#]

## ABSTRACT

**Introduction**: In late 2022, a rapid transmission of Omicron variants of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) occurred throughout China. The purpose of this study was to provide the latest data and evaluate trends of SARS-CoV-2 infection in rural China among the community population.

**Methods**: Data on SARS-CoV-2 infection among approximately 90,000 participants in rural China were collected by the National Sentinel Community-Based Surveillance (NSCS) system. Participants were tested for SARS-CoV-2 infection (defined as positive for SARS-CoV-2 nucleic acid or antigen) twice weekly from December 16, 2022 to January 12, 2023. The daily average of newly positive rate and its estimated daily percentage change were calculated to describe the national and regional trends of SARS-CoV-2 infection in rural China.

**Results**: In rural China, the daily average new positive rate of SARS-CoV-2 infection peaked at 4.79% between December 20–22, 2022 and then decreased to 0.57% between January 10–12, 2023, with an average decrease of 29.95% per round. The peak of new SARS-CoV-2 infection was slightly earlier and lower in North China (5.28% between December 20–22, 2022) than in South China (5.63% between December 23–26, 2022), and then converged from December 30, 2022 to January 2, 2023. The peak of 6.09% occurred between December 20–22, 2022 in eastern China, while the peak of 5.99% occurred later, between December 27–29, 2022, in central China.

**Conclusions**: Overall, the epidemic wave in rural China peaked between December 20–22, 2022, and passed quickly following the optimization of prevention and control measures. Currently, SARS-CoV-2 infection in community populations in rural China is sporadic.

The coronavirus disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has been declared as a Public Health Emergency of International Concern for over three years (*1*), leading to a combined health and socioeconomic crisis of unprecedented severity (*2*). Entering 2022, the highly contagious mutant strain of Omicron variants spread rapidly in China (*3*). In late 2022, the costs of prevention and control of the epidemic became higher due to the rapid spread of the highly contagious Omicron variants (*3*). To contain the epidemic in a shorter period, minimize the epidemic impact on socioeconomic development and people's livelihood (*3*–*4*), and take into account the highly infectious but less virulent Omicron variants, the high coverage of COVID-19 vaccines, and the significantly improved health literacy of the public (*5*), Chinese government successively issued the "20 Measures" and "Ten New Measures" to continuously optimize the epidemic prevention and control plan (*6*). Then, a rapid transmission of Omicron variants happened throughout China.

In the Omicron variants epidemic in China from late 2022, there has been widespread concern about SARS-CoV-2 infections in rural areas (*7*). Several studies have reported on SARS-CoV-2 infection in rural China (*5*,*8*); however, no study has focused on the trends and differences of SARS-CoV-2 infection by region among the general population in rural China during this period of widespread transmission. To address this knowledge gap, national and regional trends of SARS-CoV-2 infection in rural China among the general population were evaluated using data from the National Sentinel Community-Based Surveillance (NSCS) system during this critical period.

# METHODS

## Study Design and Participant Characteristics

Data on SARS-CoV-2 infection were collected by the NSCS in China (*5*). Briefly, one county in each provincial-level administrative division (PLAD) was selected to represent the rural areas of the province, and at least 1,000 households (≥2,500 people) were sampled in the selected county. The minimum sampling unit was the household, and all selected households were included in the cohort (*5*). Each site conducted nucleic acid or antigen testing twice weekly in every household (a total of eight surveillance rounds) from December 16, 2022 to January 12, 2023 (*5*).

In this study, rural China was represented by counties sampled from 27 PLADs, excluding the 4 municipalities (Beijing, Tianjin, Shanghai, and Chongqing). Data from approximately 90,000 participants from the selected counties were used to describe the trends of SARS-CoV-2 infection in rural China from December 2022 to January 2023. We reported the SARS-CoV-2 infection in 27 PLADs in rural China, which were divided into North and South China by direction, and eastern, central, and western China by region.

## Statistical Analysis

SARS-CoV-2 infection was defined as testing positive for either SARS-CoV-2 nucleic acids or antigens (*5*). The percent of SARS-CoV-2 infection = the number of SARS-CoV-2 infections / the number of participants. The daily average newly positive rate of SARS-CoV-2 infection = the percent of SARS-CoV-2 infection in the surveillance round / the number of days in the surveillance round, which was used to reflect the average daily new infection levels in the surveillance populations during a specific surveillance round (*5*).

According to the daily average of newly positive rates, estimated daily percentage change (EDPC) was calculated to measure trends in SARS-CoV-2 infection over specified time intervals. A regression line was fitted to the natural logarithm of the daily average newly positive rate, with $y = \alpha + \beta x$, where y is ln (the daily average newly positive rate) and x is the surveillance round. EDPC and its 95% confidence interval (*CI*) were calculated as $100 \times (e^{\beta} - 1)$ to measure the incidence trends between different rounds. Trends of incidence were considered downward (or upward) when EDPC value and its 95% *CI*s were below (or above) zero. Data analysis was conducted using SPSS (version 27, IBM Corp., USA).

# RESULTS

Approximately 90,000 participants in rural China were recruited into the community sentinel surveillance cohort of NSCS. The average daily rate of newly positive SARS-CoV-2 infections was 2.83%, 4.79%, 4.75%, 4.44%, 2.46%, 2.48%, 1.06%, and 0.57%, respectively, in rural China. The daily average newly positive rate in rural China increased from 2.83% in Round 1 (December 16–19, 2022) to the peak of 4.79% in Round 2 (December 20–22, 2022), then decreased by an average of 29.95% (95% *CI*: 18.28%–39.96%, *P*=0.002) per round from 4.79% in Round 2 (December 20–22, 2022) to 0.57% in Round 8 (January 10–12, 2023) (Table 1 and Figure 1A).

The peak of daily average newly positive rate occurred during Round 2 (December 20–22, 2022) in North China, with the highest observed in Gansu, Shandong, and Ningxia; while the peak occurred during Round 3 (December 23–26, 2022) in South China, with the highest in Hunan, Guangxi, and Zhejiang (Figure 1A). Subsequently, the daily average newly positive rate decreased by an average of 29.55% (95% *CI*: 15.86%–41.01%, *P*=0.004) per round from 5.28% in Round 2 (December 20–22, 2022) to 0.49% in Round 8 (January 10–12, 2023) in North China, which decreased more slowly than that in South China with an average decrease of 35.15% (95% *CI*: 23.55%–44.99%, *P*=0.002) per round from 5.63% in Round 3 (December 23–26, 2022) to 0.63% in Round 8 (January 10–12, 2023) (Table 1 and Figure 1A). The daily average newly positive rate converged between North and South China after Round 5 (December 30, 2022 to January 2, 2023).

Figure 1B and Table 2 illustrate the trends of SARS-CoV-2 infection in eastern, central, and western regions. The peak of daily average newly positive rate occurred during Round 2 (December 20–22, 2022) in eastern China, with the highest rates in Shandong, Zhejiang, and Hebei; while it occurred during Round 4 (December 27–29, 2022) in central China, with the highest rates in Hunan, Jiangxi, and Hubei. In eastern China, the daily average newly positive rate decreased by an average of 31.30% (95% *CI*: 25.15%–6.95%, *P*<0.001) per round from 6.09% in Round 2 (December 20–22, 2022) to 0.61% in Round 8 (January 10–12, 2023). In central China, it decreased

TABLE 1. SARS-CoV-2 infection among the general population in rural China, December 2022 to January 2023.

| Rounds | Number of people investigated (*n*) | Number of newly positive (*n*) | Daily average newly positive rate (%, 95% *CI*) |
|---|---|---|---|
| Total | | | |
| Round 1 (December 16–19, 2022) | 40,112 | 4,548 | 2.83 (2.67–3.00) |
| Round 2 (December 20–22, 2022) | 80,024 | 11,495 | 4.79 (4.64–4.94) |
| Round 3 (December 23–26, 2022) | 113,548 | 21,567 | 4.75 (4.62–4.87) |
| Round 4 (December 27–29, 2022) | 90,468 | 12,037 | 4.44 (4.30–4.57) |
| Round 5 (December 30, 2022 to January 2, 2023) | 89,392 | 8,782 | 2.46 (2.35–2.56) |
| Round 6 (January 3–5, 2023) | 83,454 | 6,214 | 2.48 (2.38–2.59) |
| Round 7 (January 6–9, 2023) | 93,252 | 3,969 | 1.06 (1.00–1.13) |
| Round 8 (January 10–12, 2023) | 91,792 | 1,560 | 0.57 (0.52–0.62) |
| North | | | |
| Round 1 (December 16–19, 2022) | 26,008 | 3,357 | 3.23 (3.01–3.44) |
| Round 2 (December 20–22, 2022) | 33,130 | 5,246 | 5.28 (5.04–5.52) |
| Round 3 (December 23–26, 2022) | 35,635 | 4,017 | 2.82 (2.65–2.99) |
| Round 4 (December 27–29, 2022) | 39,755 | 4,576 | 3.84 (3.65–4.03) |
| Round 5 (December 30, 2022 to January 2, 2023) | 42,168 | 4,390 | 2.60 (2.45–2.75) |
| Round 6 (January 3–5, 2023) | 37,486 | 2,621 | 2.33 (2.18–2.48) |
| Round 7 (January 6–9, 2023) | 42,586 | 1,618 | 0.95 (0.86–1.04) |
| Round 8 (January 10–12, 2023) | 42,586 | 627 | 0.49 (0.42–0.56) |
| South | | | |
| Round 1 (December 16–19, 2022) | 14,104 | 1,191 | 2.11 (1.87–2.35) |
| Round 2 (December 20–22, 2022) | 46,894 | 6,249 | 4.44 (4.26–4.63) |
| Round 3 (December 23–26, 2022) | 77,913 | 17,550 | 5.63 (5.47–5.79) |
| Round 4 (December 27–29, 2022) | 50,713 | 7,461 | 4.90 (4.72–5.09) |
| Round 5 (December 30, 2022 to January 2, 2023) | 47,224 | 4,392 | 2.33 (2.19–2.46) |
| Round 6 (January 3–5, 2023) | 45,968 | 3,593 | 2.61 (2.46–2.75) |
| Round 7 (January 6–9, 2023) | 50,666 | 2,351 | 1.16 (1.07–1.25) |
| Round 8 (January 10–12, 2023) | 49,206 | 933 | 0.63 (0.56–0.70) |

Note: North China included Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shandong, Henan, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. South China included Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Hainan, Sichuan, Guizhou, Yunnan, and Xizang (Tibet).

Abbreviation: SARS-CoV-2=severe acute respiratory syndrome coronavirus 2; *CI*=confidence interval.

by an average of 50.53% (95% *CI*: 27.54%–66.22%, *P*=0.010) per round from 5.99% in Round 4 (December 27–29, 2022) to 0.28% in Round 8 (January 10–12, 2023). In western China, the EDPC was -20.18% (95% *CI*: −32.94% to −4.99%, *P*=0.019) from Round 1 (December 16–19, 2022) to Round 8 (January 10–12, 2023).

At the provincial level, Figure 2 illustrates the daily average newly positive rate of SARS-CoV-2 infection in rural China during Round 8 (January 10–12, 2023). The highest rates were observed in Shanxi (3.21%) and Anhui (2.86%), while 15 of 27 PLADs in rural China had rates of less than 0.5%.

## DISCUSSION

Our study was the first to focus on the trends and differences of SARS-CoV-2 infection by region among the general community-based population in rural China during the rapid transmission of Omicron variants. Our results indicated that, although there was a slight gap in the peak time of new infection rates among regions, the peak of the epidemic wave in rural China had passed over a short period following the optimization of prevention and control measures. From February 17–23, 2023, the daily average newly positive rate was approximately 2 per 100,000

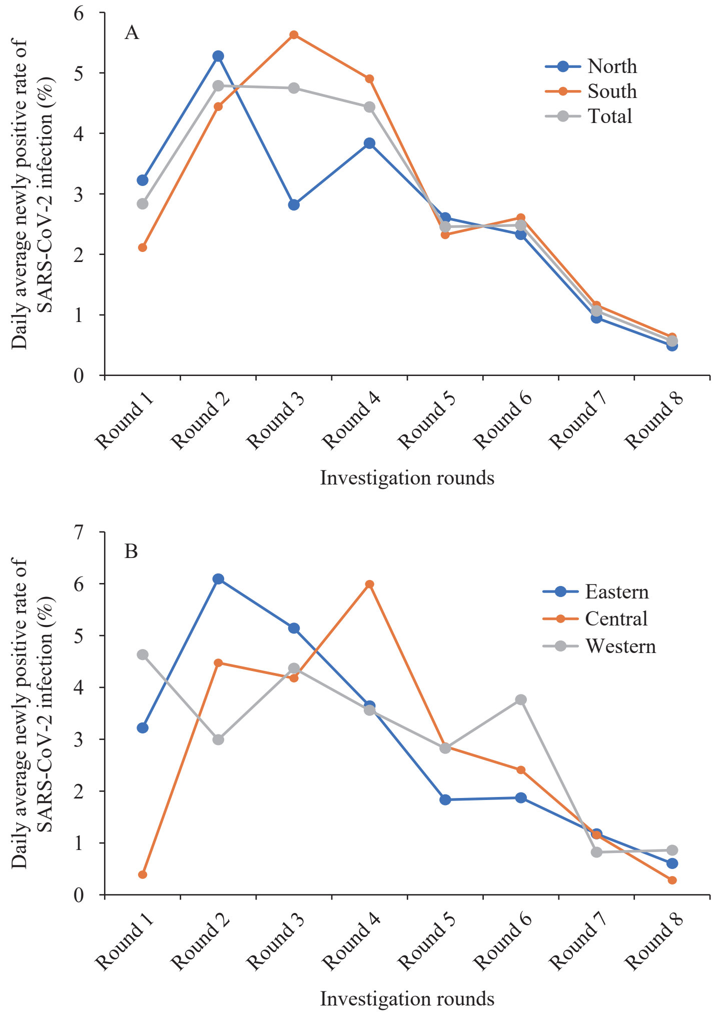


FIGURE 1. Trends of SARS-CoV-2 infection among the general population in rural China, December 2022 to January 2023. (A) Trends of SARS-CoV-2 infection in total, North, and South China; (B) Trends of SARS-CoV-2 infection in eastern, central, and western China.

Note: Investigations in the study were conducted in eight rounds, from December 16, 2022 to January 12, 2023. Round 1 was conducted from December 16–19, 2022; Round 2 from December 20–22, 2022; Round 3 from December 23–26, 2022; Round 4 from December 27–29, 2022; Round 5 from December 30, 2022 to January 2, 2023; Round 6 from January 3–5, 2023; Round 7 from January 6–9, 2023; and Round 8 from January 10–12, 2023.

Abbreviation: SARS-CoV-2=severe acute respiratory syndrome coronavirus 2.

population in rural China (unreported data). On February 23, 2023, the Chinese government declared that this epidemic wave was largely over and SARS-CoV-2 infection was sporadic (*9*).

Liu et al. (*5*) reported that the peak of new SARS-CoV-2 infections in China occurred between December 20–22, 2022, with a peak of 6.36%. Compared to the epidemic in urban China, the newly positive rates in rural China peaked at the same time, though the peak was lower than in urban areas (*5*). In the United States, the increase rate of cumulative COVID-19 cases peaked in early January 2021 and has since declined in both metro and nonmetro areas (*10*). Beginning in April 2021, the prevalence has been very similar in metro and nonmetro areas (*10*). In India, a nationwide survey found that 68% of 28,000 people had SARS-CoV-2 antibodies in June and July 2021, with little difference between the numbers in urban and rural regions (*11*).

In rural China, the population is aging and has higher medical needs, but health resources are relatively insufficient compared to those in urban China (*7*,*12*). On December 7, 2022, the Chinese government issued "Ten New Measures" and, on December 16, 2022, a work plan was published to emphasize the management of key populations, orderly channel the demand for medical treatment, and carry out classified and graded medical and health services to safeguard the

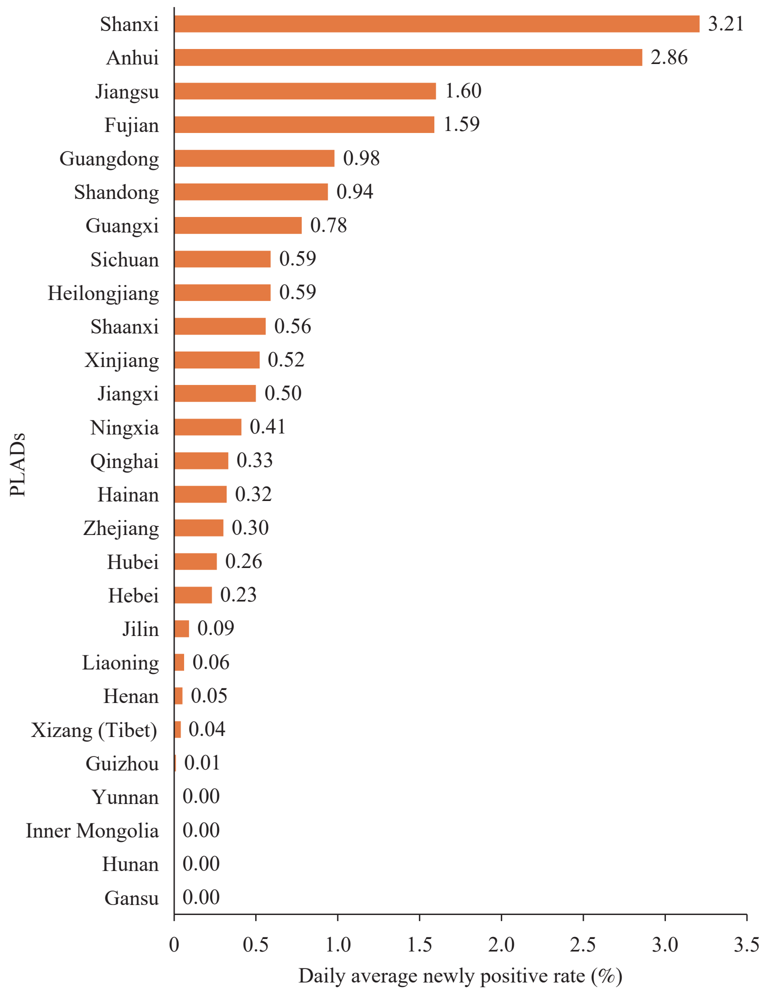


FIGURE 2. The daily average of newly positive rates of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in rural China in Round 8 (January 10–12, 2023) by provincial-level administrative divisions (PLADs).

health and lives of rural residents (*7*). To address the shortage of medicines and medical supplies in rural areas in January 2023, about 57.17 million health kits were distributed free of charge to key populations (*13*), 1.17 million finger-clamp oximeters were provided free of charge to 0.6 million village health offices, one oxygen machine was provided to each township hospital, and the rate of setting up fever clinics in township hospitals reached 99.1% (*13–14*). The implementation of these policies and distribution of medical supplies contributed to the rapid response against the COVID-19 epidemic in rural China, enabling the country to withstand the peak of the epidemic steadily (*5*).

The rapid transmission of Omicron variants throughout China prompted the Chinese government to rapidly implement the NSCS to monitor the changing situation of the epidemic among the general population since December 16, 2022. This study had several strengths. NSCS, which included a large community-based cohort of approximately 90,000 rural participants who were tested regularly, frequently, and periodically, effectively filled the current research and knowledge gap in rural areas, providing data and technical support to assess the dynamic infection level (*5*). Other systems lacked systematic surveillance and analysis of SARS-CoV-2 infection in rural areas during the same time (*8*). Additionally, NSCS has important reference significance for the subsequent prevention and control of infectious diseases in rural populations in China.

This study had several limitations. First, the aggregated data collected through the NSCS could not be analyzed in detail by individual sociodemographic characteristics or disease histories. Second, although the four municipalities had rural populations, this study divided its respondents into urban areas. Third, both population-proportional-to-size random sampling

TABLE 2. SARS-CoV-2 infection among the general population in rural China by region, December 2022 to January 2023.

| Rounds | Number of people investigated (*n*) | Number of newly positive (*n*) | Daily average newly positive rate (%, 95% *CI*) |
|---|---|---|---|
| Eastern | | | |
| Round 1 (December 16–19, 2022) | 11,926 | 1,536 | 3.22 (2.90–3.54) |
| Round 2 (December 20–22, 2022) | 34,638 | 6,333 | 6.09 (5.84–6.35) |
| Round 3 (December 23–26, 2022) | 62,204 | 12,796 | 5.14 (4.97–5.32) |
| Round 4 (December 27–29, 2022) | 34,451 | 3,766 | 3.64 (3.45–3.84) |
| Round 5 (December 30, 2022 to January 2, 2023) | 34,451 | 2,525 | 1.83 (1.69–1.97) |
| Round 6 (January 3–5, 2023) | 34,451 | 1,934 | 1.87 (1.73–2.01) |
| Round 7 (January 6–9, 2023) | 34,451 | 1,621 | 1.18 (1.06–1.29) |
| Round 8 (January 10–12, 2023) | 34,451 | 626 | 0.61 (0.52–0.69) |
| Central | | | |
| Round 1 (December 16–19, 2022) | 13,025 | 202 | 0.39 (0.28–0.49) |
| Round 2 (December 20–22, 2022) | 24,467 | 3,284 | 4.47 (4.22–4.73) |
| Round 3 (December 23–26, 2022) | 26,535 | 4,435 | 4.18 (3.94–4.42) |
| Round 4 (December 27–29, 2022) | 31,336 | 5,635 | 5.99 (5.73–6.26) |
| Round 5 (December 30, 2022 to January 2, 2023) | 31,147 | 3,566 | 2.86 (2.68–3.05) |
| Round 6 (January 3–5, 2023) | 30,791 | 2,224 | 2.41 (2.24–2.58) |
| Round 7 (January 6–9, 2023) | 31,492 | 1,451 | 1.15 (1.03–1.27) |
| Round 8 (January 10–12, 2023) | 31,499 | 267 | 0.28 (0.22–0.34) |
| Western | | | |
| Round 1 (December 16–19, 2022) | 15,161 | 2,810 | 4.63 (4.30–4.97) |
| Round 2 (December 20–22, 2022) | 20,919 | 1,878 | 2.99 (2.76–3.22) |
| Round 3 (December 23–26, 2022) | 24,809 | 4,336 | 4.37 (4.12–4.62) |
| Round 4 (December 27–29, 2022) | 24,681 | 2,636 | 3.56 (3.33–3.79) |
| Round 5 (December 30, 2022 to January 2, 2023) | 23,794 | 2,691 | 2.83 (2.62–3.04) |
| Round 6 (January 3–5, 2023) | 18,212 | 2,056 | 3.76 (3.49–4.04) |
| Round 7 (January 6–9, 2023) | 27,309 | 897 | 0.82 (0.71–0.93) |
| Round 8 (January 10–12, 2023) | 25,842 | 667 | 0.86 (0.75–0.97) |

Note: The eastern region included Hebei, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. The central region included Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan. The western region included Inner Mongolia, Guangxi, Sichuan, Guizhou, Yunnan, Xizang (Tibet), Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang.
Abbreviation: SARS-CoV-2=severe acute respiratory syndrome coronavirus 2; *CI*=confidence interval.

and convenience sampling were used in this emergency surveillance project, which may have led to sampling bias, lack of representation of the rural population, and conclusions that may not be generalizable to other populations (*5*).

In conclusion, sentinel surveillance data from community populations suggested that although there was a slight variation in the peak time of SARS-CoV-2 infection among regions, the epidemic wave in rural China peaked on December 20–22, 2022, and passed over a short period following the optimization of prevention and control measures. Currently, SARS-CoV-2 infection in community populations in rural China is sporadic.

**Conflicts of interest**: No conflicts of interest.

**Acknowledgement**: the Surveillance and Alert Department of the National Bureau of Disease Control and Prevention, the Provincial Health Commission, the Provincial Center for Disease Control and Prevention, and the staff and participants from the 31 PLADs involved in the National Sentinel Community-Based Surveillance.

**Funding:** National Natural Science Foundation of China (72122001; 72211540398; 71934002); National Key Research and Development Program of China (2021ZD0114105; 2021ZD0114104; 2021ZD0114101); the Shui Mu Tsinghua Scholar Program.

doi: 10.46234/ccdcw2023.044

# Corresponding authors: Wannian Liang, liangwn@tsinghua.edu.cn; Qun Li, liqun@chinacdc.cn; Min Liu, liumin@bjmu.edu.cn.

[1] Vanke School of Public Health, Tsinghua University, Beijing, China; Institute for Healthy China, Tsinghua University, Beijing, China; [2] Chinese Center for Disease Control and Prevention, Beijing, China; [3] School of Public Health, Peking University, Beijing, China.
[&] Joint first authors.

Submitted: February 28, 2023; Accepted: March 13, 2023

## REFERENCES

1. WHO. Statement on the fourteenth meeting of the International Health Regulations (2005) Emergency Committee regarding the coronavirus disease (COVID-19) pandemic. 2023. https://www.who.int/news/item/30-01-2023-statement-on-the-fourteenth-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-coronavirus-disease-(covid-19)-pandemic. [2023-2-19].
2. The Independent Panel for Pandemic Preparedness & Response. COVID-19: make it the last pandemic. 2021. https://theindependentpanel.org/wp-content/uploads/2021/05/COVID-19-Make-it-the-Last-Pandemic_final.pdf. [2021-2-19].
3. National Health Commission of the People's Republic of China. China enters a new phase in the fight against epidemics - A chronicle of China's efforts to optimize prevention and control measures in response to the epidemic situation. 2023. http://www.nhc.gov.cn/wjw/mtbd/202301/53e4bdbadd0f4a3384c0af7e38f16427.shtml. [2023-2-19]. (In Chinese).
4. Central People's Government of the People's Republic of China. State Council Joint Prevention and Control Mechanism announces twenty measures to further optimize epidemic prevention and control. 2022. http://www.gov.cn/xinwen/2022-11/11/content_5726144.htm. [2023-2-19]. (In Chinese).
5. Liu J, Ding F, Wu Y, Jing WZ, Yan WX, Qin CY, et al. Trends of SARS-CoV-2 infection in sentinel community-based surveillance after the optimization of prevention and control measures — China, December 2022–January 2023. China CDC Wkly 2023;5(7):159 – 64. http://dx.doi.org/10.46234/ccdcw2023.028.
6. Comprehensive Group of Joint Prevention and Control Mechanism of the State Council in Response to Novel Coronavirus Pneumonia. Notice on further optimising the implementation of measures to prevent and control the COVID-19 epidemic. 2022. http://www.gov.cn/xinwen/2022-12/07/content_5730443.htm. [2023-2-19]. (In Chinese).
7. Comprehensive Group of Joint Prevention and Control Mechanism of the State Council in Response to Novel Coronavirus Pneumonia. Notice on the issuance of a programme to strengthen the prevention, control and health services of the COVID-19 epidemic in rural areas. 2022. http://www.nhc.gov.cn/jws/s7874/202212/5f0d698fdc7746948e6f7df32c806b1c.shtml. [2023-2-20]. (In Chinese).
8. Chinese Center for Disease Control and Prevention. COVID-19 clinical and surveillance data — December 9, 2022 to January 23, 2023, China. 2023. https://weekly.chinacdc.cn/fileCCDCW/cms/news/info/upload//1b301caf-8637-47f0-88f0-38b5d8e2d2d4.pdf. [2023-2-20].
9. National Health Commission of the People's Republic of China. Transcript of the State Council Joint Prevention and Control Mechanism press conference on 23 Feb. 2023. http://www.nhc.gov.cn/xcs/yqfkdt/202302/172708cde8fb4e40976e693443bbb596.shtml. [2023-2-25]. (In Chinese).
10. Economic Research Service, U.S. Department of Agriculture. The COVID-19 pandemic and rural America. 2021. https://www.ers.usda.gov/covid-19/rural-america/. [2023-2-28].
11. Mallapaty S. Delta threatens rural regions that dodged earlier COVID waves. Nature 2021;596(7872):325 – 6. http://dx.doi.org/10.1038/d41586-021-02146-w.
12. Wei HK. China rural revitalization survey 2021. Beijing: China Social Sciences Press. 2022. https://book.kongfz.com/250927/4852701956/. (In Chinese).
13. National Health Commission of the People's Republic of China. Transcript of the State Council Joint Prevention and Control Mechanism press conference on 19 January 2023. 2023. http://www.nhc.gov.cn/xcs/yqfkdt/202301/f9dc81a1ff254460879af4be60f2dd2c.shtml. [2023-2-20]. (In Chinese).
14. Ministry of Agriculture and Rural Affairs of the People's Republic of China. Task force on epidemic prevention and control in rural areas: equipping township and village-level medical and health institutions with free oximeters and oxygen generators. 2023. http://www.moa.gov.cn/xw/zwdt/202301/t20230112_6418771.htm. [2023-2-20]. (In Chinese).

Vital Surveillances

# Trends of SARS-CoV-2 Infection Among Couriers in Risky Business After the Optimization of Prevention and Control Measures — China, December 2022 to January 2023

Yu Wu[1,&]; Fan Ding[2,&]; Jue Liu[1]; Wenzhan Jing[3]; Wenxin Yan[1]; Chenyuan Qin[1]; Fangyuan Li[2]; Yanping Zhang[2]; Guoqing Shi[2]; Wannian Liang[3,#]; Qun Li[2,#]; Min Liu[1,#]

## ABSTRACT

**Introduction**: On December 7, 2022, China implemented "Ten New Measures" to optimize prevention and control measures for coronavirus disease 2019 (COVID-19). The purpose of this study was to evaluate the national and regional trends of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection among couriers in China from December 2022 to January 2023.

**Methods**: Data from the National Sentinel Community-based Surveillance in China was utilized, including participants from 31 provincial-level administrative divisions and Xinjiang Production and Construction Corps. Participants were tested for SARS-CoV-2 infection twice a week from December 16, 2022 to January 12, 2023. Infection was defined as a positive result for SARS-CoV-2 nucleic acid or antigen. The daily average newly positive rate of SARS-CoV-2 infection and the estimated daily percentage change (EDPC) were calculated.

**Results**: In this cohort, 8 rounds of data were collected. The daily average newly positive rate of SARS-CoV-2 infection decreased from 4.99% in Round 1 to 0.41% in Round 8, with an EDPC of −33.0%. Similar trends of the positive rate were also observed in the eastern (EDPC: −27.7%), central (EDPC: −38.0%) and western regions (EDPC: −25.5%). Couriers and community population showed a similar temporal trend, with the peak daily average newly positive rate of couriers being higher than that of community population. After Round 2, the daily average newly positive rate of couriers decreased sharply, becoming lower than that of community population in the same period.

**Conclusions**: The peak of SARS-CoV-2 infection among couriers in China has passed. As couriers are a key population for SARS-CoV-2 infection, they should be monitored continuously.

Since its outbreak in late 2019, coronavirus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been spread globally and declared an epidemic by the World Health Organization (*1*). After experiencing the peak of the COVID-19 epidemic, China entered a normalization stage of prevention and control on April 29, 2020. During this stage, China effectively controlled the outbreak and spread of the epidemic by adopting the strategy of "preventing inbound cases and domestic resurgence", and effectively reduced the occurrence of death cases (*2*). On December 7, 2022, China implemented the "Ten New Measures" to deeply improve the prevention and control of COVID-19 (*3*). These measures were introduced based on the latest epidemic situations and mutation of the virus to contain the epidemic in a more science-based and targeted manner. Couriers are a key population in the prevention and control of the epidemic, as they are in daily contact with numerous clients and coworkers, and may get infected at work and spread the disease to others (*4*). Studies have revealed that the demand for couriers has risen since the outbreak of COVID-19; a study in the Republic of Korea showed that the average number of times people used a courier service rose from 6.22 to 9.74 per month after the pandemic began (*5*), and reports from Russia indicated that the demand for couriers has grown 11 times over the past five years (*6*). However, the working hazards of couriers have rarely been studied. No study has evaluated the SARS-CoV-2 infection among couriers during the wide spread of Omicron variants BA.5.2.48 and BF.7.14 in China. To fill this gap, we aimed to evaluate the national and regional trends of SARS-CoV-2 infection among couriers using a community sentinel surveillance system in China between December 2022 and January 2023 to provide the latest data.

## METHODS

Using data from the National Sentinel Community-Based Surveillance (NSCS) in China, we assessed the trends of SARS-CoV-2 infection among couriers. The NSCS was a national community-based sentinel surveillance cohort from 31 provincial-level administrative divisions (PLADs) and Xinjiang Production and Construction Corps (XPCC). Multistage stratified cluster sampling was used to select participants. Each PLAD was required to select one provincial capital city and one large city, with at least 200 couriers sampled in each provincial capital city and at least 100 couriers sampled in each large city. Nucleic acid or antigen testing was conducted twice a week for each courier, as appropriate. The neighborhood committee (village committee) of each surveillance sentinel site was responsible for the specific implementation of the investigation and information reporting, while the district CDC of each surveillance sentinel site was responsible for collecting information and reporting at each level. All participants in the monitored communities were investigated twice a week (a total of eight surveillance rounds) from December 16, 2022 to January 12, 2023.

SARS-CoV-2 infection was defined as a positive test for SARS-CoV-2 nucleic acid or antigen. The daily average newly positive rate of SARS-CoV-2 infection and its 95% confidence interval (*CI*) (*7*) were calculated, which was defined as the percentage of the number of people with positive nucleic acid or antigen detection of SARS-CoV-2 in the total number of surveyed people in a specific round of surveillance divided by the number of survey days.

The estimated daily percentage change (EDPC) was calculated, a widely used measure of the rate trend over a specified time interval globally. A regression line was fitted to the natural logarithm of the positive rate, i.e., $y = \alpha + \beta x$, where y = ln(daily average newly positive rate) and x = Rounds. The EDPC was calculated as $100 \times (e^{\beta} - 1)$ and its 95% *CI* was calculated as $[(100 \times (e^{\beta\ lower\ bound} - 1), 100 \times (e^{\beta\ upper\ bound} - 1)]$ to reflect the trends of daily average newly positive rate between different rounds. The trends of positive rate are downward (or upward) when the EDPC value and its 95% *CI* are below (or above) zero. R 4.1.3 (R Foundation for Statistical Computing, Vienna, Austria) and Excel 2010 (Microsoft Corp., Redmond, WA., USA) were used to analyze and generate statistical figures.

## RESULTS

As shown in Table 1, 21,000 couriers were recruited in the key population surveillance of NSCS. The daily average newly positive rate of SARS-CoV-2 infection decreased from 4.99% in Round 1 (December 16–19, 2022) to 0.41% in Round 8 (January 10–12, 2023), with an EDPC of −33.0% (95% *CI*: −40.2% to -25.0%, *P*<0.001). The daily average newly positive rate of SARS-CoV-2 infection for the eight surveillance rounds were 4.99%, 9.49%, 2.94%, 2.58%, 1.55%, 1.08%, 0.31%, and 0.41%, respectively. The epidemic peak occurred during Round 2 (December 20–22,

TABLE 1. Trends of SARS-CoV-2 infection among the couriers in sentinel community-based surveillance, China, December 2022 to January 2023.

| Rounds (investigate date) | Number of investigated couriers | Number of newly positive cases | Daily average newly positive rate of SARS-CoV-2 infection (%, 95% *CI*) |
|---|---|---|---|
| Round 1 | 1,990* | 397 | 4.99 (4.03, 5.94) |
| Round 2 | 9,960* | 2,837 | 9.49 (8.92, 10.07) |
| Round 3 | 21,861 | 2,574 | 2.94 (2.72, 3.17) |
| Round 4 | 21,012 | 1,628 | 2.58 (2.37, 2.80) |
| Round 5 | 22,247 | 1,381 | 1.55 (1.39, 1.71) |
| Round 6 | 22,081 | 718 | 1.08 (0.95, 1.22) |
| Round 7 | 22,112 | 276 | 0.31 (0.24, 0.39) |
| Round 8. | 23,009 | 280 | 0.41 (0.32, 0.49) |

Note: Investigations in the study were conducted in 8 rounds, from December 16, 2022 to January 12, 2023. Round 1 was conducted December 16–19, 2022; Round 2 December 20–22, 2022; Round 3 December 23–26, 2022; Round 4 December 27–29, 2022; Round 5 December 30, 2022–January 2, 2023; Round 6 January 3–5, 2023; Round 7 January 6–9, 2023; and Round 8 January 10–12, 2023.
Abbreviation: SARS-CoV-2=severe acute respiratory syndrome coronavirus 2; *CI*=confidence interval.
* Sample sizes for Rounds 1 and 2 of surveillance did not meet expectations due to the peak of SARS-CoV-2 infection from December 16 to 22, 2022, resulting in many couriers being unable to participate in the survey due to COVID-19 symptoms.

2022).

Table 2 presents the epidemic trends of SARS-CoV-2 in three regions. In eastern China, the daily average newly positive rate of SARS-CoV-2 infection among couriers decreased from 4.18% in Round 1 to 0.76% in Round 8, with an EDPC of −27.7% ($P$<0.001). For central and western China, EDPCs were −38.0% (decreasing from 2.69% to 0.17%, $P$<0.001) and −25.5% (decreasing from 5.68% to 0.60%, $P$<0.001), respectively. The daily average newly positive rates among couriers in eastern, central and western China all peaked at Round 2.

As Figure 1 shows, the daily average of newly positive rates in the eastern and western regions were generally higher than the national level, while the positive rate in the central region was lower than the national level. After Round 6 (January 3–5, 2023), the daily average of newly positive rates across regions

TABLE 2. Trends of SARS-CoV-2 infection among couriers in sentinel community-based surveillance by regions, China, December 2022 to January 2023.

| Rounds | Number of investigate couriers | Number of newly positive cases | Daily average newly positive rate of SARS-CoV-2 infection (%, 95% *CI*) | EDPC (%, 95% *CI*) | *P* value |
|---|---|---|---|---|---|
| Eastern | | | | | |
| Round 1 | 658 | 110 | 4.18 (2.65, 5.71) | −27.7 (−34.4, −20.4) | <0.001 |
| Round 2 | 3,895 | 1,172 | 10.03 (9.09, 10.97) | | |
| Round 3 | 6,274 | 1,306 | 5.20 (4.65, 5.75) | | |
| Round 4 | 4,539 | 507 | 3.72 (3.17, 4.27) | | |
| Round 5 | 5,732 | 377 | 1.64 (1.32, 1.97) | | |
| Round 6 | 4,911 | 253 | 1.72 (1.35, 2.08) | | |
| Round 7 | 5,685 | 78 | 0.34 (0.19, 0.49) | | |
| Round 8 | 6,046 | 138 | 0.76 (0.54, 0.98) | | |
| Central | | | | | |
| Round 1 | 130 | 14 | 2.69 (−0.09, 5.47) | −38.0 (−46.3, −28.5) | <0.001 |
| Round 2 | 2,881 | 929 | 10.75 (9.62, 11.88) | | |
| Round 3 | 11,920 | 302 | 0.63 (0.49, 0.78) | | |
| Round 4 | 12,190 | 432 | 1.18 (0.99, 1.37) | | |
| Round 5 | 12,284 | 431 | 0.88 (0.71, 1.04) | | |
| Round 6 | 12,285 | 239 | 0.65 (0.51, 0.79) | | |
| Round 7 | 12,573 | 127 | 0.25 (0.16, 0.34) | | |
| Round 8 | 12,607 | 63 | 0.17 (0.10, 0.24) | | |
| Western | | | | | |
| Round 1 | 1,202 | 273 | 5.68 (4.37, 6.99) | −25.5 (−31.9, −18.6) | <0.001 |
| Round 2 | 3,184 | 736 | 7.71 (6.78, 8.63) | | |
| Round 3 | 3,667 | 966 | 6.59 (5.78, 7.39) | | |
| Round 4 | 4,283 | 689 | 5.36 (4.69, 6.04) | | |
| Round 5 | 4,231 | 573 | 3.39 (2.84, 3.93) | | |
| Round 6 | 4,885 | 226 | 1.54 (1.20, 1.89) | | |
| Round 7 | 3,854 | 71 | 0.46 (0.25, 0.67) | | |
| Round 8 | 4,356 | 79 | 0.60 (0.37, 0.83) | | |

Note: EDPC stands for estimated daily percentage change from Round 1 to Round 8 between December 16, 2022 and January 12, 2023. Round 1 was conducted December 16–19, 2022; Round 2 December 20–22, 2022; Round 3 December 23–26, 2022; Round 4 December 27–29, 2022; Round 5 December 30, 2022–January 2, 2023; Round 6 January 3–5, 2023; Round 7 January 6–9, 2023; and Round 8 January 10–12, 2023. The eastern region included Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan PLADs; the western region included Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Xizang (Tibet), Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang PLADs, and XPCC; the central region included Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan PLADs.

Abbreviation: SARS-CoV-2=severe acute respiratory syndrome coronavirus 2; EDPC=estimated daily percentage change; *CI*=confidence interval; PLAD=provincial-level administrative division; XPCC=Xinjiang Production and Construction Corps.

converged and the disparities between regional incidence were noticeably decreasing, with all rates falling below 1% in Round 8.

As shown in Figure 2, the daily average of newly positive cases among couriers varied across PLADs, but all showed a downward trend after reaching a peak in Round 2, and dropped below 5% in Round 8.

Figure 3 demonstrates that couriers and the community population had a similar temporal trend, with the peak daily average newly positive rate of couriers (9.49%) being higher than that of the community population (6.36%). Following Round 2, the daily average newly positive rate of couriers decreased significantly, becoming lower than that of the community population during the same period.

## DISCUSSION

Our findings showed that the peak of daily average newly positive rates of SARS-CoV-2 infection among couriers occurred between December 20–22, 2022 and had decreased to 0.41% by January 10–12, 2023. In terms of the distribution of positive rates in different regions, the eastern, central, and western regions all reached their peak on December 20–22, 2022. The peak in the western region was relatively low and the disparities between regional incidence were shrinking, with all regions declining below 1% in Round 8. Data from different PLADs also showed a downward trend in newly positive SARS-CoV-2 infections among couriers.

Jue et al. (*8*) utilized data from the NSCS system in China to assess trends of SARS-CoV-2 infection among community population. In this national cohort, the daily average newly positive rate of SARS-CoV-2 infection decreased from 4.13% in Round 1 (December 16–19, 2022) to 0.69% in Round 8 (January 10–12, 2023). The time trend of the positive rate of couriers in our study was consistent with that of community population, which showed that the epidemic in China has reached a steady transition after the optimization of prevention and control measures.

The express delivery business in China is

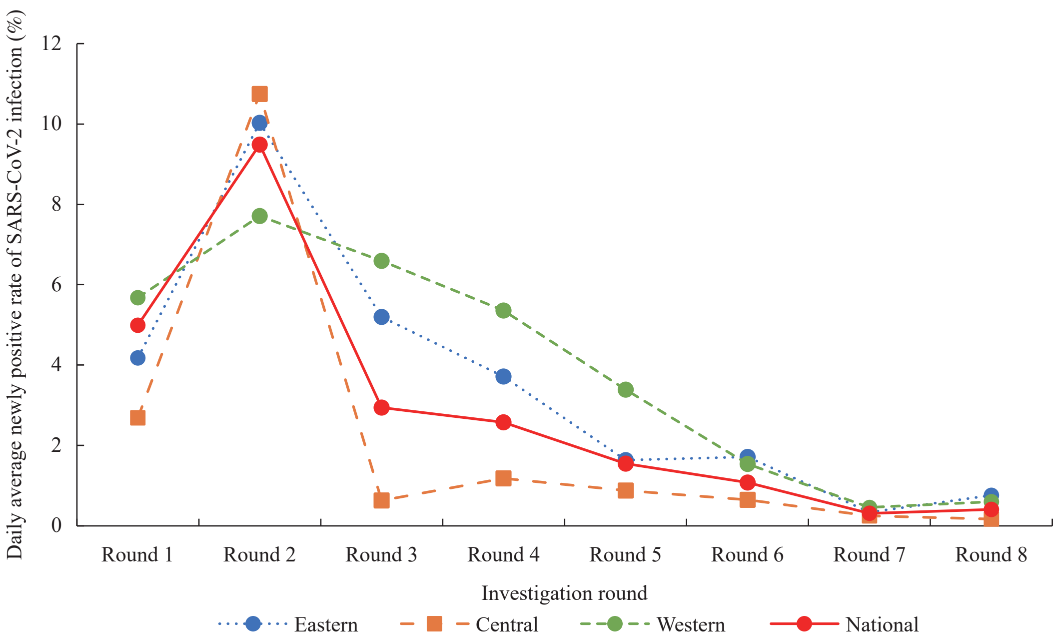


FIGURE 1. Trends of SARS-CoV-2 infection among couriers in the sentinel community-based surveillance, China, December 2022–January 2023, stratified by regions.

Note: Investigations in the study were conducted in 8 rounds, from December 16, 2022 to January 12, 2023. Round 1 was conducted December 16–19, 2022; Round 2 December 20–22, 2022; Round 3 December 23–26, 2022; Round 4 December 27–29, 2022; Round 5 December 30, 2022–January 2, 2023; Round 6 January 3–5, 2023; Round 7 January 6–9, 2023; and Round 8 January 10–12, 2023. The eastern region included Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan PLADs; the western region included Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Xizang (Tibet), Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang PLADs, and XPCC; the central region included Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan PLAD.

Abbreviation: SARS-CoV-2=severe acute respiratory syndrome coronavirus 2; PLAD=provincial-level administrative division; XPCC=Xinjiang Production and Construction Corps.

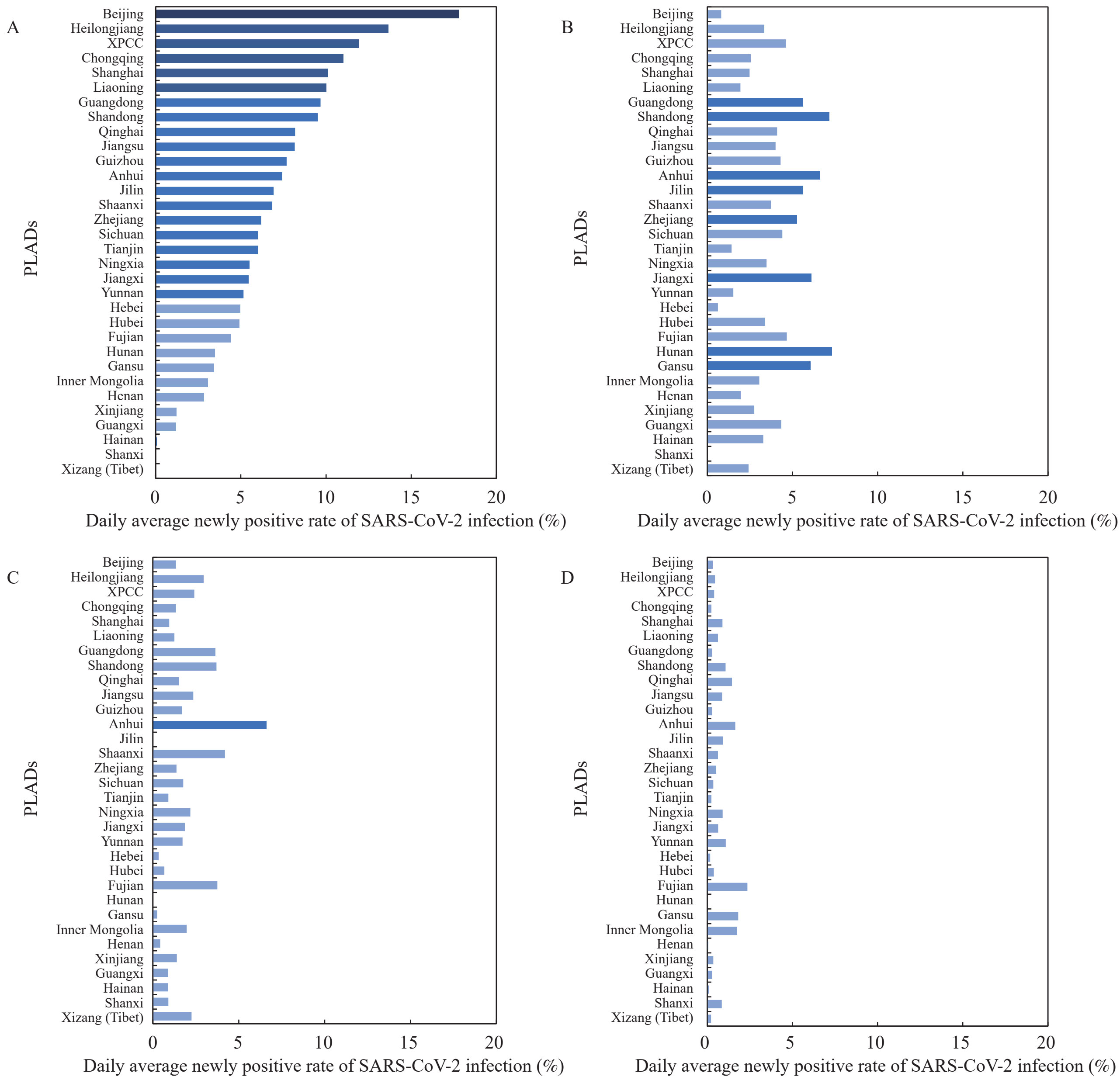


FIGURE 2. Average daily rate of newly positive couriers in the sentinel community-based surveillance in China, December 2022 to January 2023, stratified by PLAD and XPCC. (A) Round 2; (B) Round 4; (C) Round 6; (D) Round 8.
Note: Round 2 was conducted December 20–22, 2022; Round 4 December 27–29, 2022; Round 6 January 3–5, 2023; and Round 8 January 10–12, 2023.
Abbreviation: SARS-CoV-2=severe acute respiratory syndrome coronavirus 2; PLAD=provincial-level administrative division; XPCC=Xinjiang Production and Construction Corps.

burgeoning, increasing job opportunities at express delivery enterprises, resulting in a growing need for delivery personnel. Statistically, the number of couriers in China increases by 150,000–200,000 every year (*9*). Chinese couriers are generally young and poorly educated. They work long hours on consecutive days in a challenging environment with little to no downtime.

Since the outbreak of COVID-19, the demand for couriers has risen (*4*). The virus is transmitted when an infected person comes in close contact with another person. Couriers, as they have many customers, suppliers, and coworkers, are at higher risk of transmission (*10*). In the study by Egozi et al. (*4*), the couriers reported their self-compliance with regulations to prevent infection: 35% reported full compliance, 38% reported partial compliance, and 27% reported no compliance. The combination of potential safety

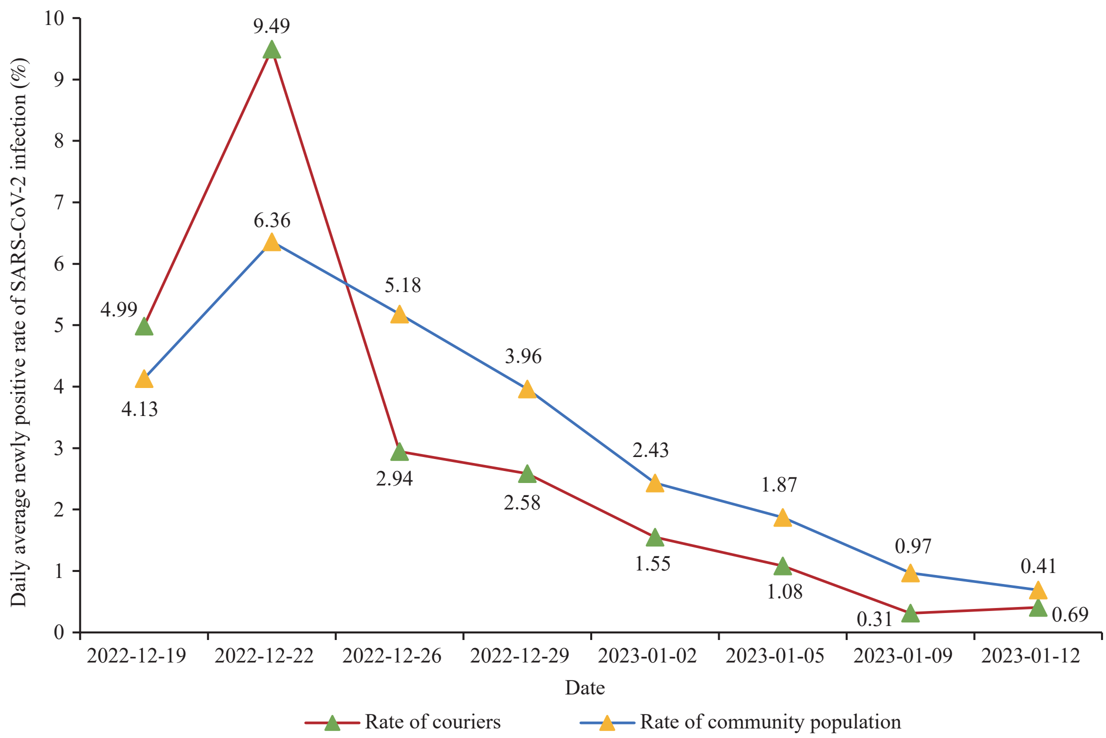


FIGURE 3. Time trends of SARS-CoV-2 infection among couriers and community population in the sentinel community-based surveillance, China, December 2022 to January 2023.
Abbreviation: SARS-CoV-2=severe acute respiratory syndrome coronavirus 2.

and health risks with varied terms of employment puts this population at risk of inadequate health and safety at work in general and during the COVID-19 pandemic in particular. The likelihood that delivery workers have direct contact with SARS-CoV-2-infected customers without ever experiencing symptoms and may subsequently act as a presymptomatic transmitter unwittingly passing the novel coronavirus to their healthy customers, coworkers, or families should be taken into consideration (*11*).

SARS-CoV-2 is primarily spread through respiratory droplets during close face-to-face contact (*12*). The risk of transmission via fomites is low, but the Omicron variant currently circulating around the world is more infectious. According to Hirose et al. (*13*), the median survival times of the Wuhan strain, Alpha variant, Beta variant, Gamma variant, Delta variant, Omicron BA.1 variant, and Omicron BA.2 variant on plastic surfaces were 56.0 h, 191.3 h, 156.6 h, 59.3 h, 114.0 h, 193.5 h, and 199.7 h, respectively. The Omicron BA.1 and BA.2 variants had the longest survival time, indicating that couriers are at a higher risk of Omicron infection. Our study found that the peak daily average newly positive rate of couriers (9.49%) was higher than that of the community population (6.36%). After the second round, the daily average newly positive rate of couriers decreased, lower than that of the community population in the same period. Couriers are generally highly mobile, thus increasing their risk of contracting SARS-CoV-2. Additionally, since couriers are usually young and healthy, the symptoms after infection are generally mild and they recover quickly, leading to a rapid decrease in the peak of the daily average newly positive rate. As a key population for SARS-CoV-2 infection, couriers should be continuously monitored. The couriers' cohort has effectively filled the current research gap, providing the most up-to-date data information and technical support for the assessment of the epidemic situations and the estimation of medical treatment requests at national, regional, and provincial levels.

This study has several strengths. First, we selected a large sample size of couriers in provincial capitals and larger cities in all 31 PLADs and XPCC. Second, the NSCS conducted regular and frequent laboratory testing of participants at the peak of the epidemic. However, several potential limitations of this study should be noted. First, since this is an emergency surveillance project supported by the National Bureau of Disease Control and Prevention, the sampling methods varied from province to province, including

PPS random sampling and convenience sampling, which may have impacted the daily positive rate. Second, we only selected couriers in urban areas as participants, and there was a lack of relevant data on rural couriers. The couriers' cohort was unstable and there was a high turnover of couriers, which may have affected the positive rate. Third, we analyzed aggregated NSCS data without individual-level data and therefore could not analyze the differences in the average daily incidence rate of SARS-CoV-2 infection among people with different characteristics (such as age, gender, and presence of underlying chronic diseases).

In conclusion, after the optimization of prevention and control measures, sentinel surveillance data of the community population indicate that the peak of SARS-CoV-2 infection in China has passed. Currently, SARS-CoV-2 infection among couriers in China is at a low epidemic level. To ensure continued control of the virus, it is necessary to maintain monitoring of the positive rate of couriers in the future.

**Conflicts of interest**: No conflicts of interest.

**Acknowledgment**: Surveillance and Alert Department of the National Bureau of Disease Control and Prevention, the Provincial Health Commission, the Provincial Center for Disease Control and Prevention, and the staff and participants from 31 PLADs and XPCC.

**Funding:** National Natural Science Foundation of China (72122001; 72211540398; 71934002); National Key Research and Development Program of China (2021ZD0114105; 2021ZD0114104; 2021ZD0114101).

**doi:** 10.46234/ccdcw2023.045

[#] Corresponding authors: Min Liu, liumin@bjmu.edu.cn; Qun Li, liqun@chinacdc.cn; Wannian Liang, liangwn@tsinghua.edu.cn.

[1] School of Public Health, Peking University, Beijing, China; [2] Chinese Center for Disease Control and Prevention, Beijing, China; [3] Vanke School of Public Health, Tsinghua University, Beijing, China; Institute for Healthy China, Tsinghua University, Beijing, China.
[&] Joint first authors.

Submitted: February 28, 2023; Accepted: March 13, 2023

# REFERENCES

1. WHO. Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. 2020. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020. [2023-3-1].
2. Liang WN, Yao JH, Wu J, Liu X, Liu J, Zhou L, et al. Experience and thinking on the normalization stage of prevention and control of COVID-19 in China. Natl Med J China 2021;101(10):695 – 9. http://dx.doi.org/10.3760/cma.j.cn112137-20210104-00008. (In Chinese).
3. The State Council of the People's Republic of China. COVID-19 response further optimized with 10 new measures. 2022. https://english.www.gov.cn/statecouncil/ministries/202212/08/content_WS63913c92c6d0a757729e4135.html. [2023-2-27].
4. Egozi L, Reiss-Hevlin N, Dallasheh R, Pardo A. Couriers' safety and health risks before and during the COVID-19 pandemic. Int Arch Occup Environ Health 2022;95(3):589 – 8. http://dx.doi.org/10.1007/s00420-021-01795-8.
5. Yim HS. Demand for courier service soared during pandemic: study. Korea Herald. 2021 Jul 4. http://www.koreaherald.com/view.php?ud=20210704000156.
6. OREANDA-NEWS. The demand for couriers in Russia has grown 11 times over the past five years. 2022. https://www.oreanda-news.com/en/torgovlya_i_uslugi/the-demand-for-couriers-in-russia-has-grown-11-times-over-the-past-five-years/article1459688/#:~:text=During%20that%20period%2C%20the%20number%20of%20courier%20vacancies,the%20salaries%20of%20delivery%20workers%20have%20also%20risen. [2023-2-27].
7. Newcombe RG. Two-sided confidence intervals for the single proportion: comparison of seven methods. Stat Med 1998;17(8):857 – 72. http://dx.doi.org/10.1002/(SICI)1097-0258(19980430)17:8<857::AID-SIM777>3.0.CO;2-E.
8. WHO. Preventing and mitigating COVID-19 at work: policy brief, 19 May 2021. 2021. https://www.who.int/publications/i/item/WHO-2019-nCoV-workplace-actions-policy-brief-2021-1. [2023-2-27].
9. Liu J, Ding F, Wu Y, Jing W, Yan W, Qin C, et al. Trends of SARS-CoV-2 infection in sentinel community-based surveillance after the optimization of prevention and control measures — China, December 2022–January 2023. China CDC Wkly 2023;5(7):159 – 64. http://dx.doi.org/10.46234/ccdcw2023.028.
10. Fang Y, Wang J, Zhou Z. An empirical study on the working and living situation of first-line couriers in cities – an empirical study on the working and living situation of young employees in the urban express industry. China Youth Study 2017;4:4 – 11.
11. Nguyen THD, Vu DC. Food delivery service during social distancing: proactively preventing or potentially spreading coronavirus disease-2019? Disaster Med Public Health Prep 2020;14(3):e9-10. http://dx.doi.org/10.1017/dmp.2020.135.
12. Wiersinga WJ, Rhodes A, Cheng AC, Peacock SJ, Prescott HC. Pathophysiology, transmission, diagnosis, and treatment of coronavirus disease 2019 (COVID-19): a review. JAMA 2020;324(8):782 – 93. http://dx.doi.org/10.1001/jama.2020.12839.
13. Hirose R, Itoh Y, Ikegaya H, Miyazaki H, Watanabe N, Yoshida T, et al. Differences in environmental stability among SARS-CoV-2 variants of concern: both omicron BA. 1 and BA.2 have higher stability. Clin Microbiol Infect 2022;28(11):1486 – 91. http://dx.doi.org/10.1016/J.CMI.2022.05.020.

Notes from the Field

# The First Case of Co-Infection with Omicron Subvariants BA.5.2.48 and BF.7.14 — Chongqing Municipality, China, February 2023

Kun Su[1,&]; Ying Huang[2,&]; Xiaofeng Chen[2]; Fangyuan Liu[2]; Qi Yan[2]; Xinyu Jiang[2]; Jing Xu[2]; Yongdong Hao[2,#]; Jin Yan[2,#]

On February 14, 2023, a co-infection of Omicron strains was detected in a sample collected and submitted for examination at the Third Affiliated Hospital of Chongqing Medical University.

On February 7, 2023, a 67-year-old female patient living in Yunyang County, Chongqing City, was identified with a history of malignant tumor that had been treated with chemotherapy, radiotherapy, targeting, and other treatments in the past 6 months. Low immunity was suspected, but no other basic diseases, history of smoking, or drinking habits were present. The patient had received two injections of the coronavirus disease 2019 (COVID-19) vaccine (Sinovac Life Sciences Co. Ltd.).

On December 23, 2022, the patient reported poor appetite. On December 29, she developed fatigue, cough, and tested positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) antigen. On January 4, 2023, she experienced chills and fever (temperature of 38.9 ℃) with accompanying cough symptoms. She was admitted to the Traditional Chinese Medicine Hospital of Yunyang County, but did not show significant improvement and was discharged on January 5. On January 6, she was admitted to the Department of Infectious Diseases at the Third Affiliated Hospital of Chongqing Medical University, where she continued to have symptoms of fever and cough. From January 6 to February 12, eight nucleic acid tests were positive in the hospital.

In the investigation, her family members and neighbors were found to be infected in late December, suggesting a potential exposure. During her two hospitalizations, she may have come into contact with other individuals infected with the SARS-CoV-2.

Upper respiratory tract samples were collected from the patients on January 28 and February 7, 2023 and designated as YB20230158 and YB20230202, respectively, to rule out contamination. SARS-CoV-2 whole-genome multiplex polymerase chain reaction (PCR) amplification was performed using the commercial SARS-CoV-2 whole-genome multiplex PCR kits (MicroFuture, Beijing, China). Libraries were prepared using the VAHTS® Universal Plus DNA Library Prep Kit for Illumina (Vazyme Biotech Co.,Ltd.) following the manufacturer's instructions and sequenced on the NextSeq2000 platform, a combination of metagenomic sequencing and tiling amplicon approaches. The seqtk-1.3 tool (https://github.com/lh3/seqtk) was used to excise primer sequences and prevent the introduction of mutations caused by primers. The coverage of the two sequencing tests reached 99.7% and 99.8%, respectively, with sequencing depths of 4,142 and 6,551. Phylogenetic analysis (maximum likelihood method) revealed that these two samples formed a separate branch distinct from Omicron subvariants BA.5.2.48 and BF.7.14 (Figure 1). Mutation sites analysis showed that both samples contained the specific defining sites of Omicron subvariants BA.5.2.48 and BF.7.14, including G1085T, C2710T, C7528T, C8626T, G1085T, C11824T, G12310A, G14181C, C16616A, T17208C, G22599C, T22917G, and G25290T. Verification of the heterozygosity status and frequency of specific mutations in these positions using IGV 2.10.2 (Figure 2) indicated that the patient was simultaneously infected with Omicron subvariants BA.5.2.48 and BF.7.14.

According to the "National Report on the Epidemic of SARS-CoV-2 Infection" released by China CDC, the predominant SARS-CoV-2 strain circulating in Chongqing is BA.5.2.48 (>90%), followed by BF.7.14 (about 3.8%) (*1*). To date, there have been no reports of co-infection with BA.5.2.48 and BF.7.14 in China, particularly in Chongqing, where the proportion of BF.7.14 is relatively low, making its report more meaningful. Monitoring SARS-CoV-2 variants should be popularized as an important strategy to identify co-infections and recombination cases. As the risk of

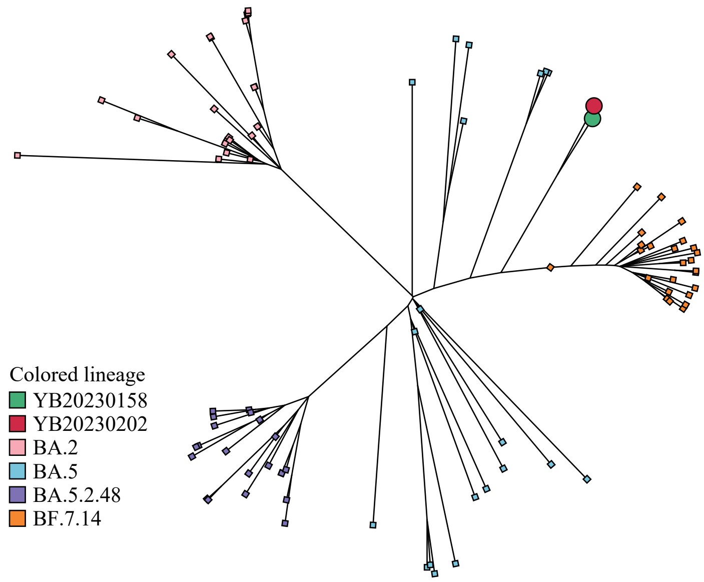


FIGURE 1. The phylogenetic analysis of two co-infection strains from one patient with Omicron BF.7.14 and BA.5.2.48.
Note: The SARS-CoV-2 genomes obtained in our laboratory were integrated into another 88 sequences of SARS-CoV-2 variants downloaded from the GISAID database. Unrooted phylogeny representing the sequences of the co-infection samples YB20230158 and YB20230202 are from the separate clades of BA.5.
Abbreviation: SARS-CoV-2=severe acute respiratory syndrome coronavirus 2.

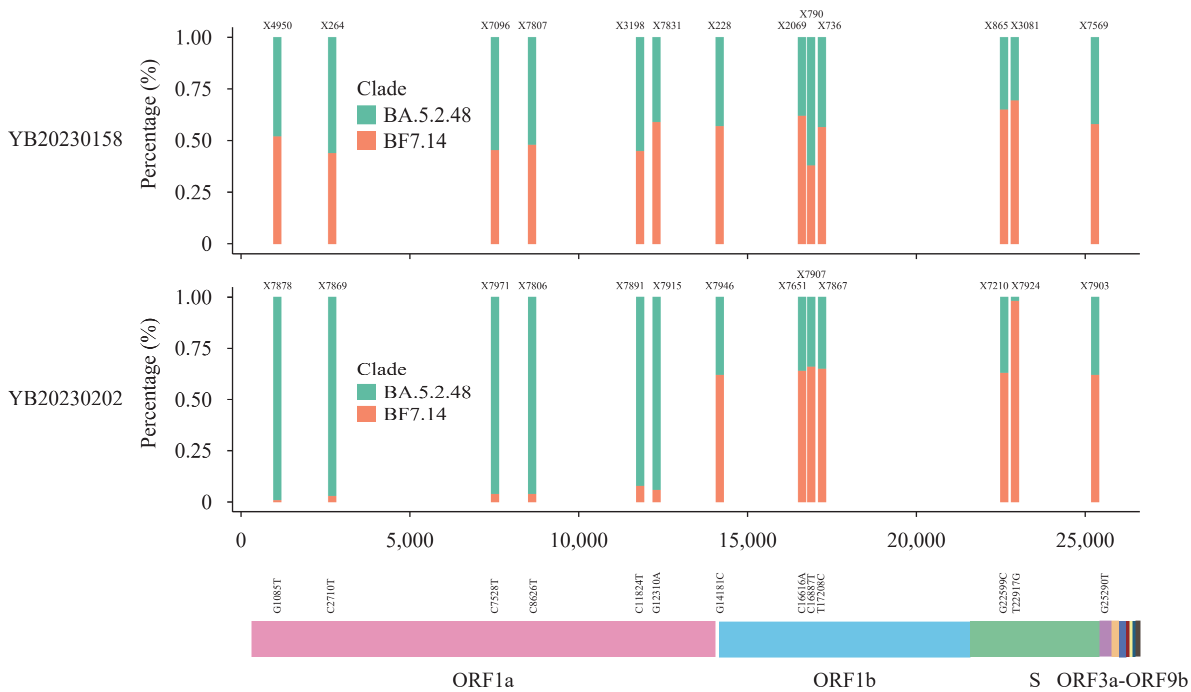


FIGURE 2. Genome-level view of the variant frequency of the SARS-CoV-2 BF.7.14 and BA.5.2.48 lineage-defining polymorphisms in specimens sequenced.
Note: The frequency of sequencing reads encoding each mutation is shown by histograms highlighting the constellation of mutations defining each lineage. A total of 13 genomic locations that define BF.7.14 and BA.5.2.48 lineages are presented in relation to the annotated SARS-CoV-2 genome, including 6 unique genomic locations that define BF.7.14 (G1085T, G14181C, C7528T, G25290T, G22599C, and T22917G) and 7 unique genomic locations that define BA.5.2.48 (C2710T, C8626T, C11824T, G12310A, C16616A, C16887T, and T17208C).
Abbreviation: SARS-CoV-2=severe acute respiratory syndrome coronavirus 2.

various variants co-circulating in a region continues to increase, the monitoring of SARS-CoV-2 variants, especially for key populations with immune deficiencies, is becoming increasingly essential.

**Conflicts of interest**: No conflicts of interest.

**Funding:** Supported by the National Natural Science Foundation of Chongqing Project (2022NSCQ-MSX4434).

**doi:** 10.46234/ccdcw2023.046

# Corresponding authors: Yongdong Hao, 12200762@qq.com; Jin Yan, yanjinkin@163.com.

[1] Chongqing Municipal Center for Disease Control and Prevention, Chongqing, China; [2] Chongqing Yubei Center for Disease Control and Prevention, Yubei District, Chongqing, China.
& Joint first authors.

Submitted: March 05, 2023; Accepted: March 11, 2023

## REFERENCES

1. Chinese Center for Disease Control and Prevention. The situation of the COVID-19 infection in China. 2023. https://www.chinacdc.cn/jkzt/crb/zl/szkb_11803/jszl_13141/202302/t20230215_263756.html. [2023-2-15]. (In Chinese).

Indexed by Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), PubMed Central (PMC), Scopus, Chinese Scientific and Technical Papers and Citations, and Chinese Science Citation Database (CSCD)



The inauguration of *China CDC Weekly* is in part supported by Project for Enhancing International Impact of China STM Journals Category D (PIIJ2-D-04-(2018)) of China Association for Science and Technology (CAST).

CCDC weekly

Vol. 5 No. 11 Mar. 17, 2023

**Responsible Authority**

National Health Commission of the People's Republic of China

**Sponsor**

Chinese Center for Disease Control and Prevention

**Editing and Publishing**

China CDC Weekly Editorial Office
No.155 Changbai Road, Changping District, Beijing, China
Tel: 86-10-63150501, 63150701
Email: weekly@chinacdc.cn

**CSSN**

ISSN 2096-7071
CN 10-1629/R1