

## Preplanned Studies

## The Long-Term Impacts of COVID-19 on Physical and Psychological Health — Beijing Municipality, China, December 2022–April 2023

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### Summary

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

Reports detailing the clinical presentation of coronavirus disease 2019 (COVID-19) are extensive in China. However, data remains limited regarding the long-term effects of the 2022 outbreak on the community and healthcare workers (HCWs).

#### What is added by this report?

In the follow-up study conducted with 1,069 community members and 3,309 HCWs infected with COVID-19, we observed that five months post-outbreak, 39.2% of community members and 28.7% of HCWs reported experiencing at least one symptom. The symptoms most frequently reported included fatigue or muscle weakness, insomnia, cognitive dysfunction, hair loss, joint or muscle pain, and persistent cough. HCWs tended to experience fewer long-term physical consequences and their symptoms had an expedited recovery time compared to the community members. Nevertheless, HCWs displayed a higher prevalence of moderate to severe depression and anxiety.

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

The establishment of a public healthcare system dedicated to continual monitoring, prevention, and clinical treatment of persistent COVID-19 symptoms is imperative.

Following the relaxation of lockdown measures in China on November 11, 2022, there was a rapid uptick in coronavirus disease 2019 (COVID-19) cases from November to December 2022. By January 31, 2023, Beijing observed a cumulative infection rate of 92.3% (1). The urgent necessity now pertains to the evaluation of the short-term and long-term impacts of

COVID-19 on the Chinese population. Long COVID-19, classified by the World Health Organization (WHO) as the persistence of symptoms for 12 weeks post-infection, is alarming in various countries (2). However, it remains inadequately explored in China's context, especially pertaining to the 2022 outbreak (3). Beyond the physical implications, the psychological ramifications of COVID-19 are increasingly concerning. Factors such as the stress associated with medical care, extensive hospital stays, social isolation, and stigma substantially contribute to prolonged mental health issues, including depression, anxiety, insomnia, and posttraumatic stress disorder (PTSD) (4). Furthermore, research accentuates the varying duration and severity of COVID-19 symptoms across different populations. Healthcare workers (HCWs) appear to be particularly susceptible (5). Thus, this research aims to conduct a comprehensive examination of the long-term physical and psychological symptoms among the community and HCWs, aiming to enhance epidemic prevention policies and health care support in the post-COVID-19 era.

In this research, two cohorts were established in January 2023: a HCW cohort comprised of 6,237 participants from Peking University Third Hospital (PUTH), a tertiary institution in Beijing Municipality, and a community-based cohort with 2,011 participants. The latter was enlisted from four Beijing communities, including 528 civilians from PUTH's Second Outpatient Department in the Haidian District, 574 from the Dongpingli Community in the Chaoyang District, 360 from the Zizhuyuan Community in the Haidian District, and 549 teachers and students associated with Peking University Health Science Center. A digital survey was employed to collect participants' demographics and COVID-19 infection details such as infection date, onset

symptoms within two weeks, duration of symptoms, treatment received, and vaccination status (6–8). Infection was diagnosed based on a positive result from either an antigen test or a nucleic acid test. Two follow-up periods were conducted: the first from March 1 to 10, 2023 (approximately three months post-outbreak), and the second from April 20 to 30, 2023 (roughly five months post-outbreak). During each follow-up, participants filled out an online questionnaire, detailing symptoms they experienced within the preceding week and the duration of symptoms. Furthermore, the Depression Anxiety and Stress Scale (DASS-21) was utilized to evaluate participants' mental health condition. By the end of the study, 4,229 HCWs and 1,287 community members had successfully completed the entire process, of which 3,309 HCWs and 1,069 community individuals, who had contracted the virus, were included in the final analysis.

The statistical analysis was executed with the use of R software (version 4.1.0, R core team, Vienna, Austria). We represent qualitative data as frequencies (percentages), which have been compared via the chi-square test or Fisher's exact test. The measurement of recovery time was conducted in days and juxtaposed between groups utilizing Kaplan-Meier analysis. To control for potential confounders, such as age, sex, history of illness, and vaccination status, Cox regression analysis was carried out. The DASS-21 was deployed to compute scores for stress, depression, and anxiety, which were then compared between groups using the Mann-Whitney nonparametric test. Log-binomial regression was additionally used to control confounders. A *P*-value of less than 0.05 was deemed statistically significant.

Among 4,229 HCWs, 3,309 (78.2%) were infected with COVID-19. Within the broader community sample of 1,287 individuals, 1,069 (83.1%) were infected (Table 1). The average ages for the infected persons were 37.4±9.8 years for HCWs, and 41.7±17.4 years for the community cohort, respectively. Preexisting medical conditions were reported in 25.5% of the HCWs and 37.0% of the community cohort. Regarding COVID-19 vaccination, 95.8% of HCWs and 92.6% of the community cohort had received the vaccine. Furthermore, 38.7% of HCWs had been administered the adenovirus-based vaccine.

As depicted in Table 2, a significant majority of both the community population (95.3%) and HCWs (97.0%) reported experiencing at least one acute symptom. Interestingly, HCWs exhibited higher rates

of acute symptoms as compared to the community population overall. A notable decrease in symptom occurrence was observed between the first and second follow-ups: by the 3-month mark, 54.3% of the community population and 59.0% of HCWs reported an absence of symptoms. This increased to 60.8% and 71.3% respectively, five months post COVID-19 infection. At the final follow-up session, the most frequently reported symptoms among both groups were fatigue or weakness (19.2% community *vs.* 18.2% HCWs), sleep disruptions (10.0% *vs.* 7.7%), cognitive dysfunction (9.0% *vs.* 9.5%), hair loss (5.7% *vs.* 6.1%), musculoskeletal discomfort (5.1% *vs.* 4.4%), and persistent cough (5.1% *vs.* 5.0%). Interestingly, five months post COVID-19 onset, HCWs had a lower symptom prevalence compared to the community population, with the exceptions of cognitive dysfunction and diminished interest.

Figure 1 demonstrates that among HCWs, the median recovery period amounted to 41 days. This duration is notably shorter than the median recovery span of 62 days observed within the broader community. The latter group reported prolonged recovery times relating to symptoms such as breathlessness, cognitive dysfunction, chest discomfort, reduced interest, hair loss, and palpitations, with the median recovery terms being equal to or surpassing 60 days. Conversely, HCWs exhibited prolonged symptoms such as reduced interest, hair loss, mood changes, palpitations, breathlessness, and chest discomfort. It's worth noting that, except for mood changes that took longer to resolve, HCWs generally reported faster symptom resolution in comparison to the community cohort.

Psychological symptom scores, including those indicating stress, depression, and anxiety, demonstrated a decreasing trend following infection with COVID-19. Importantly, during the final follow-up, both the numerical scores and the percentage of individuals displaying moderate to severe depression (15.5% *vs.* 9.4%, adjusted *P*<0.001) and anxiety (21.7% *vs.* 17.4%, adjusted *P*=0.025) were observably greater among HCWs compared to the general population (Figure 2).

## DISCUSSION

In December 2022, China revamped its policies on epidemic prevention and control due to a peak in a COVID-19 outbreak. "Long COVID-19" is rising as a significant public health crisis. Subsequently, a cohort

TABLE 1. Basic demographic characteristics of the community population and HCWs — Beijing Municipality, China, December 2022–April 2023.

Characteristics of participants	Community (N=1,069)	HCW (N=3,309)	P
Age (mean±SD)	41.67±17.43	37.40±9.80	0.003
Gender, n (%)			
Male	388 (36.3)	903 (27.3)	<0.001
Female	681 (63.7)	2,406 (72.7)	
History of disease, n (%)			
Hypertension	175 (16.4)	273 (8.3)	<0.001
Diabetes	88 (8.2)	109 (3.3)	<0.001
Hyperlipidemia	142 (13.3)	305 (9.2)	<0.001
Respiratory disease	47 (4.4)	76 (2.3)	<0.001
Cardiovascular disease	55 (5.1)	16 (0.5)	<0.001
Kidney disease	12 (1.1)	26 (0.8)	0.302
Digestive system diseases	56 (5.2)	90 (2.7)	<0.001
Immune system diseases	10 (0.9)	38 (1.1)	0.561
Reproductive system diseases	44 (4.1)	121 (3.7)	0.493
Any	396 (37.0)	845 (25.5)	<0.001
Vaccination, n (%)			
Inactivated vaccine	952 (89.1)	2,922 (88.3)	0.504
Adenovirus injection vaccine	32 (3.0)	1,281 (38.7)	<0.001
Adenovirus inhalation vaccine	18 (1.7)	165 (5.0)	<0.001
mRNA vaccine	3 (0.3)	192 (5.8)	<0.001
Recombinant protein vaccine	10 (0.9)	187 (5.7)	<0.001
Any	990 (92.6)	3,171 (95.8)	<0.001

Abbreviation: SD=standard deviation; HCW=healthcare worker.

of HCWs and a separate cohort representative of the general community were established and tracked in Beijing from November 2022 through April 2023. The research findings showed that five months post-outbreak, 39.2% of the general community and 28.7% of HCWs experienced at least one symptom. Furthermore, the median recovery durations documented were 62 days for HCWs and 41 days for the general community, respectively.

The present study has unveiled common enduring physical symptoms amongst COVID-19 patients, which include fatigue or weakness, insomnia, cognitive impairment, alopecia, musculoskeletal pain, and a persistent cough. Similar observations have emerged from numerous studies conducted in various Chinese metropolises such as Shanghai, Beijing, and Guangzhou, where fatigue, a lingering cough, cognitive focus challenges, and anxiety have been identified as chronic symptoms (4,9). Additionally, the CDC's findings from the USA corroborate this data, noting that long-haul COVID patients typically report

fatigue, cognitive difficulties, sleep disturbances, alterations in olfaction or taste, depression or anxiety, as well as digestive and other systemic symptoms (10). Such unanimous findings indicate the urgency of creating a comprehensive public health infrastructure for the continuous monitoring, prevention, and treatment of prolonged manifestations of COVID-19. Special emphasis must be placed on strategic interventions for symptoms like dyspnea, cognitive impairment, thoracic pain, mood alterations, hair loss, and sleep disorders, owing to their stubbornly prolonged recovery periods. Such endeavors will serve to augment the well-being and health outcomes of those affected by COVID-19.

HCWs face an elevated risk of contracting COVID-19 because of their constant, close contact with potentially infected individuals or critically ill patients within healthcare settings (5). Our study identified a higher prevalence of acute symptoms at the onset of COVID-19 among HCWs compared to the general population. Remarkably, HCWs demonstrated

TABLE 2. Acute and chronic symptoms reported at each follow-up among the community population and HCWs — Beijing Municipality, China, December 2022–April 2023, *n* (%).

Symptoms	Acute symptoms			First follow-up			Second follow-up		
	Community ( <i>N</i> =1,069)	HCW ( <i>N</i> =3,309)	<i>P</i>	Community <i>N</i> =1,069	HCW ( <i>N</i> =3,309)	<i>P</i>	Community ( <i>N</i> =1,069)	HCW ( <i>N</i> =3,309)	<i>P</i>
Anyone of the following symptoms									
No	50 (4.7)	99 (3.0)	0.011	580 (54.3)	1,953 (59.0)	<0.001	650 (60.8)	2,359 (71.3)	<0.001
Yes	1,019 (95.3)	3,210 (97.0)		489 (45.7)	1,134 (34.3)		419 (39.2)	950 (28.7)	
Fatigue/tired or weakness	716 (67.0)	2,555 (77.2)	<0.001	308 (28.8)	744 (22.5)	<0.001	205 (19.2)	603 (18.2)	0.513
Smell disorder	306 (28.6)	1,267 (38.3)	<0.001	51 (4.8)	94 (2.8)	<0.001	29 (2.7)	73 (2.2)	0.402
Hypogeusia	345 (32.3)	1,372 (41.5)	<0.001	51 (4.8)	73 (2.2)	<0.001	31 (2.9)	62 (1.9)	0.057
Shortness of breath or breathlessness	162 (15.2)	734 (22.2)	<0.001	37 (3.5)	106 (3.2)	<0.001	41 (3.8)	77 (2.3)	0.011
Cough	645 (60.3)	2,679 (81.0)	<0.001	107 (10.0)	218 (6.6)	<0.001	55 (5.1)	165 (5.0)	0.900
Headache	384 (35.9)	1,529 (46.2)	<0.001	49 (4.6)	129 (3.9)	<0.001	37 (3.5)	109 (3.3)	0.868
Problems sleeping	280 (26.2)	1,099 (33.2)	<0.001	123 (11.5)	351 (10.6)	<0.001	107 (10.0)	256 (7.7)	0.023
Joint or muscle pain	498 (46.6)	1,886 (57.0)	<0.001	78 (7.3)	170 (5.1)	<0.001	54 (5.1)	147 (4.4)	0.457
Cognitive dysfunction	261 (24.4)	1,095 (33.1)	<0.001	109 (10.2)	409 (12.4)	<0.001	96 (9.0)	313 (9.5)	0.684
Chest pain	153 (14.3)	671 (20.3)	<0.001	36 (3.4)	99 (3.0)	<0.001	40 (3.7)	81 (2.4)	0.033
Change in mood	80 (7.5)	373 (11.3)	0.001	29 (2.7)	107 (3.2)	<0.001	33 (3.1)	103 (3.1)	>0.999
Decreased interest	98 (9.2)	424 (12.8)	0.002	27 (2.5)	96 (2.9)	<0.001	26 (2.4)	84 (2.5)	0.936
Stomach pain	110 (10.3)	473 (14.3)	0.001	31 (2.9)	77 (2.3)	<0.001	40 (3.7)	63 (1.9)	0.001
Hair loss	103 (9.6)	415 (12.5)	0.012	45 (4.2)	215 (6.5)	<0.001	61 (5.7)	201 (6.1)	0.714
Diarrhea	111 (10.4)	612 (18.5)	<0.001	16 (1.5)	38 (1.1)	<0.001	13 (1.2)	37 (1.1)	0.923
Sore throat	394 (36.9)	1,888 (57.1)	<0.001	53 (5.0)	132 (4.0)	<0.001	41 (3.8)	116 (3.5)	0.682
Fever	596 (55.8)	2,252 (68.1)	<0.001	26 (2.4)	66 (2.0)	<0.001	10 (0.9)	50 (1.5)	0.209
Chilliness	225 (21.0)	1,105 (33.4)	<0.001	30 (2.8)	61 (1.8)	<0.001	30 (2.8)	51 (1.5)	0.011
Palpitations	172 (16.1)	829 (25.1)	<0.001	53 (5.0)	212 (6.4)	<0.001	41 (3.8)	139 (4.2)	0.664
Nausea/vomiting	104 (9.7)	506 (15.3)	<0.001	13 (1.2)	26 (0.8)	<0.001	9 (0.8)	26 (0.8)	>0.999
Postexertional malaise	117 (10.9)	775 (23.4)	<0.001	52 (4.9)	180 (5.4)	<0.001	45 (4.2)	130 (3.9)	0.751

Abbreviation: HCW=healthcare worker.

lower rates of long-term symptoms and a shorter recovery period. This phenomenon may be attributed to HCWs' comprehensive understanding of the disease and their convenient access to medical support.

COVID-19 patients may endure various psychological issues due to multiple factors such as the viral infection's direct effects, corticosteroid therapy, social isolation, and stigma. Around five months following the onset of COVID-19, an estimated 21.7% of HCWs and 17.4% of the general population reported suffering from moderate to severe anxiety. Additionally, 15.8% of HCWs and 9.4% of community members experienced depression, underscoring the necessity for heightened concern for the mental health of individuals afflicted with COVID-19. Depression and anxiety scores were

noticeably higher among HCWs when compared to the general population. Literature consistently indicates that HCWs bear a higher risk of psychological distress during the COVID-19 pandemic, derived from the heavy workload and the exposure to patient suffering. Our research underscores the pressing need to prioritize the mental well-being of hospital HCWs and establish initiatives to safeguard their well-being both in the present and moving forward.

This study bears certain constraints that warrant acknowledgement. First, the HCW cohort is sourced from a singular facility in a Chinese tertiary hospital, positioning the study's representations of all HCWs in China as potentially incomplete. Additional research in hospitals varying in both size and location is necessitated. Second, this research gathered symptoms

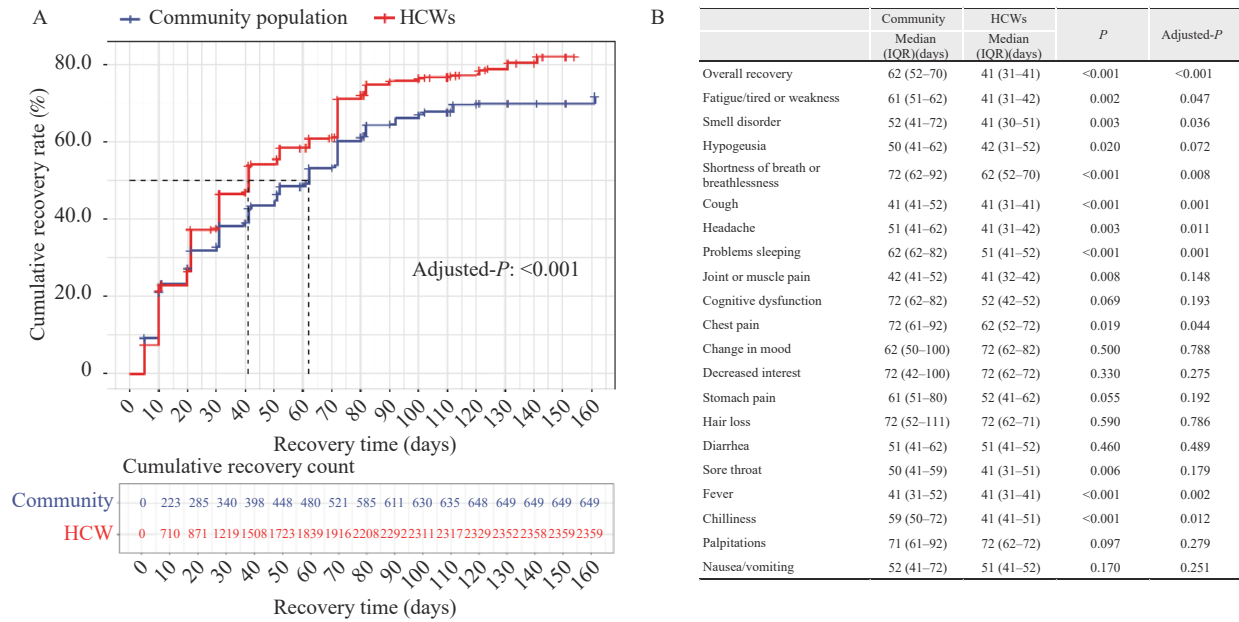


FIGURE 1. Duration of recovery for the community population and HCWs — Beijing Municipality, China, December 2022–April 2023. (A) The overall recovery duration among HCWs and the general population. (B) The median recovery duration for each symptom was also determined.

Note: The adjusted *P*-value was calculated using Cox regression, taking into account confounding variables such as age, gender distribution, history of any disease, and vaccination status. Recovery time, measured in days, was compared between these groups using Kaplan-Meier analysis in panel A.

Abbreviation: HCWs=healthcare workers; IQR=interquartile range.

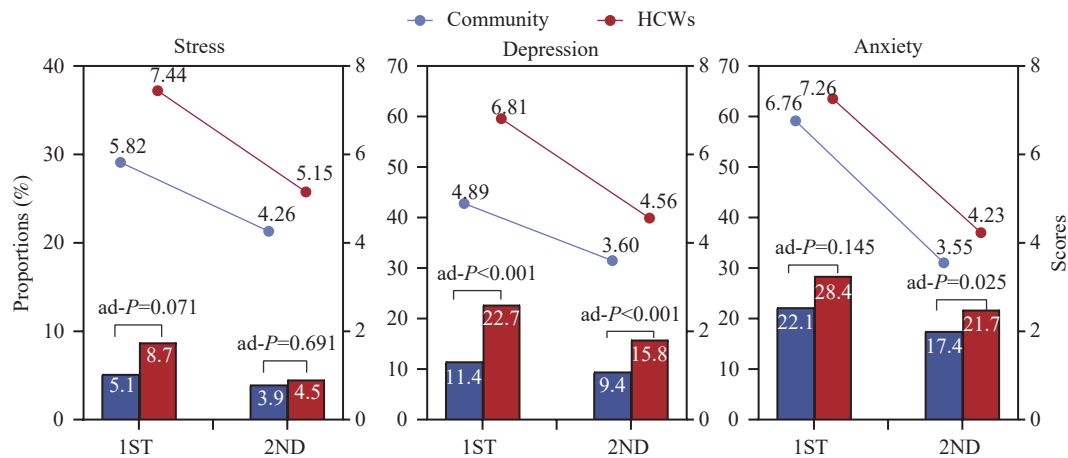


FIGURE 2. Comparison of psychological consequences among the general population and HCWs during the first and second follow-up periods — Beijing Municipality, China, December 2022–April 2023.

Note: The scores for stress, depression, and anxiety from both groups were evaluated at the first and second follow-ups and are represented as points in the associated figure. Furthermore, the prevalence of moderate to severe stress, depression, and anxiety in the observed sample was computed and illustrated as bars in the same figure. The comparative analysis between the community and HCW cohorts was executed using log-binomial regression. Potential confounders, which include age, gender proportions, medical history, and vaccination status, were accounted for in the analysis. It should be noted that “1ST” and “2ND” refer to the initial and subsequent follow-ups, respectively.

Abbreviation: HCWs=healthcare workers; ad-*P*=adjusted-*P*.

and recovery period data through self-reported online questionnaires, inherently exposing the study to potential ascertainment bias due to individual recall

processes and judgment. Finally, the focus of our study was to primarily provide a comprehensive review of the long-term effects on both the community population



and HCWs. Consequently, these distinct groups may carry inherent differences, and as such, some potential confounding factors may not be adequately considered in comparing community and hospital-based participants.

This research represents a concurrent evaluation of two cohorts with the broadest period of follow-up subsequent to the most substantial and recent outbreak of COVID-19 in China. The data suggests that among recovered COVID-19 patients, prevalent symptoms include fatigue or muscle weakness, sleep difficulties, and psychological complications. Notably, while HCWs initially presented with a higher prevalence of acute symptoms, their physical symptom recovery trajectory surpassed that of the general community population. However, HCWs experienced significant psychological distress. The findings from our comprehensive study offer critical insights into future directions for improving long-term healthcare system development in the context of the post-COVID-19 pandemic era.

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## REFERENCES

1. Leung K, Lau EHY, Wong CKH, Leung GM, Wu JT. Estimating the transmission dynamics of SARS-CoV-2 Omicron BF.7 in Beijing after adjustment of the zero-COVID policy in November–December 2022. *Nat Med* 2023;29(3):579–82. [http://dx.doi.org/10.1038/S41591-023-02212-Y](https://doi.org/10.1038/S41591-023-02212-Y).
2. Srikanth S, Boulos JR, Dover T, Boccuto L, Dean D. Identification and diagnosis of long COVID-19: a scoping review. *Prog Biophys Mol Biol* 2023;182:1 – 7. [http://dx.doi.org/10.1016/j.pbiomolbio.2023.04.008](https://doi.org/10.1016/j.pbiomolbio.2023.04.008).
3. Shabnam S, Razieh C, Dambha-Miller H, Yates T, Gillies C, Chudasama YV, et al. Socioeconomic inequalities of long COVID: a retrospective population-based cohort study in the United Kingdom. *J Roy Soc Med* 2023;116(8):263 – 73. [http://dx.doi.org/10.1177/01410768231168377](https://doi.org/10.1177/01410768231168377).
4. Zhao YM, Shi L, Jiang ZD, Zeng N, Mei H, Lu Y, et al. The phenotype and prediction of long-term physical, mental and cognitive COVID-19 sequelae 20 months after recovery, a community-based cohort study in China. *Mol Psychiatry* 2023;28(4):1793 – 801. [http://dx.doi.org/10.1038/s41380-023-01951-1](https://doi.org/10.1038/s41380-023-01951-1).
5. Zhang CM, Guo T, Zhang L, Gu AQ, Ye J, Lin M, et al. The infection of healthcare workers and the reinfection of patients by omicron variant — Jiangsu Province, China, December 2022 to January 2023. *China CDC Wkly* 2023;5(18):402 – 6. [http://dx.doi.org/10.46234/ccdcw2023.074](https://doi.org/10.46234/ccdcw2023.074).
6. Wanga V, Chevinsky JR, Dimitrov LV, Gerdes ME, Whitfield GP, Bonacci RA, et al. Long-term symptoms among adults tested for SARS-CoV-2 — United States, January 2020–April 2021. *MMWR Morb Mortal Wkly Rep* 2021;70(36):1235 – 41. [http://dx.doi.org/10.15585/mmwr.mm7036a1](https://doi.org/10.15585/mmwr.mm7036a1).
7. Raveendran AV. Long COVID-19: challenges in the diagnosis and proposed diagnostic criteria. *Diabetes Metab Syndr: Chin Res Rev* 2021;15(1):145 – 6. [http://dx.doi.org/10.1016/j.dsx.2020.12.025](https://doi.org/10.1016/j.dsx.2020.12.025).
8. Cabrera Martimbiano AL, Pacheco RL, Bagattini ÂM, Riera R. Frequency, signs and symptoms, and criteria adopted for long COVID-19: a systematic review. *Int J Clin Pract* 2021;75(10):e14357. [http://dx.doi.org/10.1111/IJCP.14357](https://doi.org/10.1111/IJCP.14357).
9. Huang CL, Huang LX, Wang YM, Li X, Ren LL, Gu XY, et al. 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. *Lancet* 2023;401(10393):e21 – 33. [http://dx.doi.org/10.1016/S0140-6736\(23\)00810-3](https://doi.org/10.1016/S0140-6736(23)00810-3).
10. Long COVID or post-COVID conditions. 2023. <https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects/>. [2023-07-28].