



## Review Article

# Challenges and Opportunities Associated with Lifting the Zero COVID-19 Policy in China



Kun Hu<sup>1</sup> and Lanjing Zhang<sup>2,3,4,5\*</sup> 

<sup>1</sup>Department of Pathology, Tufts Medical Center, Boston, MA, USA; <sup>2</sup>Department of Pathology, Princeton Medical Center, Plainsboro, NJ, USA; <sup>3</sup>Department of Chemical Biology, Ernest Mario School of Pharmacy, Rutgers University, Piscataway, NJ, USA; <sup>4</sup>Rutgers Cancer Institute of New Jersey, New Brunswick, NJ, USA; <sup>5</sup>Department of Pathology and Laboratory Medicine, University of Pennsylvania, Philadelphia, PA, USA

Received: January 18, 2023 | Revised: February 03, 2023 | Accepted: February 14, 2023 | Published online: March 8, 2023

### Abstract

Chinese government lifted its “Zero COVID-19” policy in December 2022. The estimated COVID-19 new cases and deaths after the policy change are 167–279 million (about 12.0% to 20.1% of the Chinese population) and 0.68–2.1 million, respectively. Recent data also revealed continuous drops in fertility rate and historically lowest growth in gross domestic production in China. Thus, balancing COVID-19 control and economic recovery in China is of paramount importance yet very difficult. Supply chain disruption, essential service reduction and shortage of intensive care units have been discussed as the challenges associated with lifting “Zero COVID-19” policy. The additional challenges may include triple epidemic of COVID-19, respiratory syncytial virus and influenza, mental health issues of healthcare providers, care givers and patients, impact on human mobility, lack of robust genomic and epidemiological data and long COVID-19. However, the policy-associated opportunities and other challenges are largely untouched, but warrant attention of and prompt reactions by the policy makers, healthcare providers, public health officials and other stakeholders. The associated benefits are quick reach of herd immunity, boost of economy and businesses activities and increase in social activities. At this moment, we must embrace the policy change, effectively mitigate its associated problems and timely and effectively maximize its associated benefits.

### Introduction

Much has been discussed about the undesired consequences of the Zero “coronavirus disease 2019 (COVID-19)” in China.<sup>1,2</sup> Due to uncontrolled case surges<sup>3</sup> and other reasons, the Chinese government announced in early December 2022 to lift its “Zero COVID-19” policy.<sup>4,5</sup> Shortly after this announcement, it was reported that there was a mix of nationwide easing steps, including stopping mass COVID-19 tests, closing quarantine centers, and easing domestic travel restrictions.<sup>6,7</sup> It has been estimated that 167–279 million (approximately 12.0–20.1% of the Chinese population) new cases would occur in China if the “Zero COVID-19” policy is lifted.<sup>7–9</sup> Approximately 37 million people (2.6% of the Chinese population) were infected on 20 December 2022 alone.<sup>7</sup>

Although COVID-19 deaths are more difficult to estimate, simulation studies have revealed that 0.68–2.10 million people would die of COVID-19 after lifting the policy.<sup>6,8,9</sup> Scholars have also raised other issues associated with the policy change, including supply chain disruption, essential service reduction, and shortage of intensive care units.<sup>6,10</sup> However, there are potential opportunities and additional major challenges associated with these policy changes, which are largely unknown, but would be discussed in this study. Policymakers, healthcare providers, business communities, and other stakeholders should, in our view, maximize the benefits of these opportunities, and prepare for and mitigate the challenges. It is noteworthy that the listed opportunities and challenges are by no means complete, nor would these all become a reality.

**Keywords:** COVID-19; Tripledemic; Respiratory syncytial virus; Influenza; Outbreak.

**Abbreviations:** COVID-19, coronavirus disease 2019; GDP, gross domestic production; RSV, respiratory syncytial virus.

\*Correspondence to: Lanjing Zhang, Department of Pathology, Princeton Medical Center, Plainsboro, NJ, USA. ORCID: <https://orcid.org/0000-0001-5436-887X>. Tel: +1-609-853-6833, Fax: +1-609-853-6841, E-mail: [lanjing.zhang@rutgers.edu](mailto:lanjing.zhang@rutgers.edu)

**How to cite this article:** Hu K, Zhang L. Challenges and Opportunities Associated with Lifting the Zero COVID-19 Policy in China. *Explor Res Hypothesis Med* 2023;000(000):000–000. doi: 10.14218/ERHM.2023.00002.

### Additional major challenges associated with lifting the zero COVID-19 policy

First, there may be an outbreak scenario of a triple epidemic of COVID-19, respiratory syncytial virus (RSV), and influenza in China. The United States data has already revealed the surge of a triple epidemic, which was also named as a “triple epidemic,” as the winter and influenza season entered.<sup>11</sup> The “triple epidemic” indeed has caused the shortage of over-the-counter medicine in the United States.<sup>12</sup> It is

likely that China and other countries may experience a similar “tripledemic.” Indeed, RSV has been the most frequently detected virus among children with community-acquired pneumonia, which required hospitalization in China during the “Zero COVID-19” policy period, followed by adenovirus (a pathogen of common cold) and influenza A virus.<sup>13</sup> The RSV positive rate was approximately 35.7% and 35.9% of these children, before and after adopting the “Zero COVID-19” policy, respectively.<sup>13</sup> Strikingly, influenza A had a higher positive rate before the “Zero COVID-19” policy was adopted, when compared to the rate after the policy was adopted (4.5% vs. 1.0%),<sup>13</sup> suggesting the possible rise in influenza A cases/positive rates after lifting the “Zero COVID-19” policy. Another study in Beijing revealed that the implementation of non-pharmaceutical interventions (NPIs) reduced the incidence of RSV from 31.9% to 4.4% in children.<sup>14</sup> These lines of evidence support the likelihood of a “tripledemic” in China after lifting the “Zero COVID-19” policy.

Therefore, mitigation tools and policies should be considered. These may include starting online educational classes (vs. in-person classes), influenza vaccine mandates, and the implementation of NPIs, such as community mitigation strategies, including handwashing, staying home when ill, cleaning frequently touched surfaces, keeping distance from others, and wearing a mask or respirator. Some parts of China have adopted these approaches to slow the spread of COVID-19 and reduce its incidence.<sup>10</sup> Hopefully, these can be widely adopted in China and other countries. The preparedness for a “tripledemic” should be assessed, and this may include vaccine/medicine availability, staffing for fever outpatient/emergency services, and surveillance (refer below for more details). Evidence-based guidelines for its diagnosis, prevention and treatment in healthcare providers, together with user-friendly, plain-language Community Mitigation Guidelines, particularly those for combined infections, should be developed and disseminated in a timely manner. Some recently published guidelines can be used as a guide or blueprint.<sup>15,16</sup> It is also of paramount importance to educate the public and perhaps nonexpert healthcare providers about the “tripledemic.”

Second, the mental health of healthcare providers, COVID-19 patients, and caregivers must be one of the public health priorities. During the COVID-19 pandemic, healthcare workers have been experiencing challenges of significantly increased patient volume, changing of clinical roles, and adopting new technologies. At the same time, due to limited personal protective equipment, healthcare workers faced a higher risk of infection. In the midst of ensuring the continuation of their obligations and services, a number of health workers have experienced elevated psychological distress, burnout, and increased risk of mental illness.<sup>17,18</sup> The burnout rate reached as high as 67% at that time, for physicians and nurses in the intensive care units in China.<sup>19</sup> Similarly, in the general population, changes in social behavior, working conditions, daily habits, and routine have imposed further stress, combined with the economic crisis and possible unemployment.<sup>20</sup> Therefore, these mental health issues should be actively monitored, prevented and controlled. The frequency of these issues may be lower at present, when compared to the frequency during the COVID-19 early outbreak. COVID-19 specific burnout assessment scales, such as the COVID-19 Burnout Scale, may be helpful.<sup>21</sup>

Third, the rigorous surveillance of epidemiologic data, viral mutations and viral virulence in China may be required after lifting the “Zero COVID-19” policy. SARS-CoV is known for its rapid mutation and dynamic changes in dominant variants.<sup>22</sup> For example, the US dominant variant has changed from BA.5 (70%) in October 2022 to BQ.1.1 (37.2%) in December 2022, and to

XBB.1.5 (43%) in January 2023.<sup>23</sup> It was predicted that XBB.1.5 may become a global dominant variant.<sup>24</sup> However, the mortality rate and comorbidity of new variants are largely unknown. Thus, these should become a research and surveillance priority.

Furthermore, the quality and trustworthiness of the COVID-19 data must be ensured. The rollback of mass COVID-19 tests would inevitably decrease the reported COVID-19 counts and deaths. Indeed, the Chinese National Health Commission has reportedly stopped reporting national tallies.<sup>7</sup> However, effective resource allocation and efficient crisis preparedness require high-quality and trustworthy COVID-19 data. Therefore, public health officers and epidemiologists should, in our view, act promptly in conducting field epidemiological and genomic surveillances, in order to collect these data. This would allow evidence-based, data-driven policymaking to be possible. Alternative approaches, such as the internet-based estimation of COVID-19 trends, may also be used as a supplement.<sup>25</sup> It may also be necessary to introduce third-party data monitoring or auditing, since the governmental data collection on COVID-19 is not monitored in most countries.

Moreover, local government and public health agencies may consider conducting mass or randomized representative COVID-19 tests with timely genotyping, when an outbreak of a highly contagious, yet virulent variant, is suspected or identified in a community. This database system would enable the continuous monitoring of the population’s virus exposure for better decision making.

Fourth, the policy change may impact human mobility. The lifting of the policy of NPIs in the US was followed by a short-lived reduction in mobility outside of homes, and subsequently, an increase in mobility.<sup>26</sup> Therefore, lifting the “Zero COVID-19 policy” may increase domestic and international travel. However, in the long term, this may impact job-housing relationships and urban structures.

Finally, long COVID-19 is defined as COVID-19 symptoms that lasted for 4–12 weeks after infection, and post-COVID-19 syndromes that lasted beyond 12 weeks after COVID-19 infection.<sup>27,28</sup> This would cause lasting symptoms, reduced quality of life, and loss of productivity.<sup>27–29</sup> Given the high incidence of approximately 24–59% in COVID-19 patients,<sup>29,30</sup> there is a need for awareness of the timely diagnosis and effective management of long COVID-19. Among the reported symptoms and imaging characteristics, CT abnormalities (60.5%) were the most prevalent in patients with the wild-type COVID-19 strain, fatigue (66.1%) was the most prevalent in patients with the Alpha variant, having more than one general symptom (28.4%) was the most prevalent in patients with the Omicron variant, and myalgia was the most prevalent in patients with the Omicron variant.<sup>31</sup> The effective risk reduction and treatment of long COVID-19 can be realized using various guidelines and tools,<sup>27,28</sup> such as early diagnosis, close follow-up, and vaccination.<sup>32</sup> On the other hand, resource limitation and lack of experience may greatly hinder the ability to successfully combat long COVID-19.

### Major opportunities associated with lifting the “Zero COVID-19” policy

First, herd immunity is essential for controlling the COVID-19 outbreak, but this appears to be difficult to reach even with mass vaccination.<sup>33,34</sup> However, this may be achieved in a short period of time due to voluntary vaccination or infection after lifting the “Zero COVID-19” policy in China. Although the overall COVID-19 vaccination rate was approximately 89.5% in China,<sup>10,35,36</sup> most of the vaccinated individuals were jabbed seven months ago, and would likely have lost immunity. Indeed, China has approved



Fig. 1. Major challenges and opportunities associated with lifting the “Zero COVID-19” policy in China.

five COVID-19 vaccines for emergency use, and reported an efficacy of 72–91% against being symptomatic.<sup>37</sup> However, no data is available at present on the long-term immunity that the vaccines may provide.<sup>34,36</sup> In addition, given the enormous challenges in mass vaccination,<sup>34</sup> it may not be feasible to reach a very high booster rate in a short period time. Furthermore, new variants, such as the Omicron variant, may not be covered by the available vaccines at present, since these are less virulent.<sup>38–40</sup> Therefore, lifting the “Zero COVID-19” policy may help a large population to rapidly reach herd immunity, but with a high case count and associated costs. If properly prepared, lifting the “Zero COVID-19” policy may be time efficient in this regard.

Second, lifting the “Zero COVID-19” policy would lead to economic recovery, and a drastic increase in business activities in China, which are urgently needed to improve the Chinese economy.<sup>41,42</sup> These activities would boost the economy, and subsequently increase governmental investments and spending on healthcare and public health infrastructures. Indeed, the Chinese gross domestic production (GDP) has marked one of the worst years of economic growth on record under stringent COVID restrictions, including the 2.1%, 8.4% and 3.0% of the annual GDP growth in 2020, 2021 and 2022, respectively, and the 0% quarter-to-quarter GDP growth in the fourth quarter of 2022.<sup>41,42</sup> The Chinese government expects to see a sharp rebound in 2023 as China continues to prioritize the economy over its Zero COVID-19 policy, and the government’s fiscal policies have provided additional support and stimuli for economic growth.

Third, social activities would be greatly enhanced after lifting the “Zero COVID-19” policy. These activities would result in more interpersonal activities, better societal morale, and a possible increase in fertility rate. The survey data collected in China from August 2022 indeed revealed that the optimism of China’s economy has decreased below 50%, and that fewer people have become involved in “normal” out-of-home activities after the implementation of the “Zero COVID-19” policy.<sup>43</sup> Furthermore, the fertility rate for Chinese women has been dropping in the past years: 1.8 in 2017, 1.6 in 2018, 1.5 in 2019, 1.3 in 2020, and 1.16 in 2021, respectively.<sup>44,45</sup> Some attributed that the decline in fertility rate was in part exacerbated by the “Zero COVID-19” policy.<sup>46</sup> That is, the COVID-19 pandemic and “Zero COVID-19” policy indirectly influenced the fertility rates, and the fertility rate is one of the main drivers for the growth of the population and GDP.<sup>47</sup> Thus, lifting the “Zero COVID-19” policy may help reverse the decline or plateau in China’s fertility rate, population growth, and GDP growth.

### Future direction

Future epidemiological research should in our view focus on the impact of the policy change on the prevalence and outcomes of the “triple epidemic,” long-COVID-19, and mental issues, the prevalence of COVID-19 immunity in the populations by geographic and demographic determinants, and genomic surveillance of COVID-19. Future socioeconomic research may focus on the economic recovery and growth by industry sections and geographic regions, productivity of workers, fertility rates and residents’ social activities before and after lifting the “Zero COVID-19” policy. It is also suggested to conduct simulation studies to understand the limitations and advantages of the abrupt policy changes, as well as the factors that help reach the best health and socioeconomic outcomes yet minimize harms.

### Conclusion

In conclusion, the Chinese government has lifted its “Zero COVID-19” policy in December 2022, and opened its door for international travelers. In addition to the challenges of sustained mass vaccination, protecting high-risk populations, supply chain disruption, and essential service reduction, the study also raises concerns on the prevention and control of “triple epidemic,” burnouts in healthcare providers, high-quality surveillance data, mental health issues, long COVID-19, and the balance between economic recovery and COVID-19 control (Fig. 1). On the bright side, this policy change may help quickly reach herd immunity, drastically increase business activities, and boost social activities in China. At this moment, we must embrace the policy change, effectively address its associated challenges, and timely benefit from its associated opportunities.

### Acknowledgments

We would to thank Zheng Chen for the critical review of the manuscript and constructive comments.

### Funding

This work was in part supported by the National Science Foundation (IIS-2128307 to L.Z.) and the National Cancer Institute of the National Institutes of Health (1R37CA277812 to L.Z.). The funders had no role in the writing the article and the decision to submit the article for publication.



**Conflict of interest**

LZ has been an editor-in-chief of *Exploratory Research and Hypothesis in Medicine* since 2017. ZC is an employee and owns stocks of Bristol Myers Squibb, Co. The spouse of LZ is an employee and owns stocks of Bristol Myers Squibb, Co. The opinions expressed in the article are solely those of the authors, and not of their affiliations.

**Author contributions**

Both authors conceptualized, wrote and edited the manuscript.

**References**

- [1] Yuan S. Zero COVID in China: what next? *Lancet* 2022;399(10338):1856–1857. doi:10.1016/S0140-6736(22)00873-X, PMID:35569453.
- [2] Mallapaty S. China's zero-COVID strategy: what happens next? *Nature* 2022;602(7895):15–16. doi:10.1038/d41586-022-00191-7, PMID:35087249.
- [3] Farge E. China's COVID spike not due to lifting of restrictions, WHO director say. Available from: <https://www.reuters.com/world/china/chinas-covid-spike-not-due-lifting-restrictions-who-director-2022-12-14/>. Accessed January 13, 2023.
- [4] Woo R, Pollard MQ. Beijing drops COVID testing burden as wider easing beckons. Available from: <https://www.reuters.com/world/china/chinese-capital-prepares-life-again-lockdowns-lift-across-country-2022-12-06/>. Accessed January 15, 2023.
- [5] Cheng S. China Scraps Most Covid Testing, Quarantine Requirements in Policy Pivot. Available from: <https://www.wsj.com/articles/china-scraps-most-testing-quarantine-requirements-in-covid-19-policy-pivot-11670398522>. Accessed January 15, 2023.
- [6] Huang Y. The Reckoning Ahead for China's Zero-Covid Policy. Available from: <https://www.wsj.com/articles/the-reckoning-ahead-for-chinas-zero-covid-policy-11671721521>. Accessed January 15, 2023.
- [7] Liu Q, Leng C, Yu S, McMorrow R. China estimates 250mn people have caught Covid in 20 days. Available from: <https://www.ft.com/content/1fb6044a-3050-44d8-b715-80c18ca5c9ab>. Accessed January 16, 2023.
- [8] Burki T. Moving away from zero COVID in China. *Lancet Respir Med* 2023;11(2):132. doi:10.1016/S2213-2600(22)00508-2, PMID:36535298.
- [9] Reuters. Factbox: How many people might die, and why, under relaxed China COVID curb. Available from: <https://www.reuters.com/world/china/how-many-people-might-die-why-if-china-loosens-covid-restrictions-2022-12-03/>. Accessed January 15, 2023.
- [10] Cowling B. The impact of ending 'zero COVID' in China. *Nat Med* 2023;29(2):302. doi:10.1038/d41591-023-00001-1, PMID:36604517.
- [11] Tanne JH. US faces triple epidemic of flu, RSV, and covid. *BMJ* 2022;379:o2681. doi:10.1136/bmj.o2681, PMID:36343961.
- [12] Stamm S. Flu, RSV and Covid Drive Demand for Children's Pain Relievers and Fever Reducers. Available from: <https://www.wsj.com/articles/flu-rsv-and-covid-drive-demand-for-childrens-pain-relievers-and-fever-reducers-11671517354>. Accessed February 28, 2023.
- [13] Feng Z, Xu B, Zhong L, Chen J, Deng J, Luo Z, *et al*. A multicentre study on the incidence of respiratory viruses in children with community-acquired pneumonia requiring hospitalization in the setting of the zero-COVID policy in China. *Arch Virol* 2023;168(2):64. doi:10.1007/s00705-023-05698-6, PMID:36639581.
- [14] Jiang ML, Xu YP, Wu H, Zhu RN, Sun Y, Chen DM, *et al*. Changes in endemic patterns of respiratory syncytial virus infection in pediatric patients under the pressure of nonpharmaceutical interventions for COVID-19 in Beijing, China. *J Med Virol* 2023;95(1):e28411. doi:10.1002/jmv.28411, PMID:36524893.
- [15] National Immunization Advisory Committee (NIAC), Technical Working Group (TWG), Influenza Vaccination TWG. Technical guidelines for seasonal influenza vaccination in China (2022-2023). *Zhonghua Liu Xing Bing Xue Za Zhi* 2022;43(10):1515–1544. doi:10.3760/cma.j.cn112338-20220825-00734, PMID:36456484.
- [16] Roche N, Crichton ML, Goeminne PC, Cao B, Humbert M, Shteinberg M, *et al*. Update June 2022: management of hospitalised adults with coronavirus disease 2019 (COVID-19): a European Respiratory Society living guideline. *Eur Respir J* 2022;60(2):2200803. doi:10.1183/13993003.00803-2022, PMID:35710264.
- [17] Huo L, Zhou Y, Li S, Ning Y, Zeng L, Liu Z, *et al*. Burnout and Its Relationship With Depressive Symptoms in Medical Staff During the COVID-19 Epidemic in China. *Front Psychol* 2021;12:616369. doi:10.3389/fpsyg.2021.616369, PMID:33746836.
- [18] Wu Y, Wang J, Luo C, Hu S, Lin X, Anderson AE, *et al*. A Comparison of Burnout Frequency Among Oncology Physicians and Nurses Working on the Frontline and Usual Wards During the COVID-19 Epidemic in Wuhan, China. *J Pain Symptom Manage* 2020;60(1):e60–e65. doi:10.1016/j.jpainsymman.2020.04.008, PMID:32283221.
- [19] Hu Z, Wang H, Xie J, Zhang J, Li H, Liu S, *et al*. Burnout in ICU doctors and nurses in mainland China-A national cross-sectional study. *J Crit Care* 2021;62:265–270. doi:10.1016/j.jcrrc.2020.12.029, PMID:33477093.
- [20] Pressley T. Factors contributing to teacher burnout during COVID-19. *Educational Researcher* 2021;50(5):325–327. doi:10.3102/0013189X211004138.
- [21] Yildirim M, Solmaz F. COVID-19 burnout, COVID-19 stress and resilience: Initial psychometric properties of COVID-19 Burnout Scale. *Death Stud* 2022;46(3):524–532. doi:10.1080/07481187.2020.1818885, PMID:32915702.
- [22] Vilar S, Isom DG. One Year of SARS-CoV-2: How Much Has the Virus Changed? *Biology (Basel)* 2021;10(2):91. doi:10.3390/biology10020091, PMID:33530355.
- [23] CDC. Variant Proportion. Available from: <https://covid.cdc.gov/covid-data-tracker/#variant-proportions>. Accessed January 16, 2023.
- [24] Callaway E. Coronavirus variant XBB.1.5 rises in the United States - is it a global threat? *Nature* 2023;613(7943):222–223. doi:10.1038/d41586-023-00014-3, PMID:36624320.
- [25] Yuan X, Xu J, Hussain S, Wang H, Gao N, Zhang L. Trends and Prediction in Daily New Cases and Deaths of COVID-19 in the United States: An Internet Search-Interest Based Model. *Explor Res Hypothesis Med* 2020;5(2):1–6. doi:10.14218/ERHM.2020.00023, PMID:32348380.
- [26] Singh S, Shaikh M, Hauck K, Miraldo M. Impacts of introducing and lifting nonpharmaceutical interventions on COVID-19 daily growth rate and compliance in the United States. *Proc Natl Acad Sci U S A* 2021;118(12):e2021359118. doi:10.1073/pnas.2021359118, PMID:33658331.
- [27] Raveendran AV, Jayadevan R, Sashidharan S. Long COVID: An overview. *Diabetes Metab Syndr* 2021;15(3):869–875. doi:10.1016/j.dsx.2021.04.007, PMID:33892403.
- [28] Crook H, Raza S, Nowell J, Young M, Edison P. Long covid-mechanisms, risk factors, and management. *BMJ* 2021;374:n1648. doi:10.1136/bmj.n1648, PMID:34312178.
- [29] Barbara JM, Gatt J, Xuereb RA, Tabone Adami N, Darmanin J, Erasmii R, *et al*. Clinical outcomes at medium-term follow-up of COVID-19. *J R Coll Physicians Edinb* 2022;52(3):220–227. doi:10.1177/14782715221124617, PMID:36369815.
- [30] Di Gennaro F, Belati A, Tulone O, Diella L, Fiore Bavaro D, Bonica R, *et al*. Incidence of long COVID-19 in people with previous SARS-CoV-2 infection: a systematic review and meta-analysis of 120,970 patients. *Intern Emerg Med* 2022;doi:10.1007/s11739-022-03164-w, PMID:36449260.
- [31] Du M, Ma Y, Deng J, Liu M, Liu J. Comparison of Long COVID-19 Caused by Different SARS-CoV-2 Strains: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health* 2022;19(23):16010. doi:10.3390/ijerph192316010, PMID:36498103.
- [32] Notarte KI, Catahay JA, Velasco JV, Pastrana A, Ver AT, Pangiliinan FC, *et al*. Impact of COVID-19 vaccination on the risk of developing long-COVID and on existing long-COVID symptoms: A systematic review. *EclinicalMedicine* 2022;53:101624. doi:10.1016/j.eclinm.2022.101624, PMID:36051247.
- [33] Anderson RM, Vegvari C, Truscott J, Collyer BS. Challenges in creating herd immunity to SARS-CoV-2 infection by mass vaccination. *Lancet* 2020;396(10263):1614–1616. doi:10.1016/s0140-6736(20)32318-7, PMID:33159850.

- [34] Chen Z, Zhang L. Meet the challenges of mass vaccination against COVID-19. *Explor Res Hypothesis Med* 2021;6(2):77–79. doi:10.14218/ERHM.2020.00075.
- [35] China Coronavirus Full Vaccination Rate. Available from: [https://ycharts.com/indicators/china\\_coronavirus\\_full\\_vaccination\\_rate](https://ycharts.com/indicators/china_coronavirus_full_vaccination_rate). Accessed January 17, 2023.
- [36] Mathieu E, Ritchie H, Rodés-Guirao L, Appel C, Giattino C, Hasell J, *et al*. Coronavirus Pandemic (COVID-19). Available from: <https://ourworldindata.org/covid-vaccinations?country=CHN>. Accessed January 17, 2023.
- [37] Baraniuk C. What do we know about China's covid-19 vaccines? *BMJ* 2021;373:n912. doi:10.1136/bmj.n912, PMID:33836994.
- [38] Wolter N, Jassat W, Walaza S, Welch R, Moultrie H, Groome M, *et al*. Early assessment of the clinical severity of the SARS-CoV-2 omicron variant in South Africa: a data linkage study. *Lancet* 2022;399(10323):437–446. doi:10.1016/S0140-6736(22)00017-4, PMID:35065011.
- [39] Ulloa AC, Buchan SA, Daneman N, Brown KA. Estimates of SARS-CoV-2 Omicron Variant Severity in Ontario, Canada. *JAMA* 2022;327(13):1286–1288. doi:10.1001/jama.2022.2274, PMID:35175280.
- [40] Planas D, Saunders N, Maes P, Guivel-Benhassine F, Planchais C, Buchrieser J, *et al*. Considerable escape of SARS-CoV-2 Omicron to antibody neutralization. *Nature* 2022;602(7898):671–675. doi:10.1038/s41586-021-04389-z, PMID:35016199.
- [41] Sahu S. Instant View: China's economy slows sharply in Q4, 2022 growth one of the worst on record. Available from: <https://www.reuters.com/world/china/view-chinas-q4-growth-slows-29-yy-beats-expectations-2023-01-17/>. Accessed January 16, 2023.
- [42] Douglas J. China's Economic Growth Fell to Near-Historic Lows as Covid Took a Bite. Available from: <https://www.wsj.com/articles/chinas-economic-growth-fell-to-near-historic-lows-as-covid-took-a-bite-11673921199>. Accessed January 17, 2023.
- [43] Zhang C, Xiao D, Zhou J, Zipser D. Survey: Chinese consumer sentiment during the coronavirus crisis. Available from: <https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/survey-chinese-consumer-sentiment-during-the-coronavirus-crisis>. Accessed February 28, 2023.
- [44] The World Bank. Fertility rate, total (births per woman) – China. Available from: <https://data.worldbank.org/indicator/SP.DYN.TFRT.IN?end=2020&locations=CN&start=1980&view=chart>. Accessed January 16, 2023.
- [45] Master F, Zhang A. China to discourage abortions to boost low birth rate. Available from: <https://www.reuters.com/world/china/china-discourage-abortions-boost-low-birth-rate-2022-08-16/>. Accessed February 01, 2023.
- [46] Sliver L, Huang C. Key facts about China's declining population. Available from: <https://www.pewresearch.org/fact-tank/2022/12/05/key-facts-about-chinas-declining-population/>. Accessed January 15, 2023.
- [47] Aassve A, Cavalli N, Mencarini L, Plach S, Livi Bacci M. The COVID-19 pandemic and human fertility. *Science* 2020;369(6502):370–371. doi:10.1126/science.abc9520, PMID:32703862.