A Temporal and Spatial Analysis of the COVID-19 Epidemic in China

by

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A Temporal and Spatial Analysis of the COVID-19 Epidemic in China[§]

Lawrence J. Lau and Yanyan Xiong[1]

September 2024

Abstract: The COVID-19 epidemic, which broke out in the city of Wuhan, Province of Hubei, China in late 2019, was finally over in 2023, after almost four years. The objective of this study is to summarise the history of the evolution of this epidemic in China, over both time and space, with the focus on the cumulative population infection rates, the cumulative population death rates (adjusted for possible "excess deaths" as necessary), and the cumulative mortality rates of those infected. Based on these data, four distinct phases of the COVID-19 epidemic may be identified in China: the Beginning Phase, the Controlled Phase, the Explosive Phase, and the "Living with the Virus" Phase. The strategies, policies and measures used in China to control the epidemic are also examined. Overall, the COVID-19 epidemic must be considered to have been reasonably well managed in China, with its national cumulative population infection rate and population death rate among the lowest in the world, even after adjustment for "excess deaths".

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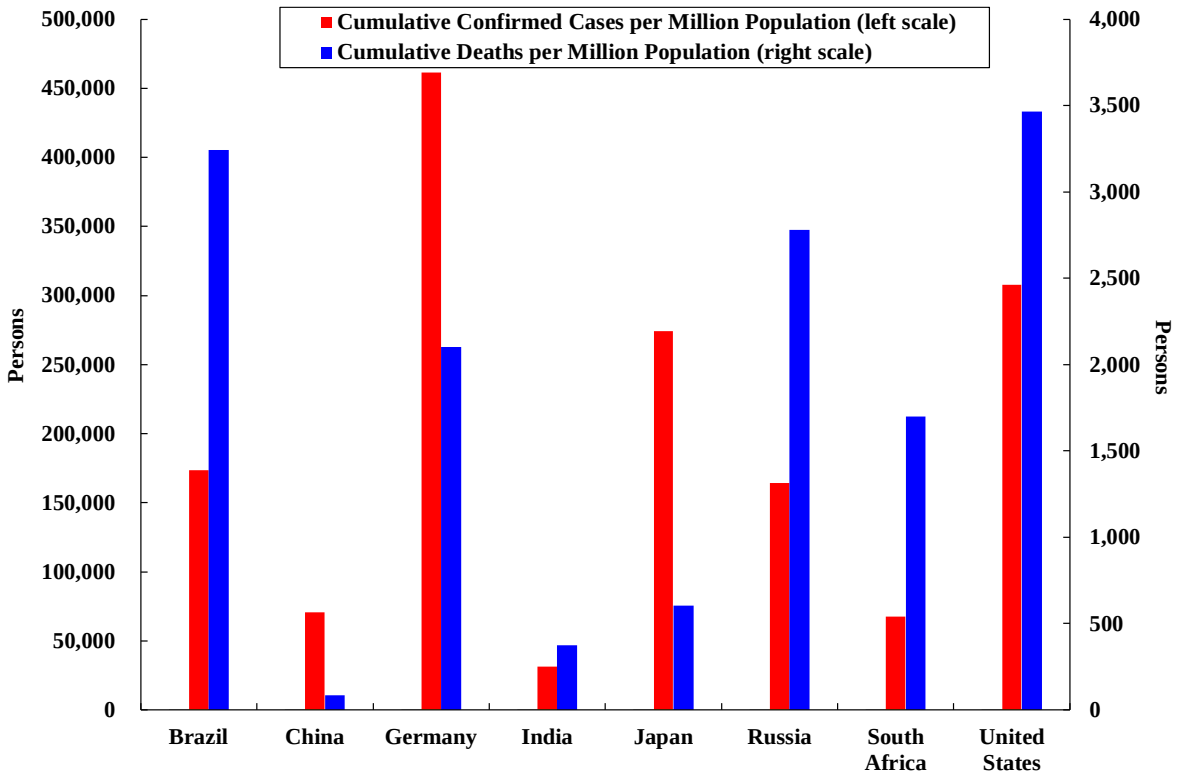
1. Introduction

The objective of this study is to present a whole-picture analysis of what actually happened in China from the beginning of the COVID-19 epidemic to its end and across all of China. The epidemic, which broke out in the city of Wuhan, Province of Hubei, China in late 2019, was finally over in 2023, after almost four years, and is now considered to be just another virus like the regularly occurring influenza.

It is instructive to compare the outcomes of the COVID-19 pandemic across the major countries of the world with respect to their cumulative population infection and population death rates as well as mortality rates, defined as the probability of death conditional on infection. In Chart 1, we present the cumulative number of infections and deaths due to the COVID-19 virus per million population for Brazil, the Mainland of China, Germany, India, Japan, Russia, South Africa and U.S.A. as of year-end 2023. We use Our World in Data as our source for all countries,[2] and we accept the Chinese COVID-19 infection data in Our World in Data as basically reliable.

[2] https://ourworldindata.org/coronavirus. We use our own adjustments of the Chinese data for the early stage of the COVID-19 epidemic in 2020 that preserve the cumulative totals (see Lau and Xiong (2020a, 2020b, 2021a and 2021b)).

Chart 1: Cumulative Confirmed COVID-19 Cases and Deaths per Million Population
Brazil, China, Germany, India, Japan, Russia, South Africa and U.S.A.
Year-End 2023



Source: The numbers of cumulative confirmed COVID-19 cases and deaths are from Our World in Data (https://ourworldindata.org/coronavirus). The total populations of all countries, exept for the United States, are also from Our World in Data. The total population of the U. S. in 2023 is from the U.S. Bureau of the Census.

We note that in terms of the cumulative confirmed COVID-19 infection rates (red columns) as of year-end 2023, the developing countries as a group (Brazil, China, India and South Africa), somewhat unexpectedly, did considerably better than the developed countries as a group (Germany, Japan and the U.S.), all of which had cumulative population infection rates of more than 250,000 per million.[3] India had the lowest infection rate at 31,508 per million population, followed by South Africa (67,412) and China (70,458), with the cumulative infection rate of the rest of the world ex China being 101,669 per million population,[4] slightly more than ten percent, also significantly lower than those of the included developed countries. We believe that this may be due, in part, to the possibility of insufficiently complete reporting

[3] Even with data from the same source, Our World in Data, there may well be definitional differences in the actual implementation of the measurements across countries. For example: countries may differ as to whether the confirming test for COVID-19 infection should be a nucleic acid test.

[4] According to Our World in Data, the cumulative total number of COVID-19 infections for the world and China respectively as of the end of 2023 were 773,960,065 and 99,322,727, respectively. Total population of the world and China at the end of 2023 were 8,045,311,447 and 1,409,670,000, respectively. Thus, the cumulative infection rate of the rest of the world ex China may be calculated as (773,960,065-99,322,727)/(8,045,311,447-1,409,670,000)×1,000,000=101,669 per million population.

of infections in the developing countries. In terms of cumulative COVID-19 death rates (blue columns) as of year-end 2023, China did much better than all of the other major countries, developing and developed, at 84.5 deaths per million population, followed by India (373.3) and Japan (605.8), with the rest of the world ex China at 1,039 per million population, or approximately 0.1%.[5] [6]

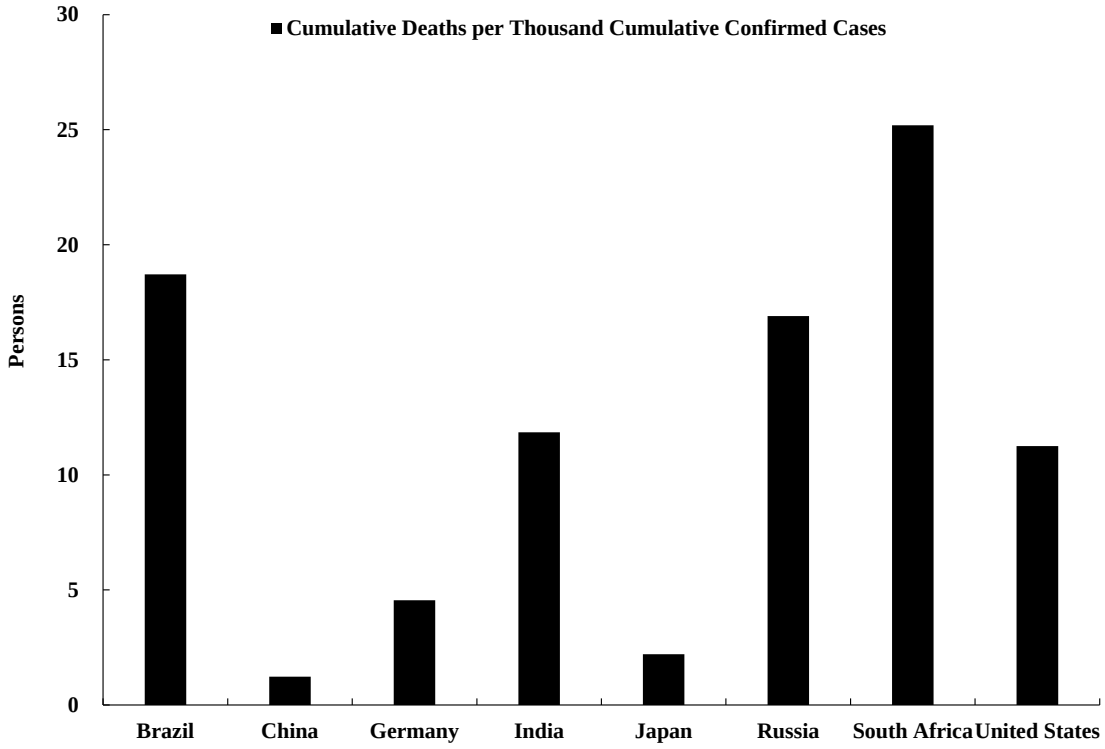
In Chart 2, we present the cumulative number of deaths per thousand cumulative confirmed COVID-19 cases (the mortality rate) for the same countries, also as of year-end 2023. China also had the lowest mortality rate, at 1.2 deaths per thousand cases, or 0.1%, followed by Japan (0.2%) and Germany (0.5%). South Africa had the highest mortality rate at 2.5%. For the rest of the world ex China, the mortality rate was 1.0%. The developed countries, as might be expected because of their better medical facilities, had lower mortality rates than the developing countries with the exception of China.[7]

[5] According to Our World in Data, the cumulative total number of COVID-19 deaths for the world and China as of the end of 2023 were 7,015,550 and 121,893 respectively. Total population of the world and China at the end of 2023 were 8,045,311,447 and 1,409,670,000 respectively. Thus, the cumulative death rate of the rest of the world ex China may be calculated as (7,015,550-121,893)/(8,045,311,447-1,409,670,000) ×1,000,000=1,039 per million population.

[6] However, as noted above, there may well be differences in the actual implementation of the measurements across countries. For example: How should one decide whether a given death should be attributed to COVID-19? In Section 2 below, we attempt to estimate upper bounds for the possible under-estimation of the COVID-19 death rates in China and the U.S.

[7] From the onset to the end of the global COVID-19 pandemic, China consistently reported among the lowest mortality rates internationally (Jamison, et al., 2020; Jamison and Wu, 2021).

Chart 2: Cumulative Number of COVID-19 Deaths per Thousand Confirmed Cases
Brazil, China, Germany, India, Japan, Russia, South Africa and U.S.A.
Year-End 2023



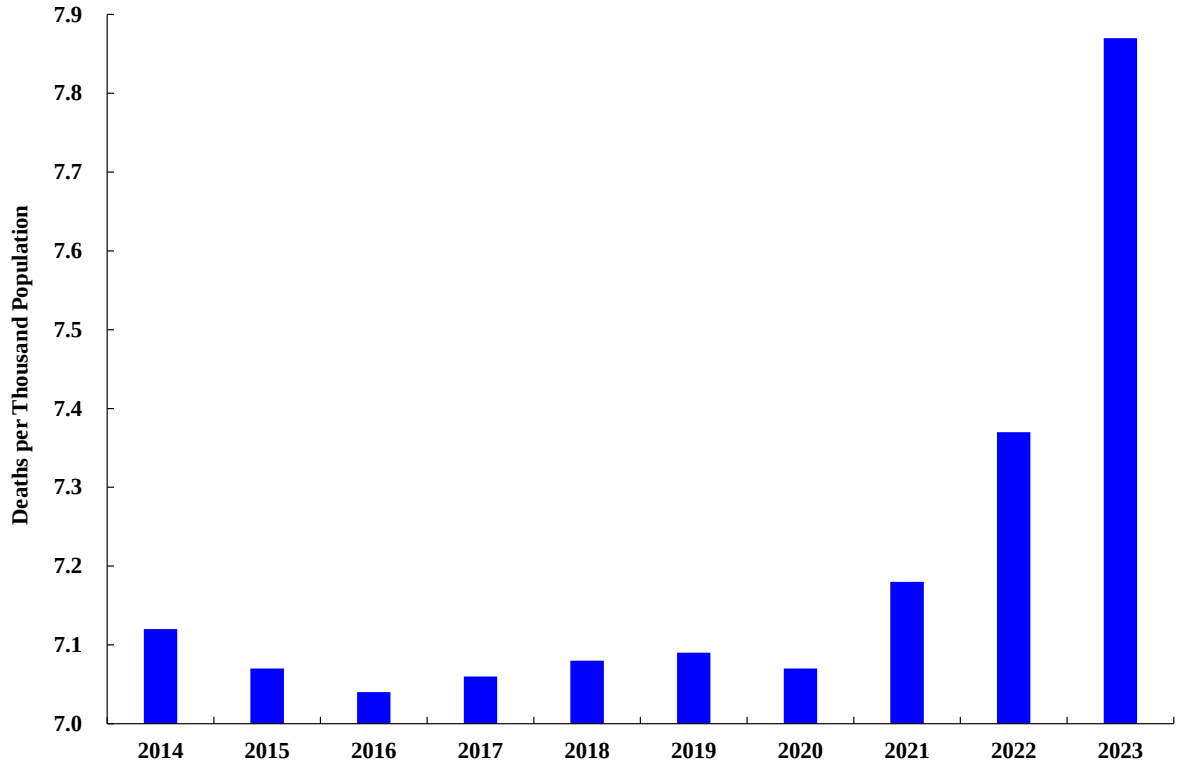
Source: Our World in Data.

How did China manage to do relatively so well? The differences between China and the other countries, especially the developed ones, are indeed pronounced. We want to make sure that the source of the differences is not simply the difference in terms of the actual implementations of the measurements, in particular, of the COVID-19 death rates. There are well-known possibilities of errors of mis-attribution and omission in the data on COVID-19 deaths, which are present in the data of almost all countries. In the case of mis-attribution, if a patient who suffers from both COVID-19 and another condition dies, the cause of death may be attributed to COVID-19 or not to COVID-19 or to both. It is difficult to determine unambiguously the primary cause of death. In the case of omission, it is possible that a patient dies because he or she could not receive the proper and timely medical care due to the COVID-19 epidemic, for various reasons ranging from the over-crowding of the medical facilities to the inaccessibility of health care caused by the lockdown and to the unsatisfied excess demand for medical treatment. For both mis-attribution and omission, the death rate is increased by COVID-19 but not directly attributed to COVID-19. We attempt to estimate an upper bound on the magnitude of such effects on the cumulative Chinese and U.S. death rates in Section 2 below.

2. Adjustment of the Chinese and U.S. COVID-19 Death Rates

We begin by estimating what would have been the normal Chinese death rates for 2020-2023 in the absence of the COVID-19 epidemic. In Chart 3, the Chinese crude death rates for the ten years from 2014 to 2023 are presented. It shows very clearly the COVID-19 effects on the death rates during the period 2021-2023. We note that between 2014 and 2019, before the outbreak of the epidemic, the death rate fluctuated within a narrow band between 7.04 per thousand and 7.12 per thousand. The six-year average of 2014-2019 is 7.077 per thousand. We shall assume that this would have been the normal death rate for the period 2021 through 2023 in the absence of COVID-19.[8] For 2020, the actual death rate was 7.07 and the reported COVID-19 death rate was 0.003; we subtract the COVID-19 death rate from the actual death rate to obtain an estimate of the "normal" death rate for 2020 of 7.067.

Chart 3: Chinese Crude Death Rates (Deaths per Thousand Population), 2014-2023

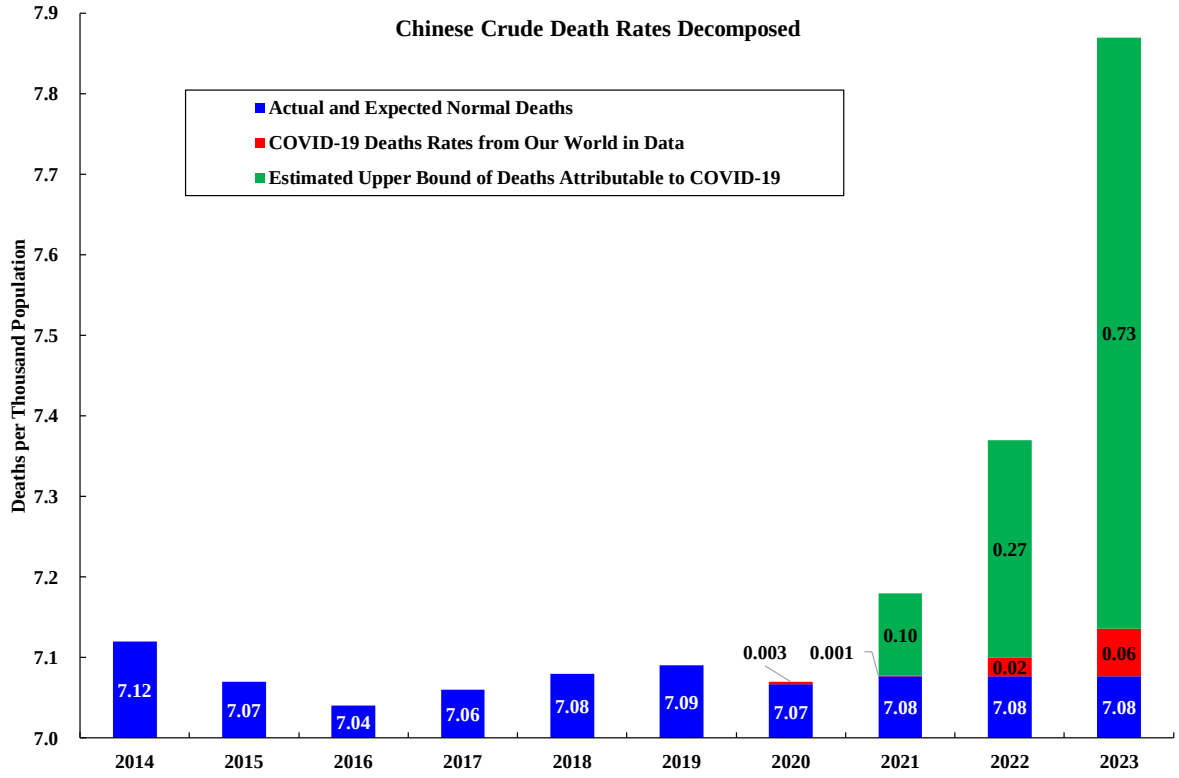


Source: National Bureau of Statistics of China.

[8] We did not take into account the possibility that the "normal" death rate might have been rising over time because of the rise in the average age of the population.

In Chart 4, we decompose the Chinese crude death rates for the years 2020-2023 into three components: the expected normal deaths (in blue), the COVID-19 deaths (in red),[9] and the residual, identified as the estimated possible indirect COVID-19 deaths (in green). The green parts of the death rates represent the estimates of the upper bounds of "excess deaths", that is, deaths that may be considered to be COVID-19 related. Chart 4 shows that the residuals can be quite large (due, in part, to the selected scaling of the chart)—for 2023, the residual was over 0.7 per thousand.

Chart 4: Chinese Crude Death Rates Decomposed (Deaths per Thousand Population) 2014-2023

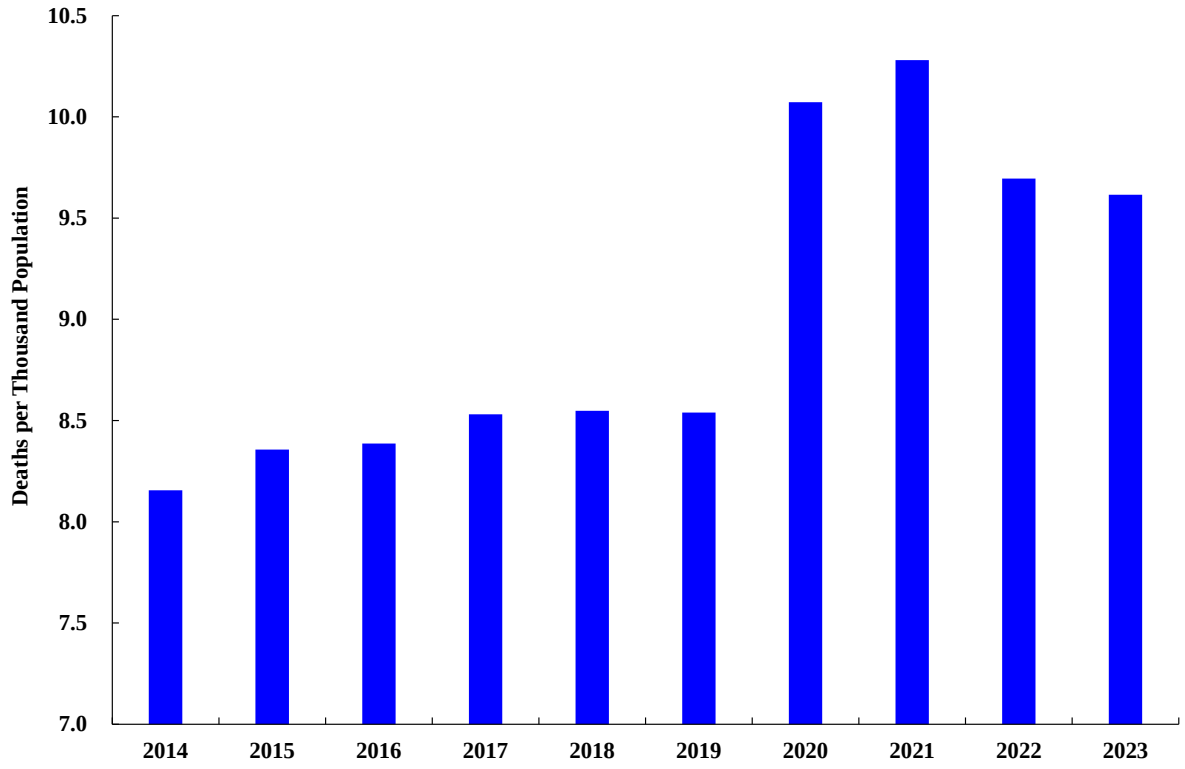


Source: National Bureau of Statistics of China; Our World in Data.

We next estimate what would have been the normal U.S. death rates for 2020-2023 in the absence of the COVID-19 epidemic. In Chart 5, the U.S. crude death rates for the ten years from 2014 to 2023 are presented. It shows very clearly the COVID-19 effects on the death rates during the period 2020-2023. We note that between 2017 and 2019, before the outbreak of the epidemic, the death rate fluctuated within a very narrow band between 8.53 per thousand and 8.55 per thousand. We shall assume that 8.54 would have been the normal death rate for the period 2020 through 2023 in the absence of COVID-19.

[9] We may also note that the actual reported number of COVID-19 deaths in China was very low in 2021.

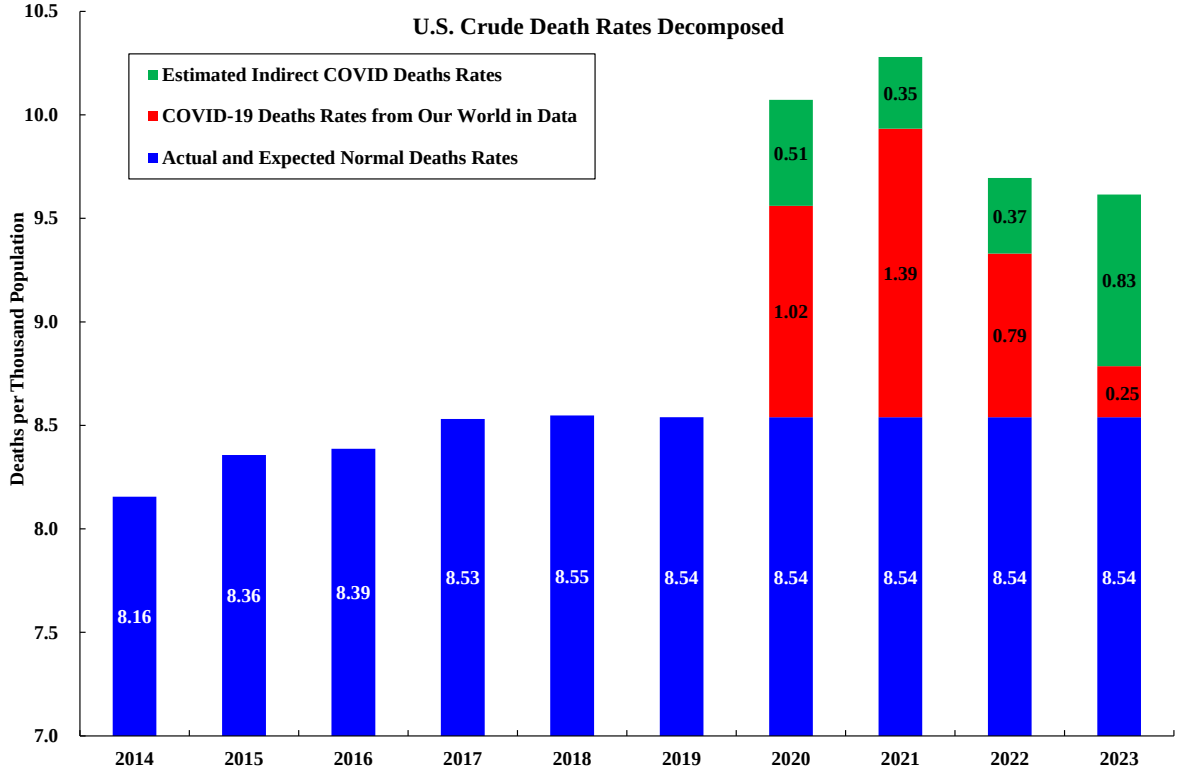
Chart 5: U.S. Crude Death Rates (Deaths per Thousand Population), 2014-2023



Source: The U.S. Center for Disease Control and Prevention; Population Reference Bureau (https://www.prb.org/about/).

In Chart 6, we decompose the U.S. crude death rates for the years 2020-2023 into three components: the expected normal deaths (in blue), the COVID-19 deaths (in red), and the residual, identified as the estimated possible indirect COVID-19 deaths (in green). The green parts of the death rates represent the estimates of the upper bounds of "excess deaths", deaths that may be considered to be COVID-19 related. Chart 6 shows that the U.S. residuals, while not zero, are quite small when compared to the Chinese residuals in Chart 4.

Chart 6: U.S. Crude Death Rates Decomposed (Deaths per Thousand Population) 2014-2023



Source: The U.S. Center for Disease Control and Prevention; Population Reference Bureau; Our World in Data.

Using these estimated death rates, we can calculate the number of "excess deaths" in China and the U.S. indirectly attributable to COVID-19 for the years 2020 through 2023. The results are presented in Table 1. We note that the expected normal deaths declined in China in 2022 and 2023 because the Chinese total population declined in these years. The "excess deaths" indirectly attributable to COVID-19 in China may be estimated to be a cumulative 1,561,315 persons between 2020 and 2023.[10] Similarly, the "excess deaths" indirectly attributable to COVID-19 in the U.S. may be estimated to be a cumulative 694,244 persons between 2020 and 2023.[11]

[10] Our estimate of the total cumulative Chinese "excess deaths" between January 2020 and year-end 2023, is 1.561 million (see Table 1), similar in magnitude to that of Jamison, et al. (2024) for the period from January 2020 to 4 May 2023 (see its Appendix table 7.2). Since the total number of actual deaths should be the same, what this means is that our estimates of China's expected normal deaths must have been higher than those of Jamison et al. (2024). However, even if the Jamison, et al. (2024) estimates of excess deaths were used, Charts 7 and 8 would not be changed materially.

[11] Jamison, et al. (2024) found that the number of "excess deaths" in the U.S. was almost doubled our estimate of 0.694 million in Table 1 (see its Appendix table 7.2).

Table 1: Actual, Expected Normal, COVID-19 and Estimated "Excess Deaths" in China and the U.S., 2020-2023

	Annual Total Deaths, persons		Estimated Expected Normal Deaths, persons		Official Annual COVID-19 Deaths , persons		Estimated Excess Deaths, persons		Total Direct and Indirect Estimated COVID-19 Deaths	
	China	The U.S.	China	The U.S.	China	The U.S.	China	The U.S.	China	The U.S.
2020	9,983,688	3,383,729	9,978,900	2,868,791	4,788	342,920	0	172,018	4,788	514,938
2021	10,142,468	3,464,231	9,996,499	2,877,805	911	469,667	145,058	116,759	145,969	586,426
2022	10,404,598	3,279,857	9,990,484	2,888,841	46,845	267,389	367,268	123,627	414,113	391,016
2023	11,094,103	3,269,090	9,975,765	2,903,415	69,349	83,835	1,048,989	281,840	1,118,338	365,675
Total	41,624,857	13,396,907	39,941,649	11,538,852	121,893	1,163,811	1,561,315	694,244	1,683,208	1,858,055

Sources: Chinese actual deaths are from the National Bureau of Statistics of China; U.S. actual deaths are from Center for Disease Control and Prevention; COVID-19 deaths from Our World in Data; expected normal deaths and "excess deaths" estimated by the authors.

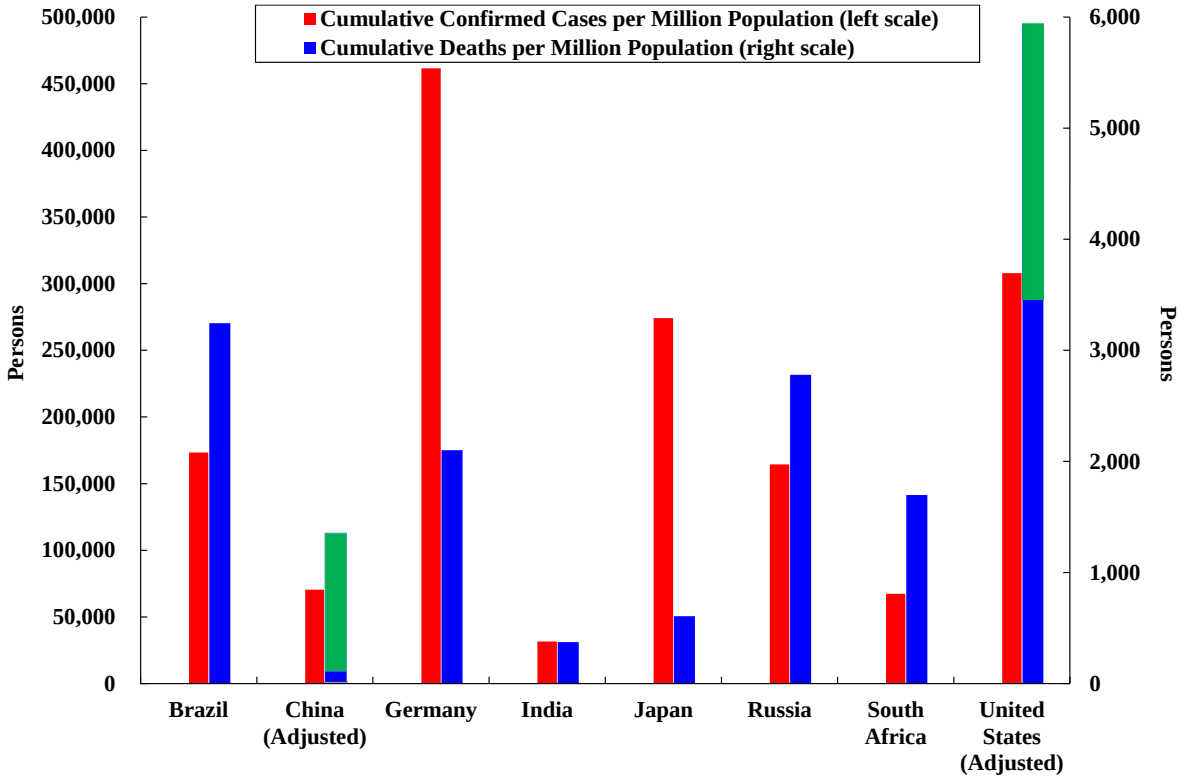
In Chart 7, we modify our Chart 1 so that the cumulative deaths per million population (blue column) for China and the U.S. also include the estimated respective possible indirect COVID-19 deaths, represented by the green parts of the columns in Charts 4 and 6.[12] [13] We can see that even though the estimated Chinese total cumulative COVID-19 death rate, including both direct and indirect, at year-end 2023, is significantly increased, it remains lower than the similarly adjusted U.S. cumulative death rate as well as the unadjusted German cumulative death rate, but is no longer lower than the unadjusted Japanese death rate. Actually, the data of all the other countries also suffer from the same effects of under-attribution and omission to different degrees and the situation may be worse in developing countries.[14]

[12] Our estimates of the numbers of "excess deaths" for China in 2020 and 2021 are higher than the mean estimates of Msemburi et al. (2022) of -75,524.91 and 23,462.18 respectively (see Msemburi et al. (2022) Supplementary Information, p. 26, Supplementary Table 5).

[13] Our estimates of the numbers of "excess deaths" for the U.S. in 2020 and 2021 are lower than the mean estimates of Msemburi et al. (2022) of 465,706 and 466,752.44 respectively (see Msemburi et al. (2022) Supplementary Information, p. 33, Supplementary Table 12).

[14] Jamison, et al. (2024) found that the number of "excess deaths" in India was more than three times their estimate of "excess deaths" for China, even though the populations of the two countries were almost the same (see its Appendix table 7.2).

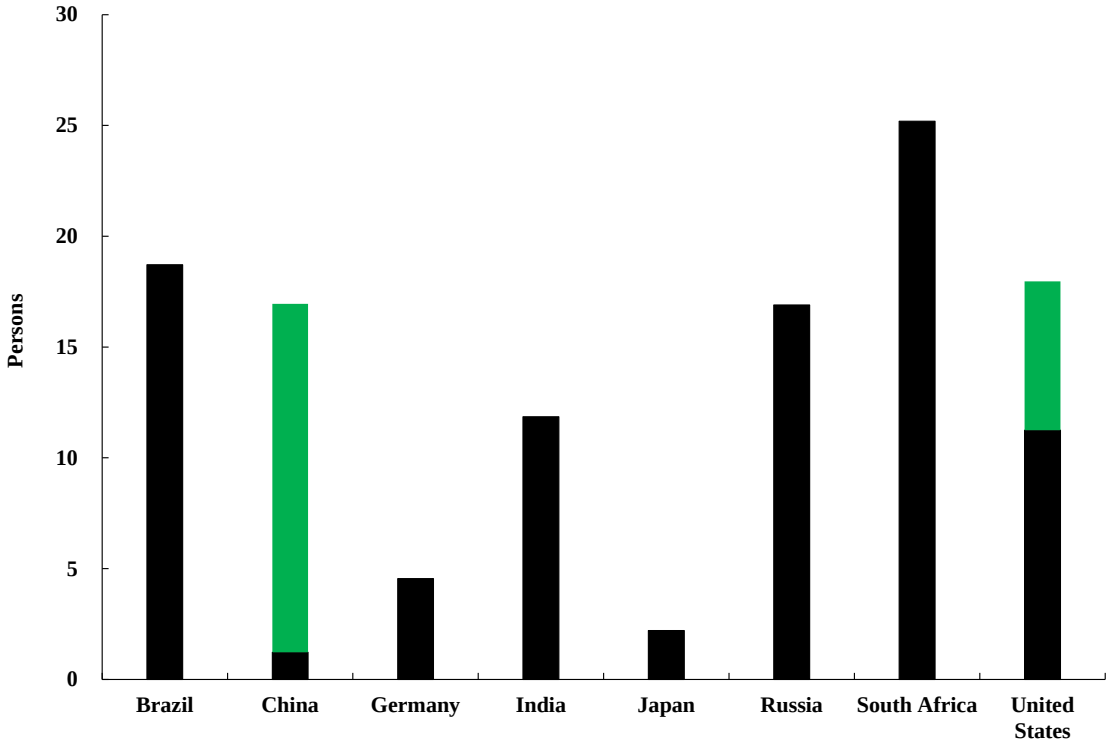
Chart 7: Cumulative Confirmed COVID-19 Cases and Deaths per Million Population Brazil, China (Adjusted), Germany, India, Japan, Russia, South Africa and U.S.A (Adjusted) Year-End 2023



Source: Our World in Data and Charts 4 and 6.

In Chart 8, we modify our Chart 2 so that the cumulative deaths per thousand confirmed cases for China and the U.S. also include the estimated respective possible indirect COVID-19 deaths, represented by the green parts of the columns in Charts 4 and 6 and presented in Table 1. The estimated Chinese mortality rate, including both direct and estimated indirect COVID-19 deaths, at year-end 2023, is significantly increased, and is clearly an over-estimate of the "true" mortality rate because it includes deaths not caused by COVID-19 and these excess deaths themselves are not reflected in the number of confirmed cases. However, it remains slightly lower than the similarly adjusted U.S. mortality rate but is no longer lower than the unadjusted German and Japanese mortality rates.

Chart 8: Cumulative Number of COVID-19 Deaths per Thousand Confirmed Cases Brazil, China, Germany, India, Japan, Russia, South Africa and U.S.A. (Adjusted) Year-End 2023



Source: Our World in Data and Table 1.

3. A Chronology of the COVID-19 Epidemic in China

The COVID-19 virus was first detected in Wuhan, the capital of the Province of Hubei, China, a city of approximately 8.5 million population, in December 2019. The COVID-19 epidemic lasted for almost four years. It was officially declared to be over in China on 8 January 2023.[15] It is possible to identify four critical decisions made by the Chinese Government in its efforts to control the COVID-19 epidemic. The first was the imposition of a blockade and lockdown of the city of Wuhan on 23 January 2020, the day before the Lunar New Year's Eve, the traditional family reunion night of China. The blockade and lockdown were extended to cover twelve additional cities in the Province of Hubei on the next day.[16] This was a momentous, and at the time extremely unpopular, decision, as tens of millions of rural labourers in Hubei had been waiting to go home to their respective provinces and regions to spend the lunar new year with their families, whom they had not seen for an entire year! This first decision prevented the rapid spread of the COVID-19 virus to the rest of Mainland China and to the rest of the world.

The second was the decision to impose a quarantine on all persons entering Mainland China from the outside, which was announced on 1 March 2020.[17] This second decision minimised the import into Mainland China of the different new variants of the COVID-19 virus from other countries and regions. It thus protected Mainland China during the most lethal phase of the COVID-19 pandemic. As a result, the COVID-19 epidemic was basically under control on the Mainland during the period from 15 April 2020 to 28 February 2022, until the beginning of the outbreak in Shanghai.

The policies and measures adopted by the Chinese Government during this period included the strengthening of the efforts for early identification, confirmation, real-time follow-

[15] On 26 December 2022, the National Health Commission of China released an official announcement regarding two significant decisions. First, the term "novel coronavirus pneumonia" has been renamed as "novel coronavirus infection". Second, effective from 8 January 2023, COVID-19 infections will be downgraded from Category A to Category B. On 3 May 2023, at the 15th meeting of the International Health Regulations (2005) Emergency Committee on the COVID-19 pandemic, the assembly concurred that COVID-19 had become an established and ongoing health issue and would no longer be considered a public health emergency of international concern (PHEIC).

[16] The original announcements of the blockades of Wuhan and other cities of Hubei are reproduced in Appendix 1.

[17] The original announcement of the quarantine of entrants from outside of the Mainland is reproduced in Appendix 2.

up of all close contacts of the infected, and the management of asymptomatic infections,[18] as well as the control of high-risk locations, units and population clusters, which were implemented on 6 April 2020.[19]

The third was the decision to adopt the full "Dynamic Zero"[20] policy in August 2021.[21] The "Dynamic Zero" policy aimed at achieving zero new COVID-19 infection through timely prevention of its inter-personal transmission. As part of this policy, already on 27 August 2020, the government announced measures to improve the capacity for nucleic acid testing of COVID-19.[22] On 18 January 2021, the government again stressed the importance of strict preventive measures to contain the epidemic.[23] On 25 November 2021, the government reinforced the importance of strengthening epidemic prevention and control in port cities.[24] These policies and measures worked quite well until the unexpected massive outbreak in Shanghai in early 2022.

The implementation of the complete "Dynamic Zero" policy, which mandates the total prevention of inter-personal transmission of the COVID-19 virus, required the imposition of a lockdown at the individual household level in Shanghai, given the size and suddenness of the outbreak.[25] For such a policy to work effectively, each household under the lockdown must be provided with food and beverage in a timely manner and its members should be tested daily within its own residence.[26] At the end of seven days (the average gestation period of the virus) or at most fourteen days of lockdown, the residents of the household would have either tested positive for the virus, in which case they would be sent to an isolation facility or a hospital to be treated, or tested negative, in which case they would be freed from the lockdown.[27] Because of the failure of full implementation, zero was ultimately not achieved in Shanghai, and the virus spread to other provinces, municipalities and regions.

[18] https://www.gov.cn/zhengce/content/2020-04/08/content_5500371.htm.
[19] https://www.gov.cn/zhengce/content/2020-04/08/content_5500241.htm.
[20] In Chinese, "dongtaiqingling (動態清零)".
[21] The original announcement of the "Dynamic Zero" policy is reproduced in Appendix 3. https://new.qq.com/rain/a/20211201A0BS3U00. See also the discussion in Liang et al. (2022).
[22] https://app.www.gov.cn/govdata/gov/202008/31/462364/article.html.
[23] https://www.gov.cn/zhengce/content/2021-01/20/content_5581361.htm.
[24] https://www.gov.cn/zhengce/content/2021-12/11/content_5659950.htm.
[25] It is not possible to prevent intra-household transmission of the COVID-19 virus effectively.
[26] This is to avoid transmission of the virus to other households.
[27] In principle, there is no reason for the lockdown to exceed fourteen days at a maximum.

The fourth was the decision to change from the "Dynamic Zero" policy to the "Co-Existing with the Virus"[28] policy on 7 December of 2022.[29] By this time, the lethality of the COVID-19 virus had diminished significantly, in part also because of the experience accumulated in the treatment of the virus. The adoption of the "Co-Existing with the Virus" policy led to a huge increase in the number of infections but a relatively small increase in the number of deaths, reflecting the diminished lethality of the COVID-19 virus.

4. The Identification of the Four Phases of the COVID-19 Epidemic

Based on the daily data on cumulative confirmed cases and cumulative deaths attributable to the COVID-19 virus, four distinct phases of the COVID-19 epidemic may be identified within the Mainland of China. In Chart 9, the daily data on the cumulative confirmed cases[30] and cumulative number of deaths from COVID-19 are presented, with the former as a red line (left scale) and the latter as a black line (right scale), from 16 January 2020 to 28 February 2023.[31] While the very first confirmed COVID-19 case was reported in Wuhan on 1 December 2019, systematic data on infections were not collected until 16 January 2020.[32] The red and black lines in Chart 9 look remarkably similar, except for the difference in scale, with the black line lagging the red line by approximately seven days. Taken together, the two lines show that four distinct phases for the COVID-19 epidemic can be clearly and unambiguously identified in Mainland China. The four phases are, respectively: (1) Phase I, the Beginning Phase, from 1 December 2019 to 15 April 2020; (2) Phase II, the Controlled Phase, from 16 April 2020 to 28 February 2022; (3) Phase III, the Explosive Phase, from 1 March 2022 to 7 December 2022; and (4) Phase IV, the "Co-Existing with the Virus" Phase, from 8 December 2022 to the present. The four phases are separated by three vertical blue lines in Chart 9.

[28] In Chinese, "yubindugongcun (與病毒共存)".

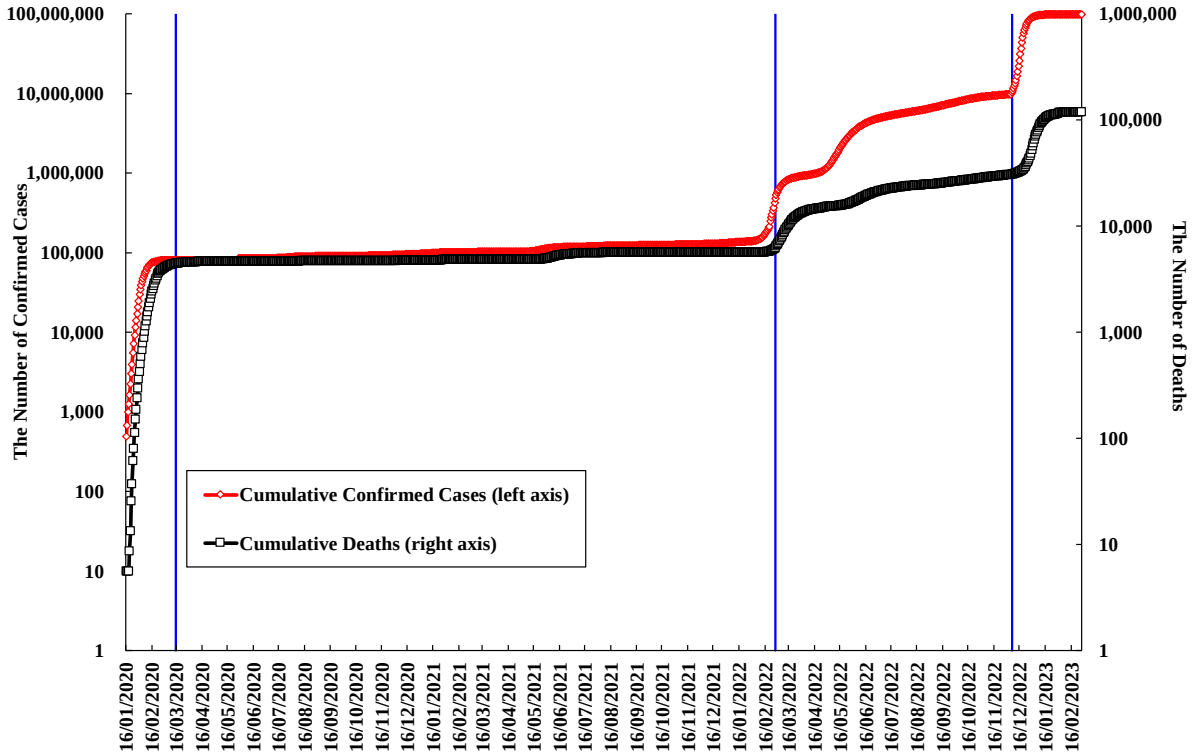
[29] The original announcement of the relaxation of the "Dynamic Zero" policy is reproduced in Appendix 4. The decision was apparently taken by the newly elected Standing Committee of the Politburo of the Communist Party of China.

[30] A repeated COVID-19 infection of the same person will count as another confirmed case.

[31] For the period from 16 January 2020 to 31 May 2020, the adjusted cumulative confirmed cases and deaths data of Lau and Xiong (2021a) are used; thereafter, the data from One World in Data are used.

[32] The first patient was identified with an unknown viral pneumonia on 1 December 2019, and subsequently reported and confirmed in a study published in *The Lancet*, on 24 January 2020 (Huang, et al., 2020).

Chart 9: Daily Cumulative Confirmed COVID-19 Cases and Deaths: Mainland China



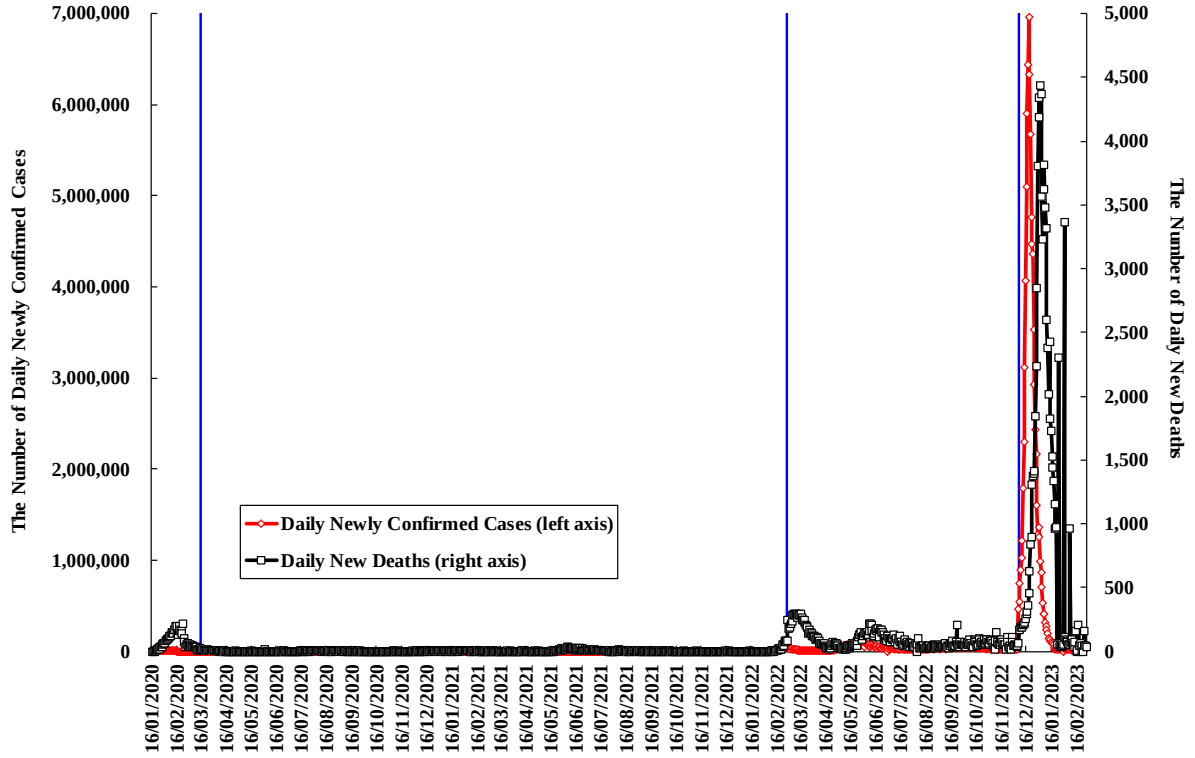
Source: Our World in Data.

In the Beginning Phase, the numbers of both cumulative confirmed cases and deaths rose steeply at first, and then levelled off. In the Controlled Phase, which lasted almost two years, the numbers of both cumulative confirmed cases and deaths grew gradually and slowly. In the Explosive Phase, the numbers of both cumulative confirmed cases and deaths grew by leaps and bounds. Finally, in the "Co-Existing with the Virus" Phase, there was a one-off rapid increase in the cumulative numbers of both cases and deaths, and then they levelled off once again.

In Chart 10, the daily number of newly confirmed cases and new deaths, from 16 January 2020 to 28 February 2023, are presented in the forms of a red line (left scale) and a black line (right scale) respectively. Chart 10 tells more or less the same story as Chart 9. In the Beginning Phase, the number of newly confirmed cases shot up to as high as 15,000 a day at its peak and then fell to an average of about 10 a day; and the number of new deaths shot up to over 250 a day and then fell to zero or one a day. In the Controlled Phase, for the whole of the Mainland, the total number of newly confirmed cases mostly stayed below 100 a day and the total number of new deaths never exceeded 40 and averaged below 10 a day. In the Explosive Phase, the number of newly confirmed cases rose to almost 100,000 a day at its peak

and the number of new deaths fluctuated between 12 and 280 a day. In the "Co-Existing with the Virus" Phase, the number of newly confirmed cases reached a peak of almost 7 million a day but settled down to an average of below 1,000 a day by the end of March 2023. The number of new deaths got as high as almost 4,400 a day but eventually settled down to an average of single-digit level a day by the end of March 2023. Chart 10 also confirms clearly and unambiguously the existence and the identification of the four distinct phases of the COVID-19 epidemic in China (also separated by three vertical blue lines).

Chart 10: Daily Newly Confirmed Cases and New Deaths: Mainland China

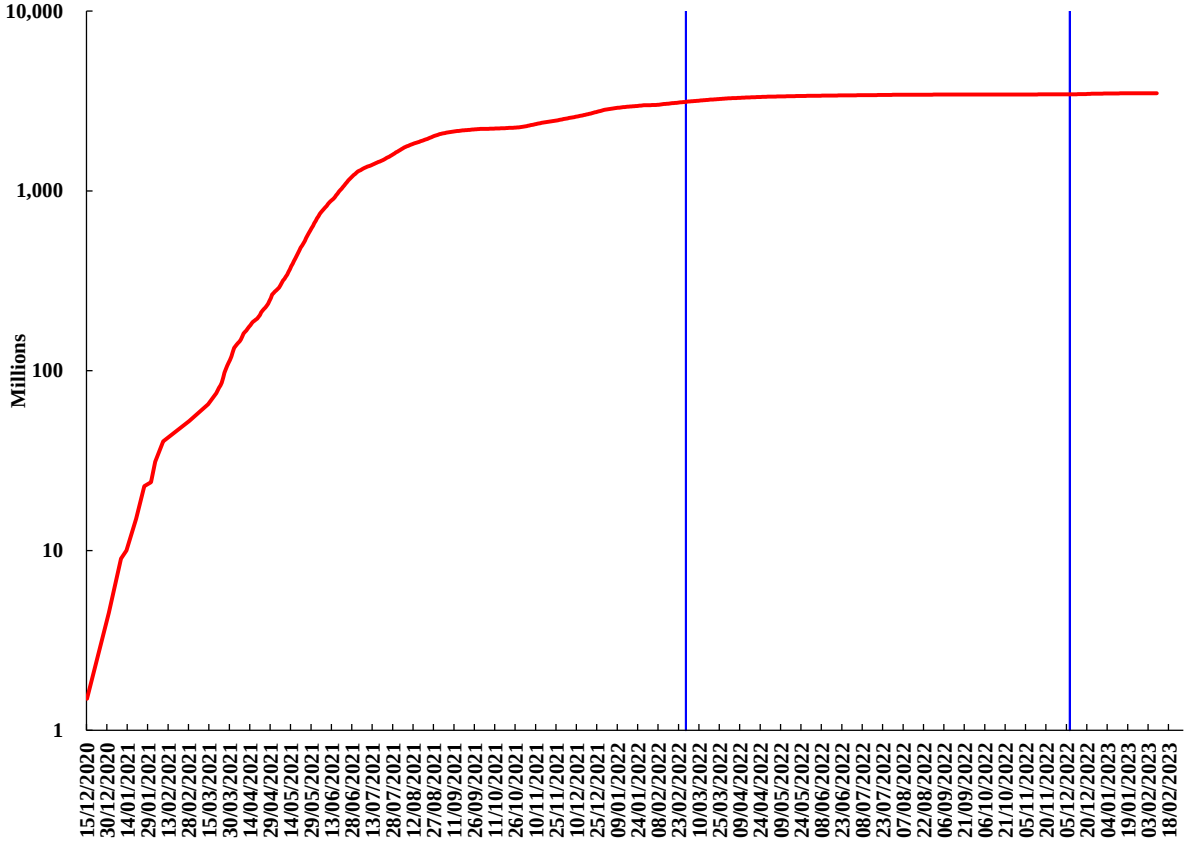


Source: Our World in Data.

5. The Role of Vaccinations

It is useful to examine the incidence of vaccinations against the COVID-19 virus and the role it played in controlling the COVID-19 epidemic in China. The first Chinese COVID-19 vaccine, from *Guoyao* (Sinopharm), based on de-activated virus, became available in China on 31 December 2020, fully one year after the first confirmed case.[33] This was followed by another vaccine, from *Kexing* (Sinovac), also based on de-activated virus.[34] However, vaccination against the COVID-19 virus never became mandatory or universal in China. In Chart 11, the cumulative number of COVID-19 vaccinations of whatever type on the Mainland is presented, with any repeated vaccination of the same person counting as another vaccination (with the three later phases of the COVID-19 epidemic separated by two vertical blue lines).[35]

Chart 11: The Cumulative Number of COVID-19 Vaccinations: Mainland China



Source: Our World in Data.

[33] http://www.xinhuanet.com/english/2020-12/31/c_139632627.htm.
[34] https://www.voanews.com/a/covid-19-pandemic_who-approves-chinese-covid-vaccine-emergency-use-worldwide/6205567.html.
[35] In principle, since many individuals may have had multiple vaccinations, we may want to use the cumulative number of vaccinated persons; unfortunately, such data do not seem to be available.

We note from Chart 11 that the launch of vaccinations against COVID-19 in Mainland China was quite slow. By the end of March 2021, less than 120 million doses of the COVID-19 vaccine were administered on the entire Mainland, covering less than 10 percent of a population in excess of 1.4 billion. This shows that the success in containing the spread of the COVID-19 virus within the Mainland during the Controlled Phase was due in greater part to both the early blockade of Wuhan and Hubei and the quarantine of entrants from abroad. However, the cumulative number of doses administered did increase rapidly during 2021. By 28 February 2022, almost 3.13 billion doses had been administered. Considering that the effective protection period of the vaccines is approximately six months and that most of the vaccinated have been encouraged to have a booster shot, this means that probably no more than half of the population had some protection at any one time. The cumulative number of doses administered ultimately reached 3.5 billion by early February 2023. These vaccinations may have helped to stem the infections somewhat and in particular may have reduced the mortality rates during the Explosive Phase.

6. The Spatial Distribution of the COVID-19 Epidemic in China

In Charts 12 through 19, we present maps of China showing the thirty-one individual provinces, municipalities and autonomous regions on the Mainland; highlighting the spatial incidence of the COVID-19 epidemic among them, with the relative darkness of the colours reflecting the relative severity in terms of the number of cumulative confirmed cases and deaths per million population on the end dates of each of the four phases.[36]

[36] The detailed data used in the preparation of the maps on cumulative infection rates are presented in Appendix Table 1. The detailed data used in the preparation of the maps on cumulative death rates are presented in Appendix Table 2.

Chart 12: Cumulative Confirmed Cases per Million Population on 15 April 2020

Source: Appendix Table 1.

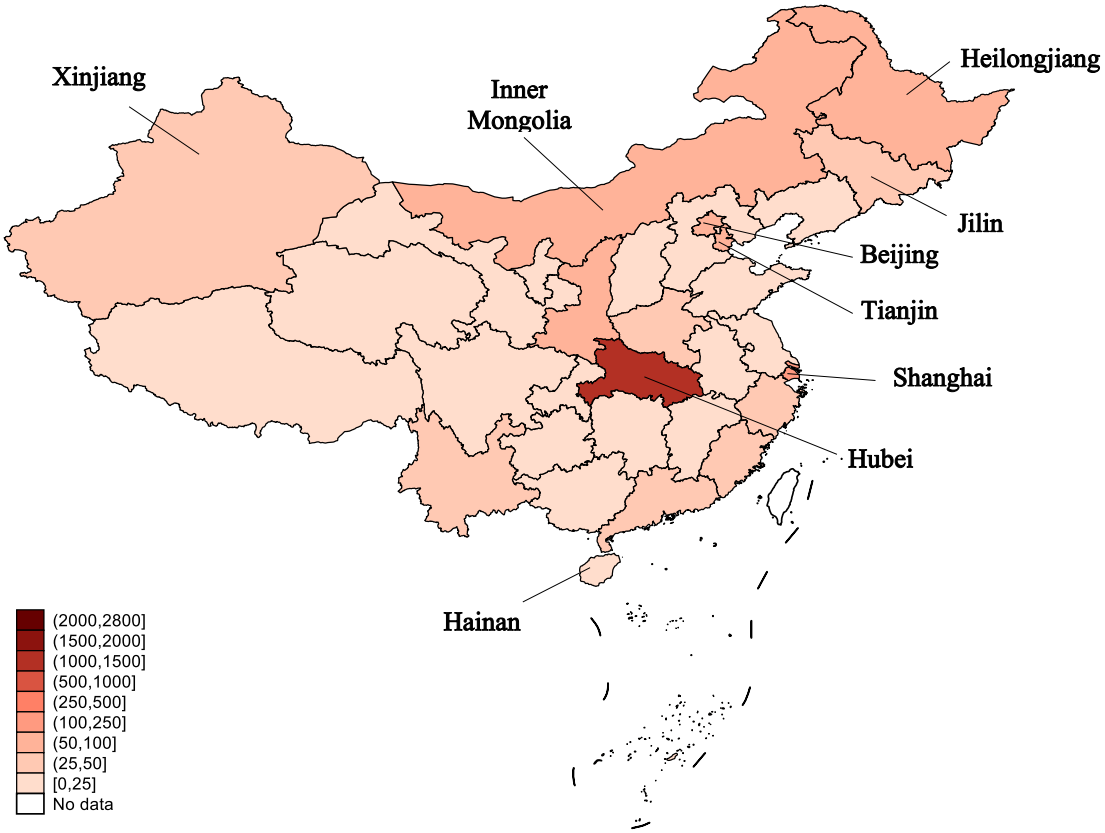
Chart 12 shows that, in the Beginning Phase (up to 15 April 2020), the COVID-19 epidemic was largely confined to the Province of Hubei. While Hubei had an infection rate of over 1,140 per million population, the highest among all provinces, municipalities and regions, the second highest, Beijing, had only less than 27 per million, or less than 2.4% of the infection rate of Hubei. Beijing was followed by Heilongjiang and Shanghai, both with slightly over 25 per million. The huge difference in the incidence of COVID-19 infection between Hubei and the rest of China provides convincing evidence that the policy of blockading Hubei, beginning with the day before the lunar New Year's Eve in 2020, was quite effective in preventing the spread of the COVID-19 virus to the rest of the Mainland in this phase.

Chart 13: Cumulative Deaths per Million Population on 15 April 2020

Source: Appendix Table 2.

Chart 13 shows clearly that Hubei also had the highest cumulative death rate from COVID-19 in the country, with almost 55 per million population on 15 April 2020. This was not unexpected, since Hubei also had the highest infection rate in the country. However, the death rates were quite moderate in the rest of the country--Hubei was followed by Hainan (0.6 per million), Heilongjiang (0.4), and Beijing (0.37), all vastly lower by a factor of almost 100. This also demonstrates the correctness of the policy of blockading Hubei. It also shows that the incidence of deaths from the COVID-19 virus was closely related to the incidence of confirmed cases of infection in the early phases of the epidemic. If the infection rate can be controlled, the death rate will be lowered.

Chart 14: Cumulative Confirmed Cases per Million Population on 28 February 2022



Source: Appendix Table 1.

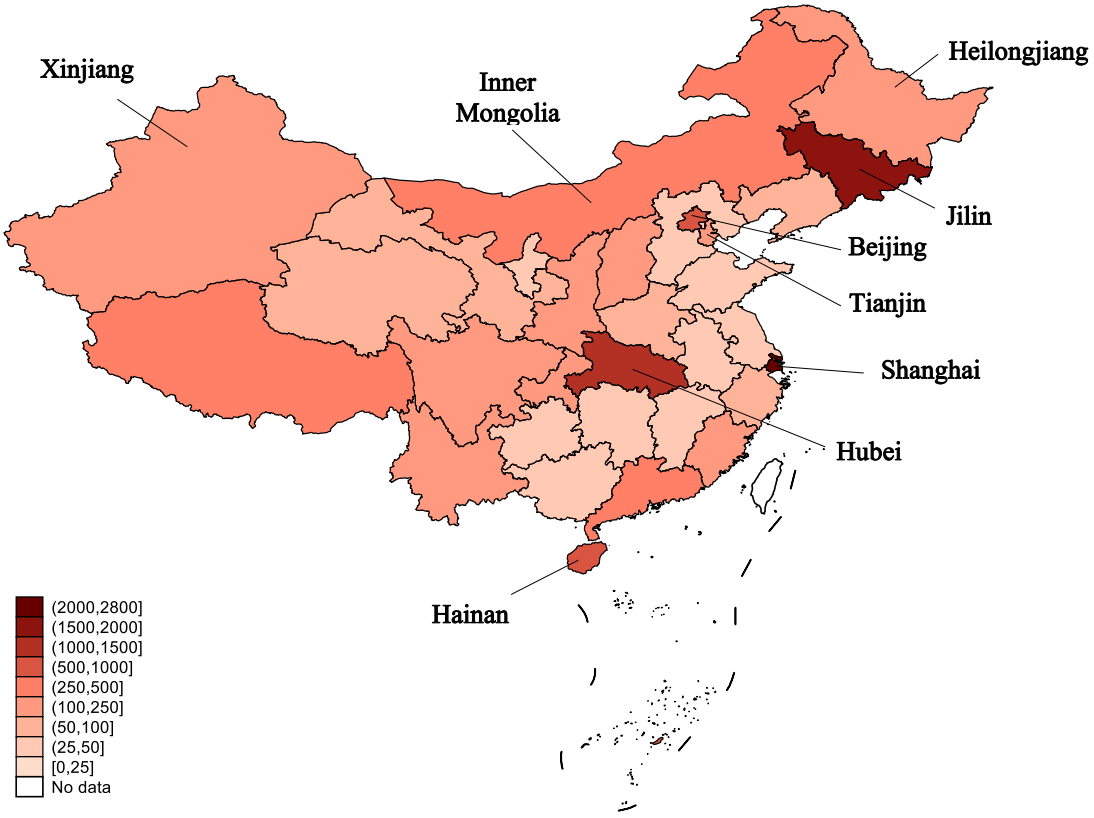
Chart 14 shows that from 15 April 2020 to 28 February 2022, a period of almost two years, the COVID-19 epidemic remained under control within Mainland China. The infection rate in Hubei only increased marginally from over 1,140 per million population to over 1,170 per million. For the rest of the country, the infection rates remained quite moderate, except for the provinces, municipalities and autonomous regions on the land and sea borders of China, such as Heilongjiang, Inner Mongolia, Beijing, Shanghai and Tianjin. Even then, Shanghai, with the second highest infection rate, had less than 175 cumulative confirmed cases per million, followed by Tianjin, with slightly over 82 per million, all considerably lower than Hubei. The relatively moderate national infection rate during this relatively long period while the infection rate in the rest of the world rose rapidly also shows that the government policy of requiring the testing and quarantining of entrants from outside of the Mainland since 1 March 2020 was quite justified and contributed to the low national infection and hence also death rates.

Chart 15: Cumulative Deaths per Million Population on 28 February 2022

Source: Appendix Table 2.

Chart 15, which presents the spatial distribution of cumulative COVID-19 deaths per million population on 28 February 2022, does not look that different from Chart 13, which is for 15 April 2020, and for that matter also not that different from Chart 14, which presents the cumulative COVID-19 infections per million population on 28 February 2022, except for the colours. The cumulative death rate did not increase materially over the almost two-year period between 15 April 2020 and 28 February 2022. Hubei continued to have the highest cumulative death rate from COVID-19 in the country, at over 77 per million population on 28 February 2022. Hainan (0.59) continued to be the second highest, but at less than 1% of that of Hubei, followed by Heilongjiang (0.42) and Beijing (0.41). All of this is consistent with the fact that the COVID-19 epidemic was under control prior to the outbreak in Shanghai in March 2022.

Chart 16: Cumulative Confirmed Cases per Million Population on 7 December 2022



Source: Appendix Table 1.

However, there was an unexpected explosive outbreak in Shanghai in March 2022, when apparently the COVID-19 virus was unknowingly allowed to spread within a quarantine hotel. As a result, the cumulative infection rate of Shanghai shot up from 175 to more than 2,600 confirmed cases per million population, surpassing even Hubei. The cumulative infection rate of Hubei, where the COVID-19 epidemic first started in December 2019, remained steady at just below 1,180, hardly changed from 15 April 2020. The infections in Shanghai also spread to the rest of the country--the cumulative infection rate of Jilin rose above 1,700 per million and that of Beijing almost reached 950. Chart 16, in comparison with Chart 14, shows how the outbreak in Shanghai changed the whole picture—every province, municipality and autonomous region had a significant increase in the number of cumulative confirmed cases per million population with the exception of Hubei.

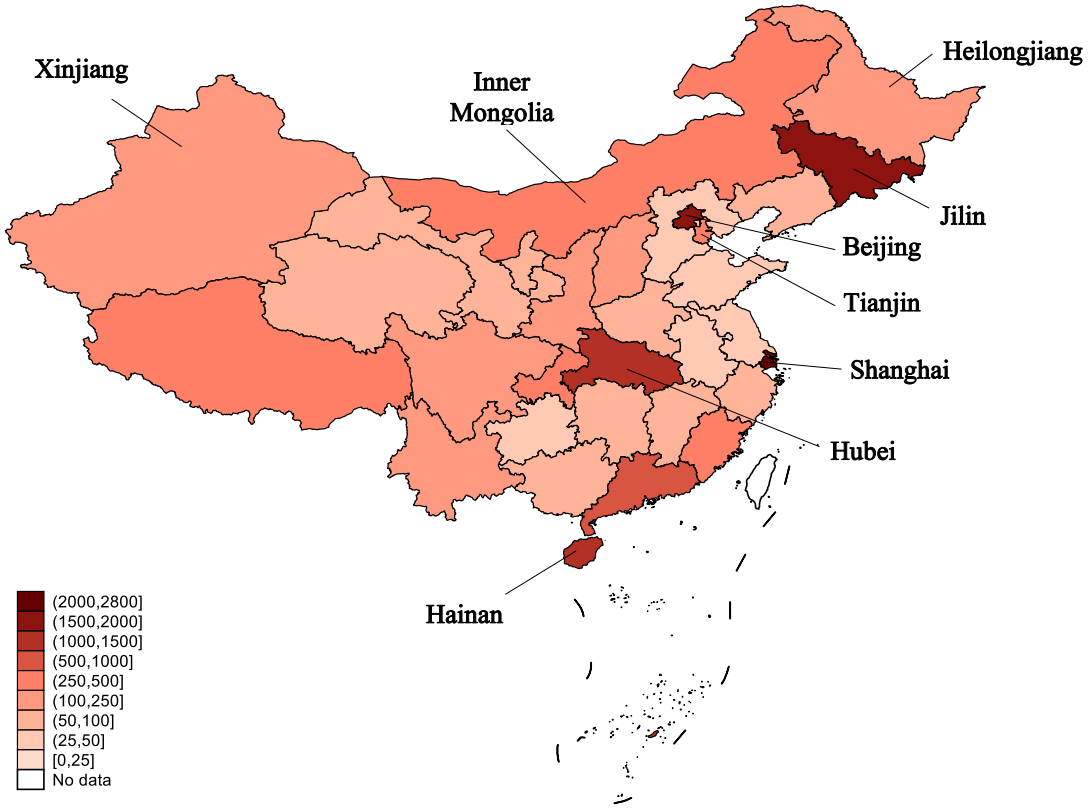
Chart 17: Cumulative Deaths per Million Population on 7 December 2022

Source: Appendix Table 2.

Chart 17 shows that there was a significant rise in the cumulative deaths per million population in Shanghai as a result of the massive outbreak in March 2022. The cumulative death rate shot up almost a hundred times from 0.28 per million to almost 24. While the cumulative infection rate also rose in the rest of the country, the cumulative death rate did not change much—with Beijing increasing from 0.41 per million population to 0.59 and Jilin from 0.13 to 0.21. The death rate of Hubei remained the same as on 28 February 2022 at 77.39 per million. The significant increases in the cumulative infection rates (Chart 16 in comparison with Chart 14) without corresponding increases in the death rates (Chart 17 in comparison with Chart 15) shows that the lethality of the COVID-19 virus had declined significantly between 2020 and 2022.[37]

[37] Note that the cumulative number of vaccination doses increased by only 300 million, from 3.1 billion to 3.4 billion, a relatively insignificant amount relative to the total population, between 28 February 2022 and 7 December 2022, bearing in mind that the effective protection period of the vaccines is approximately 6 months.

Chart 18: Cumulative Confirmed Cases per Million Population on 28 February 2023



Source: Appendix Table 1.

The prolonged use of the lockdown measures in the implementation of the "Dynamic Zero" policy in Shanghai in the spring of 2022 caused significant hardships on its citizens. It also resulted in economic disruption in not only Shanghai but also the rest of the country because of the pivotal position of Shanghai in the national and international supply chains. However, these measures were not sufficient to achieve the objective of "Dynamic Zero".[38] Thus, on 7 December 2022, in view of the significantly reduced mortality rate of the COVID-19 virus (see below), it was announced by the government that the policy of "Dynamic Zero" would be changed to that of "Co-Existing with the Virus", with many of the control measures relaxed. The result was a further significant leap in the cumulative infection rates across the board, as shown in Chart 18 (and Chart 9), with Shanghai (2,709), Beijing (1,867) and Jilin (1,736) overtaking Hubei (1,234) in terms of cumulative infections per million population.

[38] The success of the "Dynamic Zero" policy depends crucially on the ability to totally prevent inter-household transmission of the COVID-19 virus, which means that the residents of different households should be completely isolated from one another for seven days, the average gestation period of the virus (or at most a maximum of fourteen days). However, during this period, they should be provided with food and water and tested daily within their own households. Hardships were caused because these principles were not faithfully followed. There were households that were lockdowned for three months, which served no purpose. It was not a failure of the "Dynamic Zero" policy. It was a failure of the implementation.

Fortunately, the rise in the infection rates did not lead to a significant increase in the death rates because of the decline in the lethality of the new variants of the COVID-19 virus.

Chart 19: Cumulative Deaths per Million Population on 28 February 2023

Source: Appendix Table 2.

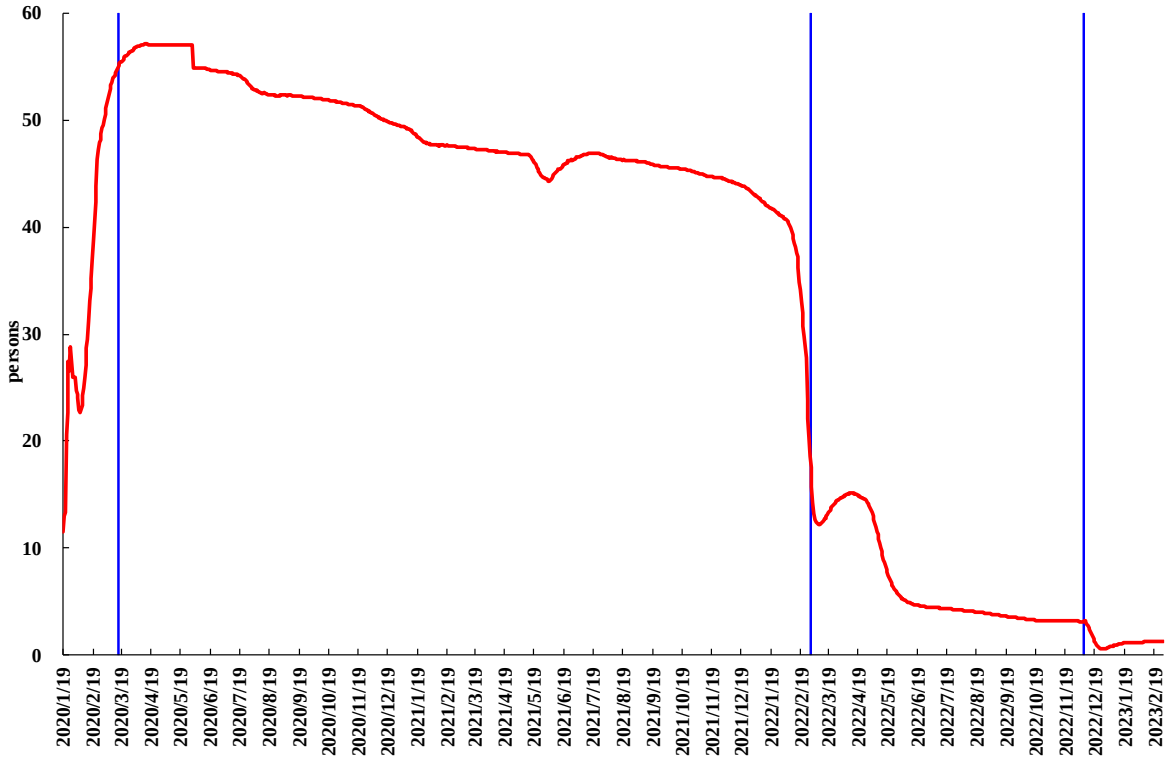
As noted above, because of the declined lethality of the COVID-19 virus variants, the death rates also did not change much between 7 December 2022 and 28 February 2023. Chart 19 looks virtually the same as Chart 17, with Hubei (77) and Shanghai (24) having the highest cumulative death rates per million population. The only significant change occurred in Beijing, with its death rate rising from 0.59 per million population to 0.92, the third highest in the country, but still quite low relatively speaking.

7. The Declining Mortality of the COVID-19 Virus in Mainland China

While the number of infections per million population rose over time, especially during the "Co-Existing with the Virus" Phase, the number of cumulative COVID-19 deaths per million population rose much more slowly, resulting in a decline in the mortality rate, that is, the cumulative number of deaths per thousand cases, over time. In Chart 20, we present the cumulative number of deaths per thousand cumulative cases over time. In the Beginning Phase of the COVID-19 epidemic, the virus was quite lethal and there was a great deal of uncertainty as to the proper method of treatment. Thus, the mortality rate rose quickly and reached a peak of 5.7% (or equivalently 57 cumulative deaths per thousand cumulative cases)[39] around 15 April 2020. During the Controlled Phase, both the number of cumulative infections and the number of cumulative deaths rose very slowly, and since better treatment became available, the mortality rate gradually declined to around 4.0%. Then the number of infections exploded in the spring of 2022, without a corresponding increase in the death rate because of the reduced lethality of the virus, so that the mortality rate took a dive during the "Explosive Phase" to 0.3% by 7 December 2022. Finally, in the "Co-Existing with the Virus" Phase, the mortality rate declined further to 0.1%, that is, cumulatively, about one in a thousand persons infected by the COVID-19 virus would die.

[39] This means that for every 100 persons infected by the virus, 5.7 persons would die.

Chart 20: The Cumulative Number of Deaths per Thousand Cumulative Confirmed Cases



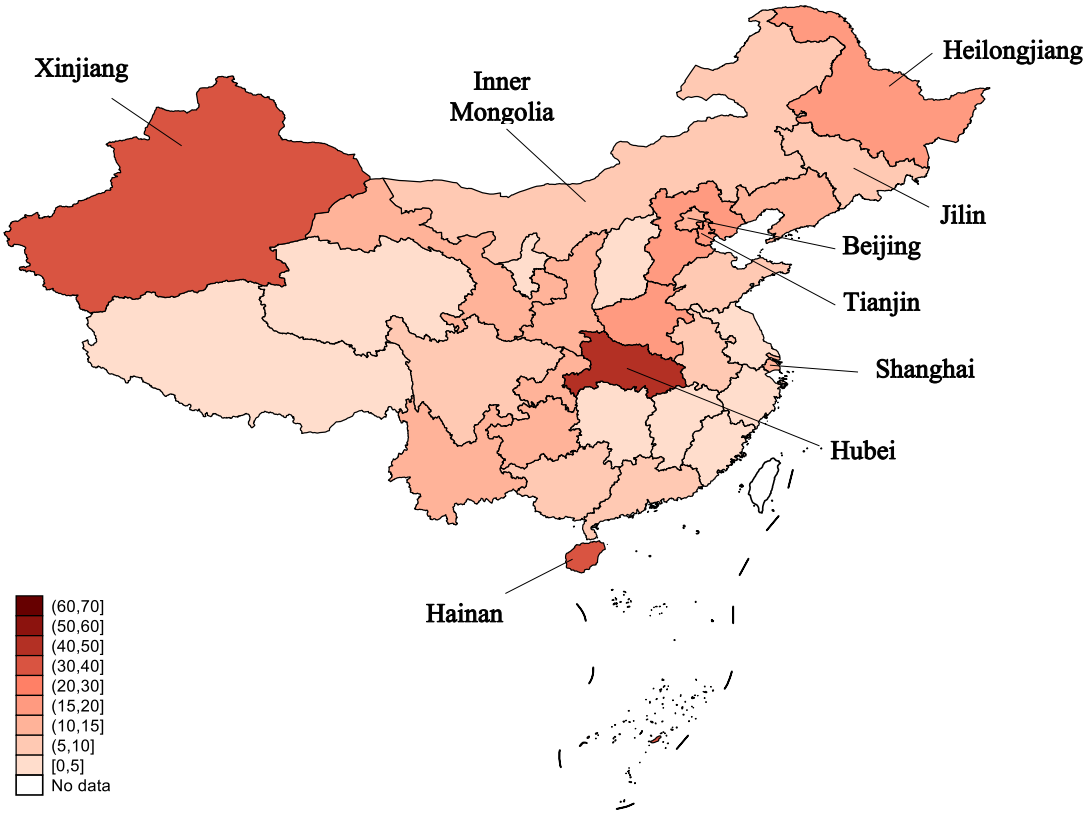
Source: Our World in Data.

In Charts 21 through 24 we present the data on the cumulative number of deaths per thousand cumulative cases graphically by province, municipality and autonomous region on the end dates of the different phases of the epidemic: 15 April 2020, 28 February 2022, 7 December 2022 and 28 February 2023.[40] These charts also confirm how the lethality of the COVID-19 virus has been declining over time.

Chart 21 shows that as of 15 April 2020, Hubei had the highest mortality rate in China, 47.5 per thousand, followed by Xinjiang (39.5) and Hainan (35.7).

[40] The detailed data used in the preparation of the maps on the mortality rates of the COVID-19 virus are presented in Appendix Tables 3.

Chart 21: The Cumulative Number of Deaths per Thousand Cumulative Cases on 15 April 2020



Source: Appendix Table 3.

Chart 22 shows that as of 28 February 2022, only Hubei continued to have a high mortality rate, 66.0 per thousand cumulative cases, followed by Hainan (31.4) as a distant second.

Chart 22: The Cumulative Number of Deaths per Thousand Cumulative Cases on 28 February 2022

Source: Appendix Table 3.

Charts 23 and 24, which look essentially the same, show very clearly that for the entire country, except Hubei and Shanghai, for both the Explosive Phase and the "Co-Existing with the Virus" Phase, the mortality rate of the COVID-19 virus is less than five per thousand cases. Hubei, with a mortality rate of between 63 and 66 per thousand cases, is more than twelve times higher than the rest of the country except for Shanghai, which had a mortality rate between 8.9 and 9.2 per thousand cases. This again demonstrates how important the initial decision to blockade Hubei was. Otherwise, it was possible that the entire country would have suffered from a high mortality rate similar to that of Hubei. By 7 December 2022, the death rates have essentially gone to almost zero on the margin because of the reduced lethality of the COVID-19 virus. As a result, Hubei remains the only province with a high cumulative mortality rate because of the legacy from the Beginning Phase. Shanghai is a distant second in terms of the mortality rate.

Chart 23: The Cumulative Number of Deaths per Thousand Cumulative Cases on 7 December 2022

Source: Appendix Table 3.

Chart 24: The Cumulative Number of Deaths per Thousand Cumulative Cases on 28 February 2023

Source: Appendix Table 3.

8. Concluding Remarks

Based on our temporal and spatial analysis of the COVID-19 epidemic on the Mainland of China, we must conclude that the control and management of the COVID-19 epidemic has been on the whole reasonably successful, notwithstanding the surge in infections in Shanghai in March 2022 which eventually spread nationwide. The high mortality rate has been confined to the Province of Hubei, with 63 deaths per thousand confirmed cases. In the rest of China (ex Hubei), including even Shanghai (9 deaths per thousand cases), the mortality rates have remained low, with a population-weighted average of 1.06 per thousand cases (see Appendix Table 3). In terms of the cumulative number of infections per million population, Shanghai leads with 2,710, followed by Beijing (1,870), Jilin (1,740) and then Hubei (1,230) (see Appendix Table 1). In terms of the cumulative number of deaths per million population, Hubei leads with 77, followed by Shanghai (24), with the rest of China all lower than 1.0 (see Appendix Table 2). China was able to confine and isolate the epidemic to essentially Hubei itself during the virus's most lethal phase through the blockade of Hubei and the imposition of quarantine on visitors from abroad. That is the principal reason for the low cumulative death rate from the COVID-19 virus in China.

Relative to the rest of the world, the cumulative population infection rate and the population death rate of the Mainland of China as a whole are among the lowest in the world, as shown in Charts 1 above and even after taking into account the relatively large estimated "excess deaths" that may be indirectly attributed to COVID-19 (see Chart 7). China compares well with the developed countries, with the exception of Japan. It also compares well with the developing countries, except for India, which has a lower cumulative population infection rate and a lower unadjusted cumulative death rate.[41]

The economic costs of the epidemic are not insignificant for China. The average annual real rate of growth of the Chinese economy for the three years 2020, 2021 and 2022 was 4.5%. The average level of real GDP for the three years was US$16.5 trillion (in 2022 prices). Assuming that in the absence of the COVID-19 epidemic, the Chinese economy would have grown at 6% per annum on average, the total loss of real GDP over the three years may be

[41] However, we are not sure about the comparability of the Indian data; in particular, the number of "excess deaths" may be quite high for India. See footnote 14 above.

estimated at 1.5% × US$16.5 trillion × 3 = US$743 billion, a not insignificant amount. The reduction in real GDP also would result in a corresponding reduction in employment. The normal annual incremental employment on the Mainland is on the order of 10-12 million. Over three years, approximately 33 million jobs would have been created, assuming a normal rate of growth of 6%. Since the realised rate of growth averaged only 4.5%, approximately a quarter fewer jobs would have been created, or an estimated 8.25 million less jobs. But job creation depends on not only the current rate of growth, but also the expected future rate of growth. Hence 8.25 million is likely an under-estimate of the employment lost due to COVID-19.

It is also important to note that there is nothing intrinsically wrong with the "Dynamic Zero" policy. The objective of such a policy is to prevent inter-household transmission of the virus, which must be the case in order to control any highly infectious epidemic. However, in order for the policy to work effectively, proper implementation is crucial. For example, the lockdowned households must be provided with the necessary supplies of food and beverage directly and on time during the lockdown period. Moreover, in order to avoid inter-household transmission, daily testing should be conducted inside each household by adequately protected medical personnel instead of queuing up at the front of the building. Done properly, a lockdown period of at most fourteen days (the gestation period of the COVID-19 virus) should be sufficient. China is actually quite fortunate that the COVID-19 virus during the Shanghai surge turned out not to be as lethal as the original virus in Wuhan. "Dynamic Zero" should remain as a possible control policy in the event of the emergence of a more lethal variant of the COVID-19 virus or a new infectious virus.

Appendix 1

The Announcements of the Blockades of Wuhan (and Other Cities in Hubei) (23 January 2020)

Wuhan (武漢), lockdowned at 10:00 am on 23 January 2020:
https://www.gov.cn/xinwen/2020-01/23/content_5471751.htm


中华人民共和国中央人民政府
www.gov.cn
首页 | 简 | 繁 | EN | 登录 | 邮箱 | 无障碍

武汉市新型冠状病毒感染的肺炎疫情防控指挥部通告（第1号）

2020-01-23 09:45 来源： 湖北省人民政府网站 字号： 默认 大 超大 | 打印 |

武汉市新型冠状病毒感染的肺炎疫情防控指挥部通告（第1号）

为全力做好新型冠状病毒感染的肺炎疫情防控工作，有效切断病毒传播途径，坚决遏制疫情蔓延势头，确保人民群众生命安全和身体健康，现将有关事项通告如下：

自2020年1月23日10时起，全市城市公交、地铁、轮渡、长途客运暂停运营；无特殊原因，市民不要离开武汉，机场、火车站离汉通道暂时关闭。恢复时间另行通告。

恳请广大市民、旅客理解支持！

武汉市新型冠状病毒感染的肺炎疫情防控指挥部
2020年1月23日

扫一扫在手机打开当前页

Ezhou (鄂州), lockdowned at 11:20 am on 23 January 2020:
https://fgw.ezhou.gov.cn/xwzx_1411/tzgg_1413/202001/t20200123_322345.html

Xiantao (仙桃), lockdowned at 17:00 on 23 January 2020:
https://weibo.com/ttarticle/p/show?id=2309404463989374451996&sudaref=passport.weibo.com

Zhijiang (枝江), lockdowned at 17:00 on 23 January 2020:
http://www.yichang.gov.cn/html/zhengwuyizhantong/zhengwuzixun/gongshigonggao/2020/0124/1017189.html

Qianjiang (潛江), lockdowned at 22:00 on 23 January 2020:
http://wjw.hbqj.gov.cn/zfxxgk/fdzdgknr/gysyjs_34501/tfggsj_36471/202011/t20201119_3039339.html

Huanggang (黃岡), lockdowned at 24:00 on 23 January 2020:
http://www.hmjjjc.gov.cn/Item/8763.aspx

Chibi (赤壁), lockdowned at 00:00 on 24 January 2020:
http://www.chibi.gov.cn/xxgk/ztzl/2022zt/yqfk/zcwj/202001/t20200123_1921722.shtml

Jingmen (荊門), lockdowned at 00:00 on 24 January 2020:
http://www.jingmen.gov.cn/art/2020/1/23/art_4816_643468.html

Xianning (咸寧), lockdowned at 00:00 on 24 January 2020:
http://www.xianning.gov.cn/ztzl/2020zt/zxccjjezyqksmy/fkcs/202001/t20200130_1923366.shtml

Enshi (恩施), lockdowned at 00:00 on 24 January 2020:
http://www.enshi.gov.cn/zt/n2020/zzcckyq/tzgg/202101/t20210113_1090941.shtml

Huangshi (黃石), lockdowned at 10:00 on 24 January 2020:
http://jtj.huangshi.gov.cn/zwgk/fdzdgknr/tzgg2/202001/t20200125_597341.html

Dangyang (當陽), lockdowned at 12:00 on 24 January 2020:
http://www.yichang.gov.cn/content-62000-1018620-1.html

Xiaogan (孝感), lockdowned at 24:00 on 24 January 2020:
http://gkml.xiaogan.gov.cn/c/www/gsgg/63513.jhtml

Appendix 2

The Announcement of the Quarantine of Entrants from Outside of the Mainland (1 March 2020)

http://www.scio.gov.cn/xwfb/bwxwfb/gbwfbh/wsjkwyh/202307/t20230703_721102.html

国务院联防联控机制举行依法有效防控海外疫情输入发布会

时间： 2020-03-01 来源： 国家卫生健康委员会网站

原标题：国务院联防联控机制2020年3月1日新闻发布会 介绍依法有效防控海外疫情输入有关情况

3月1日，国务院联防联控机制举行新闻发布会，请外交部领事司司长崔爱民、海关总署卫生检疫司司长林伟、国家移民管理局边防检查管理司司长刘海涛、民航局飞行标准司司长朱涛就防范输入、风险管理、航线运行等回答媒体提问，请国家体育总局体育科学研究所研究员徐建方介绍健康知识。

国家卫生健康委新闻发言人、宣传司副司长米锋：

各位媒体朋友大家下午好！我是国家卫生健康委新闻发言人、宣传司副司长米锋。欢迎参加国务院联防联控机制举办的新闻发布会。习近平总书记强调，继续同世界卫生组织紧密合作，同相关国家密切沟通，分享防疫经验，协调防控措施，共同维护地区和世界公共卫生安全。李克强总理提出了明确要求，推动建立和完善与人员往来较多国家的卫生防疫沟通协调应急机制，有效防止人员跨境流动中疫情输出或输入。今天发布会的主题是：依法有效防控海外疫情输入。

我们请来了外交部领事司司长崔爱民先生，海关总署卫生检疫司司长林伟先生，国家移民管理局边防检查管理司司长刘海涛先生，民航局飞行标准司司长朱涛先生，请他们就防范输入、风险管理、航线运行等回答媒体提问，今天我们还请来了国家体育总局体育科学研究所研究员徐建方先生介绍健康知识。

首先，通报一下疫情情况。

Appendix 3

The Announcement that the "Dynamic Zero" Policy has been Implemented Beginning in August 2021 (18 December 2021)

国家卫健委：自今年8月起，我国已进入全链条精准防控“动态清零”阶段

成都商报红星新闻
2021-12-18 16:13:25 发布于四川 成都商报红星新闻官方账号

+ 关注

12月18日，国务院联防联控机制召开新闻发布会，介绍科学精准做好元旦春节期间疫情防控有关情况。

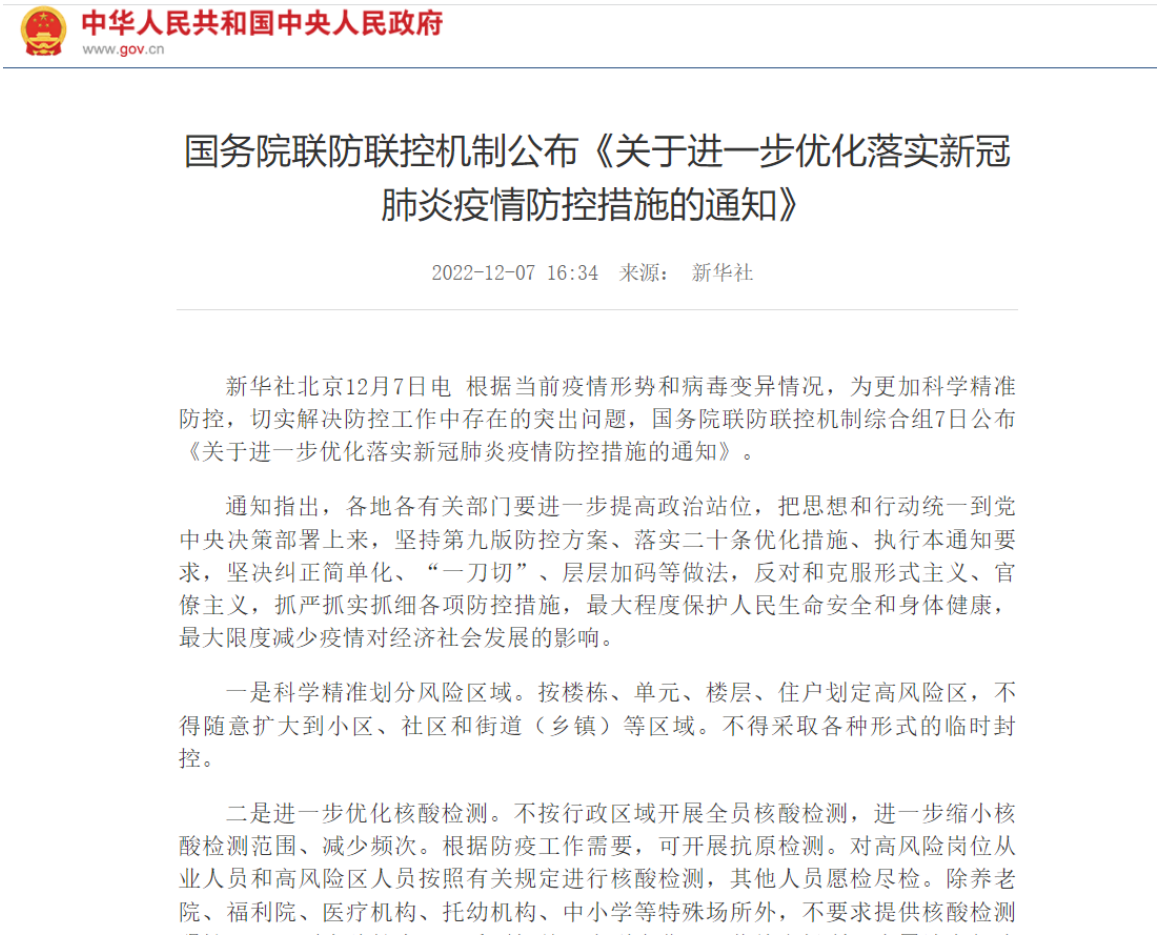
红星新闻记者注意到，前不久，国家卫健委曾表示我国正处于全链条精准防控的“动态清零”阶段。那么，在此阶段，我国全链条的精准防控将如何开展？对此，国家卫生健康委疫情应对处置工作领导小组专家组组长梁万年在会上作出详细回应。

梁万年表示，从2021年8月，我国就开始进入了全链条精准防控的“动态清零”阶段。而本阶段的防控目标，是尽量的减少疫情的发生，在疫情发生后，高效地处置散发病例和聚集性的疫情，力争在一个最长潜伏期内防控住疫情，以最小的社会成本获得最大的防控成效。

Appendix 4

The Announcement of the Relaxation of the "Dynamic Zero" Policy (7 December 2022)

https://www.gov.cn/xinwen/2022-12/07/content_5730475.htm



中华人民共和国中央人民政府
www.gov.cn

国务院联防联控机制公布《关于进一步优化落实新冠肺炎疫情防控措施的通知》

2022-12-07 16:34 来源： 新华社

新华社北京12月7日电 根据当前疫情形势和病毒变异情况，为更加科学精准防控，切实解决防控工作中存在的突出问题，国务院联防联控机制综合组7日公布《关于进一步优化落实新冠肺炎疫情防控措施的通知》。

通知指出，各地各有关部门要进一步提高政治站位，把思想和行动统一到党中央决策部署上来，坚持第九版防控方案、落实二十条优化措施、执行本通知要求，坚决纠正简单化、“一刀切”、层层加码等做法，反对和克服形式主义、官僚主义，抓严抓实抓细各项防控措施，最大程度保护人民生命安全和身体健康，最大限度减少疫情对经济社会发展的影响。

一是科学精准划分风险区域。按楼栋、单元、楼层、住户划定高风险区，不得随意扩大到小区、社区和街道（乡镇）等区域。不得采取各种形式的临时封控。

二是进一步优化核酸检测。不按行政区域开展全员核酸检测，进一步缩小核酸检测范围、减少频次。根据防疫工作需要，可开展抗原检测。对高风险岗位从业人员和高风险区人员按照有关规定进行核酸检测，其他人员愿检尽检。除养老院、福利院、医疗机构、托幼机构、中小学等特殊场所外，不要求提供核酸检测

Appendix Table 1: The Cumulative Number of Confirmed Cases per Million Persons, Mainland Chinese Provinces, Municipalities and Autonomous Regions

		The Cumulative Number of Confirmed Cases per Million Persons			
ID	name	2020.04.15	2022.02.28	2022.12.07	2023.02.28
Beijing	北京市	26.94	67.57	948.42	1,866.94
Tianjin	天津市	13.36	82.01	190.24	322.23
Hebei	河北省	4.39	19.82	37.93	44.37
Shanxi	山西省	5.32	8.16	142.24	205.89
Inner Mongolia	內蒙古自治區	7.87	66.58	335.42	368.47
Liaoning	遼寧省	3.39	24.28	66.11	84.51
Jilin	吉林省	4.17	25.47	1,704.46	1,736.12
Heilongjiang	黑龍江省	25.84	66.66	164.99	213.07
Shanghai	上海市	25.07	174.77	2,605.91	2,708.69
Jiangsu	江蘇省	7.71	20.92	43.12	59.60
Zhejiang	浙江省	19.89	34.63	77.63	180.14
Anhui	安徽省	16.27	16.55	27.61	37.13
Fujian	福建省	8.53	37.28	162.98	408.83
Jiangxi	江西省	20.75	21.23	34.16	75.60
Shandong	山東省	7.76	11.13	42.24	57.86
Henan	河南省	12.89	26.98	81.26	100.77
Hubei	湖北省	1,143.97	1,172.50	1,179.73	1,234.27
Hunan	湖南省	15.35	18.62	36.09	112.61
Guangdong	廣東省	12.54	36.94	391.34	815.74
Guangxi	廣西壯族自治區	5.10	22.14	48.14	264.93
Hainan	海南省	16.88	18.73	926.76	1,020.74
Chongqing	重慶市	18.16	19.30	236.61	457.98
Sichuan	四川省	6.71	17.46	127.40	173.96
Guizhou	貴州省	3.79	4.21	38.81	65.72
Yunnan	雲南省	3.90	41.71	103.41	207.61
Tibet	西藏自治區	0.28	0.27	415.03	452.47
Shaanxi	陝西省	6.49	71.47	135.69	185.19
Gansu	甘肅省	5.54	14.78	62.61	69.90
Qinghai	青海省	3.05	5.05	84.01	131.43
Ningxia	寧夏回族自治區	10.46	16.83	32.69	175.27
Xinjiang	新疆維吾爾自治區	2.97	38.47	101.43	119.40

Source: The cumulative number of confirmed cases for Chinese provinces, municipalities and autonomous regions are from Oxford Covid-19 Government Response Tracker (https://www.bsg.ox.ac.uk/research/covid-19-government-response-tracker). The population is from the National Bureau of Statistics of China.

Appendix Table 2: The Cumulative Number of COVID-19 Deaths per Million Persons, Mainland Chinese Provinces, Municipalities and Autonomous Regions

		The Cumulative Number of Deaths per Million Persons			
ID	name	2020.04.15	2022.02.28	2022.12.07	2023.02.28
Beijing	北京市	0.37	0.41	0.59	0.92
Tianjin	天津市	0.22	0.22	0.22	0.22
Hebei	河北省	0.08	0.09	0.09	0.09
Shanxi	山西省	0.00	0.00	0.00	0.03
Inner Mongolia	內蒙古自治區	0.04	0.04	0.04	0.04
Liaoning	遼寧省	0.05	0.05	0.05	0.05
Jilin	吉林省	0.04	0.13	0.21	0.21
Heilongjiang	黑龍江省	0.40	0.42	0.42	0.58
Shanghai	上海市	0.28	0.28	23.91	24.04
Jiangsu	江蘇省	0.00	0.00	0.00	0.00
Zhejiang	浙江省	0.02	0.02	0.02	0.02
Anhui	安徽省	0.10	0.10	0.10	0.11
Fujian	福建省	0.02	0.02	0.02	0.05
Jiangxi	江西省	0.02	0.02	0.02	0.04
Shandong	山東省	0.07	0.07	0.08	0.10
Henan	河南省	0.22	0.22	0.23	0.23
Hubei	湖北省	54.36	77.39	77.39	77.26[a]
Hunan	湖南省	0.06	0.06	0.06	0.06
Guangdong	廣東省	0.06	0.06	0.06	0.08
Guangxi	廣西壯族自治區	0.04	0.04	0.04	0.04
Hainan	海南省	0.60	0.59	0.59	0.58[b]
Chongqing	重慶市	0.19	0.19	0.22	0.34
Sichuan	四川省	0.04	0.04	0.06	0.14
Guizhou	貴州省	0.05	0.05	0.05	0.05
Yunnan	雲南省	0.04	0.04	0.04	0.09
Tibet	西藏自治區	0.00	0.00	0.00	0.00
Shaanxi	陝西省	0.08	0.08	0.08	0.13
Gansu	甘肅省	0.08	0.08	0.08	0.08
Qinghai	青海省	0.00	0.00	0.00	0.00
Ningxia	寧夏回族自治區	0.00	0.00	0.00	0.00
Xinjiang	新疆維吾爾自治區	0.12	0.12	0.12	0.12

Notes: [a] On 28 February 2023, the number of deaths per million COVID-19 cases was 77.26 (=4515/58.44), lower than 77.39 (=4512/58.30) on 7 December 2022. This is mainly because the total population increase of Hubei in 2022 over 2021 was greater than the increase in the cumulative number of deaths between the two years. [b] On 28 February 2023, the number of deaths per million COVID-19 cases was 0.58 (=6/10.20), lower than 0.59 (=6/10.27) on 7 December 2022. This is mainly due to the fact that the total population of Hainan increased while the death toll of COVID-19 remained unchanged.

Source: The cumulative number of COVID-19 deaths for Chinese provinces, municipalities and autonomous regions are from Oxford Covid-19 Government Response Tracker (https://www.bsg.ox.ac.uk/research/covid-19-government-response-tracker). The population is from the National Bureau of Statistics of China.

Appendix Table 3: The Mortality Rates of the COVID-19 Virus (Cumulative Number of Deaths per Thousand Cumulative Confirmed Cases), Mainland Chinese Provinces, Municipalities and Autonomous Regions

		The Cumulative Number of Deaths per Thousand Cases			
ID	name	2020.04.15	2022.02.28	2022.12.07	2023.02.28
Beijing	北京市	13.56	6.09	0.63	0.49
Tianjin	天津市	16.22	2.66	1.15	0.68
Hebei	河北省	18.35	4.74	2.48	2.13
Shanxi	山西省	0.00	0.00	0.00	0.14
Inner Mongolia	內蒙古自治區	5.26	0.63	0.12	0.11
Liaoning	遼寧省	13.79	1.95	0.72	0.56
Jilin	吉林省	9.8	4.96	0.12	0.12
Heilongjiang	黑龍江省	15.46	6.24	2.52	2.73
Shanghai	上海市	11.25	1.61	9.17	8.88
Jiangsu	江蘇省	0.00	0.00	0.00	0.00
Zhejiang	浙江省	0.79	0.44	0.2	0.08
Anhui	安徽省	6.05	5.93	3.55	3.08
Fujian	福建省	2.83	0.64	0.15	0.12
Jiangxi	江西省	1.07	1.04	0.65	0.58
Shandong	山東省	8.93	6.18	1.86	1.70
Henan	河南省	17.24	8.25	2.86	2.31
Hubei	湖北省	47.52	66.01	65.6	62.59
Hunan	湖南省	3.93	3.24	1.67	0.54
Guangdong	廣東省	5.11	1.71	0.16	0.10
Guangxi	廣西壯族自治區	7.87	1.79	0.82	0.15
Hainan	海南省	35.71	31.41	0.63	0.57
Chongqing	重慶市	10.36	9.68	0.92	0.75
Sichuan	四川省	5.36	2.05	0.47	0.82
Guizhou	貴州省	13.7	12.35	1.34	0.79
Yunnan	雲南省	10.87	1.02	0.41	0.41
Tibet	西藏自治區	0.00	0.00	0.00	0.00
Shaanxi	陝西省	11.72	1.06	0.56	0.68
Gansu	甘肅省	14.39	5.43	1.28	1.15
Qinghai	青海省	0.00	0.00	0.00	0.00
Ningxia	寧夏回族自治區	0.00	0.00	0.00	0.00
Xinjiang	新疆維吾爾自治區	39.47	3.01	1.14	0.97

Source: Author's calculation using data from Appendix Table 1 and Appendix Table 2.

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