Doubling Time of the COVID-19 Epidemic by Chinese Province

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NOTE: This preprint reports new research that has not been certified by peer review and should not be used to guide clinical practice.
Abstract: 50 words

COVID-19 epidemic doubling time by Chinese province was increasing from January 20 through February 9, 2020. The harmonic mean of the arithmetic mean doubling time estimates ranged from 1.4 (Hunan, 95% CI, 1.2-2.0) to 3.1 (Xinjiang, 95% CI, 2.1-4.8), with an estimate of 2.5 days (95% CI, 2.4-2.6) for Hubei.
Our ability to estimate the basic reproduction number of emerging infectious diseases is often hindered by the paucity of information about the epidemiological characteristics and transmission mechanisms of new pathogens (1). Alternative metrics could synthesize real-time information about the extent to which the epidemic is expanding over time. Such metrics would be particularly useful if they rely on minimal and routinely collected data that capture the trajectory of an outbreak (2).

Epidemic doubling times characterize the sequence of intervals at which the cumulative incidence doubles (3). If an epidemic is growing exponentially with a constant growth rate $r$, the doubling time remains constant and equals to $(\ln 2)/r$. An increase in the doubling time indicates a slowdown in transmission if the underlying reporting rate remains unchanged (Technical Appendix) (4).

Here we analyzed by province the number of times COVID-19 cumulative incidence doubled and the evolution of the doubling times in mainland China (5), from January 20 (when nationwide reporting began) through February 9, 2020. Province-level daily cumulative incidence data were retrieved from provincial health commissions’ websites. Two sensitivity analyses based on a longer and a shorter time period respectively were conducted (Technical Appendix). Tibet was excluded from further analysis because there had only been one case reported during the study period.

From January 20 through February 9, the harmonic mean of the arithmetic means of the doubling times estimated from cumulative incidence ranged from 1.4 (95% CI, 1.2, 2.0) days (Hunan) to 3.1 (95% CI, 2.1, 4.8) days (Xinjiang). In Hubei, it was estimated as 2.5 (95% CI, 2.4, 2.6) days. The cumulative incidence doubled 6 times in Hubei. The harmonic mean of the arithmetic means of doubling times in all of mainland China except Hubei was 1.8 (95% CI, 1.5, 2.3) days. Provinces with a harmonic mean of the arithmetic means of doubling times <2d included Fujian, Guangxi, Hebei, Heilongjiang, Henan, Hunan, Jiangxi, Shandong, Sichuan, and Zhejiang (Figures 1 and S1).
As the epidemic progressed, it took longer for the cumulative incidence in mainland China (except Hubei) to double itself, which indicated an overall sub-exponential growth pattern outside Hubei (Figures S1, S2). In Hubei, the doubling time decreased and then increased. A gradual increase in the doubling time coincided with the social distancing measures and intra-and-inter-provincial travel restrictions imposed across China since the implementation of quarantine of Wuhan on January 23 (6).

Our estimates of doubling times are shorter than prior estimates of 7.4 days (95% CI, 4.2-14) (5), 6.4 days (95% CrI, 5.8-7.1) (7), and 7.1 days (95% CI, 3.0-20.5) (8) respectively. Li et al. covered cases reported by January 22 (5). Wu et al. statistically inferred case counts in Wuhan by internationally exported cases as of January 25 (7). Volz et al. identified a common viral ancestor on December 8, 2019 using Bayesian phylogenetic analysis and fitted an exponential growth model to provide the epidemic growth rate (8). Our estimates are based on cumulative confirmed case count by reporting date by province from January 20 through February 9.

Our study is subject to limitations, including underreporting of cases (9). One reason for underreporting is underdiagnosis, due to lack of diagnostic tests, healthcare workers, and other resources. Furthermore, underreporting is likely heterogeneous across provinces. As long as reporting remains invariant over time within the same province, the calculation of doubling times remains reliable; however, this is a strong assumption. Growing awareness of the epidemic and increasing availability of diagnostic tests might have strengthened reporting over time, which could have artificially shortened the doubling time. Nevertheless, apart from Hubei and Guangdong (first case reported on January 19), nationwide reporting only began on January 20, and at this point, Chinese authorities had openly acknowledged the magnitude and severity of the epidemic. Due to a lack of detailed case data describing incidence trends for imported and local cases, we focused our analysis on the overall trajectory of the epidemic without adjusting for the role of imported cases on the local transmission dynamics. Indeed, it is likely that the proportion of imported cases was significant for provinces that only reported a few cases; their short doubling times in the study period could simply reflect rapid detection of imported cases. However, with the data until
February 9, only two provinces had a cumulative case count of <40 (Table S1). It would be interesting to investigate the evolution of the doubling time after accounting for case importations if more detailed data becomes available.

To conclude, we observed an increasing trend in the epidemic doubling time of COVID-19 by Chinese province from January 20 through February 9, 2020. The harmonic mean of the arithmetic means of doubling times of cumulative incidence in Hubei during the study period was estimated at 2.5 (95% CI, 2.4, 2.6) days.

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Disclaimers

This article does not represent the official positions of the Centers for Disease Control and Prevention, the National Institutes of Health, or the United States Government.

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Figure legend

**Figure 1.** The map of the harmonic mean of the arithmetic means of doubling time estimates (Panel A) and the number of times the COVID-19 epidemic cumulative incidence has doubled (Panel B) by province in mainland China, from January 20 through February 9, 2020.
Harmonic mean of the arithmetic means of COVID-19 epidemic doubling times

- 1.4 - 1.79
- 1.8 - 1.99
- 2.0 - 2.29
- 2.3 - 2.49
- 2.5 - 2.79
- 2.8 - 3.09
Doubling Time of the COVID-19 Epidemic by Chinese Province

Technical Appendix

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Technical appendix

Additional information on our motivation, scope and methods

Motivation. \( R_0 \) is a widely used indicator of transmission potential in a totally susceptible population and is driven by the average contact rate and the mean infectious period of the disease (1). Yet, it only characterizes transmission potential at the onset of the epidemic and varies geographically for a given infectious disease according to local healthcare provision, outbreak response, as well as socioeconomic and cultural factors. Furthermore, estimating \( R_0 \) requires information about the natural history of the infectious disease. Thus, our ability to estimate reproduction numbers for novel infectious diseases is hindered by the paucity of information about their epidemiological characteristics and transmission mechanisms. More informative metrics could synthesize real-time information about the extent to which the epidemic is expanding over time. Such metrics would be particularly useful if they rely on minimal data on the outbreak’s trajectory (2).

Scope and definition. Our analysis is restricted to mainland China in this paper. A ‘province’ herein encompasses three different types of political sub-divisions of mainland China, namely, a province, a centrally (literally, ‘directly’) administered municipality (Beijing, Chongqing, Shanghai, and Tianjin) and an ‘ethnic minority’ autonomous region (Guangxi, Inner Mongolia, Ningxia, Tibet, and Xinjiang). Our analysis does not include the Hong Kong Special Administrative Region and the Macau Special Administrative Region, which are under the effective rule of the People’s Republic of China through the so-called ‘One Country, Two Systems’ political arrangements. Likewise, our analysis does not include Taiwan, which is de facto governed by a different government (the Republic of China).

Data sources. Daily cumulative incidence data were retrieved from provincial health commissions’ websites (Table S8). Data were double-checked against the cumulative national total published by the National Health Commission (3), data compiled by the Centre for Health Protection, Hong Kong, when
available (4) and by John Hopkins University Center for Systems Science and Engineering (5). Whenever discrepancies arose, provincial government sources were deemed authoritative.

**Doubling time calculation and its relationship with growth rate of an epidemic**

As the epidemic grows, the times at which cumulative incidence doubles are given by \( t_{d_i} \) such that

\[
2C(t_{d_i}) = C(t_{d_{i+1}}) \quad \text{where} \quad t_{d_0} = 0, \ C(t_{d_i}) = C^{'} \quad \text{and} \quad i = 0,1,2,3, \ldots, n_d \quad \text{where} \quad n_d \quad \text{is the total number of times cumulative incidence doubles. The actual sequence of “doubling times” are defined as follows:}
\]

\[
d_j = \Delta t_{d_j} = t_{d_j} - t_{d_{j-1}} \quad \text{where} \quad j = 1,2,3, \ldots, n_d.
\]

To quantify parameter uncertainty, we used parametric bootstrapping with a Poisson error structure around the harmonic mean of doubling times \( d_j \) to obtain the 95% confidence interval. See references (6-8) for further details.

If we assume homogeneous mixing (equal probability of acquiring infection through contacts) and exponential growth, then, \( C(t_{2}) = C(t_{1})\exp(rt) \), and therefore, \( \ln(C(t_{2})/C(t_{1})) = rt \). When \( C(t_{2})/C(t_{1}) = 2 \) and thus \( t \) is the doubling time, i.e. \( t = t_d \), \( \ln2 = rt_d \). Therefore, the doubling time, \( t_d \), equals to \((\ln2)/r\). See Vynnycky and White (9), panel 4.1, p.74 for further explanation.

**Additional details on methods.** Doubling time calculation was conducted using MATLAB R2019b (Mathworks, Natick, MA). Figures were created either using R version 3.6.2 (R Core Team) or MATLAB 2019b. Significance level in this manuscript was a priori decided to be \( \alpha = 0.05 \).

**Additional information on our results and discussion**

**Cumulative incidence over time.** From Figure S7 to Figure S10, we provided plots of cumulative incidence over time (left panel) and semi-log plots with log10-transformed cumulative incidence over time...
(right panel) for a total of 8 provinces with a relatively high number of cases, namely, the epicenter Hubei, followed by (in alphabetical order) Fujian, Guangdong, Heilongjiang, Henan, Hubei, Hunan, Jiangxi and Shandong. If the epidemic is growing exponentially, the log10-transformed cumulative incidence over time will be a linear curve. If social distancing would have an impact, the slope of the semi-log plot would decrease, indicating a decreasing epidemic growth rate.

Harmonic mean of the harmonic mean. In this study, we also presented the harmonic mean of the harmonic means of the estimates of the epidemic doubling times. The harmonic means of the epidemic doubling times are shorter than their arithmetic means. From January 20 through February 9, the harmonic mean of the harmonic means of the doubling times estimated ranged from 0.5 (95% CI, 0.2, 1.3) days for Guangxi, to 2.3 (95% CI, 2.3, 2.4) days for Hubei. The harmonic mean of the harmonic means of doubling times in mainland China except Hubei were 1.2 (95% CI, 1.0, 1.4) days.

Further discussion. The slowing-down of the epidemic as represented in increasing epidemic doubling times in our study is also consistent with a study by Benjamin F. Maier and Dirk Brockmann, “Effective containment explains sub-exponential growth in confirmed cases of recent COVID-19 outbreak in Mainland China” (pre-print available at arXiv. 2020:2002.07572). They also identified sub-exponential growth of the outbreak across provinces, as mass quarantine and restriction of travels across mainland China began since January 23, 2020.

Sensitivity analysis #1. We performed a sensitivity analysis by expanding our data analysis to the data since December 31, 2019, when Hubei first reported a cluster of pneumonia cases with unexplained etiology that turned out to be COVID-19. The only difference between the sensitivity analysis and the main analysis is the inclusion of Hubei and Guangdong data from December 31, 2019, through January 19, 2020, because nationwide reporting started on January 20, 2020. The only differences in results were found for Hubei and Guangdong. For Hubei, the harmonic mean of the arithmetic mean of the doubling
times was 4.06 (95% CI, 3.85-4.33); the harmonic mean of the harmonic means of the doubling times for Hubei was 2.28 (95% CI, 2.08-2.56); and the cumulative incidence in Hubei doubled nine times from December 31, 2019, through February 9, 2020 (Table S5, Figures S3, S4, S12, S13, S14). The first doubling time of Hubei (Figure S3) was high, reflecting that real-time data was unavailable before mid-January. It was only by January 17, 2020, onwards when data reporting become increasingly transparent and timely.

*Sensitivity analysis #2.* We also performed a sensitivity analysis by restricting our data analysis to the data from January 23, 2020 through February 9, 2020, to allow for the time that all the other provinces to ramp up their testing. January 23 was also the day when the Chinese authorities to put the city of Wuhan on ‘lockdown’ and major inter-provincial travel restrictions were put in place. When we changed the start date of our study period from January 20 (main analysis) to January 23, 2020 (sensitivity analysis #2), the epidemic doubling time of the aggregate cumulative incidence of mainland China (except Hubei) increased from 1.79 (95% CI, 1.52, 2.25) to 2.90 (95% CI, 2.62, 3.24) (harmonic mean of the arithmetic means), and from 1.18 (95% CI, 0.96, 1.42) to 1.98 (95% CI, 1.82, 2.17) (harmonic mean of the harmonic means) (Table S7, Figure S5, S6). Apart from the epidemic doubling time of the aggregate cumulative incidence of mainland China (except Hubei), we did not observe significant differences by province between results in the main analysis and sensitivity analysis #2. Therefore, our results should be robust for the purpose of this study.
**Table S1.** Confirmed cases of COVID-19 (December 31, 2019 to January 19, 2020) by province in mainland China extracted from official government sources used for the sensitivity analysis.

| Locations¹ | Dec | January |
|------------|-----|---------|
|            | 31  | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       | 10      | 11      | 12      | 13      | 14      | 15      | 16      | 17      | 18      | 19      |
| Mainland China (Excluding Hubei) (Sum of provincial reports) | NR  | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | 1       |
| Mainland China (Including Hubei) (Sum of provincial reports) | 27  | NR      | NR      | 44      | NR      | 59      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | 1       |
| Mainland China (Including Hubei) (Sum by NCH)² | NA  | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      | NA      |
| Hubei       | 27  | NR      | NR      | 44      | NR      | 59      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | 1       |
| Guangdong  | NR  | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | NR      | 1       |

*Note.* NA, not applicable. NR, not reported. ¹Observations were collected directly from government official sites from each province in mainland China. If a press release included data reported at midnight and early morning, they were considered to belong to the previous day the data was reported. ²Official national tally of cumulative case count of confirmed cases was first published by the National Health Commission of China on January 21, 2020 for January 20, 2020 (3).
Table S2. Confirmed cases of COVID-19 (January 20 to 31, 2020) by province in mainland China extracted from official government sources used for the main analysis and sensitivity analysis.

| Locations1 | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Mainland China (Excluding Hubei) (Sum of provincial reports) | 26  | 71  | 145 | 291 | 585 | 923 | 1321 | 1802 | 2386 | 3126 | 3885 | 4637 |
| Mainland China (Including Hubei) (Sum of provincial reports) | 296 | 446 | 589 | 840 | 1314| 1975| 2744 | 4516 | 5940 | 7712 | 9691 | 11790|
| Mainland China (Including Hubei) (Sum by NCH)2 | 291 | 440 | 571 | 830 | 1287| 1975| 2744 | 4515 | 5974 | 7711 | 9692 | 11791 |
| Tibet       |     |     |     |     |     |     |     |     |     |     |     |     |
| Sichuan     |     |     |     |     |     |     |     |     |     |     |     |     |
| Shanghai    |     |     |     |     |     |     |     |     |     |     |     |     |
| Shanxi      |     |     |     |     |     |     |     |     |     |     |     |     |
| Sichuan     |     |     |     |     |     |     |     |     |     |     |     |     |
| Tianjin     |     |     |     |     |     |     |     |     |     |     |     |     |
| Tibet       |     |     |     |     |     |     |     |     |     |     |     |     |
| Xinjiang    |     |     |     |     |     |     |     |     |     |     |     |     |
| Yunnan      |     |     |     |     |     |     |     |     |     |     |     |     |
| Zhejiang    |     |     |     |     |     |     |     |     |     |     |     |     |

Note. 1Observations were collected directly from government official sites from each province in mainland China. If a press release included data reported at midnight and early morning, they were considered to belong to the previous day the data was reported. 2Data was collected of press releases of the National Health Commission of China (3).
| Locations¹ | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Mainland China (Excluding Hubei) (Sum of provincial reports) | 5396 | 6031 | 6910 | 7646 | 8352 | 9049 | 9614 | 10098 | 10507 |
| Mainland China (Including Hubei) (Sum of provincial reports) | 14381 | 17208 | 20432 | 24324 | 28017 | 31161 | 34567 | 37198 | 40138 |
| Mainland China (Including Hubei) (Sum by NCH)² | 14380 | 17205 | 20438 | 24324 | 28018 | 31161 | 34546 | 37198 | 40171 |
| Hubei | 9074 | 11177 | 13522 | 16678 | 19665 | 22112 | 24953 | 27100 | 29631 |
| Anhui | 340 | 408 | 480 | 530 | 591 | 665 | 733 | 779 | 830 |
| Beijing | 183 | 212 | 228 | 253 | 274 | 297 | 315 | 326 | 337 |
| Chongqing | 262 | 300 | 337 | 366 | 389 | 411 | 426 | 446 | 468 |
| Fujian | 159 | 179 | 194 | 205 | 215 | 224 | 239 | 250 | 261 |
| Gansu | 40 | 51 | 55 | 57 | 62 | 67 | 71 | 79 | 83 |
| Guangdong | 604 | 683 | 797 | 870 | 944 | 1018 | 1075 | 1120 | 1131 |
| Guangxi | 111 | 127 | 139 | 150 | 168 | 172 | 183 | 195 | 210 |
| Guizhou | 38 | 46 | 56 | 64 | 69 | 77 | 89 | 96 | 99 |
| Hainan | 63 | 70 | 79 | 89 | 100 | 111 | 122 | 128 | 136 |
| Hebei | 104 | 113 | 126 | 135 | 157 | 171 | 195 | 206 | 218 |
| Heilongjiang | 95 | 118 | 155 | 190 | 227 | 277 | 295 | 307 | 331 |
| Henan | 493 | 566 | 675 | 764 | 851 | 914 | 981 | 1033 | 1073 |
| Hunan | 463 | 521 | 593 | 661 | 711 | 772 | 803 | 838 | 879 |
| Inner Mongolia | 27 | 34 | 35 | 42 | 46 | 50 | 52 | 54 | 58 |
| Jiangsu | 333 | 391 | 476 | 548 | 600 | 661 | 698 | 740 | 771 |
| Jilin | 23 | 31 | 42 | 54 | 59 | 65 | 69 | 78 | 80 |
| Liaoning | 64 | 73 | 74 | 81 | 89 | 94 | 99 | 105 | 108 |
| Ningxia | 28 | 31 | 34 | 34 | 40 | 43 | 45 | 45 | 49 |
| Qinghai | 9 | 13 | 15 | 17 | 18 | 18 | 18 | 18 | 18 |
| Shaanxi | 116 | 128 | 142 | 165 | 173 | 184 | 195 | 208 | 213 |
| Shandong | 225 | 246 | 270 | 298 | 343 | 379 | 407 | 435 | 466 |
| Shanghai | 177 | 193 | 208 | 233 | 254 | 269 | 281 | 292 | 295 |
| Shanxi | 56 | 66 | 74 | 81 | 81 | 86 | 96 | 104 | 115 |
| Sichuan | 231 | 254 | 282 | 301 | 321 | 344 | 363 | 386 | 405 |
| Tianjin | 45 | 48 | 60 | 67 | 69 | 81 | 88 | 90 | 94 |
| Tibet | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Xinjiang | 21 | 24 | 29 | 32 | 36 | 39 | 42 | 45 | 49 |
| Yunnan | 99 | 109 | 117 | 122 | 128 | 135 | 138 | 140 | 141 |
| Zhejiang | 661 | 724 | 829 | 895 | 954 | 1006 | 1048 | 1075 | 1092 |

Note. ¹Observations were collected directly from government official sites from each province in mainland China. If a press release included data reported at midnight and early morning, they were considered to belong to the previous day the data was reported. ²Data was collected of press releases of the National Health Commission of China (3).
Table S4. Main analysis: Doubling times of COVID-19 cumulative incidence and their harmonic mean of the arithmetic means of the doubling times and harmonic mean of the harmonic means of the doubling times (95% Confidence interval) by province in mainland China from January 20 through February 9, 2020.

| Mainland China (Except Hubei) | Hubei | Anhui | Beijing | Chongqing | Fujian | Gansu | Guangdong | Guangxi | Guizhou | Hainan |
|-------------------------------|-------|-------|---------|-----------|--------|-------|-----------|---------|---------|--------|
| **Harmonic mean of harmonic means** | 1.18 (0.96-1.42) | 2.34 (2.27-2.41) | 1.72 (1.13-2.67) | 1.48 (0.63-2.70) | 1.23 (0.67-1.96) | 0.82 (0.46-1.41) | 1.36 (0.76-2.86) | 2.01 (1.53-2.54) | 0.48 (0.22-1.34) | 1.88 (0.81-3.28) | 2.91 (0.65-2.99) |
| Times-doubled | 1 | 0.59 | 2.91 | 2.12 | 2.00 | 0.25 | 1 | 1.33 | 0.18 | 2.5 | 1.00 |
| | 2 | 0.86 | 2.16 | 0.75 | 1.5 | 0.56 | 0.5 | 1.14 | 1.79 | 0.36 | 3.5 | 1.55 |
| | 3 | 0.98 | 1.5 | 2.18 | 1.8 | 0.82 | 0.85 | 1.26 | 2.17 | 0.76 | 1.64 | 2.28 |
| | 4 | 1 | 2.17 | 1.77 | 2.7 | 1.71 | 1.15 | 4.1 | 2.38 | 1.6 | 2.56 | 5.31 |
| | 5 | 1.3 | 3.03 | 4.03 | 4.14 | 3.58 | 1.07 | 5.9 | 2.76 | 3.4 | 5.8 | 6.86 |
| | 6 | 1.98 | 3.43 | 4.9 | 7.31 | 4.82 | 1.39 | 4.92 | 4.78 | | |
| | 7 | 2.55 | | | | | | | | | |
| | 8 | 4.53 | | | | | | | | | |

| Hebei | Heilongjiang | Henan | Hunan | Inner Mongolia | Jiangsu | Jiangxi | Jilin | Liaoning | Ningxia | Qinghai |
|-------|-------------|-------|-------|---------------|--------|--------|-------|----------|---------|---------|
| **Harmonic mean of harmonic means** | 1.88 (1.57-2.72) | 1.93 (1.76-2.36) | 1.81 (1.35-2.05) | 1.42 (1.24-2.04) | 2.37 (1.80-3.67) | 2.43 (1.77-3.26) | 1.68 (1.45-2.33) | 2.64 (2.13-3.50) | 2.10 (1.45-3.30) | 2.54 (1.76-4.33) | 2.50 (1.50-5.00) |
| Times-doubled | 1 | 0.67 | 1.93 | 0.81 | 0.71 | 0.17 | 1.93 | 1.13 | 1.48 | 1.05 | 1.59 | 1.00 |
| | 2 | 0.33 | 0.33 | 0.25 | 0.33 | 0.67 | 0.4 | 1.31 | 0.84 | 2.5 | 0.5 | 1 | 0.33 |
| | 3 | 0.67 | 0.67 | 0.5 | 0.67 | 0.67 | 0.4 | 1.31 | 0.84 | 2.5 | 0.5 | 1 | 0.67 |
| | 4 | 1 | 1.36 | 0.55 | 0.4 | 2.75 | 2.32 | 0.96 | 3.66 | 2.76 | 2.55 | 4.5 |
| | 5 | 1.33 | 2.12 | 0.7 | 0.47 | 4.71 | 4.07 | 1.89 | 2.43 | 4.67 | 4.53 | |
| | 6 | 2.01 | 2.95 | 0.62 | 1.13 | | | 1.69 | 3.74 | | |
| | 7 | 5.28 | 3.04 | 1.38 | 1.85 | | | 1.99 | | | |
| | 8 | 3.31 | 2.69 | 1.97 | | | | 4.16 | | | |
| | 9 | | 3.57 | 4.22 | | | | | | | |
| | 10 | | | | | | | | | | |

| Shaanxi | Shandong | Shanghai | Shanxi | Sichuan | Tianjin | Tibet | Xinjiang | Yunnan | Zhejiang |
|--------|----------|----------|--------|---------|--------|-------|----------|--------|---------|
| **Harmonic mean of harmonic means** | 2.82 (2.12-9.97) | 1.68 (1.42-2.39) | 2.19 (1.88-2.68) | 2.31 (1.67-3.25) | 1.83 (1.39-2.70) | 2.78 (2.07-4.06) | Not applied | 3.05 (2.06-4.75) | 2.05 (1.34-2.72) | 1.91 (1.60-2.51) |
| Times-doubled | 1 | 2.04 (1.28-3.01) | 0.48 (0.28-1.15) | 0.77 (0.34-1.73) | 0.66 (0.68-2.51) | 0.96 (0.51-1.75) | 1.69 (0.80-3.55) | Not applied | 1.91 (0.83-4.46) | 1.25 (0.89-1.81) | 1.20 (0.74-1.70) |
| | 1 | 1.33 | 2.05 | 0.28 | 1.2 | 0.66 | 1 | 2 | 2 | 1 | |
| | 2 | 2.24 | 0.1 | 0.57 | 0.4 | 0.64 | 2 | 1.6 | 0.66 | 0.58 | |
| | 3 | 3.76 | 0.19 | 1.15 | 1.06 | 0.77 | 2.22 | 3.06 | 0.84 | 1.23 | |
| | 4 | 0.41 | 1.92 | 1.76 | 1.18 | 4.78 | 5.34 | 1.12 | 1.61 | | |
| | 5 | 0.86 | 2.92 | 2.2 | 1.55 | 3.57 | 1.61 | 2.29 | | | |
| | 6 | 1.43 | 3.16 | 4.18 | 2.78 | | | 1.45 | 1.47 | | |
| | 7 | 2.66 | 6.13 | 4.49 | | | | 7.32 | 3.48 | | |
| | 8 | 4.71 | | | | | | | | | |
Table S5. Sensitivity analysis #1 (1 of 2 tables): Doubling times of COVID-19 cumulative incidence and their harmonic mean of the arithmetic means of the doubling times and harmonic mean of the harmonic means of the doubling times (95% Confidence interval) by province in mainland China from December 31, 2019 through February 9, 2020: Mainland China (Except Hubei), Hubei, and from Anhui to Qinghai.

| Times doubled | Mainland China (Except Hubei) | Hebei | Heilongjiang | Henan | Hunan | Inner Mongolia | Jiangsu | Jiangxi | Jilin | Liaoning | Ningxia | Qinghai |
|---------------|-------------------------------|-------|--------------|-------|-------|----------------|---------|---------|-------|----------|---------|---------|
|               | Harmonic mean of arithmetic means | 1.34 (1.28-1.52) | 4.06 (3.85-4.33) | 2.57 (2.12-3.00) | 2.51 (1.99-3.26) | 2.22 (1.60-2.23) | 1.82 (1.18-2.55) | 2.55 (1.83-3.79) | 1.88 (1.74-2.19) | 1.93 (1.47-2.96) | 2.78 (2.00-3.97) | 2.92 (1.97-4.25) |
|               | Harmonic mean of harmonic means | 0.29 (0.15-0.59) | 2.28 (2.08-2.56) | 1.76 (1.21-2.40) | 1.60 (0.93-2.70) | 1.23 (0.74-1.88) | 0.83 (0.47-1.42) | 1.33 (0.70-2.62) | 0.44 (0.25-1.13) | 0.49 (0.22-1.29) | 1.98 (1.09-3.53) | 1.55 (0.60-3.29) |
| 1             | 0.04                          | 17.33 | 2.12         | 1.00  | 2.05  | 0.25          | 1.00  | 0.07   | 0.18  | 2.50     | 1.00    | 1.00    |
| 2             | 0.08                          | 1.22  | 0.75         | 1.5   | 0.56  | 0.5           | 1.14  | 0.16   | 0.36  | 3.5      | 1.55    | 1.55    |
| 3             | 0.15                          | 2     | 2.18         | 1.8   | 0.82  | 0.85          | 1.26  | 0.3    | 0.76  | 1.64     | 2.28    | 2.28    |
| 4             | 0.33                          | 3.04  | 1.77         | 2.7   | 1.71  | 1.15          | 4.1   | 0.63   | 1.6   | 2.56     | 5.31    | 5.31    |
| 5             | 0.53                          | 2.11  | 4.03         | 4.14  | 3.58  | 1.07          | 5.9   | 1.84   | 3.4   | 5.8      | 6.86    | 6.86    |
| 6             | 0.73                          | 1.23  | 4.9          | 7.31  | 4.82  | 1.39          | 1.44  | 4.78   |       |          |         |         |
| 7             | 0.92                          | 2.61  |              | 3.12  |       |               |       |        |       |          |         |         |
| 8             | 0.98                          | 3.13  |              | 9.21  |       |               |       |        |       |          |         |         |
| 9             | 1.01                          | 3.87  |              | 2.72  |       |               |       |        |       |          |         |         |
| 10            | 1.48                          |       |              |       |       |               |       |        |       |          |         |         |
| 11            | 2.17                          |       |              |       |       |               |       |        |       |          |         |         |
| 12            | 2.88                          |       |              |       |       |               |       |        |       |          |         |         |
| 13            | 5.55                          |       |              |       |       |               |       |        |       |          |         |         |

| Times doubled | Hebei | Heilongjiang | Henan | Hunan | Inner Mongolia | Jiangsu | Jiangxi | Jilin | Liaoning | Ningxia | Qinghai |
|---------------|-------|--------------|-------|-------|----------------|---------|---------|-------|----------|---------|---------|
|               | Harmonic mean of arithmetic means | 1.89 (1.55-2.74) | 1.96 (1.76-2.26) | 1.80 (1.31-2.10) | 1.41 (1.26-1.99) | 2.37 (1.82-3.57) | 2.45 (1.75-3.31) | 1.72 (1.44-2.36) | 2.67 (2.13-3.50) | 2.16 (1.49-3.53) | 2.58 (1.72-4.43) | 2.64 (1.79-5.00) |
|               | Harmonic mean of harmonic means | 1.07 (0.66-1.90) | 1.12 (0.66-1.97) | 0.77 (0.48-1.14) | 0.73 (0.48-1.15) | 1.15 (0.65-2.71) | 1.92 (1.31-2.68) | 1.17 (0.81-1.74) | 1.60 (0.70-3.11) | 1.06 (0.50-2.45) | 1.67 (0.37-3.65) | 0.96 (0.39-3.69) |
| 1             | 1.00                          | 0.33  | 0.25         | 0.33  | 1.00  | 2.00          | 1.25  | 0.50   | 1.00  | 1.00     | 0.03    | 0.33    |
| 2             | 0.33                          | 0.67  | 0.5          | 0.67  | 0.4   | 1.31          | 0.84  | 2.5    | 0.5   | 2        | 0.67    |         |
| 3             | 0.67                          | 0.8   | 1            | 0.8   | 0.85  | 1.75          | 0.72  | 2      | 1.07  | 1.25     | 4       |         |
| 4             | 1.6                           | 1.36  | 0.55         | 0.4   | 2.75  | 2.32          | 0.96  | 3.66   | 2.76  | 2.55     | 4.5      |         |
| 5             | 1.33                          | 2.12  | 0.7          | 0.47  | 4.71  | 4.07          | 1.89  | 2.43   | 4.67  | 4.5      |         |         |
| 6             | 2.01                          | 2.95  | 0.62         | 1.13  |       |               | 1.69  | 3.74   |       |          |         |         |
| 7             | 5.28                          | 3.04  | 1.38         | 1.85  |       |               | 1.99  |       |       |          |         |         |
| 8             | 3.31                          | 2.69  | 1.97         |       |       |               | 4.16  |       |       |          |         |         |
| 9             | 3.57                          |       | 4.22         |       |       |               |       |        |       |          |         |         |
| 10            | 6.56                          |       |              |       |       |               |       |        |       |          |         |         |
Table S6. Sensitivity analysis #1 (2 of 2 tables): Doubling times of COVID-19 cumulative incidence and their harmonic mean of the arithmetic means of the doubling times and harmonic mean of the harmonic means of the doubling times (95% Confidence interval) by province in mainland China from December 31, 2019 through February 9, 2020: from Shaanxi to Zhejiang.

| Times doubled | Shaanxi | Shandong | Shanghai | Shanxi | Sichuan | Tianjin | Tibet | Xinjiang | Yunnan | Zhejiang |
|---------------|---------|----------|----------|--------|---------|---------|-------|----------|--------|----------|
| 1             | 2.77 (2.06-3.93) | 1.68 (1.41-2.36) | 2.21 (1.91-2.78) | 2.12 (1.67-3.00) | 1.79 (1.40-2.65) | 2.75 (2.10-3.89) | Not applied | 3.09 (2.12-4.89) | 2.10 (1.42-2.78) | 1.90 (1.59-2.55) |
| 2             | 2.03 (1.27-2.93) | 0.48 (0.30-1.11) | 0.82 (0.40-1.83) | 1.26 (0.68-2.60) | 0.96 (0.62-1.73) | 1.67 (0.78-3.38) | Not applied | 1.98 (0.80-4.69) | 1.28 (0.80-1.93) | 1.23 (0.77-1.72) |
| 3             | 1.33 | 2.05 | 0.28 | 1.20 | 0.66 | 1.00 | 2.00 | 2 | 1.00 |
| 4             | 2.24 | 0.1 | 0.57 | 0.4 | 0.64 | 2 | 1.6 | 0.66 | 0.58 |
| 5             | 3.76 | 0.19 | 1.15 | 1.06 | 0.77 | 2.22 | 3.06 | 0.84 | 1.23 |
| 6             | 0.41 | 1.92 | 1.76 | 1.18 | 4.78 | 5.34 | 1.12 | 1.61 |
| 7             | 0.86 | 2.92 | 2.2 | 1.55 | 3.57 | 1.61 | 2.29 |
| 8             | 1.43 | 3.16 | 4.18 | 2.78 | 1.45 | 1.47 |
| 9             | 2.66 | 6.13 | 4.49 | 7.32 | 3.48 |
Table S7. Sensitivity analysis #2: Doubling times of COVID-19 cumulative incidence and their harmonic mean of the arithmetic means of the doubling times and harmonic mean of the harmonic means of the doubling times (95% Confidence interval) by province in mainland China from January 23, 2020 through February 9, 2020.

| Mainland China (Except Hubei) | Hubei | Anhui | Beijing | Chongqing | Fujian | Gansu | Guangdong | Guangxi | Guizhou | Hainan |
|-------------------------------|-------|-------|---------|-----------|--------|-------|-----------|---------|---------|--------|
| Harmonic mean of arithmetic means | 2.9 (2.62-3.24) | 2.46 (2.37-2.55) | 2.54 (2.12-2.99) | 3.46 (2.77-4.57) | 3.11 (2.38-4.17) | 2.03 (1.29-3.10) | 2.54 (1.80-3.89) | 2.91 (2.40-3.61) | 3.26 (2.37-4.22) | 2.67 (1.85-3.92) | 3.43 (2.57-4.62) |
| Harmonic mean of harmonic means | 1.98 (1.82-2.17) | 2.25 (2.18-2.33) | 1.47 (0.90-2.29) | 3.03 (2.23-3.99) | 1.87 (1.28-2.80) | 1.26 (0.69-2.01) | 1.27 (0.66-2.84) | 2.65 (2.14-3.10) | 2.23 (1.33-3.29) | 1.73 (0.67-3.40) | 2.31 (1.40-3.71) |
| Times doubled | 1 | 1.01 | 2.12 | 0.62 | 2.15 | 0.90 | 1.00 | 1.00 | 2.16 | 1.30 | 2.50 | 1.55 |
| 2 | 1.59 | 1.47 | 1.38 | 3.50 | 2.04 | 1.11 | 1.14 | 2.29 | 2.84 | 3.50 | 2.28 |
| 3 | 2.30 | 2.22 | 2.30 | 4.21 | 4.37 | 1.09 | 1.26 | 2.79 | 4.22 | 1.64 | 5.31 |
| 4 | 3.21 | 3.03 | 3.74 | 7.99 | 1.71 | 4.10 | 4.45 | 8.50 | 2.56 | 6.86 |
| 5 | 6.41 | 3.45 | 3.96 | 4.13 | 5.90 | 5.80 | | | | |

| Hebei | Heilongjiang | Henan | Hunan | Inner Mongolia | Jiangsu | Jiangxi | Jilin | Liaoning | Ningxia | Qinghai |
|-------|-------------|-------|-------|---------------|---------|--------|------|---------|---------|--------|
| Harmonic mean of arithmetic means | 1.91 (1.42-2.83) | 2.21 (1.74-2.81) | 1.87 (1.50-2.40) | 1.89 (1.48-2.77) | 2.39 (1.84-4.00) | 2.31 (1.80-3.10) | 1.89 (1.44-2.52) | 3.01 (2.14-4.06) | 2.44 (1.49-4.00) | 2.68 (1.70-4.50) | 3.21 (2.25-5.67) |
| Harmonic mean of harmonic means | 0.81 (0.39-1.78) | 1.47 (0.77-2.51) | 0.85 (0.48-1.37) | 0.75 (0.41-1.27) | 1.16 (0.66-2.36) | 1.60 (1.06-3.26) | 1.18 (0.62-1.86) | 2.44 (1.29-3.73) | 0.99 (0.37-2.46) | 1.88 (0.94-3.96) | 1.8 (0.80-5.08) |
| Times doubled | 1 | 0.33 | 0.80 | 0.39 | 0.26 | 1.00 | 1.00 | 0.63 | 3.00 | 0.50 | 2.00 | 2.33 |
| 2 | 0.67 | 1.36 | 0.68 | 0.53 | 0.40 | 1.31 | 0.92 | 2.59 | 1.07 | 1.25 | 0.67 |
| 3 | 1.60 | 2.12 | 0.71 | 1.30 | 0.85 | 1.75 | 1.78 | 3.53 | 2.76 | 2.55 | 4.00 |
| 4 | 1.33 | 2.95 | 1.62 | 1.92 | 2.75 | 2.32 | 1.72 | 2.38 | 4.67 | 4.53 | 4.50 |
| 5 | 2.01 | 3.04 | 2.73 | 2.19 | 4.71 | 4.07 | 1.74 | | | |
| 6 | 5.28 | 3.31 | 3.96 | 4.56 | | | | | | | |

| Shaanxi | Shandong | Shanghai | Shanxi | Sichuan | Tianjin | Tibet | Xinjiang | Yunnan | Zhejiang |
|---------|----------|----------|--------|---------|--------|-------|---------|--------|---------|
| Harmonic mean of arithmetic means | 3.44 (2.76-4.40) | 1.43 (1.18-2.14) | 3.08 (2.52-4.07) | 1.93 (1.50-3.09) | 2.61 (1.89-3.60) | 3.17 (2.16-4.59) | Not applied | 3.05 (2.10-4.67) | 1.82 (1.20-2.87) | 2.37 (1.87-3.14) |
| Harmonic mean of harmonic means | 2.84 (1.82-4.05) | 0.24 (0.14-0.60) | 2.61 (1.72-3.59) | 0.71 (0.32-1.88) | 1.82 (1.28-2.57) | 0.79 (0.34-1.88) | Not applied | 1.86 (0.83-4.40) | 1.03 (0.56-1.77) | 1.98 (1.73-2.41) |
| Times doubled | 1 | 3.33 | 0.05 | 2.00 | 0.20 | 1.12 | 2.00 | 2.00 | 0.66 | 1.57 |
| 2 | 2.24 | 0.10 | 3.00 | 0.40 | 1.51 | 1.66 | 1.60 | 0.84 | 2.4 |
| 3 | 3.76 | 0.20 | 3.29 | 1.06 | 2.72 | 4.95 | 3.06 | 1.12 | 1.39 |
| 4 | 0.40 | 1.76 | 4.04 | 5.30 | 5.34 | 1.61 | 4.06 |
| 5 | 0.86 | 2.20 | | | | | | | |
| 6 | 1.43 | 4.18 | | | | | | | |
| 7 | 2.66 | | | | | | | | |
| 8 | 4.71 | | | | | | | | |
| Health commission                          | URL                                      | Notes                                                                 |
|-------------------------------------------|------------------------------------------|----------------------------------------------------------------------|
| National Health Commission of the People’s Republic of China | http://www.nhc.gov.cn                     |                                                                      |
| Provincial health commissions              |                                          |                                                                      |
| Anhui                                     | http://wjw.ah.gov.cn/                    |                                                                      |
| Beijing                                   | http://wjw.beijing.gov.cn/               |                                                                      |
| Chongqing                                 | http://wsjkw.cq.gov.cn/                  |                                                                      |
| Fujian                                    | http://fjwsik.fjsen.com/                 |                                                                      |
| Gansu                                     | http://wsjk.gansu.gov.cn/                |                                                                      |
| Guangdong                                 | http://wsjkw.gd.gov.cn/                  |                                                                      |
| Guangxi                                   | http://wsjkw.gzxf.gov.cn/                |                                                                      |
| Guizhou                                   | http://www.gzhfpc.gov.cn/                |                                                                      |
| Hainan                                    | http://wst.hainan.gov.cn/                |                                                                      |
| Hebei                                     | http://www.hebwst.gov.cn/               | Our team members found it often inaccessible from Statesboro, GA, USA. |
| Heilongjiang                              | http://wsjkw.hlj.gov.cn/                 |                                                                      |
| Henan                                     | http://www.hnwsjsw.gov.cn/               |                                                                      |
| Hubei                                     | http://wjw.hubei.gov.cn/                 |                                                                      |
| Hunan                                     | http://wjw.hunan.gov.cn/                 |                                                                      |
| Inner Mongolia                            | http://wjw.nmg.gov.cn/                   |                                                                      |
| Jiangsu                                   | http://wjw.jiangsu.gov.cn/               |                                                                      |
| Jiangxi                                   | http://hc.jiangxi.gov.cn/                |                                                                      |
| Jilin                                     | http://www.jl.gov.cn/                    |                                                                      |
| Liaoning                                  | http://www.shenyang.gov.cn/              |                                                                      |
| Ningxia                                   | http://wsjkw.nx.gov.cn/index.htm          |                                                                      |
| Qinghai                                   | https://wsjkw.qinghai.gov.cn/            |                                                                      |
| Shaanxi                                   | http://sxwjw.shaanxi.gov.cn/             |                                                                      |
| Shandong                                  | http://wsjkw.shandong.gov.cn             | Our team members found it persistently inaccessible from Statesboro, GA, USA. |
| Shanghai                                  | http://www.shanghai.gov.cn/              |                                                                      |
| Shanxi                                    | http://wjw.shanxi.gov.cn/                |                                                                      |
| Sichuan                                   | http://wsjkw.sc.gov.cn/                  |                                                                      |
| Tianjin                                   | http://www.tj.gov.cn/                    |                                                                      |
| Tibet                                     | http://wjw.xizang.gov.cn/                |                                                                      |
| Xinjiang                                  | http://www.xjhfc.gov.cn/                 |                                                                      |
| Yunnan                                    | http://ynswsjkw.yn.gov.cn/               |                                                                      |
| Zhejiang                                  | https://www.zjwjw.gov.cn                 |                                                                      |

Notes: If our team was unable to directly retrieve the press release from a provincial health commissions, we will use mainland Chinese media reports that directly reported on the provincial health commissions’ announcements. Please note that mainland Chinese media are controlled by the Chinese Communist Party and they could not deviate from the government’s announcements.
Figure S1. Main analysis: The harmonic mean of the arithmetic means of COVID-19 epidemic doubling times (red circle) with 95% confidence interval (red bar) of the doubling times (days), and their values (black diamond) by the number of times the reported cumulative incidence doubles by province within mainland China from January 20, 2020 through February 9, 2020. Each panel represents a province except the panel representing “Mainland China (except Hubei)” that is the aggregate of all other provinces in mainland China, except Hubei. Doubling time for Tibet is not available, because there had only been 1 confirmed case in Tibet as of February 9, 2020.

Figure S2. Main analysis: The harmonic mean of the harmonic means of COVID-19 epidemic doubling times (red circle) with 95% confidence interval (red bar) of the doubling times (days), and their values (black diamond) by the number of times the reported cumulative incidence doubles by province within mainland China from January 20, 2020 through February 9, 2020. Each panel represents a province except the panel representing “Mainland China (except Hubei)” that is the aggregate of all other provinces in mainland China, except Hubei. Doubling time for Tibet is not available, because there had only been 1 confirmed case in Tibet as of February 9, 2020.

Figure S3. Sensitivity analysis #1: The harmonic mean of the arithmetic means of COVID-19 doubling times (red circle) with 95% confidence interval (red bar) of the doubling times (days), and their values (black diamond) by the number of times the reported cumulative incidence doubles by province within mainland China from December 31, 2019 through February 9, 2020. Each panel represents a province except the panel representing “Mainland China (except Hubei)” that is the aggregate of all other provinces in mainland China, except Hubei. Doubling time for Tibet is not available, because there had only been 1 confirmed case in Tibet as of February 9, 2020.

Figure S4. Sensitivity analysis #1: The harmonic mean of the harmonic means of COVID-19 doubling times (red circle) with 95% confidence interval (red bar) of the doubling times (days), and their values (black diamond) by the number of times the reported cumulative incidence doubles by province within mainland China from December 31, 2019 through February 9, 2020. Each panel represents a province except the panel representing “Mainland China (except Hubei)” that is the aggregate of all other provinces in mainland China, except Hubei. Doubling time for Tibet is not available, because there had only been 1 confirmed case in Tibet as of February 9, 2020.

Figure S5. Sensitivity analysis #2: The harmonic mean of the arithmetic means of COVID-19 doubling times (red circle) with 95% confidence interval (red bar) of the doubling times (days), and their values (black diamond) by the number of times the reported cumulative incidence doubles by province within mainland China from January 23, 2020 through February 9, 2020. Each panel represents a province except the panel representing “Mainland China (except Hubei)” that is the aggregate of all other provinces in mainland China, except Hubei. Doubling time for Tibet is not available, because there had only been 1 confirmed case in Tibet as of February 9, 2020.

Figure S6. Sensitivity analysis #2: The harmonic mean of the harmonic means of COVID-19 doubling times (red circle) with 95% confidence interval (red bar) of the doubling times (days), and their values (black diamond) by the number of times the reported cumulative incidence doubles by province within mainland China from January 23, 2020 through February 9, 2020. Each panel represents a province except the panel representing “Mainland China (except Hubei)” that is the aggregate of all other provinces in mainland China, except Hubei. Doubling time for Tibet is not available, because there had only been 1 confirmed case in Tibet as of February 9, 2020.
Figure S7. Cumulative incidence and log10 cumulative incidence over time (date) for Hubei (upper panel) and Fujian (lower panel).

Figure S8. Cumulative incidence and log10 cumulative incidence over time (date) for Guangdong (upper panel) and Heilongjiang (lower panel).

Figure S9. Cumulative incidence and log10 cumulative incidence over time (date) for Henan (upper panel) and Hunan (lower panel).

Figure S10. Cumulative incidence and log10 cumulative incidence over time (date) for Jiangxi (upper panel) and Shandong (lower panel).

Figure S11. Main analysis: The map of the harmonic mean of the harmonic means of COVID-19 by province in mainland China, from January 20, 2020 through February 9, 2020.

Figure S12. Sensitivity analysis #1: The map of the harmonic mean of the arithmetic means of COVID-19 by province in mainland China, from December 31, 2019 through February 9, 2020.

Figure S13. Sensitivity Analysis #1: The map of the harmonic mean of the harmonic means of COVID-19 by province in mainland China, from December 31, 2019 through February 9, 2020.

Figure S14. Sensitivity analysis #1: The map of the number of times the COVID-19 outbreak has doubled by province in mainland China, from December 31, 2019 through February 9, 2020.
Authors’ contributions

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Data management and quality check of epidemic data entry: Ms. Kamalich Muniz-Rodriguez, Dr. Isaac Chun-Hai Fung

Curation of epidemic data for countries and territories outside mainland China (including Hong Kong, Macao and Taiwan): Ms. Kamalich Muniz-Rodriguez and Ms. Sylvia K. Ofori

Curation of epidemic data for provinces in mainland China: Ms. Manyun Liu (from the early reports, up to Jan 24, 2020 data), Ms. Po-Ying Lai (since Jan 25, 2020 data to today), Mr. Chi-Hin Cheung (since Jan 27, 2020 data to today), and Ms. Kamalich Muniz-Rodriguez and Dr. Isaac Chun-Hai Fung (whenever there is a backlog).

Retrieval of epidemic data from official websites (downloading and archiving of China’s national and provincial authorities’ press releases): Ms. Manyun Liu and Dr. Dongyu Jia (at the very beginning of our project)

Retrieval of statistical data from the official website of National Bureau of Statistics of the People’s Republic of China: Mr. Chi-Hin Cheung

Retrieval of publicly available statistical data from various sources: Ms. Yiseul Lee, Dr. Isaac Chun-Hai Fung

Table S8: Ms. Manyun Liu, Dr. Isaac Chun-Hai Fung

Map creation: Ms. Kimberlyn M. Roosa

Assistance provided to Dr. Fung and Ms. Muniz-Rodriguez: Ms. Sylvia K. Ofori
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| Province         | Times cumulative incidence doubles | Time doubling occurs (days) |
|------------------|------------------------------------|-----------------------------|
| Hubei            | ![Graph](image)                     |                             |
| Mainland China   | ![Graph](image)                     |                             |
| Anhui            | ![Graph](image)                     |                             |
| Beijing          | ![Graph](image)                     |                             |
| Chongqing        | ![Graph](image)                     |                             |
| Fujian           | ![Graph](image)                     |                             |
| Gansu            | ![Graph](image)                     |                             |
| Guangdong        | ![Graph](image)                     |                             |
| Guangxi          | ![Graph](image)                     |                             |
| Guizhou          | ![Graph](image)                     |                             |
| Hainan           | ![Graph](image)                     |                             |
| Hebei            | ![Graph](image)                     |                             |
| Heilongjiang     | ![Graph](image)                     |                             |
| Henan            | ![Graph](image)                     |                             |
| Hunan            | ![Graph](image)                     |                             |
| Inner Mongolia   | ![Graph](image)                     |                             |
| Jiangsu          | ![Graph](image)                     |                             |
| Jiangxi          | ![Graph](image)                     |                             |
| Jilin            | ![Graph](image)                     |                             |
| Liaoning         | ![Graph](image)                     |                             |
| Ningxia          | ![Graph](image)                     |                             |
| Qinghai          | ![Graph](image)                     |                             |
| Shaanxi          | ![Graph](image)                     |                             |
| Shandong         | ![Graph](image)                     |                             |
| Shanghai         | ![Graph](image)                     |                             |
| Shanxi           | ![Graph](image)                     |                             |
| Sichuan          | ![Graph](image)                     |                             |
| Tianjin          | ![Graph](image)                     |                             |
| Xinjiang         | ![Graph](image)                     |                             |
| Yunnan           | ![Graph](image)                     |                             |
| Zhejiang         | ![Graph](image)                     |                             |
Harmonic mean of the harmonic means of COVID-19 epidemic doubling times
Harmonic mean of the arithmetic means of COVID-19 epidemic doubling times

- 1.4 - 1.69
- 1.7 - 1.99
- 2.0 - 2.29
- 2.3 - 2.69
- 2.7 - 3.09
- > 4
Harmonic mean of the harmonic means of COVID-19 epidemic doubling times:

- 0.4 - 0.69
- 0.7 - 0.99
- 1.0 - 1.19
- 1.2 - 1.49
- 1.5 - 1.89
- 1.9 - 2.29
Number of times COVID-19 incidence has doubled by province

- 3 - 4
- 5
- 6
- 7 - 8
- 9 - 10