Article DOI: https://doi.org/10.3201/eid2611.201074

Early Insights from Statistical and Mathematical Modeling of Key Epidemiologic Parameters of COVID-19

Appendix

Appendix Table 1. Search terms in study of modeling of key epidemiologic parameters of COVID-19

Topic	Search terms
	"nCoV," "2019-nCoV," "nCoV-2019," "COVID," "COVID-19," "novel coronavirus," "SARS-CoV-2" AND "evolution*" or "phylogenetics"
Incubation period	In PubMed, medRxiv, bioRxiv and arXiv: #1: "incubation period" #2: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" #3: #1 AND #2 In SSRN: #1: "incubation period" #2: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" #3: #1 AND search within each of the term in #2 In research square, Virological, and Wellcome Open Research: #1: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" Then read through all the papers
Serial interval	In PubMed: #1: "serial interval" OR "generation interval" OR "generation time" OR "serial distribution" OR "secondary infections" OR "secondary cases" #2: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" #3: #1 AND #2 In medRxiv, bioRxiv, and arXiv: #1: "serial interval" #2: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" #3: #1 AND #2 In SSRN: #1: "serial interval" #2: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" #3: #1 AND search within each of the term in #2 In research square, Virological, and Wellcome Open Research: #1: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" Then read through all the papers
Generation interval	In PubMed and arXiv: #1: "generation interval" #2: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" #3: #1 AND #2 In medRxiv and bioRxiv:

Topic	Search terms
	"generation interval" for full text or abstract or title (match whole all) In SSRN: #1: "generation interval" #2: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" #3: #1 AND search within each of the term in #2 In research square, Virological, and Wellcome Open Research: #1: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" Then read through all the papers
Doubling time	In PubMed, medRxiv, bioRxiv and arXiv: #1: "doubling time" OR "growth rate" #2: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" #3: #1 AND #2 In SSRN: #1: "doubling time" OR "growth rate" #2: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" #3: #1 AND search within each of the term in #2 In research square, Virological, and Wellcome Open Research: #1: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV-2019" OR "SARS-CoV-2" Then read through all the papers
CFR	In PubMed: ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "2019-ncov"[All Fields] OR "COVID-19"[All Fields] OR "COVID"[All Fields] OR "SARS-COV-2"[All Fields] OR "ncov"[All Fields] OR "ncov-2019"[All Fields]) AND "2019/12/31 00.00"[MHDA]: "2020/03/06 23.59"[MHDA] AND ("fatality"[All Fields] OR "Case Fatality"[All Fields] OR "Infection Fatality"[All Fields]) In biorXiv and medrXiv: for title "coronavirus fatality" (match all words) and abstract or title "coronavirus fatality" (match all words) and posted between "01 Jan 2020 and 07 Mar 2020" In arXiv: Query: order: -announced_date_first; size: 50; date_range: from 2020–01–01 to 2020–03–07; include_cross_list: True; terms: AND abstract = coronavirus; AND abstract = fatality In ResearchSquare: SARS-CoV-2 Preprints In Wellcome Research: Query: "coronavirus" In WHO Global Research Database: Query: "sever*" Cited by WHO: Imperial College London, IDO
Nonpharmaceutical interventions	In all databases: "coronavirus" OR "nCoV" OR "COVID" OR "COVID-19" OR "2019-nCoV" OR "nCoV- 2019" OR "SARS-CoV-2"

Appendix Table 2. Summary of published studies on COVID-19 included in review of incubation period, serial interval, doubling time, and generation interval*

Study	Study setting	Incubation period (days)	Serial interval (days)	Doubling time (days)	Generation interval (days)
Backer 2020 (*1*)	88 confirmed cases detected outside Wuhan, Jan 20–28, 2020	Mean 6.4, median NA, SD 2.3, 95% CrI 5.6–7.7 based on Weibull distribution	NA	NA	NA
Chinazzi 2020 (*2*)	Modeling study	NA	NA	4.2 (90% CI 3.8–4.7) based on reporting dates	NA
Du 2020a (*3*)	Modeling study	NA	NA	7.31 (95% CrI 6.26–9.66) based on onset dates	NA
Du 2020b (*4*)	468 confirmed infector–infectee pairs in 18 Chinese provinces, from Jan 21– Feb 8, 2020	NA	Mean 3.96,median NA,SD 4.75,95% CI 3.53–4.39, based on normal distribution	NA	NA
Ganyani 2020 (*5*)	Modeling study	NA	Mean 5.21, median NA, SD 4.32, 95% CrI −3.35 to 13.94 in Singapore	NA	Mean 5.20, median NA, SD 1.72, 95% CrI 3.78–6.78 in Singapore
Ganyani 2020 (*5*)	Modeling study	NA	Mean 3.95, median NA, SD 4.24, 95% CrI −4.47 to 12.51 in Tianjin, China	NA	Mean 3.95, median NA, SD 1.51, 95% CrI 3.01–4.91 in Tianjin, China
Jung 2020 (*6*)	Modeling study	NA	NA	4.62 (95% CI 4.62–4.95) from a single index case with illness onset on Dec 8, 2019, calculated by growth rate of 0.15 (95% CI 0.14–0.15) based on reporting dates	NA
Jung 2020 (*6*)	Modeling study	NA	NA	2.39 (95% CI 1.93–3.15) from 20 exported cases reported by Jan 24, 2020, calculated by growth rate of 0.29 (95% CI 0.22–0.36) based on reporting dates	NA
Leung 2020 (*7*)	175 confirmed patients in China, Jan 20–Feb 12, 2020	Mean 1.8, median NA, SD NA, 95% CI 1.0–2.7 based on travelers to Hubei fitting to Weibull distribution	NA	NA	NA
Leung 2020 (*7*)	175 confirmed patients in China, Jan 20–Feb 12, 2020	Mean 7.2, median NA, SD NA, 95% CI 6.1–8.4 based on nontravelers fitting to Weibull distribution	NA	NA	NA
Li 2020 (*8*)	425 confirmed cases in Wuhan as of Jan 22, 2020	Mean 5.2, median NA, SD NA, 95% CI 4.1–7.0 based on log-normal distribution	Mean 7.5, median NA, SD 3.4, 95% CI 5.3–19.0 based on gamma distribution	7.4 (95% CI 4.2–14.0) based on onset dates	NA
Linton 2020 (*9*)	158 confirmed cases in and outside Wuhan as of Jan 31, 2020 (52 cases when excluding Wuhan residents)	Mean 5.6, median NA, SD NA, 95% CrI 5.0–6.3 based on 158 cases	NA	NA	NA
Linton 2020 (*9*)	158 confirmed cases in and outside Wuhan as of Jan 31, 2020 (52 cases	Mean 5.0, median NA, SD NA, 95% CrI 4.2–6.0 based on 52 cases	NA	NA	NA

Study	Study setting	Incubation period (days)	Serial interval (days)	Doubling time (days)	Generation interval (days)
	when excluding Wuhan residents)				
Nishiura 2020 (*10*)	28 infector–infectee pairs from published research articles as of Feb 12, 2020	NA	Mean 4.7, median 4.0, SD 2.9, 95% CrI 3.7–6.0 based on all 28 pairs fitting to log-normal distribution	NA	NA
Nishiura 2020 (*10*)	18 pairs with highest certainty from published research articles as of Feb 12, 2020	NA	Mean 4.8, median 4.6, SD 2.3, 95% CrI 3.8–6.1 based on 18 certain pairs fitting to Weibull distribution	NA	NA
Sanche 2020 (*11*)	Modeling study	NA	NA	2.4 (95% CI 1.9–3.3) based on onset dates	NA
Wu 2020 (*12*)	Modeling study	NA	NA	6.4 (95% CrI 5.8–7.1) based on onset dates	NA
Zhang 2020 (*13*)	8,579 confirmed cases reported outside Hubei in China as of Feb 17, 2020 (only 49 cases with no travel history to/from Wuhan/Hubei)	Mean 5.2, median NA, SD NA, 95% CI 1.8–12.4based on log-normal distribution	Mean 5.1, median NA, SD NA, 95% CI 1.3–11.6 based on gamma distribution	NA	NA

*CI, confidence interval; CrI, credible interval; NA, not applicable; SD, standard deviation

Appendix Table 3. Summary of the COVID-19 studies included in the review of incubation period, serial interval, and doubling time based on search in gray literature*

Study	Study setting	Incubation period (days)	Serial interval (days)	Doubling time (days)
Bedford, unpub. data, http://virological.org/t/phylodynamic-estimation-of-incidence-and-prevalence-of-novel-coronavirus-ncov-infections-through-time/39	53 publicly available nCoV genomes collected between Dec 24, 2019–Feb 4, 2020	NA	NA	7.2 (95% CI 5.0–12.9) based on sample collection dates
Lu et al., unpub. data, https://www.medrxiv.org/content/10.1101/2020.02.19.20025031v1	265 confirmed cases in Shanghai before Feb 7, 2020 (only 27 had credible contact information)	Mean 6.4, median NA, SD NA, 95% CI 5.3–7.6 based on Weibull distribution	NA	NA
Pinotti et al., unpub. data, https://www.medrxiv.org/content/10.1101/2020.02.24.20027326v1	Modeling study	NA	NA	2.67 (95% CI 2.24–3.30) importations from Hubei, calculated by growth rate of 0.26 (95% CI 0.21–0.31) based on reporting dates
Rambaut, unpub. data, http://virological.org/t/phylodynamic-analysis-176-genomes-6-mar-2020/356	75 genomes on Feb 12, 2020; 86 genomes on Feb 24, 2020	NA	NA	6.2 (95% CI 4.1–12.3), 75 genomes based on sample collection dates
Rambaut, unpub. data, http://virological.org/t/phylodynamic-analysis-176-genomes-6-mar-2020/356	75 genomes on Feb 12, 2020; 86 genomes on Feb 24, 2020	NA	NA	7.2 (95% CI 4.7–16.3), 86 genomes based on sample collection dates
Tindale et al., unpub. data, https://www.medrxiv.org/content/10.1101/2020.03.03.20029983v1	93 confirmed cases in Singapore during Jan 19–Feb 26, 2020	Mean 7.11, median: 6.55, SD NA, 95% CI 6.13–8.25 based on Weibull distribution	Mean 4.56, median NA, SD 0.95, 95% CI 2.69–6.42 based on expectation-maximization approach	NA
Tindale et al., unpub. data, https://www.medrxiv.org/content/10.1101/2020.03.03.20029983v1	125 confirmed cases in Tianjin during Jan 21–Feb 22, 2020	Mean 9.02, median 8.62, SD NA, 95% CI 7.92–10.2 based on Weibull distribution	Mean 4.22, median NA, SD 0.4, 95% CI 3.43–5.01 based on expectation-maximization approach	NA
Volz et al., unpub. data, https://spiral.imperial.ac.uk/bitstream/10044/1/77169/11/2020-02-15-COVID19-Report-5.pdf	Phylogenetic analysis of 53 SARS-CoV-2 whole genome sequences	NA	NA	7.1 (95% CI 3.0–20.5) based on sample collection dates
Zhao et al., unpub. data, https://www.medrxiv.org/content/10.1101/2020.02.21.20026559v1	21 infector–infectee pairs in Hong Kong during Jan 16–Feb 15, 2020	NA	Mean 4.4, median NA, SD 3.0, 95% CI 2.9–6.7, based on gamma distribution	NA
Zhao et al., unpub. data, https://www.medrxiv.org/content/10.1101/2020.02.06.20020941v1	Modeling study	NA	NA	2.9 (95% CrI 2.0–4.1) based on onset dates

*CI, confidence interval; CrI, credible interval; NA, not applicable; SD, standard deviation

Appendix Table 4. Frequency of different case severities

Classification	Definition	Proportion*
Mild/moderate	Non-pneumonia and pneumonia cases	80.9%
Severe	Dyspnea, respiratory frequency ≥30/minute, blood oxygen saturation ≤93%, PaO_2/FiO_2 ratio <300, and/or lung infiltrates >50% within 24–48 h	13.8%
Critical	Respiratory failure, septic shock, and/or multiple organ dysfunction/failure	6.1%
* Proportion of 55,924 cases until Feb 20, 2020.		

Appendix Table 5. Summary of CFR and IFR estimate sources

Author	Location	Metric *	Estimate	Uncertainty type	Peer-reviewed	Source
Russell et al.	China	IFR	0.6 (0.2–1.3)	95% CI	Yes	https://www.ncbi.nlm.nih.gov/pubmed/32234121
Hauser et al.	China, Hubei	IFR	3.3 (2–4.7)	95% CrI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031104v2.full.pdf
Famulare	China, Wuhan	IFR	0.9 (0.4–2.9)	95% CI	No	https://institutefordiseasemodeling.github.io/nCoV-public/analyses/first_adjusted_mortality_estimates_and_risk_assessment/2019-nCoV-preliminary_age_and_time_adjusted_mortality_rates_and_pandemic_risk_assessment.html
Mizumoto et al.	China, Wuhan	IFR	0.2 (0.2–0.3)	95% CrI	No	https://www.medrxiv.org/content/10.1101/2020.02.12.20022434v1
Russell et al.	Diamond Princess	IFR	1.3 (0.4–3.6)	95% CI	Yes	https://www.ncbi.nlm.nih.gov/pubmed/32234121
Hauser et al.	Northern Italy	IFR	3 (2.6–3.4)	95% CrI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031104v1.full.pdf
Nishiura et al.†	Mainland China	IFR	NA (0.3–0.6)	95% CI	Yes	https://www.mdpi.com/2077-0383/9/2/419
Verity et al.	Mainland China	IFR	0.7 (0.4–1.3)	95% CrI	Yes	https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30243-7/fulltext
Russell et al.	China	CFR	1.2 (0.3–2.7)	95% CI	Yes	https://www.ncbi.nlm.nih.gov/pubmed/32234121
Deng et al.	China, Hubei	CFR	5.4 (5.3–5.6)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031005v1
Mizumoto et al.	China, Hubei not Wuhan	CFR	0.9 (0.6–1.3)	95% CrI	No	https://www.medrxiv.org/content/10.1101/2020.02.19.20025163v1
Deng et al.	China, not Hubei	CFR	0.9 (0.8–1.1)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031005v1
Deng et al.	China, not Wuhan	CFR	3.5 (3.4–3.8)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031005v1
Deng et al.	China, Wuhan	CFR	6.2 (6.1–6.4)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031005v1
Mizumoto et al.	China, Wuhan	CFR	18.9 (17.1–20.8)	95% CrI	No	https://www.medrxiv.org/content/10.1101/2020.02.19.20025163v1
Russell et al.	Diamond Princess	CFR	2.6 (0.9–6.7)	95% CI	Yes	https://www.ncbi.nlm.nih.gov/pubmed/32234121
Deng et al.	Mainland China	CFR	4.5 (4.5–4.7)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031005v1
Wang et al.	China, Hubei	sCFR	7.2 (6.6–8)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.02.17.20023630v4
Wang et al.	China, not Hubei	sCFR	1 (0.9–1.2)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.02.17.20023630v4
Verity et al.	Mainland China	sCFR	1.4 (1.2–1.5)	95% CrI	Yes	https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30243-7/fulltext
Famulare	China, Wuhan	cCFR	33 (29–37)	95% CI	No	https://institutefordiseasemodeling.github.io/nCoV-public/analyses/first_adjusted_mortality_estimates_and_risk_assessment/2019-nCoV-preliminary_age_and_time_adjusted_mortality_rates_and_pandemic_risk_assessment.html
Jung et al. ‡	Mainland China	cCFR	5.3 (3.5–7.5)	95% CI	Yes	https://www.ncbi.nlm.nih.gov/pubmed/32075152
Jung et al. §	Mainland China	cCFR	8.4 (5.3–12.3)	95% CI	Yes	https://www.ncbi.nlm.nih.gov/pubmed/32075152

Author	Location	Metric *	Estimate	Uncertainty type	Peer-reviewed	Source
Verity et al.	Outside mainland China (non-parametric)	cCFR	4.1 (2.1–7.8)	95% CrI	Yes	https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30243-7/fulltext
Verity et al.	Outside mainland China (parametric)	cCFR	2.7 (1.4–4.7)	95% CrI	Yes	https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30243-7/fulltext
Wu et al.	China, Wuhan	HFR	14 (3.9–32)	95% CI	Yes	https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.3.2000044
Deng et al.	China, Hubei	ccCFR	25.7 (25.4–26.5)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031005v1
Deng et al.	China, not Hubei	ccCFR	8 (7.5–9.6)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031005v1
Deng et al.	China, not Wuhan	ccCFR	28.8 (28–31)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031005v1
Deng et al.	China Wuhan	ccCFR	26.9 (26.6–27.9)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031005v1
Deng et al.	mainland China	ccCFR	24.2 (23.9–25)	95% CI	No	https://www.medrxiv.org/content/10.1101/2020.03.04.20031005v1

***CFR, case fatality ratio; sCFR, symptomatic CFR; cCFR, laboratory-confirmed CFR; ccCFR, critical care and severe CFR; HFR, hospitalization fatality ratio; IFR, infection fatality ratio.**
†Range based on ≈10% ascertainment.
‡Fitted to epidemic growth alone.
§Fitted to epidemic growth along with other parameters.

Appendix Table 6. Types of nonpharmaceutical interventions that could be implemented at the individual and community level

Type	Nonpharmaceutical intervention
Individual interventions	Voluntary home isolation: separation of persons ill with contagious diseases from noninfected persons
	Voluntary home quarantine: restriction of persons who are presumed to have been exposed to a contagious disease but are not ill, either because they did not become infected or because they are still in the incubation period
Community level	School closure (closure of day care facilities, schools, and higher education)
	Workplace closure (closure of nonessential services)
	Cancel or postpone large public gatherings

Appendix Table 7. Definition of nonpharmaceutical intervention search keywords*

Topic	Definition
Case detection, case detected	Detection of cases imported from an affected area
Case isolation and contact tracing	Isolation of an identified positive case.
Travel screening'	Screening of passengers at port of exit/entry
Travel reduction, reduced travel, airline suspension	Mobility reduction of persons, intra- or inter-city/country.
School closure	Closing schools to prevent further transmission
Cancellation of events and mass gatherings, lockdown	Cancellation of events and mass gatherings to prevent further transmission.
Community response	Population's psychological and behavioral responses during an outbreak

*This table gives a short definition of the search keywords related to nonpharmaceutical intervention we are interested in. Because there are no specific terms to describe these interventions, or there are different terms to describe the same kind of intervention, we considered them to be equivalent.

References

1. Backer JA, Klinkenberg D, Wallinga J. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. Euro Surveill. 2020;25:2000062. PubMed https://doi.org/10.2807/1560-7917.ES.2020.25.5.2000062

2. Chinazzi M, Davis JT, Ajelli M, Gioannini C, Litvinova M, Merler S, et al. The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. Science. 2020;368:395–400. https://doi.org/10.1126/science.aba9757

3. Du Z, Wang L, Cauchemez S, Xu X, Wang X, Cowling BJ, et al. Risk for transportation of 2019 novel coronavirus disease from Wuhan to other cities in China. Emerg Infect Dis. 2020;26:1049–52. https://doi.org/10.3201/eid2605.200146

<jrn>4. Du Z, Xu X, Wu Y, Wang L, Cowling BJ, Meyers L. Serial interval of COVID-19 among publicly reported confirmed cases. Emerg Infect Dis. 2020;26:1341–3. https://dx.doi.org/10.3201/eid2606.200357</jrn>

5. Ganyani T, Kremer C, Chen D, Torneri A, Faes C, Wallinga J, et al. Estimating the generation interval for coronavirus disease (COVID-19) based on symptom onset data, March 2020. Eurosurveillance. 2020;25:2000257. https://doi.org/10.2807/1560-7917.ES.2020.25.17.2000257

6. Jung SM, Akhmetzhanov AR, Hayashi K, Linton NM, Yang Y, Yuan B, et al. Real-time estimation of the risk of death from novel coronavirus (COVID-19) infection: inference using exported cases. J Clin Med. 2020;9:523. PubMed https://doi.org/10.3390/jcm9020523

7. Leung C. The difference in the incubation period of 2019 novel coronavirus (SARS-CoV-2) infection between travelers to Hubei and nontravelers: the need for a longer quarantine period. Infect Control Hosp Epidemiol. 2020;41:594–6. PubMed https://doi.org/10.1017/ice.2020.81

8. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus–infected pneumonia. N Eng J Med. 2020;382:1199–1207. https://doi.org/10.1056/NEJMoa2001316

9. Linton NM, Kobayashi T, Yang Y, Hayashi K, Akhmetzhanov AR, Jung SM, et al. Incubation period and other epidemiological characteristics of 2019 novel coronavirus infections with right truncation: a statistical analysis of publicly available case data. J Clin Med. 2020;9:538. PubMed https://doi.org/10.3390/jcm9020538

10. Nishiura H, Linton NM, Akhmetzhanov AR. Serial interval of novel coronavirus (COVID-19) infections. Int J Infect Dis. 2020;93:284–6. PubMed https://doi.org/10.1016/j.ijid.2020.02.060

11. Sanche S, Lin YT, Xu C, Romero-Severson E, Hengartner N, Ke R. High contagiousness and rapid spread of severe acute respiratory syndrome coronavirus 2. Emerg Infect Dis. 2020;26:1470–7. https://doi.org/10.3201/eid2607.200282

12. Wu JT, Leung K, Leung GM. Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study. Lancet. 2020;395:689–97. PubMed http://dx.doi.org/10.1016/S0140-6736(20)30260-9

13. Zhang J, Litvinova M, Wang W, Wang Y, Deng X, Chen X, et al. Evolving epidemiology and transmission dynamics of coronavirus disease 2019 outside Hubei province, China: a descriptive and modelling study. Lancet Infect Dis. 2020;20:793–802. https://doi.org/10.1016/S1473-3099(20)30230-9