cdc.gov

Healthcare Workers

13–16 minutes

Table 1. Parameter Values that vary among the five COVID-19 Pandemic Planning Scenarios. The scenarios are intended to advance public health preparedness and planning. They are **not** predictions or estimates of the expected impact of COVID-19.

Parameter	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5: Current Best Estimate
R_0*	2.0		4.0		2.5
Infection fatality ratio (Estimated number of deaths per 1,000,000 infections)†	0–17 years old: 6 18–49 years old: 150 50–64 years old: 1,800 65+ years old: 26,000		0–17 years old: 80 18–49 years old: 1,700 50–64 years old: 20,000 65+ years old: 270,000		0–17 years old: 20 18–49 years old: 500 50–64 years

Parameter	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5: Current Best Estimate
					old: 6,000 65+ years old: 90,000
Percent of infections that are asymptomatic§	15%	70%	15%	70%	30%
Infectiousness of asymptomatic individuals relative to symptomatic^	25%	100%	25%	100%	75%
Percentage of transmission occurring prior to symptom onset**	30%	70%	30%	70%	50%

* The best estimate representative of the point estimates of R0 from the following sources:

- Chinazzi M, Davis JT, Ajelli M, *et al*. The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. *Science*. 2020;368(6489):395–400; Imai N, Cori A, Dorigatti I, *et al*. (2020). Report 3: Transmissibility of 2019-nCoV. *Online report*
- Li Q, Guan X, Wu P, *et al*. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med*. 2020;382(13):1199–1207.
- Munayco CV, Tariq A, Rothenberg R, *et al*. Early transmission dynamics of COVID-19 in a southern hemisphere setting: Lima-Peru: February 29th-March 30th, 2020. *Infect Dis Model*. 2020;5:338–345.
- Salje H, Tran Kiem C, Lefrancq N, *et al*. Estimating the burden of SARS-CoV-2 in France *Science* 2020;81(5):816-846.

The range of estimates for Scenarios 1–4 represent the upper and lower bound of the widest confidence interval estimates reported in: Li Q, Guan X, Wu P, *et al*. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med*. 2020;382(13):1199–1207.

Substantial uncertainty remains around the R0 estimate. Notably, Sanche S, Lin YT, Xu C, *et al*. High contagiousness and rapid spread of severe acute respiratory syndrome coronavirus 2. *Emerg Infect Dis*. 2020;26(7):1470–1477. This study estimated a median R0 value of 5.7 in Wuhan, China. In an analysis of eight European countries and the United States, the same group estimated R0 of between 4.0 and 7.1 in the preprint manuscript: Ke R, Sanche S,

Romero-Severson E, Hengartner N. (2020). Fast spread of COVID-19 in Europe and the United States suggests the necessity of early, strong, and comprehensive interventions. *medRxiv*.

† These estimates are based on age-specific estimates of infection fatality ratios from Levin AT, Hanage WP, Owusu-Boaitey N, *et al*. Assessing the age specificity of infection fatality rates for COVID-19: Systematic review, meta-analysis, and public policy implications. *Euro J Epidemiol*. 2020;35(12):1123–1135.

Using a meta regression of data from England, France, Ireland, Italy, Netherlands, Portugal, Spain, Geneva (Switzerland), Belgium, Sweden, Ontario (Canada), and 12 U.S. locations (Atlanta, Georgia; Connecticut; Indiana; Louisiana; Miami;, Minneapolis, Minnesota; Missouri; New York; Philadelphia, Pennsylvania; Salt Lake City, Utah; San Francisco, California; and Seattle, Washington), Levin *et al*. produced estimates of IFR and associated 95% confidence intervals for 0.5–year age bands from 1 to 96 years old. To obtain the estimated values for each scenario, the IFR estimates by age were averaged to broader age groups, using weights based on the age distribution of cases from COVID-19 Case Surveillance Data reported by February 14, 2021 (public use version of data: https://data.cdc.gov/Case-Surveillance/COVID-19-Case-Surveillance-Public-Use-Data/vbim-akqf).

§ The percent of cases that are asymptomatic (i.e., never experience symptoms) remains uncertain. Longitudinal testing of individuals is required to accurately detect the absence of symptoms for the full period of infectiousness. Current peer-reviewed and preprint studies vary widely in follow-up times for re-testing, or do not include re-testing of cases. Additionally, studies

vary in the definition of a symptomatic case, which makes it difficult to make direct comparisons between estimates. Furthermore, the percent of cases that are asymptomatic may vary by age, and the age groups reported in the studies can vary.

Given these limitations, the range of estimates for Scenarios 1–4 is wide. The lower-bound estimate approximates the lower 95% confidence interval bound estimated from: Byambasuren O, Cardona M, Bell K, Clark J, McLaws ML, Glasziou P. Estimating the extent of asymptomatic COVID-19 and its potential for community transmission: Systematic review and meta-analysis. *Official Journal of the Association of Medical Microbiology and Infectious Disease Canada* 2020;5(4):223–234. The upper-bound estimate approximates the upper 95% confidence interval bound estimated from: Poletti P, Tirani M, Cereda D, *et al*. (2020). Probability of symptoms and critical disease after SARS-CoV-2 infection. *arXiv preprint arXiv:2006.08471*. The best estimate aligns with estimates from:

- Oran DP, Topol EJ. Prevalence of asymptomatic SARS-CoV-2 infection: A narrative review. *Ann Intern Med*. 2020;173(5):362–367.
- Oran DP, Topol EJ. The proportion of SARS-CoV-2 infections that are asymptomatic: A systematic review. [published online ahead of print, 2021 January 22] *Ann Intern Med*.
- Buitrago-Garcia D, Egli-Gany D, Counotte MJ, *et al*. Occurrence and transmission potential of asymptomatic and presymptomatic SARS-CoV-2 infections: A living systematic review and meta-analysis. *PLoS medicine*, 2020;17(9):e1003346.

- Ravindra K, Malik VS, Padhi BK, Goel S, and Gupta M. (2020) Consideration for the asymptomatic transmission of COVID-19: Systematic review and meta-analysis. *medRxiv*.
- Beale S, Hayward A, Shallcross L, Aldridge RW, and Fragaszy E. (2020) A rapid review of the asymptomatic proportion of PCR-confirmed SARS-CoV-2 infections in community settings. *medRxiv*.

^ The current best estimate is based on multiple assumptions. The relative infectiousness of asymptomatic cases to symptomatic cases remains highly uncertain, as asymptomatic cases are difficult to identify and transmission is difficult to observe and quantify. The estimates for relative infectiousness are assumptions based on studies of viral shedding dynamics. The upper bound of this estimate reflects studies that have shown similar durations and amounts of viral shedding between symptomatic and asymptomatic cases:

- Lee S, Kim T, Lee E, *et al*. Clinical course and molecular viral shedding among asymptomatic and symptomatic patients with SARS-CoV-2 infection in a community treatment center in the Republic of Korea. *JAMA Intern Med.* 2020;180(11):1–6.
- Zou L, Ruan F, Huang M, *et al*. SARS-CoV-2 viral load in upper respiratory specimens of infected patients. *N Engl J Med*. 2020;382(12):1177–1179.
- Zhou R, Li F, Chen F, *et al*. Viral dynamics in asymptomatic patients with COVID-19. *Int J Infect Dis*. 2020;96:288–290.

The lower bound of this estimate reflects data indicating that viral loads are higher in severe cases relative to mild cases (Liu Y, Yan

LM, Wan L, *et al*. Viral dynamics in mild and severe cases of COVID-19. *Lancet Infect Dis*. 2020;20(6):656–657) and data showing that viral loads and shedding durations are higher among symptomatic cases relative to asymptomatic cases (Noh JY, Yoon JG, Seong H, *et al*. Asymptomatic infection and atypical manifestations of COVID-19: Comparison of viral shedding duration. *J Infect*. 2020;81(5):816–846.

** The lower bound of this parameter is approximated from the lower 95% confidence interval bound from: He X, Lau EH, Wu P, *et al*. Temporal dynamics in viral shedding and transmissibility of COVID-19. *Nature Med.* 2020;26(5):672–675. The upper bound of this parameter is approximated from the higher estimates of individual studies included in: Casey M, Griffin J, McAloon CG, *et al*. (2020). Estimating presymptomatic transmission of COVID-19: A secondary analysis using published data. *medRxiv.* The best estimate is the geometric mean of the point estimates from these two studies and aligns with estimates from:

- Moghadas SM, Fitzpatrick MC, Sah P, *et al*. The implications of silent transmission for the control of COVID-19 outbreaks. *Proc Natl Acad Sci USA*. 2020;117(30):17513–17515.
- Johansson MA, Quandelacy TM, Kada S, *et al*. 2021. SARS-CoV-2 transmission from people without COVID-19 symptoms. *JAMA Network Open* 2021;4(1):e2035057-e2035057.

Table 2. Parameter Values Common to the Five COVID-19 Pandemic Planning Scenarios. The parameter values are likely to change as we obtain additional data about disease severity and viral transmissibility of COVID-19.

Parameter values are based on data received by CDC between December 31, 2020, and February 14, 2021, including COVID-19 Case Surveillance Data (public use version of data: https://data.cdc.gov/Case-Surveillance/COVID-19-Case-Surveillance-Public-Use-Data/vbim-akqf); data from the Hospitalization Surveillance Network (COVID-NET) (through December 31, 2020); and data from Human and Health Services Protect (*HHS Protect*) (through February 14, 2020).

Pre-existing immunity Assumption, ASPR and CDC	No pre-existing immunity before the pandemic began in 2019. It is assumed that all members of the U.S. population were susceptible to infection prior to the pandemic.
Time from exposure to symptom onset*	~6 days (mean)
Time from symptom onset in an individual and symptom onset of a second person infected by that individual†	~6 days (mean)
Mean ratio of estimated infections to reported case counts, overall (range)§	11 (6, 24)
Parameter Values Related to Healthcare Usage	
Median number of days from	Overall: 2 (0, 4) days

symptom onset to SARS-CoV-2 test among SARS-CoV-2 positive patients (interquartile range)^	
Median number of days from symptom onset to hospitalization (interquartile range)**	0–17 years old: 2 (0, 7) days 18–49 years old: 6 (2, 10) days 50–64 years old: 6 (2, 10) days ≥65 years old: 4 (1, 9) days
Median number of days of hospitalization among those not admitted to ICU (interquartile range) ††	0–17 years old: 2 (1, 4) days 18–49 years old: 3 (2, 6) days 50–64 years old: 4 (2, 7) days ≥65 years old: 5 (3, 9) days
Median number of days of hospitalization among those admitted to the ICU (interquartile range)††,§§	0–17 years old: 5 (2, 10.5) days 18–49 years old: 10 (6, 20) days 50–64 years old: 14 (8, 25) days ≥65 years old: 13 (7, 22) days
Percent admitted to the ICU among those hospitalized††	0–17 years old: 27.5% 18–49 years old: 18.9% 50–64 years old: 27.1% ≥65 years old: 26.9%
Percent on mechanical ventilation among those hospitalized. Includes both	0–17 years old: 5.8% 18–49 years old: 9.0% 50–64 years old: 15.1%

non-ICU and ICU admissions††	≥65 years old: 15.6%
Percent that die among those hospitalized. Includes both non-ICU and ICU admissions††	0–17 years old: 0.7% 18–49 years old: 2.1% 50–64 years old: 7.9% ≥65 years old: 18.8%
Median number of days of mechanical ventilation (interquartile range)**	Overall: 5 (2, 11) days
Median number of days from symptom onset to death (interquartile range)**	0–17 years old: 10 (4, 31) days 18–49 years old: 17 (10, 30) days 50–64 years old: 19 (11, 30) days ≥65 years old: 16 (9, 25) days
Median number of days from death to reporting (interquartile range)^^	0–17 years old: 8 (3, 33) days 18–49 years old: 26 (5, 63) days 50–64 years old: 28 (5, 64) days ≥65 years old: 23 (4, 59) days

* McAloon C, Collins Á, Hunt K, *et al*. Incubation period of COVID-19: A rapid systematic review and meta-analysis of observational research. *BMJ Open*. 2020;10(8):e039652; Ma S, Zhang J, Zeng M, *et al*. Epidemiological parameters of COVID-19: Case series study. *J Med Internet Res.* 2020;22(10):e19994.

† He X, Lau EH, Wu P, *et al*. Temporal dynamics in viral shedding and transmissibility of COVID-19. *Nat Med.* 2020;26(5):672–675; Saurabh S, Verma MK, Gautam V, *et al*. Transmission dynamics of the COVID-19 epidemic at the district level in India: Prospective observational study. *JMIR Public Health Surveill*. 2020;6(4):e22678.

§ The point estimate is the geometric mean of the location-specific point estimates of the ratio of estimated infections to reported cases, from Havers FP, Reed C, Lim T, *et al*. Seroprevalence of antibodies to SARS-CoV-2 in 10 sites in the United States, March 23-May 12, 2020. *JAMA Intern Med*. 2020 Jul 12. doi: 10.1001/jamainternmed.2020.4130. The lower and upper bounds for this parameter estimate are the lowest and highest point estimates of the ratio of estimated infections to reported cases, respectively.

^ Estimates only include symptom onset dates during March 1, 2020 – January 31, 2021, to ensure cases have had sufficient time to obtain SARS-CoV-2 tests. Estimates represent time to obtain SARS-CoV-2 tests among cases who tested positive for SARS-CoV-2. Estimates are based on line-level case surveillance data reported to CDC.

** Estimates only include symptom onset dates during March 1, 2020 – January 31, 2021, to ensure cases have had sufficient time to observe the outcome (hospital discharge or death).

†† Based on data reported to COVID-NET by December 31, 2020. https://gis.cdc.gov/grasp/COVIDNet/COVID19_5.html

§§ Cumulative length of stay for persons admitted to the ICU, inclusive of both ICU and non-ICU days.

^^ Estimates only include death dates between March 1, 2020 – January 31, 2021, to ensure sufficient time for reporting.