COVID-19

COVID-19 Pandemic Planning Scenarios

Updated Mar. 19, 2021 Print

Summary of Recent Changes

Updates as of March 19, 2021:

- The Infection Fatality Ratio (IFR) parameter has been updated to reflect recently published estimates. This parameter is now presented as the number of deaths per 1,000,000 infections for ease of interpretation.
- The healthcare utilization statistics in Table 2 have been updated to include a 0–17-years-old age group.
- This will be the final update to the COVID-19 Pandemic Planning Scenarios, as there is now a substantial body of published literature that modelers can draw on to inform parameter estimates and assumptions for their models for the general population and for sub-populations of interest. In addition, CDC has several sources that will continue to update COVID-19-related data over time, including COVID Data Tracker, COVID-19 Case Surveillance Public Use Data, and COVID-19-Associated Hospitalization Surveillance Network (COVID-NET).

CDC and the Office of the Assistant Secretary for Preparedness and Response **(ASPR)** have developed five COVID-19 Pandemic Planning Scenarios that are designed to advance public health preparedness and planning and help inform decisions by public health officials who use mathematical modeling and by mathematical modelers throughout the federal government. Models developed using the data provided in the Planning Scenario tables can help evaluate the potential effects of different community mitigation strategies (e.g., social distancing). The Planning Scenarios may also be useful to hospital administrators in assessing resource needs and can be used in conjunction with the COVID-19 Surge Tool.

Each Planning Scenario is based on a set of numerical values for the biological and epidemiological characteristics of COVID-19 illness, which is caused by the SARS-CoV-2 virus. These values—called *parameter values*—can be used in models to estimate the possible effects of COVID-19 in U.S. states and localities. This document was first posted on May 20, 2020, with the understanding that the parameter values in each Scenario would be updated and augmented over time as we learn more about the epidemiology of COVID-19. This will be the final update of the COVID-19 Pandemic Planning Scenarios, as there is now a substantial body of published literature that modelers can draw on to inform parameter estimates and assumptions for their models. In addition, CDC has several sources that will continue to update COVID-19-related data over time, including:

- COVID Data Tracker is the repository for CDC's COVID-19 data. COVID Data Tracker combines data from across the response and provides summary statistics by category (e.g., cases and deaths, testing, and vaccinations). These data are updated daily.
- COVID-19 Case Surveillance Public Use Data are deidentified line-level data from COVID-19 cases reported to CDC. This includes data on demographics and clinical information (e.g., symptom-onset date and hospital status) and is updated monthly. In addition, a restricted-use version of these data, which includes county and state information, is available to users who complete a registration process, sign a data use agreement, and obtain approval from CDC.
- COVID-NET is a population-based surveillance system that collects data on laboratory-confirmed COVID-19-associated hospitalizations through a network of more than 250 acute care hospitals in 14 states. COVID-NET provides information on age-specific clinical outcomes as well as age- and location-specific COVID-19 hospitalization rates and are updated weekly.

In this final update, the age-specific estimates of Infection Fatality Ratios (IFRs) have been updated to reflect recently published estimates of IFRs from a systematic review and meta-analysis.[1] These updated estimates have a wider uncertainty range to better reflect the potential variation in IFR geographically and over time. These values are intended to capture the national-level burden of COVID-19 deaths; however, national-level estimates may not reflect region-specific IFRs. Therefore, caution should be used when applying suggested IFR values to specific states, counties, and cities. This update also includes parameter values for healthcare utilization in individuals aged 0–17-years-old.

New data on COVID-19 are available daily, yet information about the biological aspects of SARS-CoV-2 and epidemiological characteristics of COVID-19 remain limited, and uncertainty remains around nearly all parameter values. For example, current estimates of IFRs do not account for time-varying changes in hospital capacity (e.g., bed capacity, ventilator capacity, or workforce capacity) or for differences in case ascertainment in congregate and community settings or in rates of underlying health conditions that may contribute to a higher frequency of severe illness in those settings. A nursing home, for example, may have a high incidence of infection (because of close contacts among many individuals) and severe disease (because of a high rate of underlying conditions) that does not reflect the frequency or severity of disease in the broader population of older adults. In addition, the practices for testing nursing home residents for SARS-CoV-2 upon identification of a positive resident may be different than testing practices for contacts of confirmed cases in the community. Observed parameter values may also change over

time. For example, the percentage of transmission occurring before symptom onset will be influenced by how quickly and effectively both symptomatic people and the contacts of known individuals with COVID-19 (cases) are quarantined. In addition, observed parameter values may be influenced by the recent emergence of novel SARS-CoV-2 variants.

The parameters in the Planning Scenarios:

- Are estimates intended to support public health preparedness and planning;
- Are **not** predictions of the expected effects of COVID-19;
- Do **not** reflect the impact of any behavioral changes, social distancing, or other interventions; and
- Do **not** reflect the impact of the emergence of novel SARS-CoV-2 variants.

The Five Scenarios

The five COVID-19 Pandemic Planning Scenarios (Box 1) represent a range of possible parameters for COVID-19 in the United States. All parameter values are based on current COVID-19 surveillance data and scientific knowledge.

- Scenarios 1 through 4 are based on parameter values that represent the lower and upper bounds of disease severity and viral transmissibility. The parameter values used in these Pandemic Planning Scenarios are likely to change as we obtain additional data about the upper and lower bounds of disease severity and the transmissibility of SARS-CoV-2, the virus that causes COVID-19.
- Scenario 5 represents a current best estimate about viral transmission and disease severity in the United States, with the same caveat: the parameter values will change as more data become available.

Parameter values that vary among the Pandemic Planning Scenarios are listed in Table 1, while parameter values common to all five scenarios are listed in Table 2. Definitions of the parameters are provided below, and the source for each parameter value is indicated in the Tables.

The Parameter Values: Definitions

Parameter values that vary across the five COVID-19 Pandemic Planning Scenarios (Table 1) include measures of viral transmissibility, disease severity, and pre-symptomatic and asymptomatic disease transmission. Age-stratified estimates are provided, where sufficient data are available.

Viral Transmissibility

- **Basic reproduction number (R_0):** The average number of people that one person with SARS-CoV-2 is likely to infect in a population without any immunity (from previous infection) or any interventions. R_0 is an estimate of the average transmissibility in a completely naïve population. R_0 estimates vary across populations and are a function of the duration of contagiousness, the likelihood of infection per contact between a susceptible person and an

infectious person, and the contact rate.[2,3] A separate but related parameter is the effective or time-varying reproduction number (R_e or R_t), which estimates the average transmission in a population with mitigation measures and immunity.

Disease Severity

- **Infection Fatality Ratio (IFR):** The number of individuals who **die** of the disease among all infected individuals (symptomatic and asymptomatic). This parameter is not necessarily equivalent to the number of reported deaths per reported case because many cases and deaths are never confirmed to be COVID-19 and there is a lag in time between when people are infected and when they die. This parameter also reflects the existing standard of care, which might vary by location or hospital and could be affected by the introduction of new therapeutics. The IFR values presented in Table 1 are intended to capture the national-level burden of COVID-19 deaths; however, these values may not reflect IFR in specific states, counties, or cities in the United States.

Presymptomatic and Asymptomatic Contribution to Disease Transmission

A **presymptomatic case** of COVID-19 is an individual infected with SARS-CoV-2 who has not yet exhibited symptoms at the time of testing but who later exhibits symptoms during the course of the infection. An **asymptomatic case** is an individual infected with SARS-CoV-2 who does not exhibit symptoms at any time during the course of infection. Parameter values that measure the presymptomatic and asymptomatic contribution to disease transmission include:

- **Percentage of infections that are asymptomatic:** The percentage of persons who are infected with SARS-CoV-2 but never show symptoms of the disease. Asymptomatic cases are challenging to identify because individuals do not know they are infected unless they are tested over the course of their infection, which is typically done systematically only as a part of a scientific study.
- **Infectiousness of asymptomatic individuals relative to symptomatic individuals:** The contribution to transmission of SARS-CoV-2 from asymptomatic individuals compared to the contribution to transmission of SARS-CoV-2 from symptomatic individuals. For example, a parameter value of 50% means that an asymptomatic individual is half as infectious as a symptomatic individual, whereas a parameter value of 100% means that an asymptomatic individual is just as likely to transmit infection as a symptomatic individual.
- **Percentage of transmission occurring before symptom onset:** Among symptomatic cases, the percentage of new cases of COVID-19 due to transmission from a person with COVID-19 who infects others before exhibiting symptoms (presymptomatic).

Parameter values that do not vary across the five Pandemic Planning Scenarios (Table 2) are:

- **Level of pre-existing immunity to COVID-19 in the community:** The percentage of the U.S. population with existing immunity to COVID-19 before the start of the pandemic, which began in late 2019.
- **Ratio of estimated infections to reported case counts:** The estimated number of infections divided by the number of reported cases. The level of case detection likely varies by the age distribution of cases, location, and over time.
- **Time from exposure to symptom onset:** The number of days from the time a person has contact with an infected person that results in COVID-19 infection and the first appearance of symptoms.
- **Time from symptom onset in an individual and symptom onset of a second person infected by that individual:** The number of days from the time a person becomes symptomatic and when the person who they infect becomes symptomatic.

Additional parameter values common to the five COVID-19 Pandemic Planning Scenarios are these 10 measures of healthcare usage:

- Median number of days from symptom onset to SARS-CoV-2 test among SARS-CoV-2–positive patients
- Median number of days from symptom onset to hospitalization
- Median number of days of hospitalization among those not admitted to the intensive care unit (ICU)
- Median number of days of hospitalization among those admitted to the ICU
- Percentage of patients admitted to the ICU among those hospitalized
- Percentage of patients on mechanical ventilation among those hospitalized (includes both non-ICU and ICU admissions)
- Percentage of patients who die among those hospitalized (includes both non-ICU and ICU admissions)
- Median number of days on mechanical ventilation
- Median number of days from symptom onset to death (for patients who die)
- Median number of days from death to reporting of that death

These healthcare-related parameters (Table 2) assist in the assessment of resource needs as the pandemic progresses.

Box 1 Description of the Five COVID-19 Pandemic Planning Scenarios

For each Pandemic Planning Scenario:

- Parameter value for **viral transmissibility** is the Basic Reproduction Number (R_0)

- Parameter value for **disease severity** is the Infection Fatality Ratio (IFR)
- Parameter values for the **presymptomatic and asymptomatic contribution** to disease transmission are:
  - Percentage of transmission occurring before the symptom onset (from presymptomatic individuals)
  - Percentage of infections that are asymptomatic
  - Infectiousness of asymptomatic individuals relative to symptomatic individuals

For Pandemic Scenarios 1-4:

- These Scenarios are based on parameter values that represent the lower and upper bounds of disease severity and viral transmissibility. The parameter values used in these Scenarios are likely to change as we obtain additional data about the upper and lower bounds of disease severity and viral transmissibility of COVID-19.

For Pandemic Scenario 5:

- This Scenario represents a current best estimate about viral transmission and disease severity in the United States, with the same caveat: The parameter values will change as more data become available.

Scenario 1:

- Lower-bound values for virus transmissibility and disease severity
- Lower percentage of transmission before the onset of symptoms
- Lower percentage of infections that never have symptoms and lower contribution of those cases to transmission

Scenario 2:

- Lower-bound values for virus transmissibility and disease severity
- Higher percentage of transmission before the onset of symptoms
- Higher percentage of infections that never have symptoms and higher contribution of those cases to transmission

Scenario 3:

- Upper-bound values for virus transmissibility and disease severity
- Lower percentage of transmission before the onset of symptoms
- Lower percentage of infections that never have symptoms and lower contribution of those cases to transmission

Scenario 4:

- Upper-bound values for virus transmissibility and disease severity
- Higher percentage of transmission before the onset of symptoms

- Higher percentage of infections that never have symptoms and higher contribution of those cases to transmission

Scenario 5:

- Parameter values for disease severity, viral transmissibility, and presymptomatic and asymptomatic disease transmission that represent the best estimate, based on the latest surveillance data and scientific knowledge.

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 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 symptom onset to SARS-CoV-2 test among SARS-CoV-2 positive patients (interquartile range)^	Overall: 2 (0, 4) days
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 non-ICU and ICU admissions††	0–17 years old: 5.8% 18–49 years old: 9.0% 50–64 years old: 15.1% ≥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.

References

1. 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):1123–1138.
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Last Updated Mar. 19, 2021
Content source: National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases