While Europe has already entered a marked fall/winter surge, the US has relatively steady cases and declining deaths. Based on expectations of people's decreased vigilance in the fall and seasonality, we continue to forecast a major winter surge, leading to 3,000 deaths a day by the end of the year. These forecasts do not take into account the potential deployment of vaccines later in the year.

Current situation

- Cases dropped to a low below 30,000 cases on one day last week, but have remained, in general, around 40,000 cases a day, essentially staying flat since the fourth week of August. This is sharp contrast to the fall/winter surge in Europe, which started in early August and continues to unfold (Figure 1).
- Daily deaths have continued to decline, averaging 730 a day in the last week (Figure 2).
- Nine states have an effective R over 1 based on the combined analysis of cases, hospitalizations, and deaths: Kansas, Minnesota, Montana, Nebraska, New Jersey, North Dakota, Oklahoma, Tennessee, and West Virginia (Figure 3).
- Death rates over 4 per million are now seen in Arkansas, Florida, Louisiana, Mississippi, North Dakota, Tennessee, and South Carolina (Figure 6).

Trends in key drivers of transmission (mobility, mask use, testing, and seasonality)

- Mandates differ from state to state. For example, Idaho, Missouri, Oklahoma, and South Dakota only have school closures in place whereas California has school closures along with five additional mandates in place (Figure 7).
- Mobility, after a small drop around the Labor Day weekend, is back to 20% below the pre-COVID-19 baseline (Figure 8). Only California has a level of mobility less than 30% below the pre-COVID baseline.
- National mask use has increased slightly, from just above 45% to closer to 48% (Figure 9). A larger number of states now have mask use over 50%, including Alaska, Hawaii, California, Washington, Colorado, Texas, Mississippi, Florida, North Carolina, Virginia, West Virginia, Maryland, New Jersey, Delaware, and Pennsylvania.
- National diagnostic test rates, after declining since late July, began increasing in the last week. This may be an early indication of more individuals with symptoms consistent with COVID-19.

Projections

- In our reference scenario, our most likely forecast, daily deaths are expected to reach 3,000 per day in late December. The reference scenario suggests that cumulative deaths will reach 371,000 by January 1.
- If mask use could be increased to approximately 95% – the level observed in Singapore and some other countries – forecasted cumulative deaths drop to 275,000 by January 1, saving 96,000 lives between now and the end of the year (Figure 12).
- We expect that the daily number of new infections will reach over 350,000 by the end of December.
- Mandates will be necessary in a number of states with earlier surges that have already begun, such as Kansas, North Dakota, and Tennessee. Many states will need to re-impose mandates to avoid even larger death tolls in December (Figure 15).
- Figure 18 compares our reference scenario for daily deaths with the other major modeling efforts that publicly archive their forecasts. All other models, including MIT (Delphi), Imperial College London, Los Alamos National Laboratories, USC (SIKJapha), and Youyang Gu, suggest the epidemic is ending, with death rates reaching less than 200 per day in December. The contrast in the forecasts is fundamentally driven by two factors: (1) IHME models continued relaxation of mandates in the US until things worsen in terms of the daily death rate; and (2)

the role of seasonality (temperature and weather). The presumption that the epidemic is ending as presented in these other models seems implausible. The fall surge that is unfolding in Europe after many weeks or months with very low case numbers provides further strong evidence of seasonality (Figure 18).

Model updates

1. Change made to assign a mandate date within each draw

In our projections, we generate a set of 1,000 models to get the estimates and the confidence interval. Each of these 1,000 models differs in terms of resampling past deaths, cases, and hospitalizations, and sampling ranges of key parameters such as the duration of time spent infectious. For each of the 1,000, we sample data and parameters, the regression predicting b(t), and the transmission parameter. Each model will generate different coefficients on key drivers such as mobility, mask use, testing, and pneumonia seasonality. This allows us to have a range for these estimates. In previous versions of the model, we have re-imposed mandates on all 1,000 models on the same day when the mean daily death rate for a location across the 1,000 models reaches 8 deaths per million per day. In this release, we have modified the model by re-imposing mandates for each of the 1,000 model projections on the day in that model with the death rate exceeds 8 per million per day (i.e., the re-imposing is now at each draw and we have 1,000 scenarios/dates for reaching the level). This means that we generate a range of days when the mandates will be re-imposed for each location. We believe this is a more realistic reflection of what might occur in each state. This new approach will result in lower forecasts since more extreme cases with rapidly expanding epidemics in our 1,000 models will re-impose mandates earlier.

2. The impact of increased testing

The impact of increased testing is declining with each re-estimation of the regression coefficients over the last three months for predicting b(t), the transmission parameter, the coefficient on testing per capita has decreased sharply. In many of the 1,000 models, the coefficient is now 0 and not associated with transmission. This declining role of testing in reducing transmission seen empirically may have several explanations. First, many tests are being conducted but results are not being returned fast enough to impact transmission through contact tracing and isolation. Second, the capacity of the public system to do contact tracing, testing, and isolation is overwhelmed in many locations by the large number of cases, especially during the peak. Third, since most testing is still in symptomatic individuals, testing per capita may be poorly correlated with actual testing of contacts that may have a larger impact on reducing transmission. Fourth, when the epidemic starts to increase, testing of symptomatic individuals increases and vice versa.

3. Herd immunity

Given considerable public discussion of the role of herd immunity in explaining peaks and subsequent declines in the daily death and case rate, we have explored the implied total death rate for each country based on the infection-fatality rate (IFR) and different assumptions about the level of cumulative infection that will be associated with herd immunity. The natural experiment of the Charles de Gaulle aircraft carrier suggests that up to 70% of individuals can get infected in a situation of near-random mixing. But various theories, including the role of super-spreaders, nonrandom mixing in less dense populations, non-overlapping social networks, and some prior coronavirus immunity, have led to theories that herd immunity may take place at much lower levels of cumulative infection, such as 40% to 60%. Our IFR, based on the analysis of seroprevalence data and herd immunity at 40% cumulative infection, would suggest we will eventually see 10,400,000 deaths globally; with herd immunity at 50% cumulative infection, the figure would be 13,100,000 deaths, and at 60% it would be 15,700,000deaths. Scale-up of a vaccine or improved treatments could substantially reduce these figures. These calculations only serve to suggest that the epidemic in the region is far from complete. In fact, a recent study in Manaus Brazil showed that seroprevalence range between 44% and 66%. The lower estimate of 44% does not account for false-negative cases or antibody waning observed while the upper estimate accounts for both. Therefore, herd immunity is not occurring at low levels of infections and we need to be vigilant until we have an effective and safe vaccine.

4. Seasonality

Our projections to January 1 take into account the seasonality of COVID-19. The large increase in daily deaths expected in late November and December is driven by continued increases in mobility and declines in mask use, but most importantly by seasonality. We estimate the likely impact of seasonality by examining the trends in the Northern and Southern Hemispheres. For example, Southern Hemisphere countries such as Argentina, Chile, southern Brazil, and South Africa had much larger epidemics than expected on the basis of mobility, testing, and mask use during their winter months. The statistical association between COVID-19 transmission rates and pneumonia seasonality patterns is strong in our data and is the basis for our estimate of the magnitude of the seasonal increase that is expected.

5. Infection-fatality rate

Clinical experience suggests that case management of COVID-19 has improved through oxygenation/ventilation methods and use of dexamethasone and remdesivir. This improved management would manifest itself as a reduction in the infection-fatality rate at each age. We have looked for statistical evidence of this shift in two ways. First, we have examined the COVID-19 admission-fatality rate – the number of deaths divided by hospital admissions. To date, the admission-fatality rate has remained constant since April. This could be explained by two possible factors. First, it is possible that there is no change in the infection-fatality rate. Second, it is possible that the infection-fatality rate has declined because hospitals are admitting only more severely ill patients over time, using better triage. However, we have looked at the directly measured infection-fatality rate using seroprevalence studies; to date we have not detected any statistically significant decrease in the infection-fatality rate. We will continue testing on a regular basis for statistical evidence that the infection-fatality rate is declining, but we do not see it on the basis of our seropositivity analyses yet.

IHME wishes to warmly acknowledge the support of these and others who have made our COVID-19 estimation efforts possible. Thank you.

For all COVID-19 resources at IHME, visit http://www.healthdata.org/covid.

Questions? Requests? Feedback? Please contact us at https://www.healthdata.org/covid/contact-us.

COVID-19 Results Briefing: United States of America

Institute for Health Metrics and Evaluation (IHME)

September 23, 2020

This briefing contains summary information on the latest projections from the IHME model on COVID-19 in United States of America. The model was run on September 23, 2020.

Model updates

Updates to the model this week include additional data on deaths, cases, and updates on covariates.

Current situation

Figure 1. Reported daily COVID-19 cases

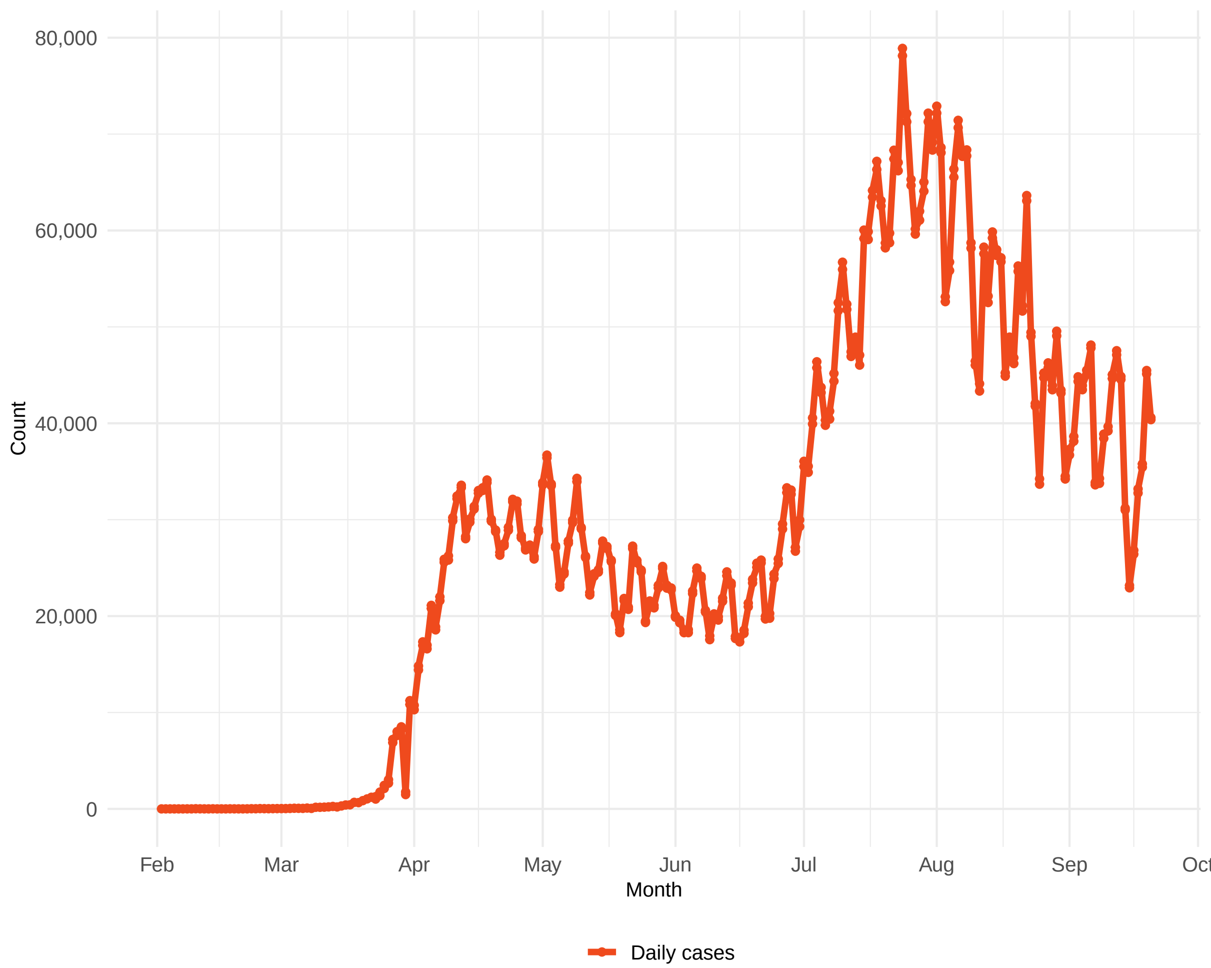


Table 1. Ranking of COVID-19 among the leading causes of mortality this week, assuming uniform deaths of non-COVID causes throughout the year

Cause name	Weekly deaths	Ranking
Ischemic heart disease	10,724	1
COVID-19	5,279	2
Tracheal, bronchus, and lung cancer	3,965	3
Chronic obstructive pulmonary disease	3,766	4
Stroke	3,643	5
Alzheimer's disease and other dementias	2,768	6
Chronic kidney disease	2,057	7
Colon and rectum cancer	1,616	8
Lower respiratory infections	1,575	9
Diabetes mellitus	1,495	10

Figure 2a. Reported daily COVID-19 deaths and smoothed trend estimate

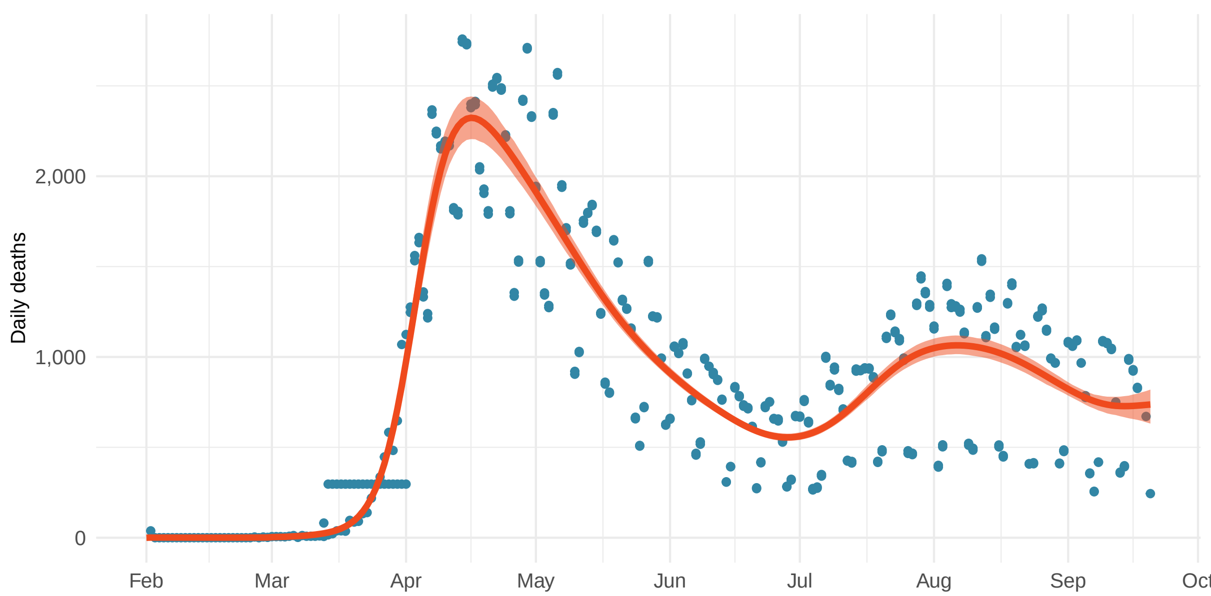


Figure 2b. Estimated cumulative deaths by age group

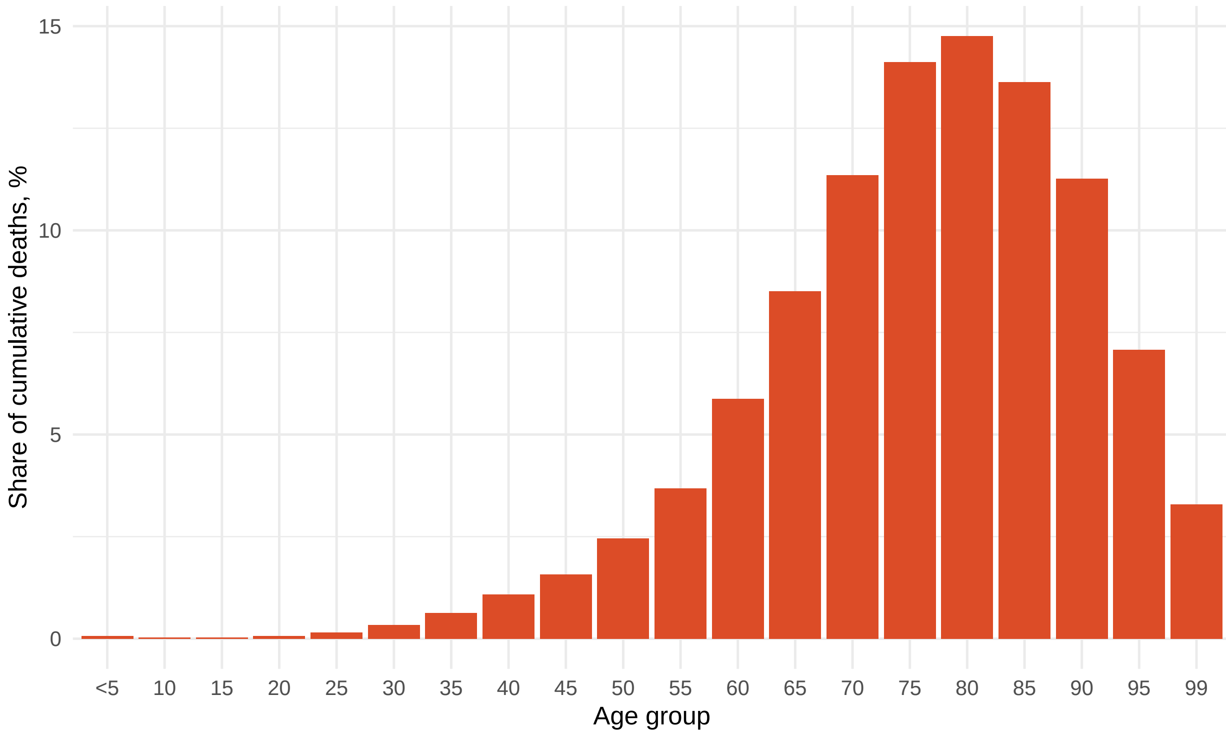


Figure 3. Mean effective R on September 10, 2020. The estimate of effective R is based on the combined analysis of deaths, case reporting and hospitalizations where available. Current reported cases reflect infections 11-13 days prior so estimates of effective R can only be made for the recent past. Effective R less than 1 means that transmission should decline all other things being held the same.

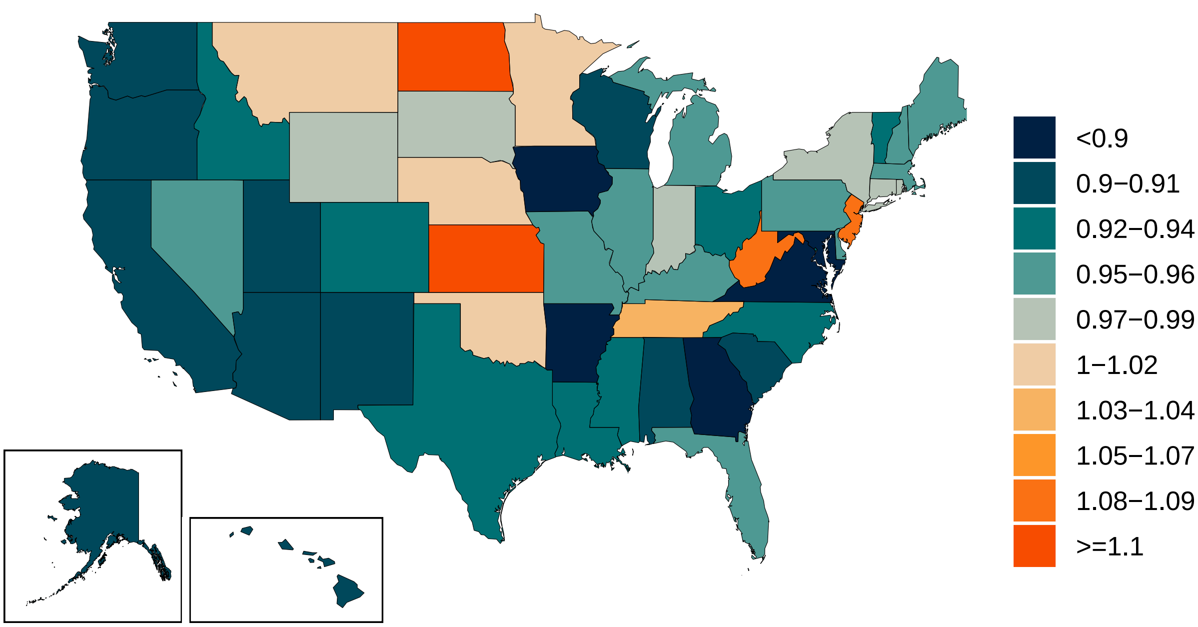


Figure 4. Estimated percent infected with COVID-19 on September 21, 2020

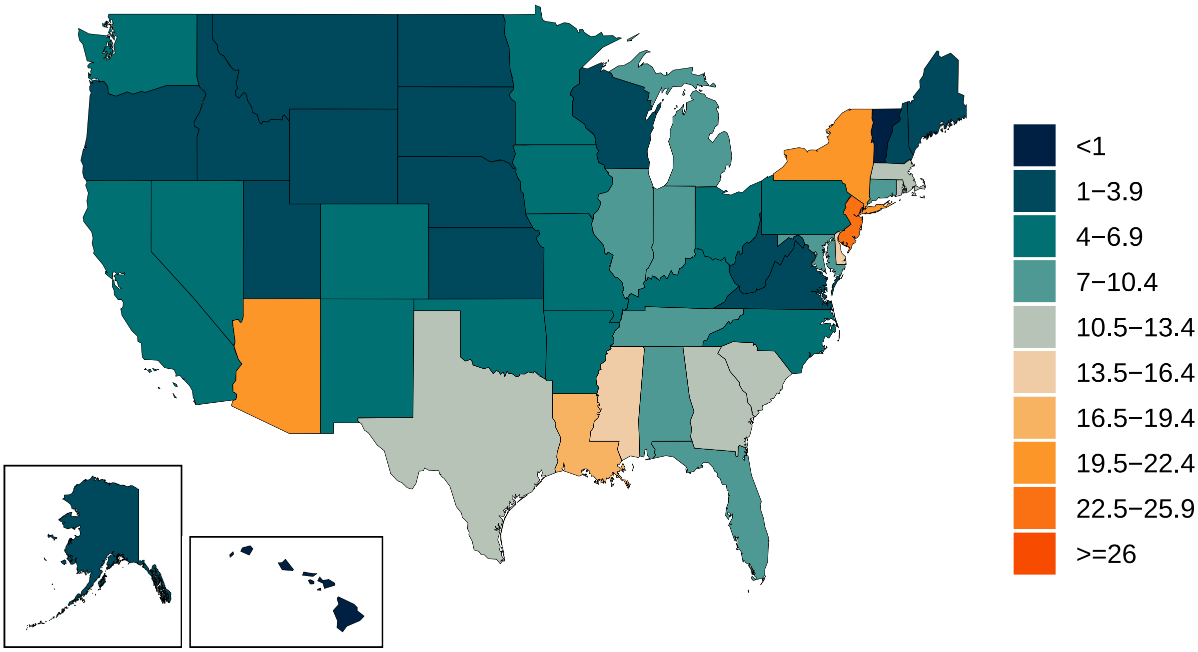


Figure 5. Percent of COVID-19 infections detected. This is estimated as the ratio of reported COVID-19 cases to estimated COVID-19 infections based on the SEIR model.

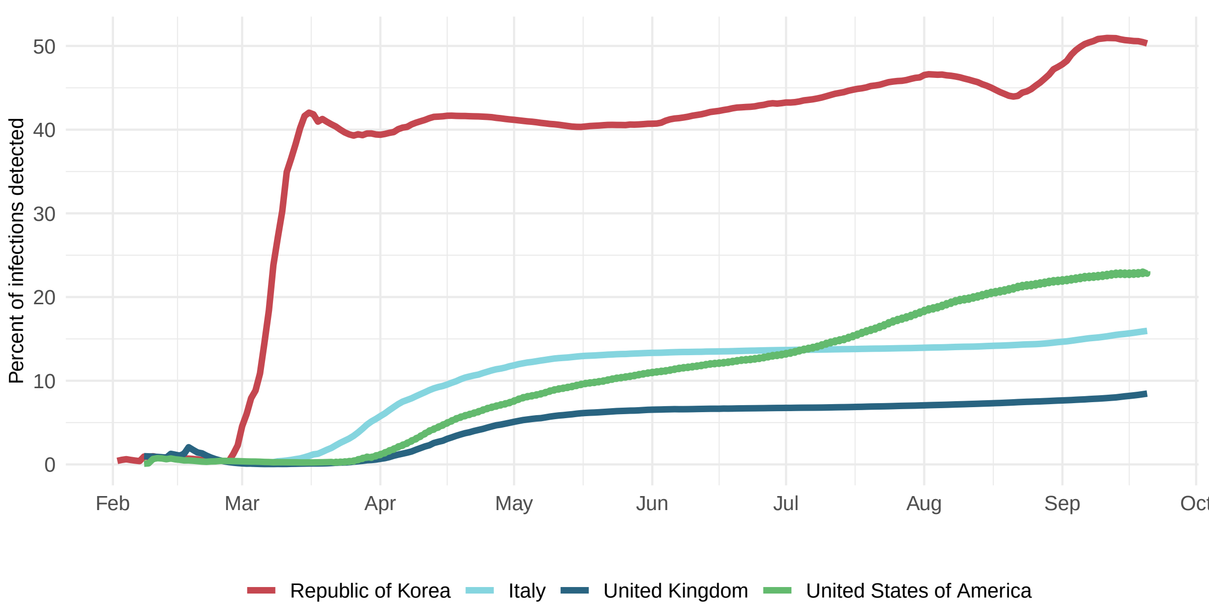
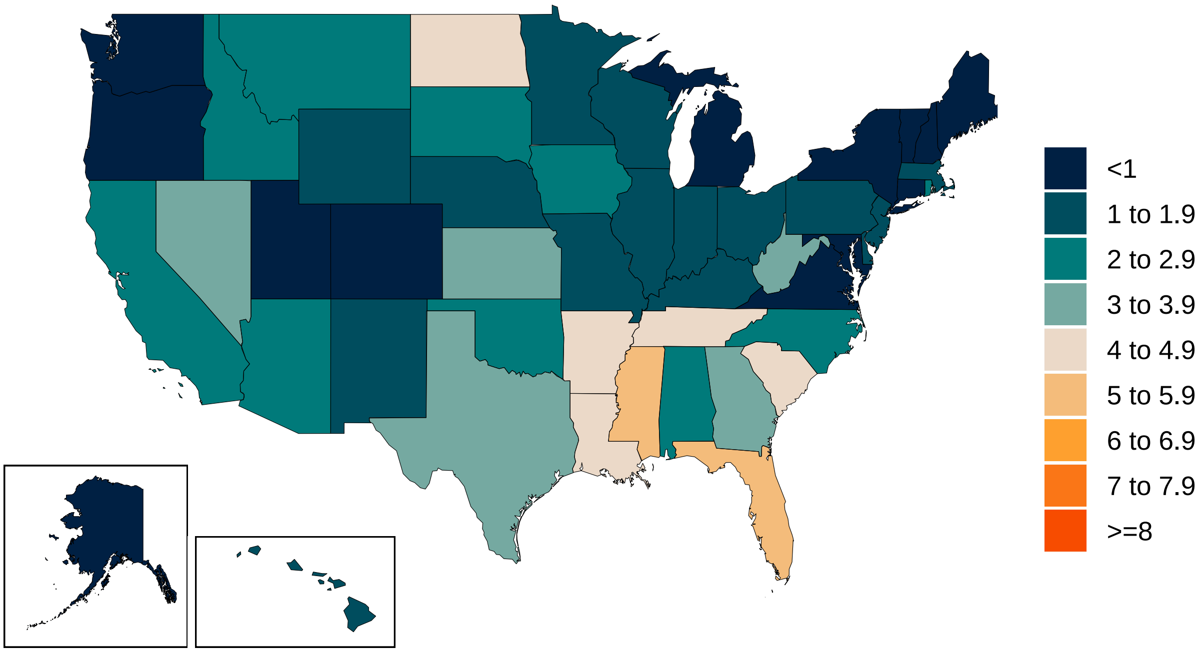


Figure 6. Daily COVID-19 death rate per 1 million on September 21, 2020



Critical drivers

Table 2. Current mandate implementation

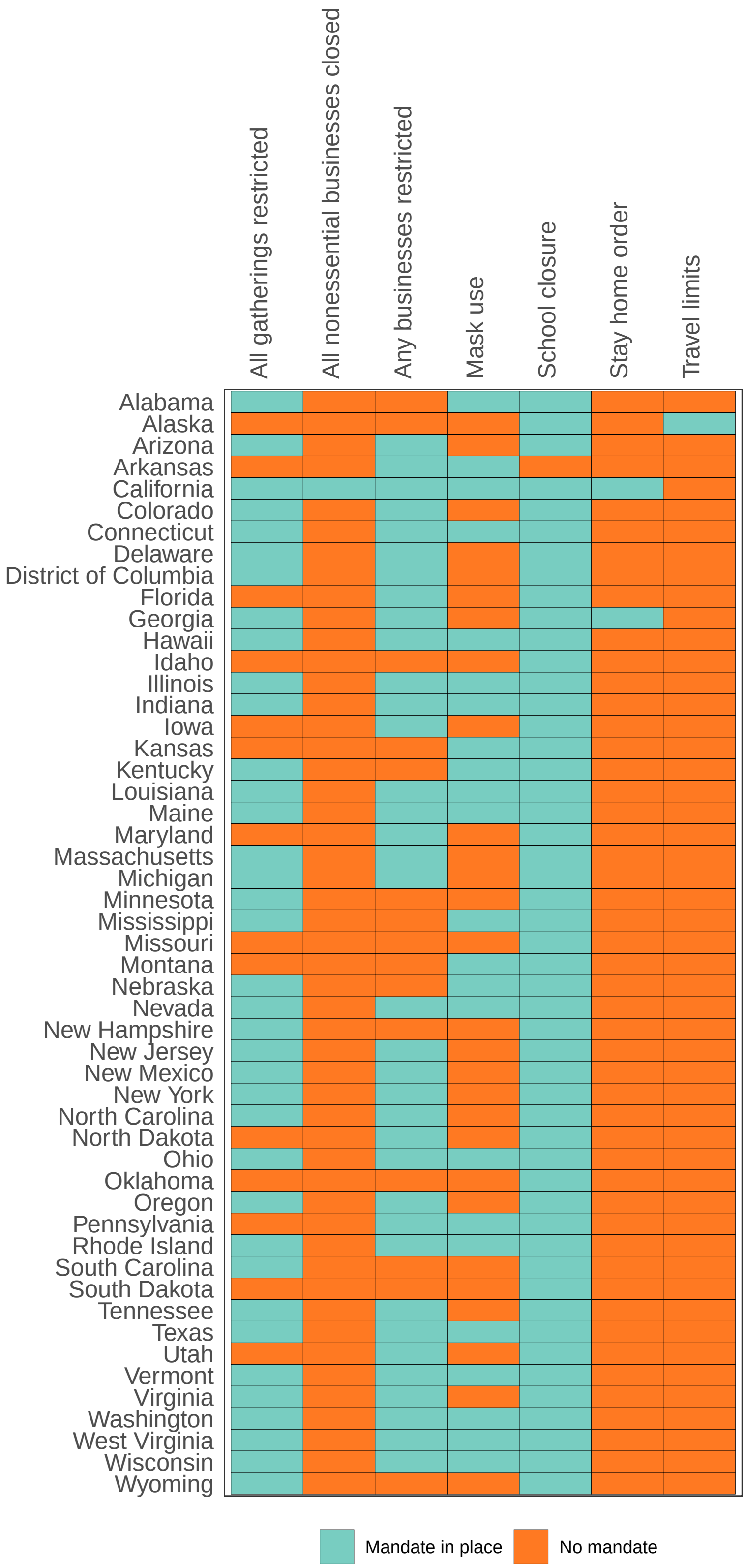


Figure 7. Total number of social distancing mandates (not including mask use)

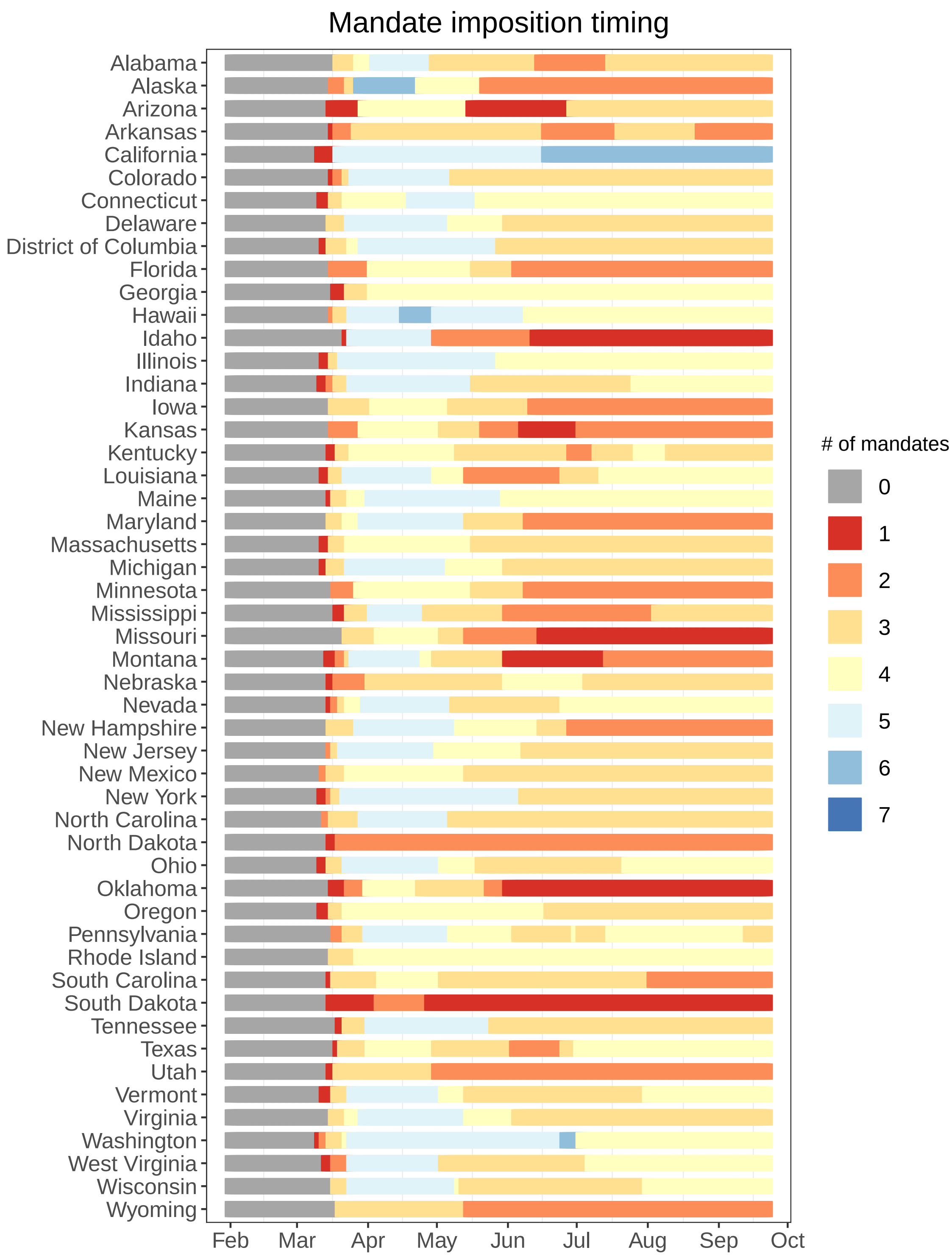


Figure 8a. Trend in mobility as measured through smartphone app use compared to January 2020 baseline

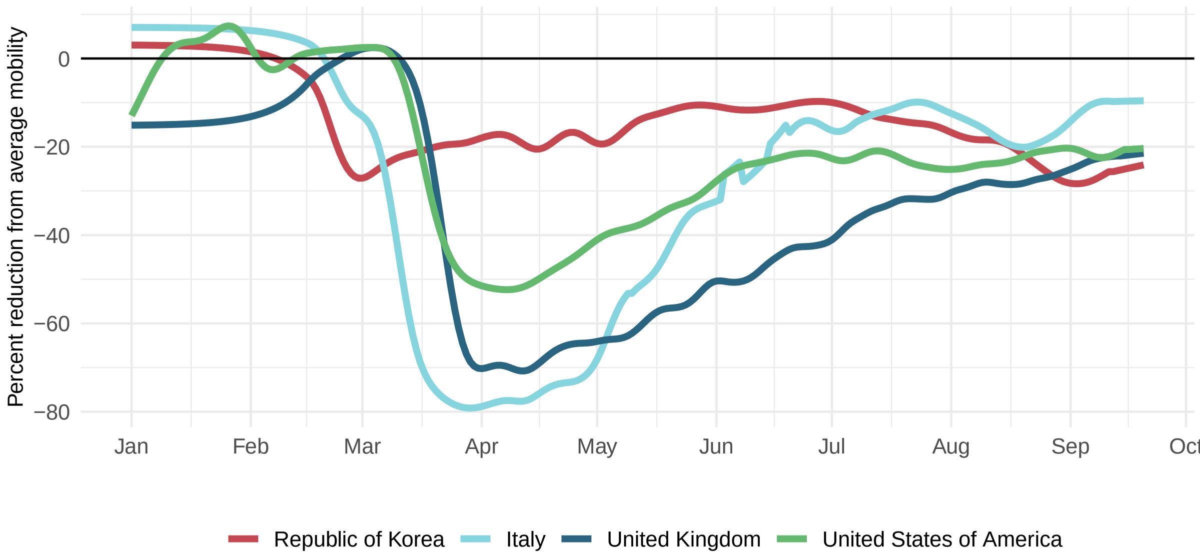


Figure 8b. Mobility level as measured through smartphone app use compared to January 2020 baseline (percent)

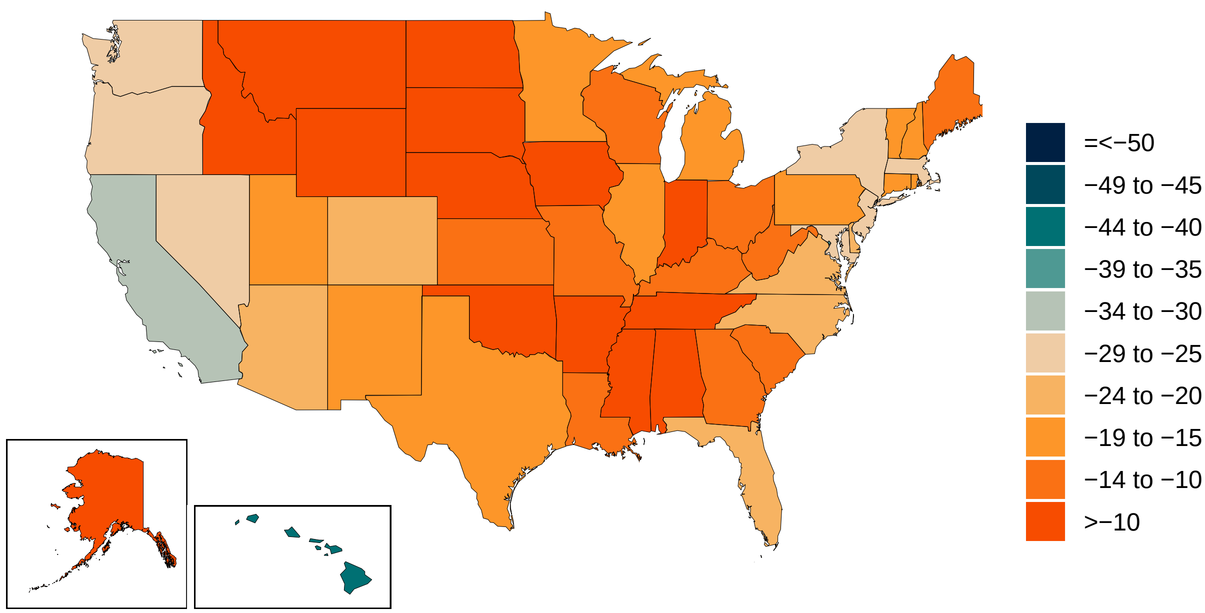


Figure 9a. Trend in the proportion of the population reporting always wearing a mask when leaving home

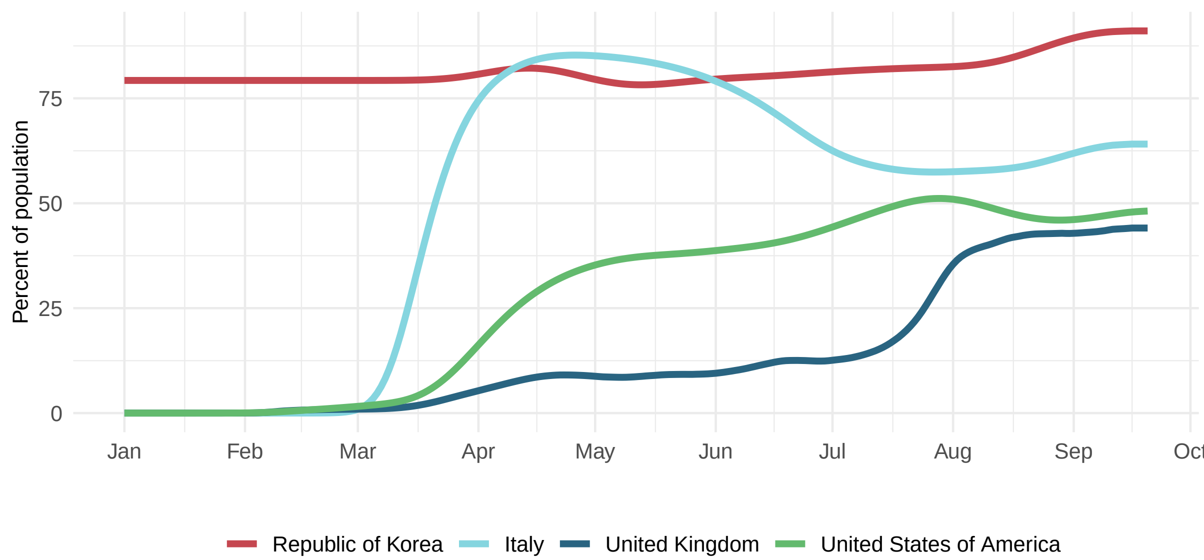


Figure 9b. Proportion of the population reporting always wearing a mask when leaving home on September 21, 2020

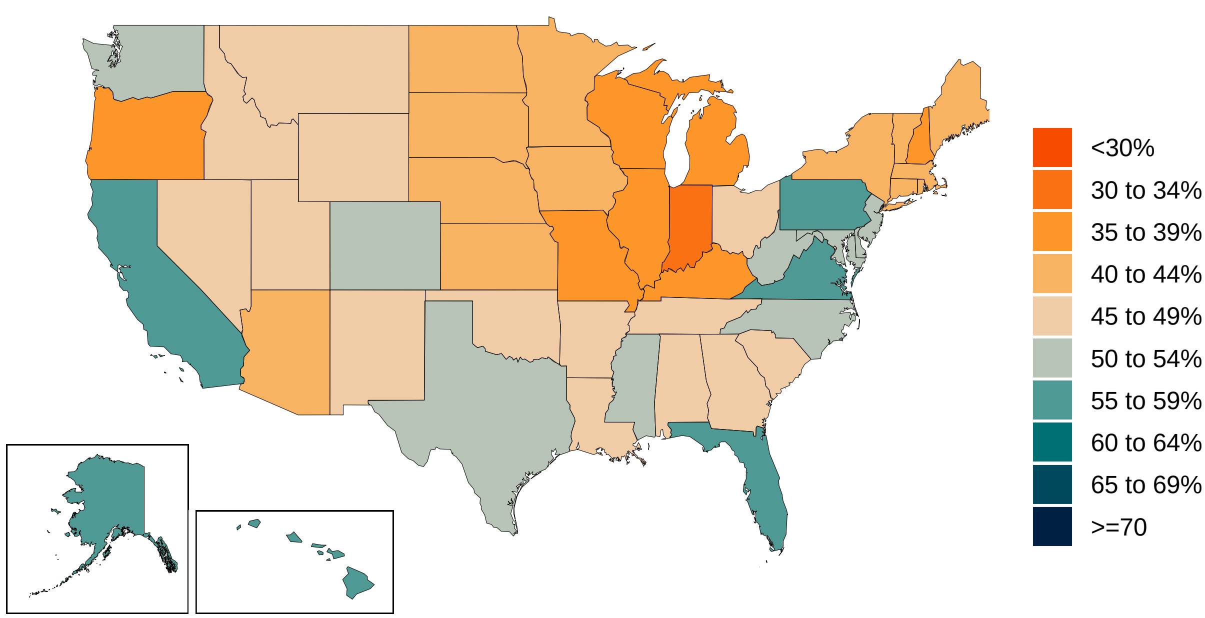


Figure 10a. Trend in COVID-19 diagnostic tests per 100,000 people

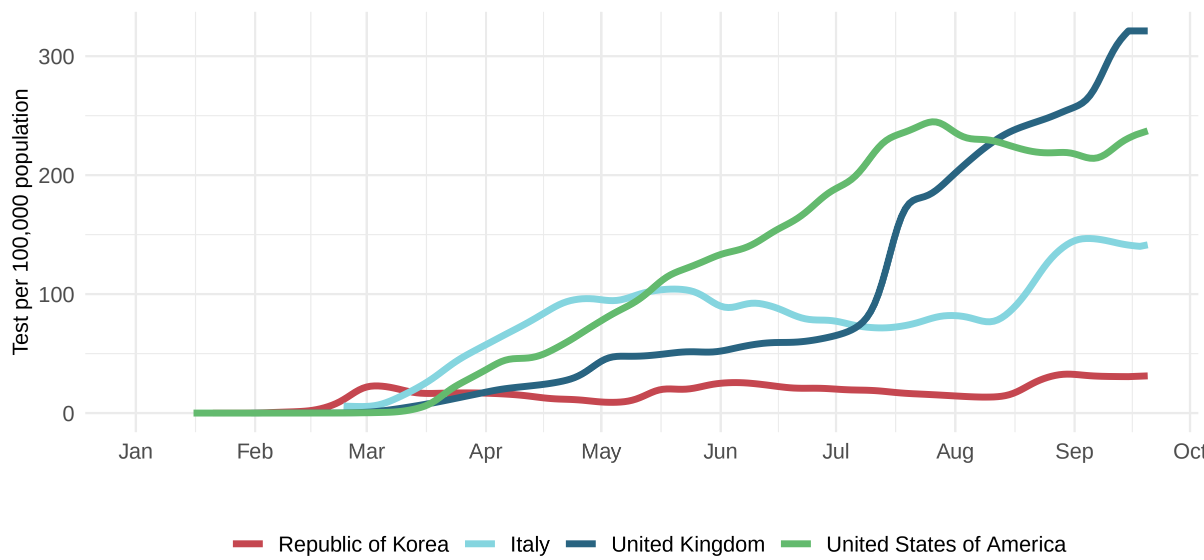


Figure 10b. COVID-19 diagnostic tests per 100,000 people on September 17, 2020

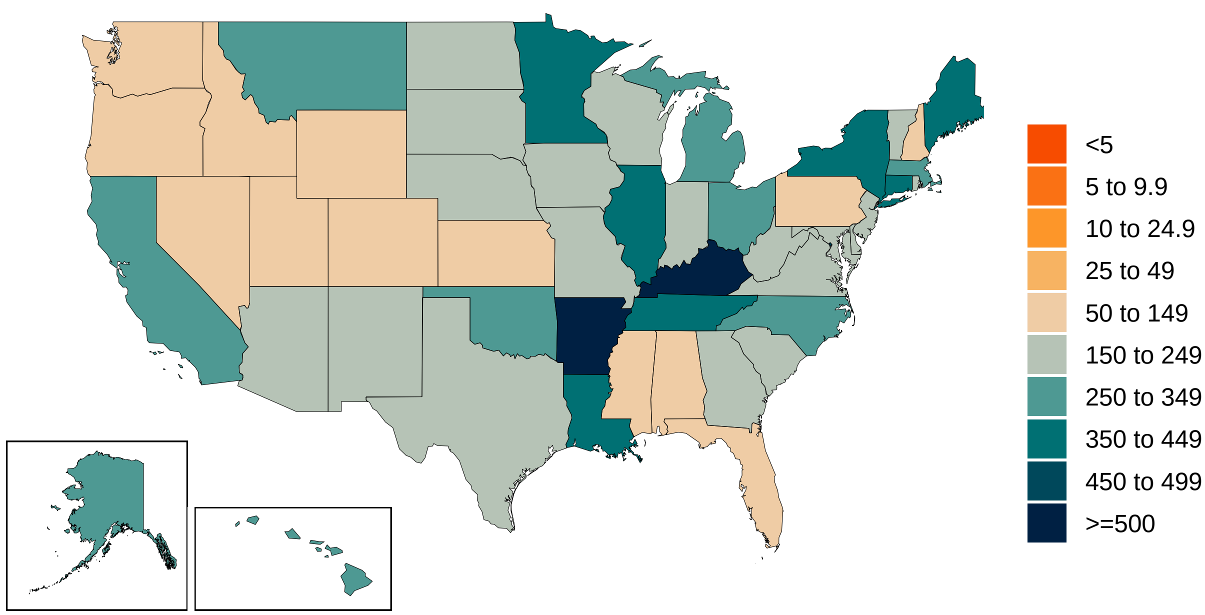
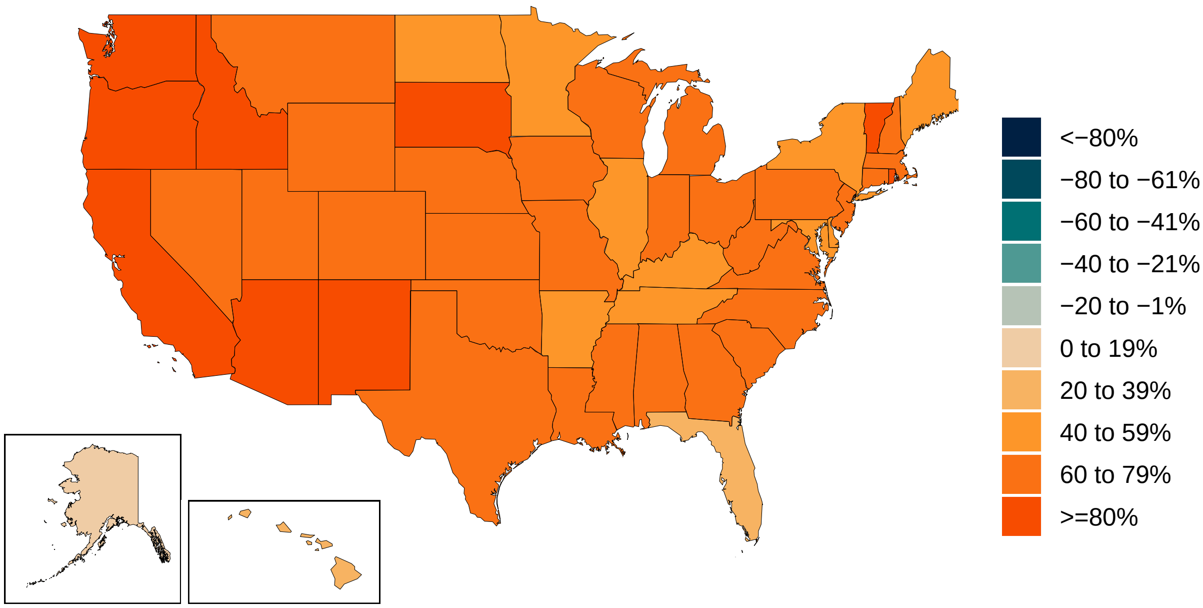


Figure 11. Increase in the risk of death due to pneumonia on February 1 compared to August 1



Projections and scenarios

We produce three scenarios when projecting COVID-19. The reference scenario is our forecast of what we think is most likely to happen. We assume that if the daily mortality rate from COVID-19 reaches 8 per million, social distancing (SD) mandates will be re-imposed. The mandate easing scenario is what would happen if governments continue to ease social distancing mandates with no re-imposition. The universal mask mandate scenario is what would happen if mask use increased immediately to 95% and social distancing mandates were re-imposed at 8 deaths per million.

Figure 12. Cumulative COVID-19 deaths until January 01, 2021 for three scenarios.

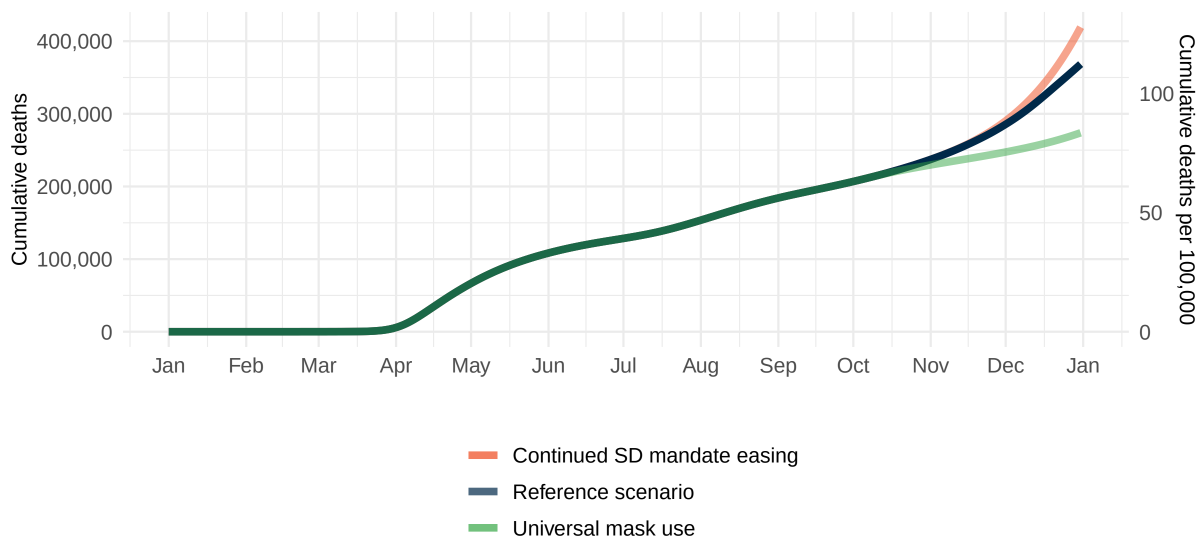


Fig 13. Daily COVID-19 deaths until January 01, 2021 for three scenarios.

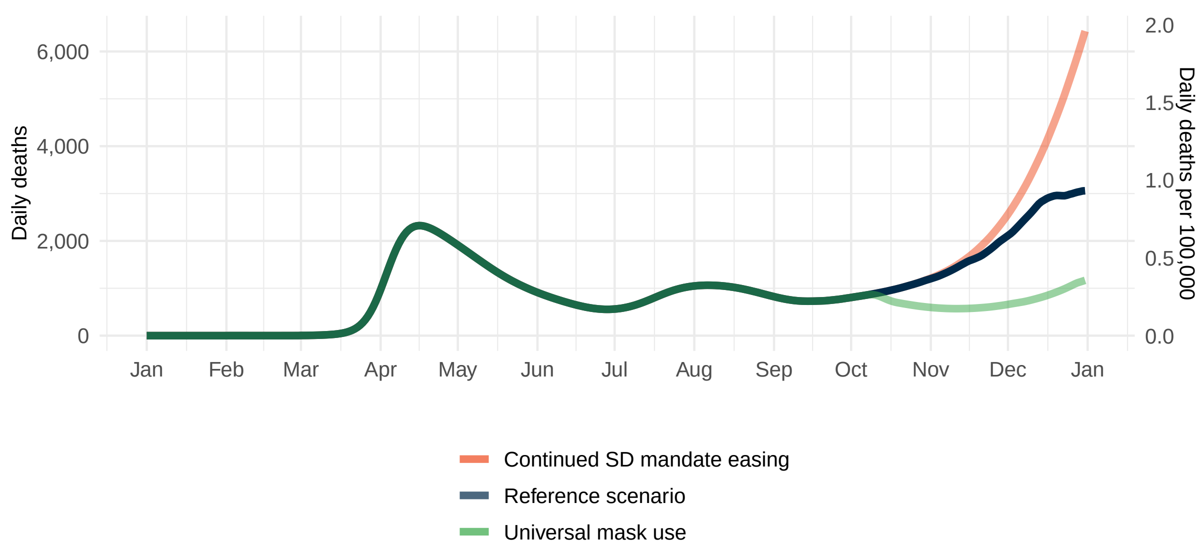


Fig 14. Daily COVID-19 infections until January 01, 2021 for three scenarios.

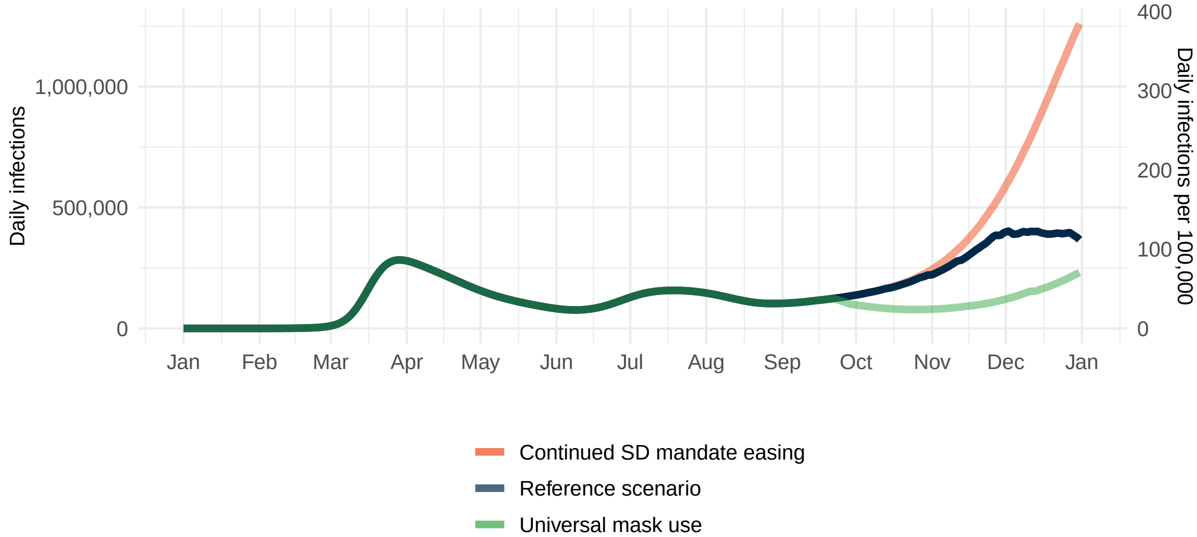


Fig 15. Month of assumed mandate re-implementation. (Month when daily death rate passes 8 per million, when reference scenario model assumes mandates will be re-imposed.)

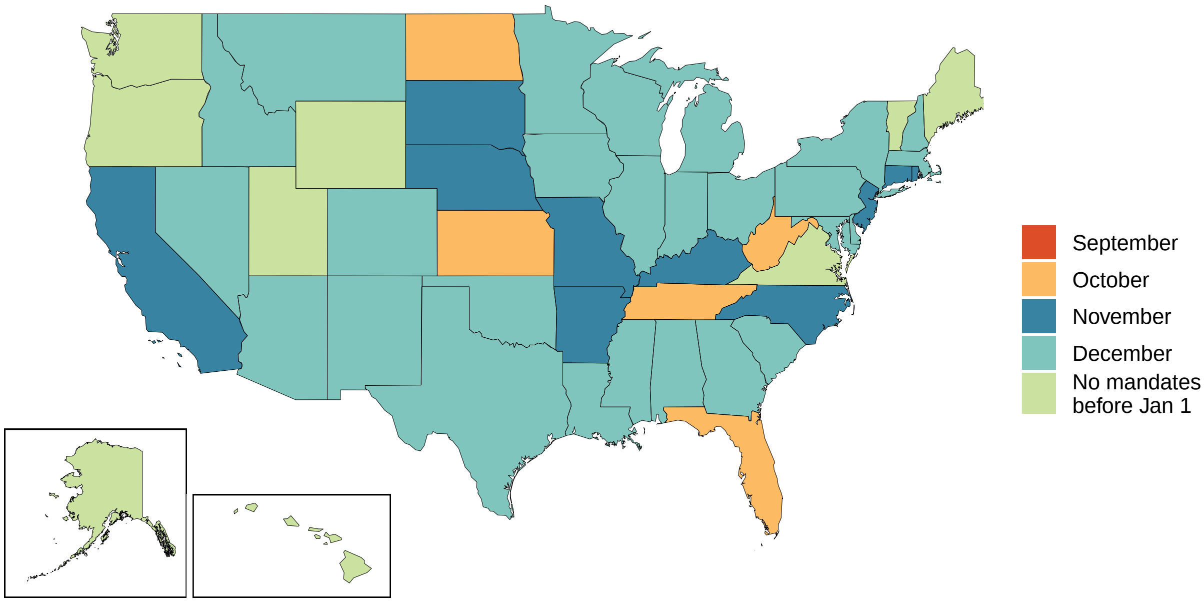


Figure 16. Forecasted percent infected with COVID-19 on January 01, 2021

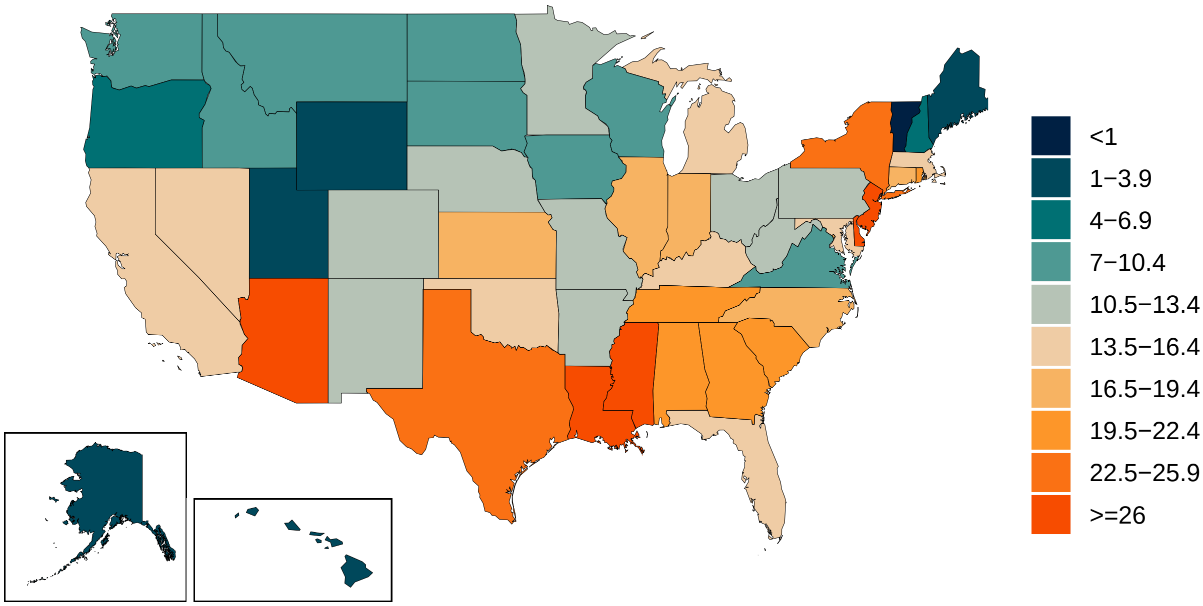


Figure 17. Daily COVID-19 deaths per million forecasted on January 01, 2021 in the reference scenario

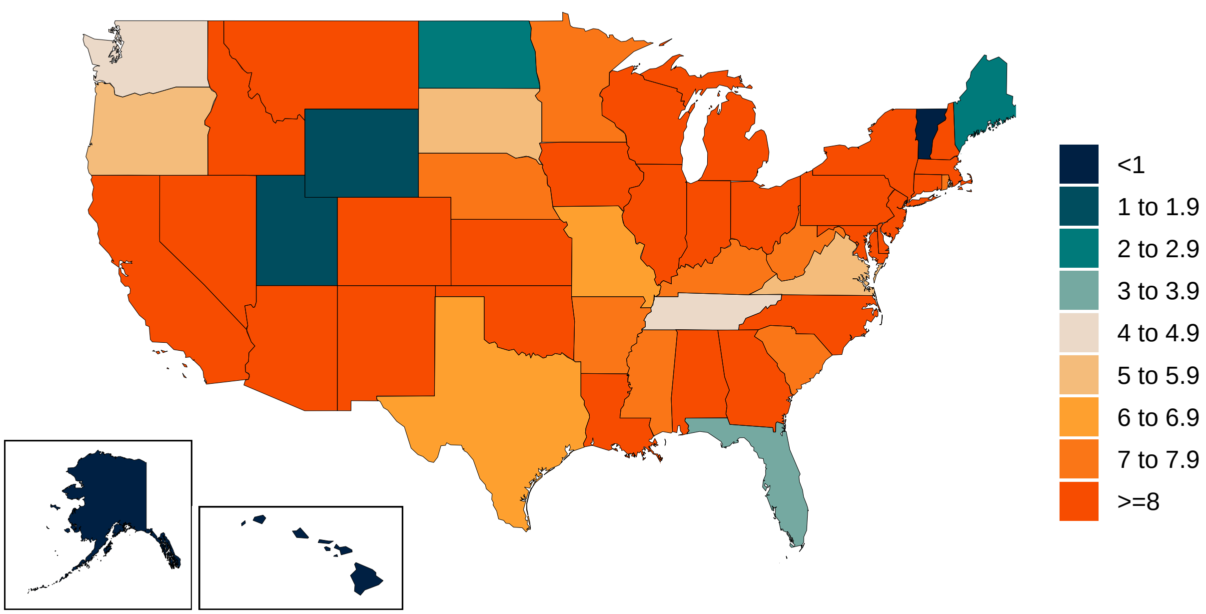


Figure 18. Comparison of reference model projections with other COVID modeling groups. For this comparison, we are including projections of daily COVID-19 deaths from other modeling groups when available: Delphi from the Massachussets Institute of Technology (Delphi; https://www.covidanalytics.io/home), Imperial College London (Imperial; https://www.covidsim.org), The Los Alamos National Laboratory (LANL; https://covid-19.bsvgateway.org/), the SI-KJalpha model from the University of Southern California (SIKJalpha; https://github.com/scc-usc/ReCOVER-COVID-19), and Youyang Gu (YYG; https://covid19-projections.com/). Daily deaths from other modeling groups are smoothed to remove inconsistencies with rounding. Regional values are aggregates from availble locations in that region.

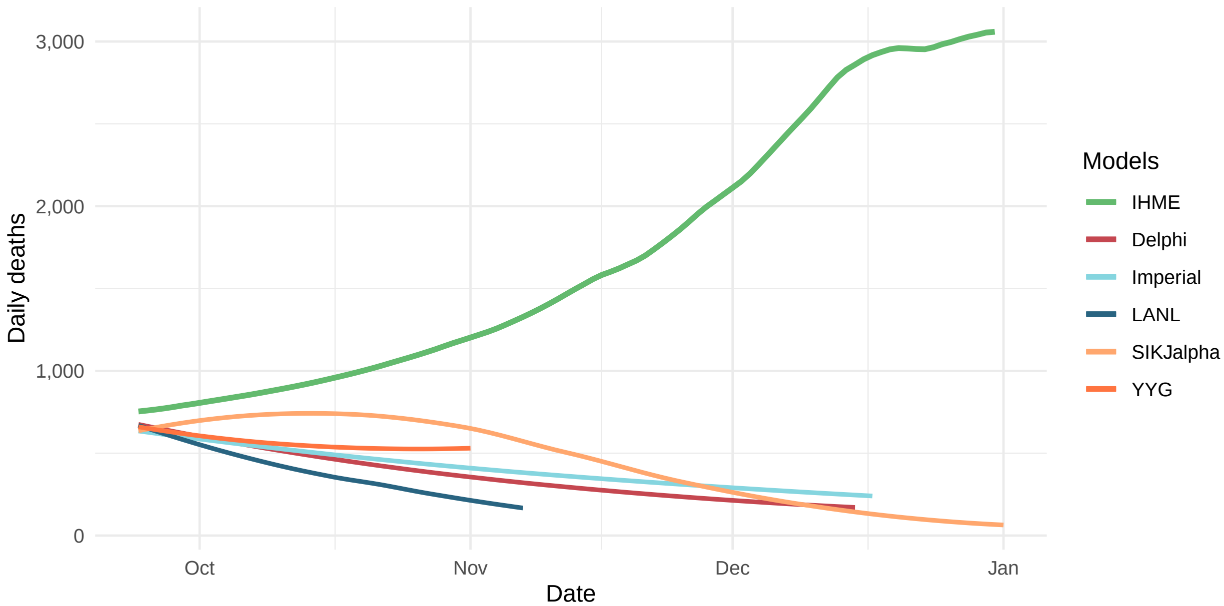


Table 3. Ranking of COVID-19 among the leading causes of mortality in the full year 2020. Deaths from COVID-19 are projections of cumulative deaths on Jan 1, 2021 from the reference scenario. Deaths from other causes are from the Global Burden of Disease study 2019 (rounded to the nearest 100).

Cause name	Annual deaths	Ranking
Ischemic heart disease	557,600	1
COVID-19	371,509	2
Tracheal, bronchus, and lung cancer	206,200	3
Chronic obstructive pulmonary disease	195,800	4
Stroke	189,500	5
Alzheimer's disease and other dementias	143,900	6
Chronic kidney disease	107,000	7
Colon and rectum cancer	84,000	8
Lower respiratory infections	81,900	9
Diabetes mellitus	77,700	10

Mask data source: Premise; Facebook Global symptom survey (This research is based on survey results from University of Maryland Social Data Science Center); Kaiser Family Foundation; YouGov COVID-19 Behaviour Tracker survey

A note of thanks:

We would like to extend a special thanks to the Pan American Health Organization (PAHO) for key data sources; our partners and collaborators in Argentina, Brazil, Bolivia, Chile, Colombia, Cuba, the Dominican Republic, Ecuador, Egypt, Honduras, Israel, Japan, Malaysia, Mexico, Moldova, Panama, Peru, the Philippines, Russia, Serbia, South Korea, Turkey, and Ukraine for their support and expert advice; and to the tireless data collection and collation efforts of individuals and institutions throughout the world.

In addition, we wish to express our gratitude for efforts to collect social distancing policy information in Latin America to University of Miami Institute for Advanced Study of the Americas (Felicia Knaul, Michael Touchton), with data published here: http://observcovid.miami.edu/; Fundación Mexicana para la Salud (Héctor Arreola-Ornelas) with support from the GDS Services International: Tómatelo a Pecho A.C.; and Centro de Investigaciones en Ciencias de la Salud, Universidad Anáhuac (Héctor Arreola-Ornelas); Lab on Research, Ethics, Aging and Community-Health at Tufts University (REACH Lab) and the University of Miami Institute for Advanced Study of the Americas (Thalia Porteny).

Further, IHME is grateful to the Microsoft AI for Health program for their support in hosting our COVID-19 data visualizations on the Azure Cloud. We would like to also extend a warm thank you to the many others who have made our COVID-19 estimation efforts possible.