COVID-19 Results Briefing

The United States of America

April 21, 2021

This document contains summary information on the latest projections from the IHME model on COVID-19 in the United States of America. The model was run on April 21, 2021 with data through April 19, 2021.

Transmission is increasing in 34 states, leading to a national increase of 3% in daily cases over the last week. In contrast, daily deaths declined slightly in the last week. Michigan, with the largest spring surge, appears to be reaching a peak. While increasing case numbers are occurring in many states, no other state has had a surge like Michigan. In the race between increasing vaccination and the increase in transmission driven by B.1.1.7 (combined with less cautious behavior), vaccination expansion and declining seasonality have been enough to stop deaths increasing. Our reference scenario suggests that this trend will continue, and daily deaths will steadily decline through to August. Sustained high levels of mask use is a critical reason why the spread of B.1.1.7 so far has not been associated with a larger surge. In our worse scenario, faster declines in mask use and faster increases in mobility lead to daily deaths increasing to nearly 750 a day and staying nearly constant through to August 1. Given how central vaccination is to the US strategy to control the B.1.1.7 potential surge, the slow erosion of vaccine confidence unfolding over the last two or more months is cause for concern. Encouraging vaccination and continued mask use, along with avoidance of large gatherings should be the mainstays of policy at the state level.

Current situation

- Daily reported cases in the last week increased to 68,900 per day on average compared to 66,700 the week before, an increase of 3% (Figure 1).
- Daily deaths in the last week decreased slightly to 670 per day on average compared to 700 the week before (Figure 2). COVID-19 remains the number 2 cause of death in the US this week (Table 1).
- The daily death rate is greater than 4 per million in Michigan (Figure 3).
- We estimated that 30% of people in the US have been infected as of April 19 (Figure 4). Our estimate of the percent infected to date has increased considerably from last week due to introducing corrections for waning antibodies in our analysis of seroprevalence surveys – see the model updates section below.
- Effective R, computed using cases, hospitalizations, and deaths, is greater than 1 in 34 states (Figure 5).
- The infection-detection rate in the US is close to 40% (Figure 6). After correcting for waning antibodies in seroprevalence surveys, our estimate of the infection-detection rate is down from our previous estimates.

- Based on GISAID and CDC sequence data combined with our variant spread model, we estimate current prevalence of key variants (Figure 7). B.1.1.7 is becoming the dominant variant in most of the US. While B.1.351 and P1 have been sequenced in many states, as in Europe, these variants are not increasing in prevalence in the presence of B.1.1.7.

Trends in drivers of transmission

- New Hampshire lifted its mask mandate; 30 states still have mask mandates.
- Mobility last week was 16% lower than the pre-COVID-19 baseline (Figure 9). Mobility was near baseline (within 10%) in 24 states. Mobility was lower than 30% of baseline in Massachusetts and New York.
- In Facebook surveys, 73% of people self-report that they always wore a mask when leaving their home (Figure 11). Mask use was lower than 50% in South Dakota and Wyoming.
- There were 374 diagnostic tests per 100,000 people on April 19 (Figure 13).
- In the US, 67.2% of people have been vaccinated or say they would accept or would probably accept a vaccine for COVID-19. This is down by 0.9 percentage points from last week, continuing a steady but slow decline since early February. The fraction of the population who are open to receiving a COVID-19 vaccine ranges from 49% in Wyoming to 86% in the District of Columbia (Figure 17).
- In our current reference scenario, we expect that 176 million will be vaccinated by August 1 (Figure 18). We expect that vaccination will shift to being demand-constrained rather than supply-constrained in May.

Projections

- In our **reference scenario**, which represents what we think is most likely to happen, our model projects 603,000 cumulative deaths on August 1. This represents 38,000 additional deaths from April 19 to August 1 (Figure 19). Daily deaths are expected to decline steadily until August 1 (Figure 20).
- If **universal mask coverage (95%)** were attained in the next week, our model projects 6,900 fewer cumulative deaths compared to the reference scenario on August 1 (Figure 19).
- Under our **worse scenario**, our model projects 634,000 cumulative deaths on August 1, an additional 31,000 deaths compared to our reference scenario (Figure 19). Daily deaths would increase until late May and then remain constant at just under 750 a day.
- By August 1, we project that 25,700 lives will be saved by the projected vaccine rollout from now forward. This does not count lives saved through vaccines that have already been delivered.

- Daily infections in the reference scenario are expected to decline steadily until early July and then increase slightly. In the worse scenario, daily infections remain above 100,000 through to August 1.
- Figure 22 compares our reference scenario forecasts to other publicly archived models. IHME and CDC ensemble forecasts suggest similar trends over the next four weeks. Los Alamos National Labs and MIT forecast more rapid declines, and the Imperial model now forecasts increasing daily deaths through to mid-July.
- At some point from April through August 1, 13 states will have high or extreme stress on hospital beds (Figure 23). At some point from April through August 1, four states will have high or extreme stress on ICU capacity (Figure 24).

Model updates

Estimates of infections by day are the critical input into SEIR models. Many early models assumed that cases equaled infections or that the infection-detection rate (IDR) was constant over time and across locations. Early scarcity of PCR testing for COVID-19 in some high-income countries and continued low testing rates in many low-resource settings means that it is very likely that the IDR varies over space and time. Until January 2021, the IHME model used deaths that have been less affected by PCR testing availability to estimate infections using empirical estimates of the infection-fatality ratio (IFR). Estimates of the IFR based on seroprevalence surveys matched to deaths vary over time and location. Starting with the January 21 release, we adopted an approach mapping: 1) cases to infections, 2) hospitalizations to infections, and 3) deaths to infections, and then generating a best estimate of past infections based on these three series. For the April 22, 2021, release, we made further improvements to this model to take into account the effect of waning immunity on seroprevalence surveys and a more appropriate method for predicting the IDR, infection-hospitalization rate (IHR), and IFR in settings without seroprevalence surveys.

Our approach has six distinct components. First, we address certain types of missingness and reporting anomalies present in daily reported COVID-19 statistics. Second, we correct seroprevalence surveys for vaccination rates, re-infection from escape variants (B.1.351 and P1), and test-specific information on antibody test sensitivity. Third, we use corrected cumulative infections derived from seroprevalence surveys that are representative paired with cumulative cases, cumulative hospitalizations, and cumulative deaths to get empirical estimates of the IDR, IHR, and IFR. Statistical models for each have been developed to project the IDR, IHR, and IFR for each location and day taking into account population age structure where appropriate. Fourth, a smooth curve of daily cases, daily hospitalizations (where available), and daily deaths is generated. Fifth, all three smooth series of cases, hospitalizations, and deaths are divided by the relevant IDR, IHR, and IFR to generate three estimates of past daily infections. All three of these series are combined into a single best estimate of past infections. Sixth, daily infections are used to estimate the cumulative percent of individuals with one or more infection, which can be compared to seroprevalence surveys to assess internal consistency in each step of the process.

A detailed description of the approach, available here, provides more on the statistical models used and the diagnostic plots generated as part of the analysis.

Figure 1. Reported daily COVID-19 cases

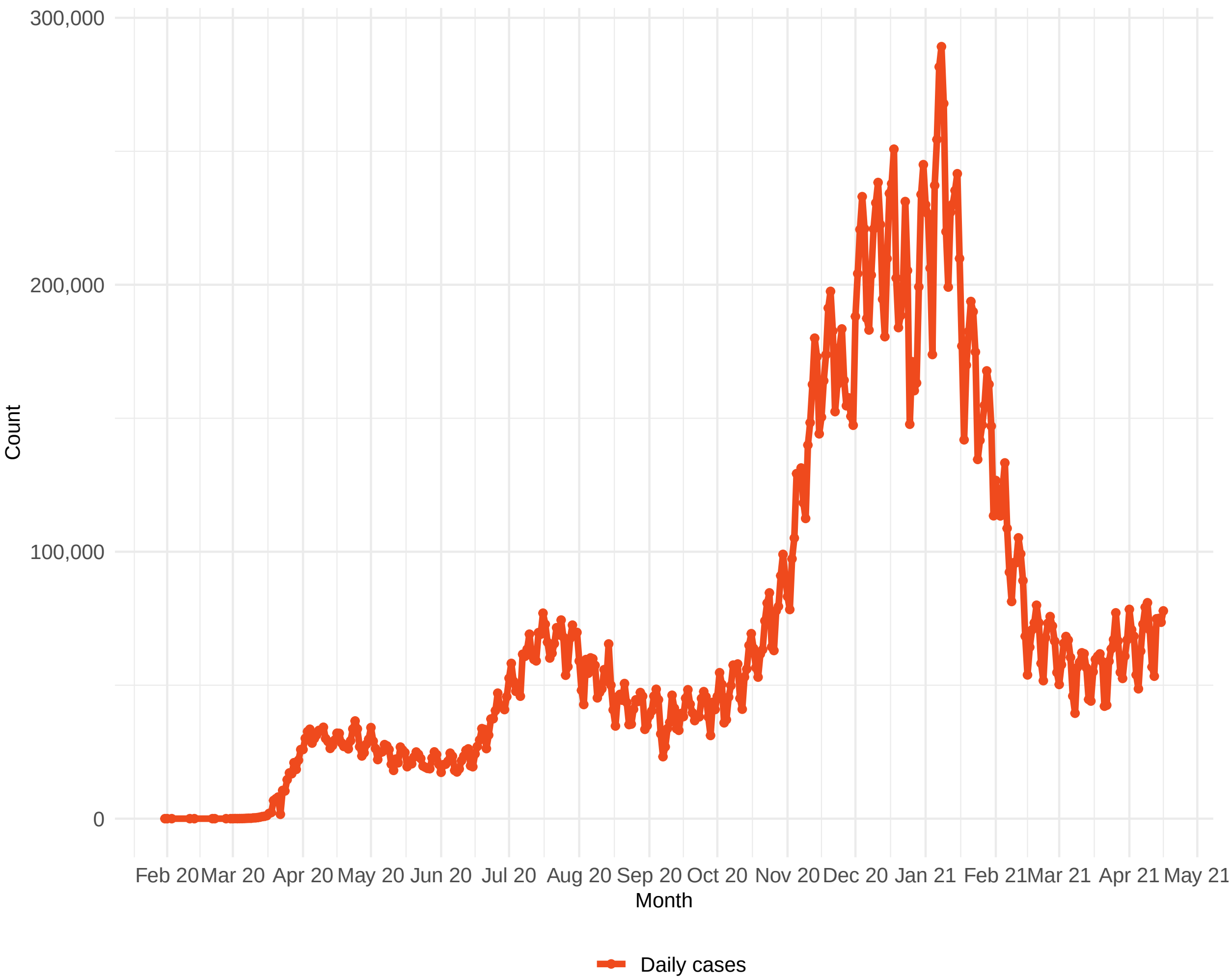


Table 1. Ranking of COVID-19 among the leading causes of mortality this week, assuming uniform deaths of non-COVID causes throughout the year

Cause name	Weekly deaths	Ranking
Ischemic heart disease	10,724	1
COVID-19	4,661	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 2. Reported daily COVID-19 deaths and smoothed trend estimate.

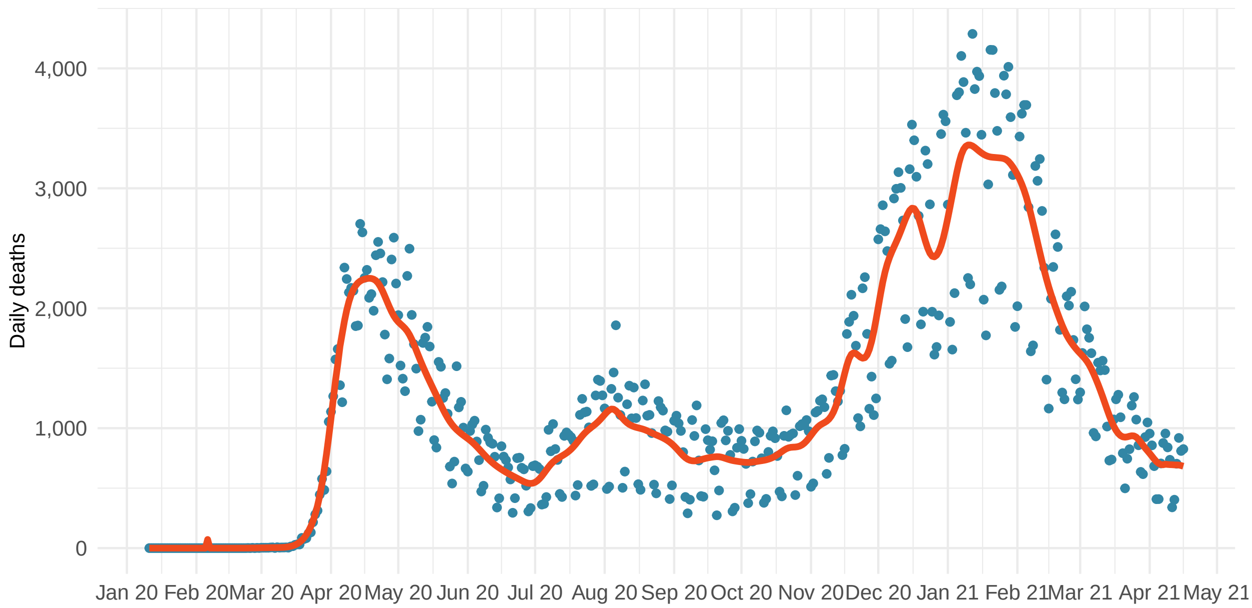


Figure 3. Daily COVID-19 death rate per 1 million on April 19, 2021

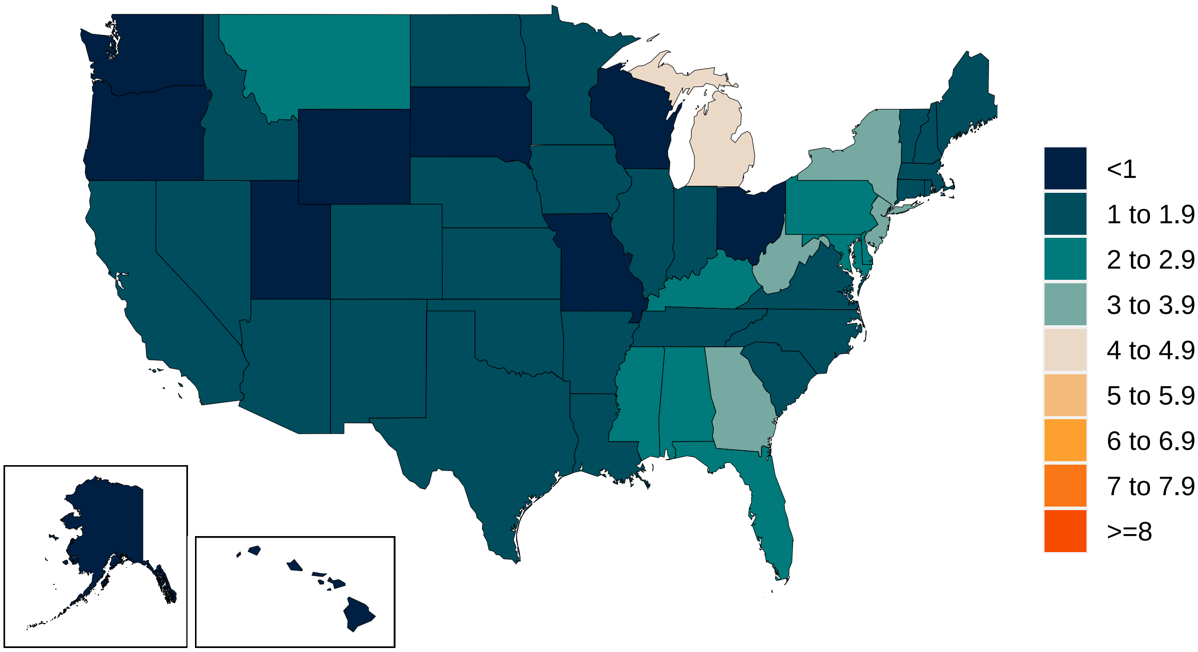


Figure 4. Estimated percent of the population infected with COVID-19 on April 19, 2021

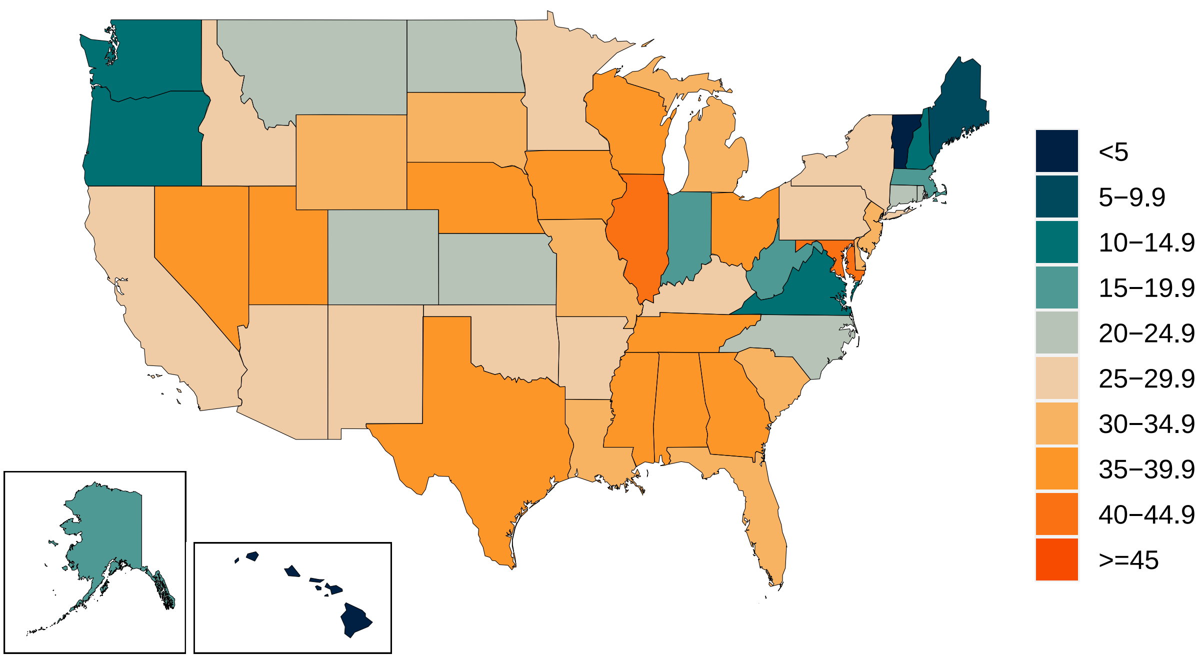


Figure 5. Mean effective R on April 08, 2021. The estimate of effective R is based on the combined analysis of deaths, case reporting, and hospitalizations where available. Current reported cases reflect infections 11-13 days prior, so estimates of effective R can only be made for the recent past. Effective R less than 1 means that transmission should decline, all other things being held the same.

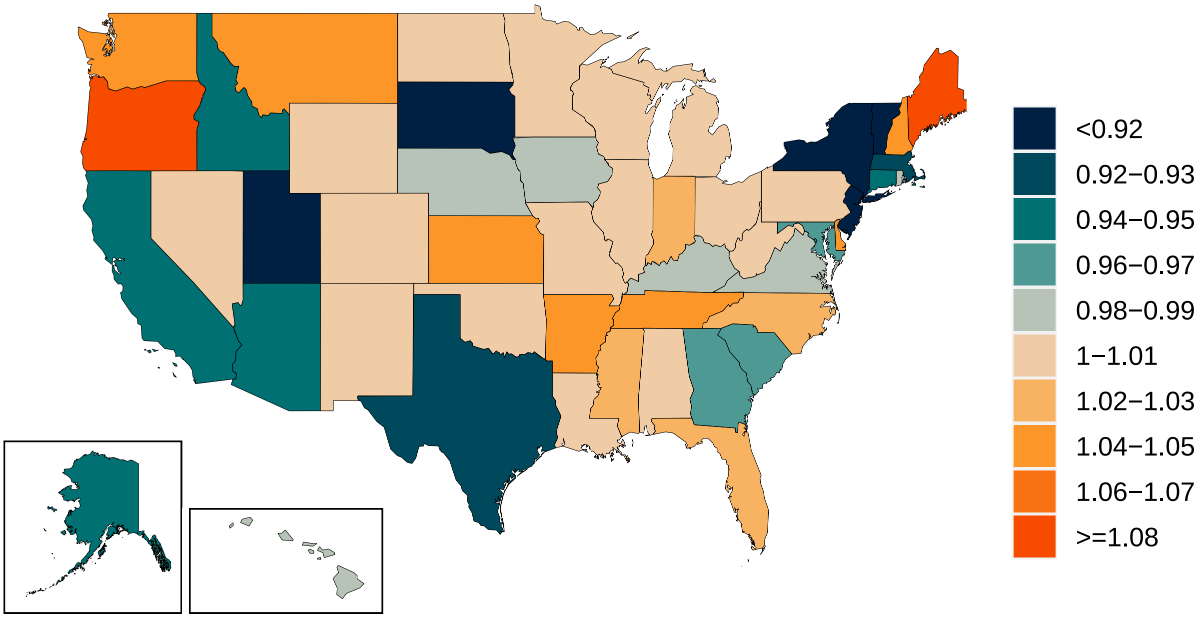
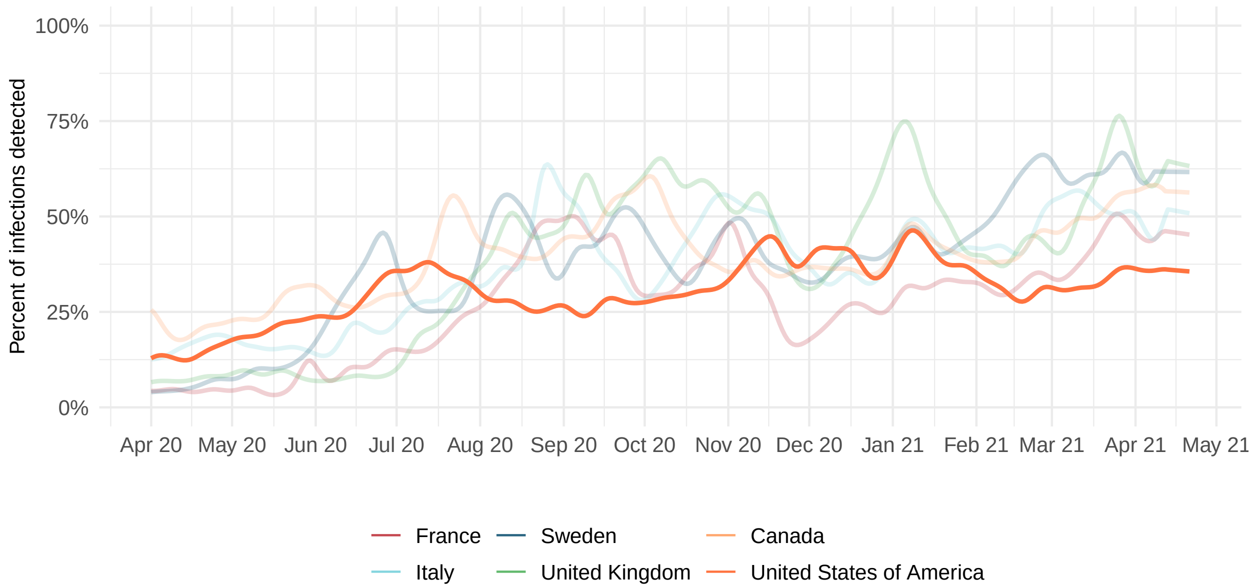


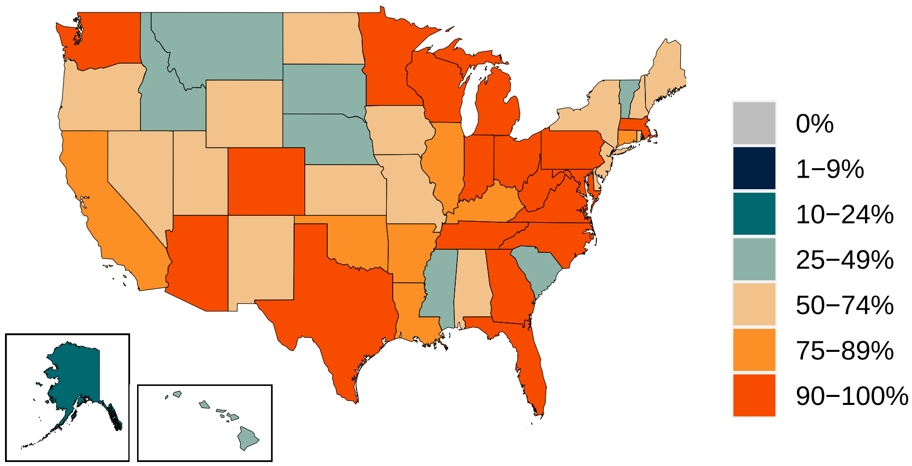
Figure 6. Percent of COVID-19 infections detected. This is estimated as the ratio of reported daily COVID-19 cases to estimated daily COVID-19 infections based on the SEIR disease transmission model.



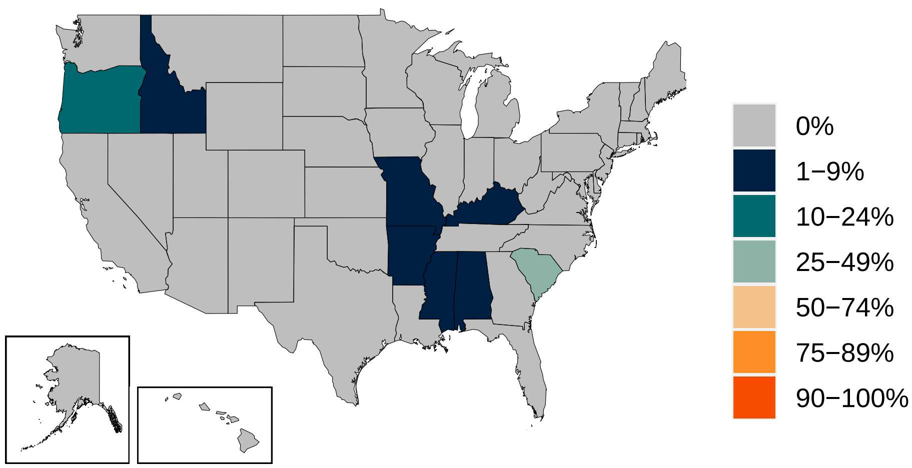
*Due to measurement errors in cases and testing rates, the infection to detection rate (IDR) can exceed 100% at particular points in time.

Figure 7. Percent of circulating SARS-CoV-2 for 3 primary variants on April 19, 2021.

A. Percent B.1.1.7 variant



B. Percent B.1.351 variant



C. Percent P1 variant

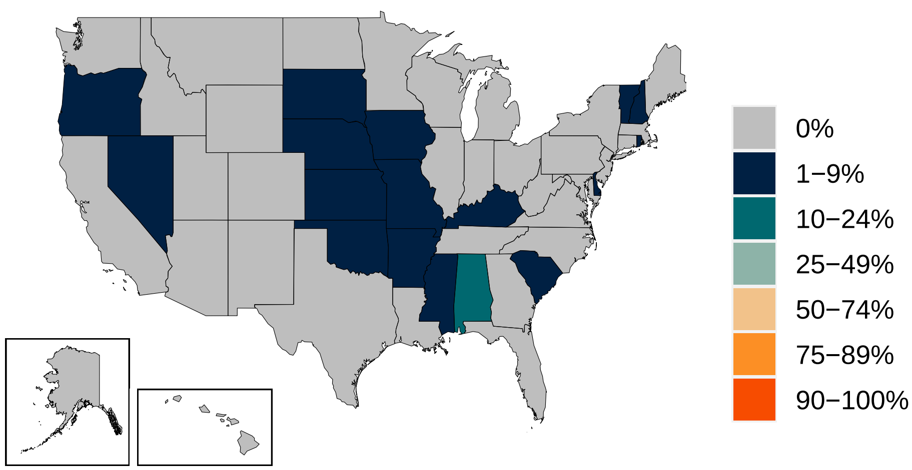
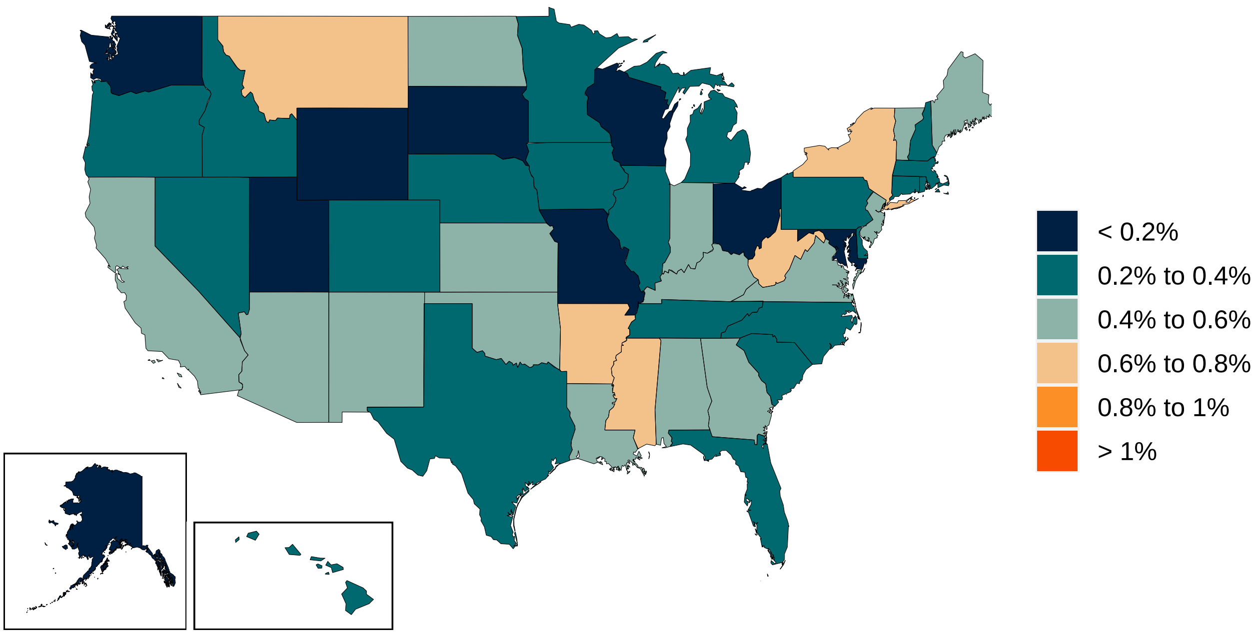


Figure 8. Infection fatality ratio on April 19, 2021. This is estimated as the ratio of COVID-19 deaths to infections based on the SEIR disease transmission model.



Critical drivers

Table 2. Current mandate implementation

*Not all locations are measured at the subnational level.

Figure 9. Trend in mobility as measured through smartphone app use compared to January 2020 baseline

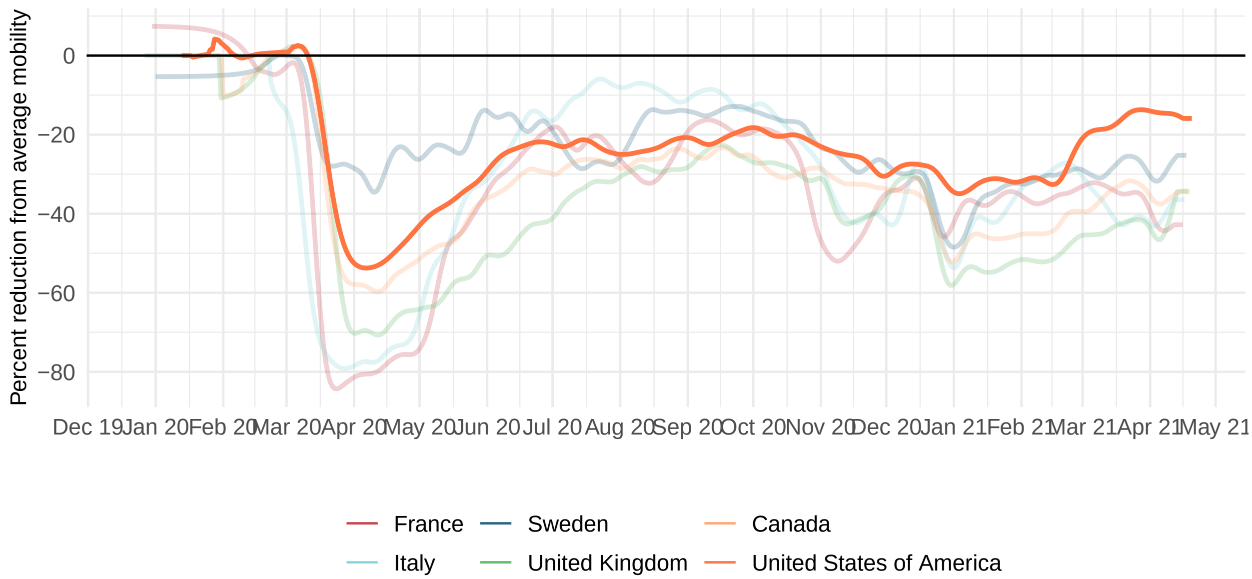


Figure 10. Mobility level as measured through smartphone app use compared to January 2020 baseline (percent) on April 19, 2021

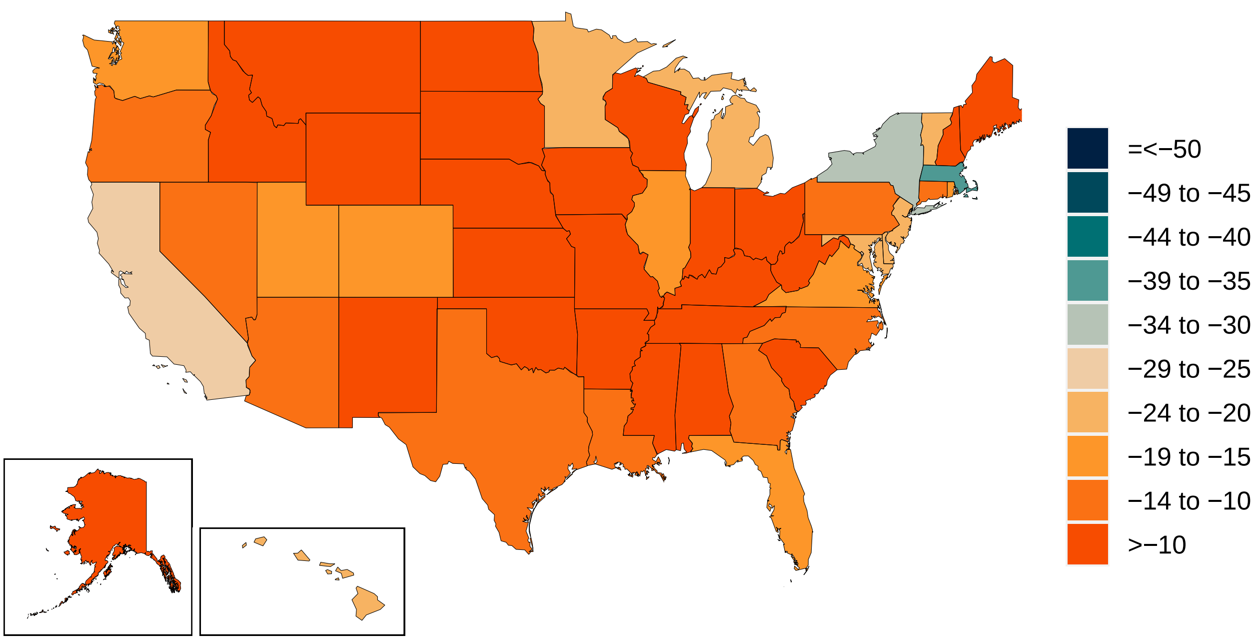


Figure 11. Trend in the proportion of the population reporting always wearing a mask when leaving home

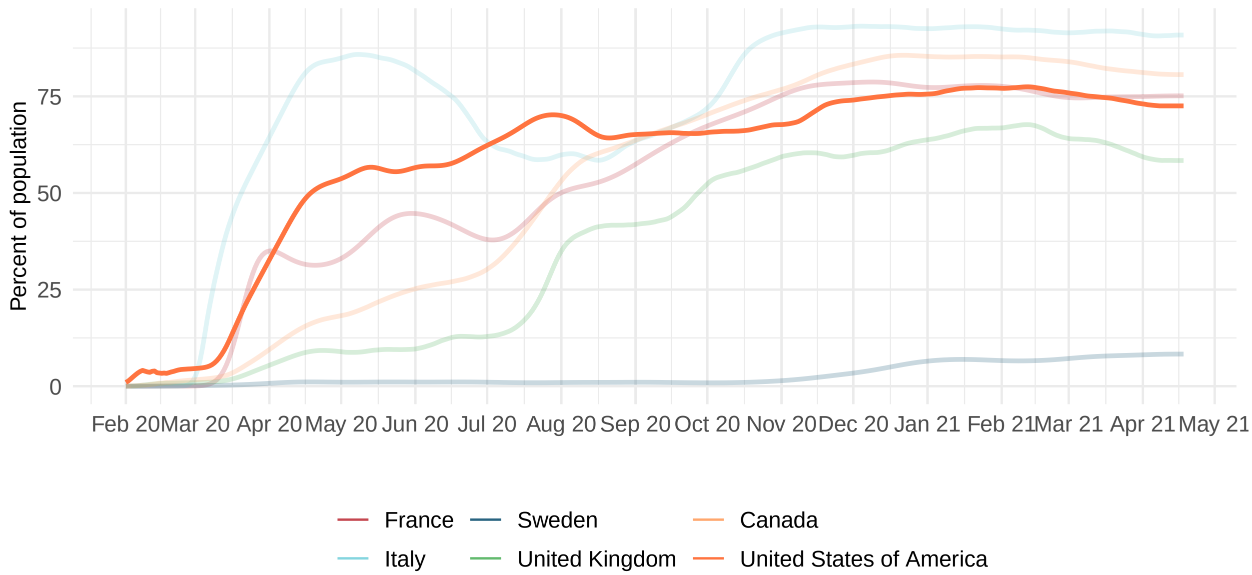


Figure 12. Proportion of the population reporting always wearing a mask when leaving home on April 19, 2021

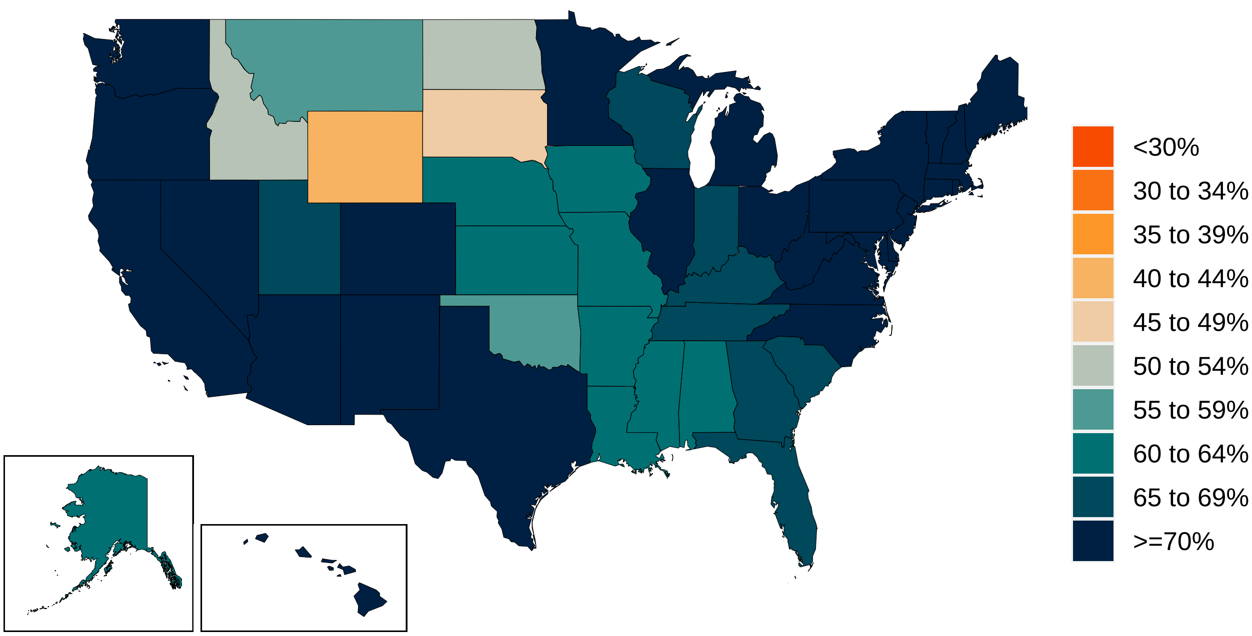


Figure 13. Trend in COVID-19 diagnostic tests per 100,000 people

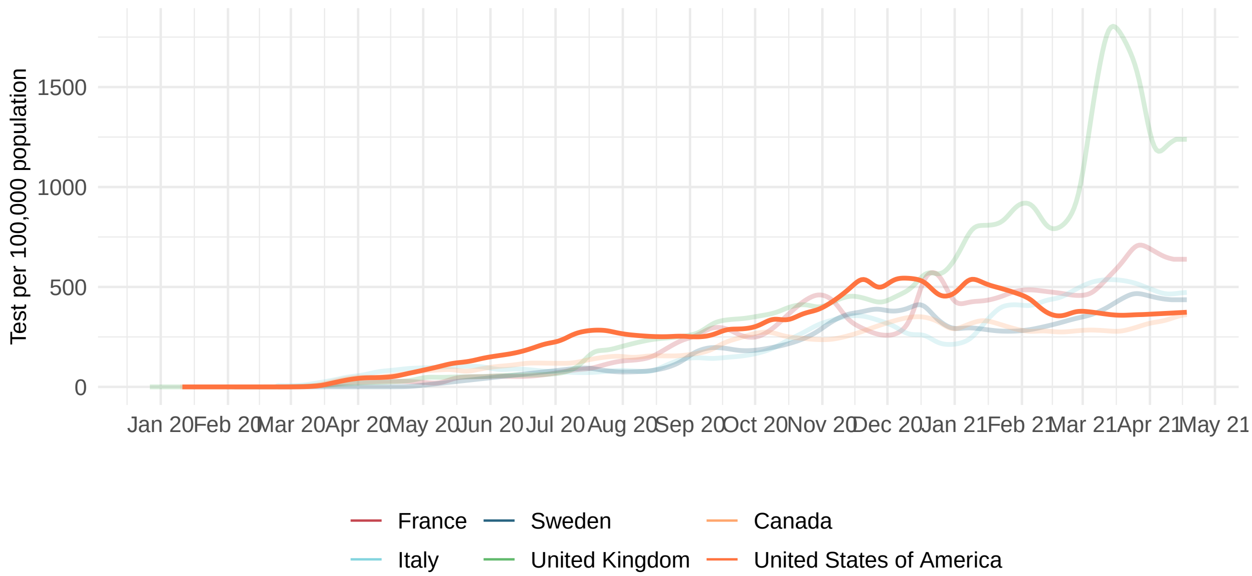


Figure 14. COVID-19 diagnostic tests per 100,000 people on March 29, 2021

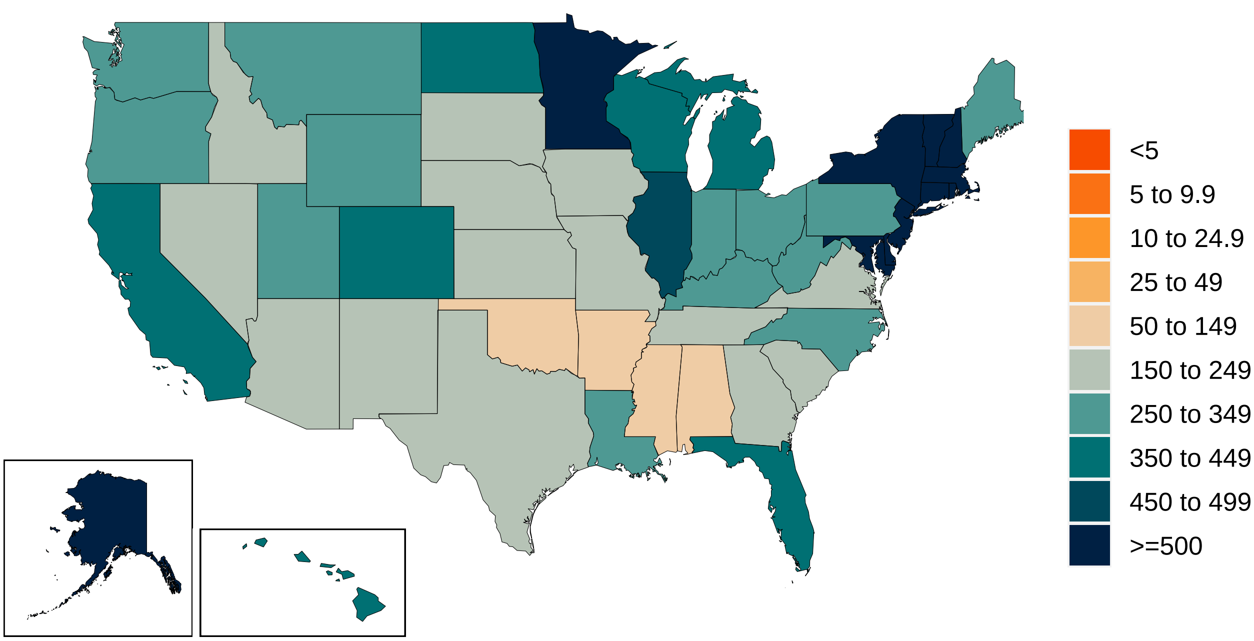


Figure 15. Increase in the risk of death due to pneumonia on February 1 2020 compared to August 1 2020

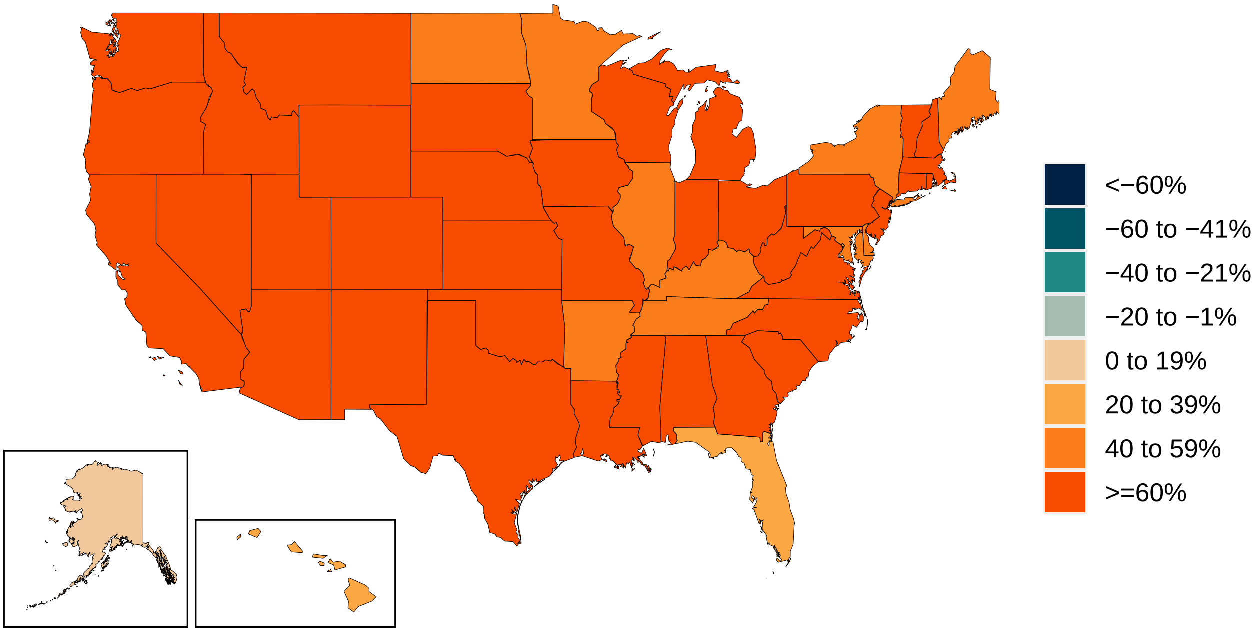


Table 3. The SEIR model uses variant-specific estimates of vaccine efficacy at preventing symptomatic disease and at preventing infection. We use data from clinical trials directly, where available, and make estimates otherwise. More information can be found on our website (http://www.healthdata.org/node/8584).

Vaccine	Efficacy at preventing disease: D614G & B.1.1.7	Efficacy at preventing infection: D614G & B.1.1.7	Efficacy at preventing disease: B.1.351 & P.1	Efficacy at preventing infection: B.1.351 & P.1
AstraZeneca	75%	52%	10%	6%
CoronaVac	50%	43%	38%	25%
Janssen	72%	72%	64%	42%
Moderna	94%	85%	72%	47%
Novavax	89%	77%	49%	32%
Pfizer/BioNTech	91%	86%	69%	45%
Sinopharm	73%	63%	56%	36%
Sputnik-V	92%	80%	70%	45%
Tianjin CanSino	66%	57%	50%	32%
Other vaccines	75%	65%	57%	37%
Other vaccines (mRNA)	95%	83%	72%	47%

Figure 16. Trend in the estimated proportion of the adult (18+) population that have been vaccinated or is open to receiving a COVID-19 vaccine based on Facebook survey responses (yes and yes, probably).

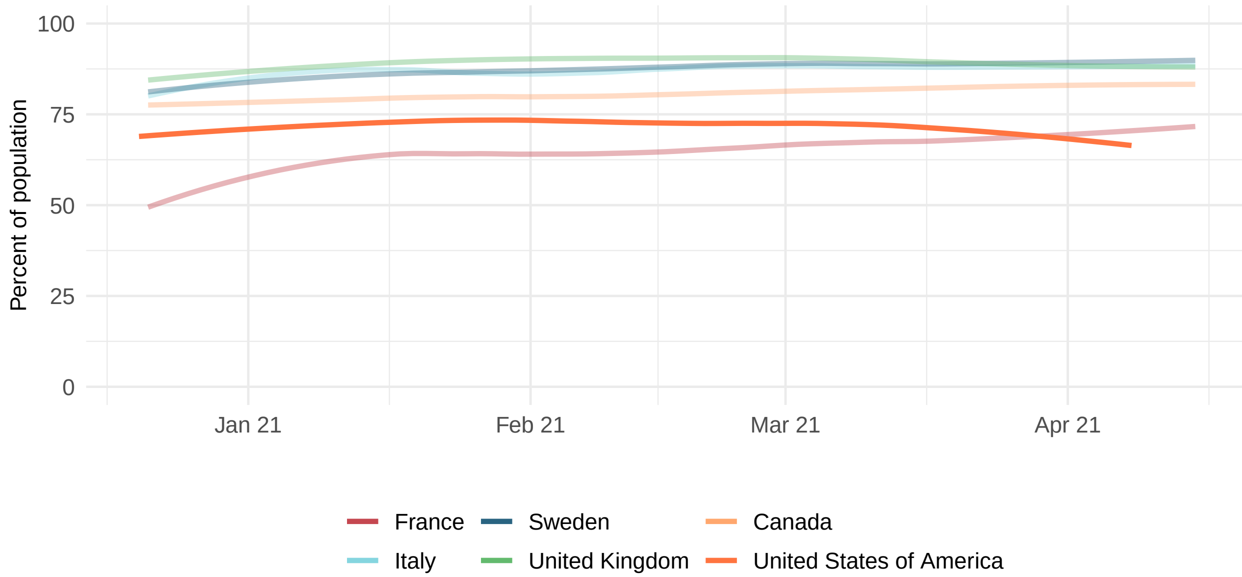


Figure 17. This figure shows the estimated proportion of the adult (18+) population that has been vaccinated or is open to receiving a COVID-19 vaccine based on Facebook survey responses (yes and yes, probably).

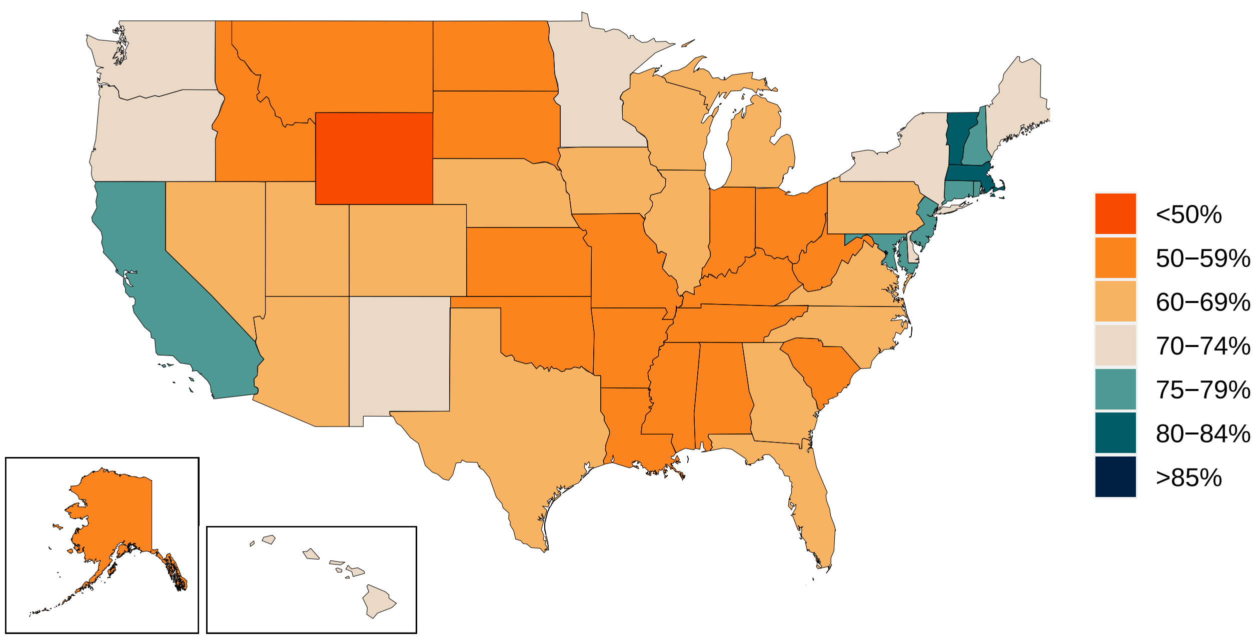
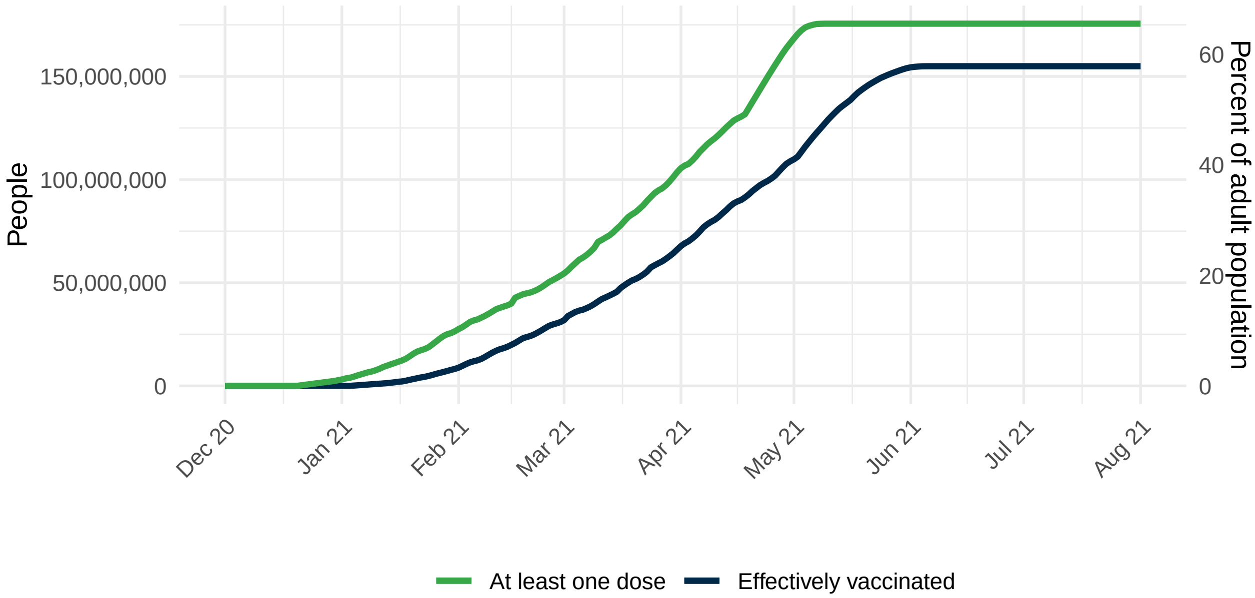


Figure 18. The number of people who receive any vaccine and those who are effectively vaccinated and protected against disease, accounting for efficacy, loss to follow up for two-dose vaccines, partial immunity after one dose, and immunity after two doses.



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:

- Vaccines are distributed at the expected pace.
- Governments adapt their response by re-imposing social distancing mandates for 6 weeks whenever daily deaths reach 8 per million, unless a location has already spent at least 7 of the last 14 days with daily deaths above this rate and not yet re-imposed social distancing mandates. In this case, the scenario assumes that mandates are re-imposed when daily deaths reach 15 per million.
- Variants B.1.1.7 (first identified in the UK), B.1.351 (first identified in South Africa), and P1 (first identified in Brazil) continue to spread from locations with (a) more than 5 sequenced variants, and (b) reports of community transmission, to adjacent locations following the speed of variant scale-up observed in the regions of the UK.
- In one-quarter of those vaccinated, mobility increases toward pre-COVID-19 levels.

The **worse scenario** modifies the reference scenario assumptions in three ways:

- First, it assumes that variants B.1.351 or P1 begin to spread within 3 weeks in adjacent locations that do not already have B.1.351 or P1 community transmission.
- Second, it assumes that all those vaccinated increase their mobility toward pre-COVID-19 levels.
- Third, it assumes that among those vaccinated, mask use starts to decline exponentially one month after completed vaccination.

The **universal masks scenario** makes all the same assumptions as the reference scenario but also assumes 95% of the population wear masks in public in every location.

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

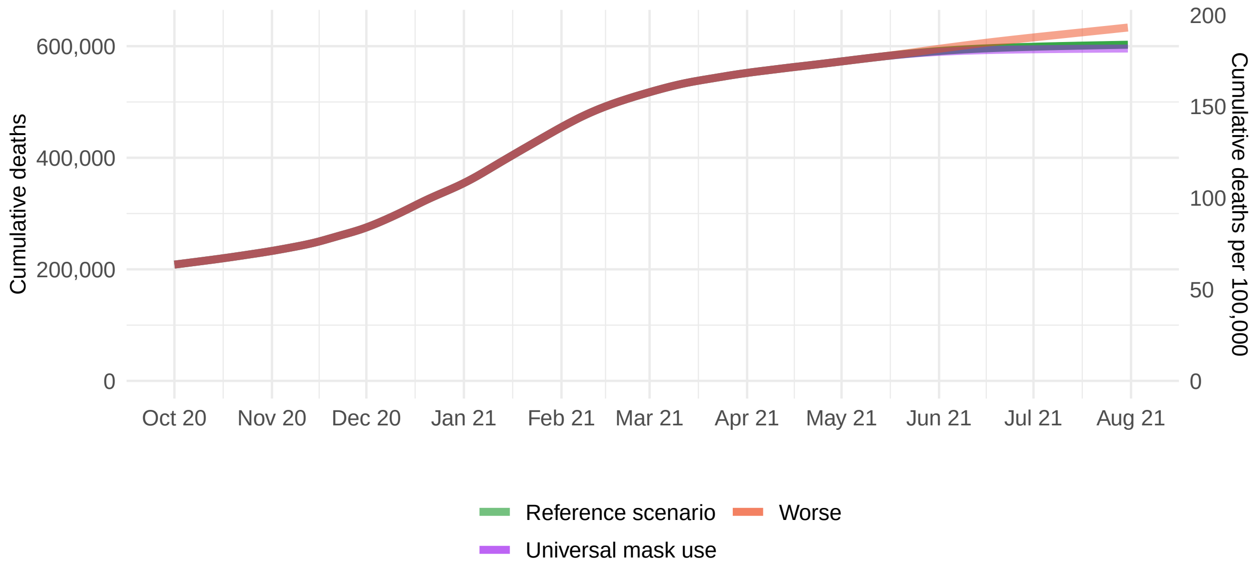


Figure 20. Daily COVID-19 deaths until August 01, 2021 for three scenarios,

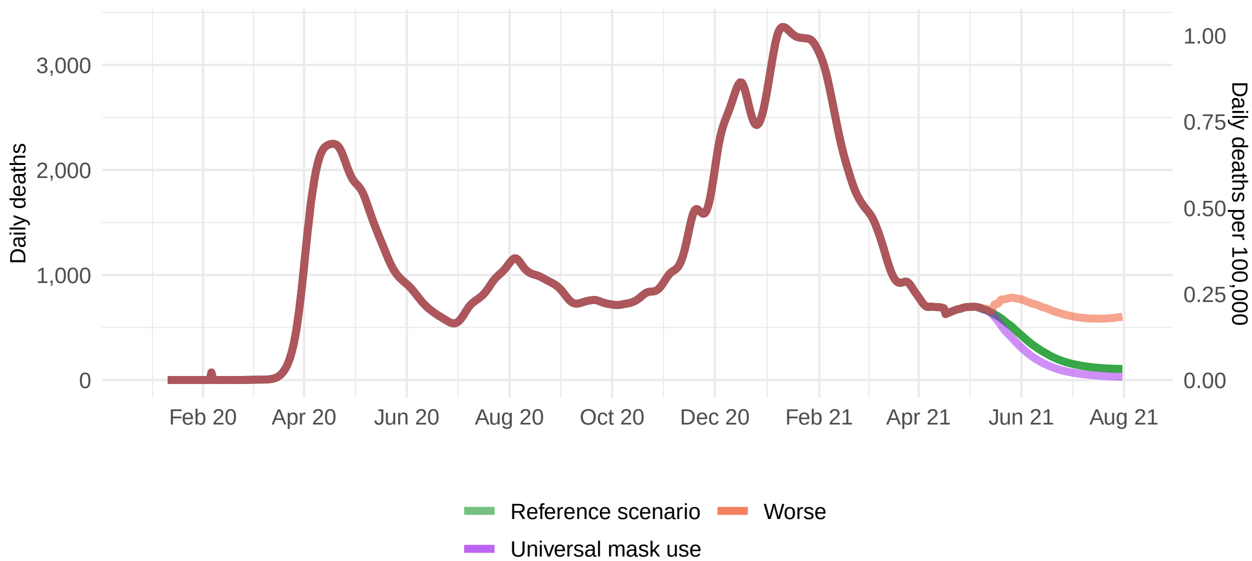


Figure 21. Daily COVID-19 infections until August 01, 2021 for three scenarios.

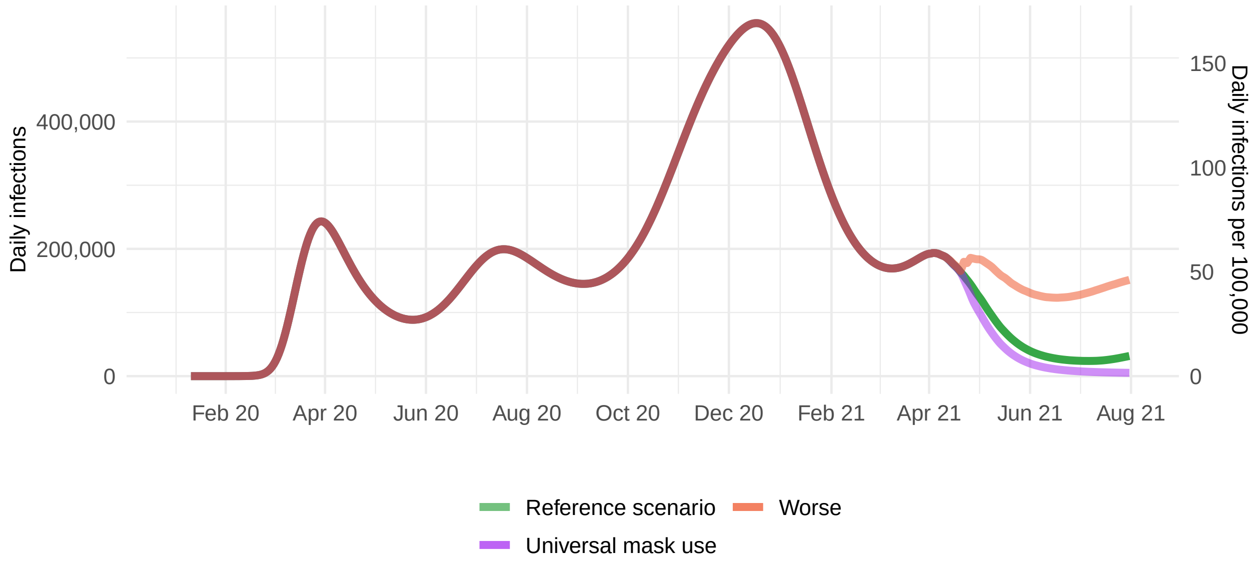


Figure 22. Comparison of reference model projections with other COVID modeling groups. For this comparison, we are including projections of daily COVID-19 deaths from other modeling groups when available: Delphi from the Massachussets Institute of Technology (Delphi; https://www.covidanalytics.io/home), 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 the CDC Ensemble Model (CDC; https://www.cdc.gov/coronavirus/2019-ncov/covid-data/forecasting-us.html#ensembleforecast.) Daily deaths from other modeling groups are smoothed to remove inconsistencies with rounding. Regional values are aggregates from available locations in that region.

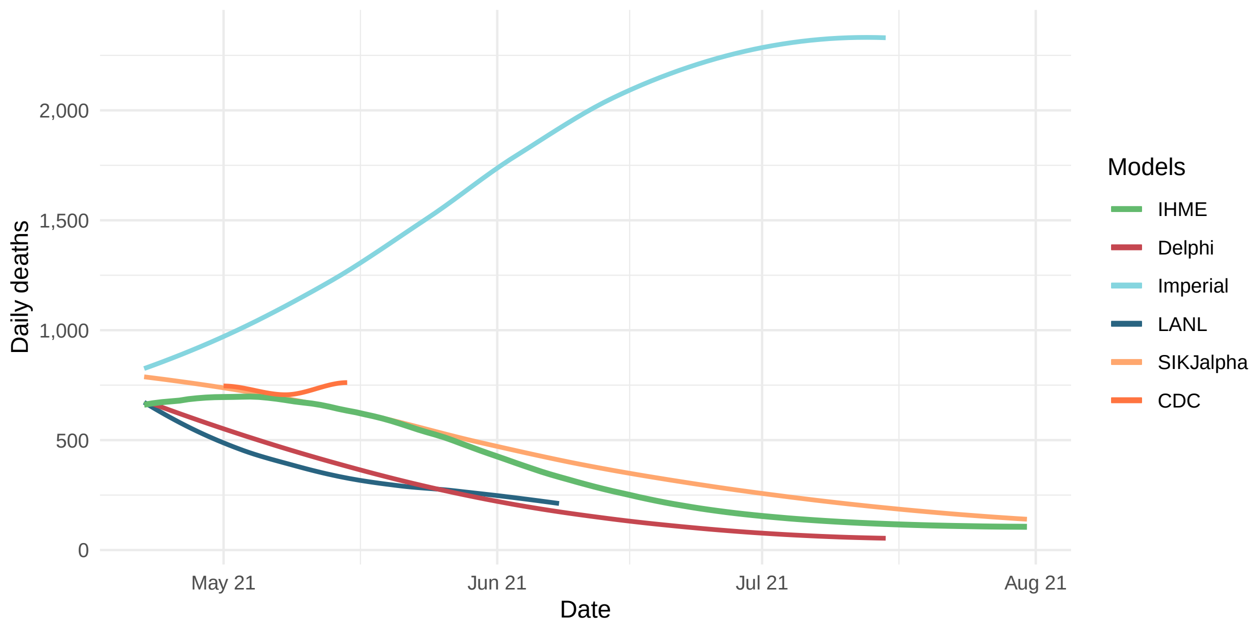


Figure 23. The estimated inpatient hospital usage is shown over time. The percent of hospital beds occupied by COVID-19 patients is color coded based on observed quantiles of the maximum proportion of beds occupied by COVID-19 patients. Less than 5% is considered *low stress*, 5-9% is considered *moderate stress*, 10-19% is considered *high stress*, and greater than 20% is considered *extreme stress*.

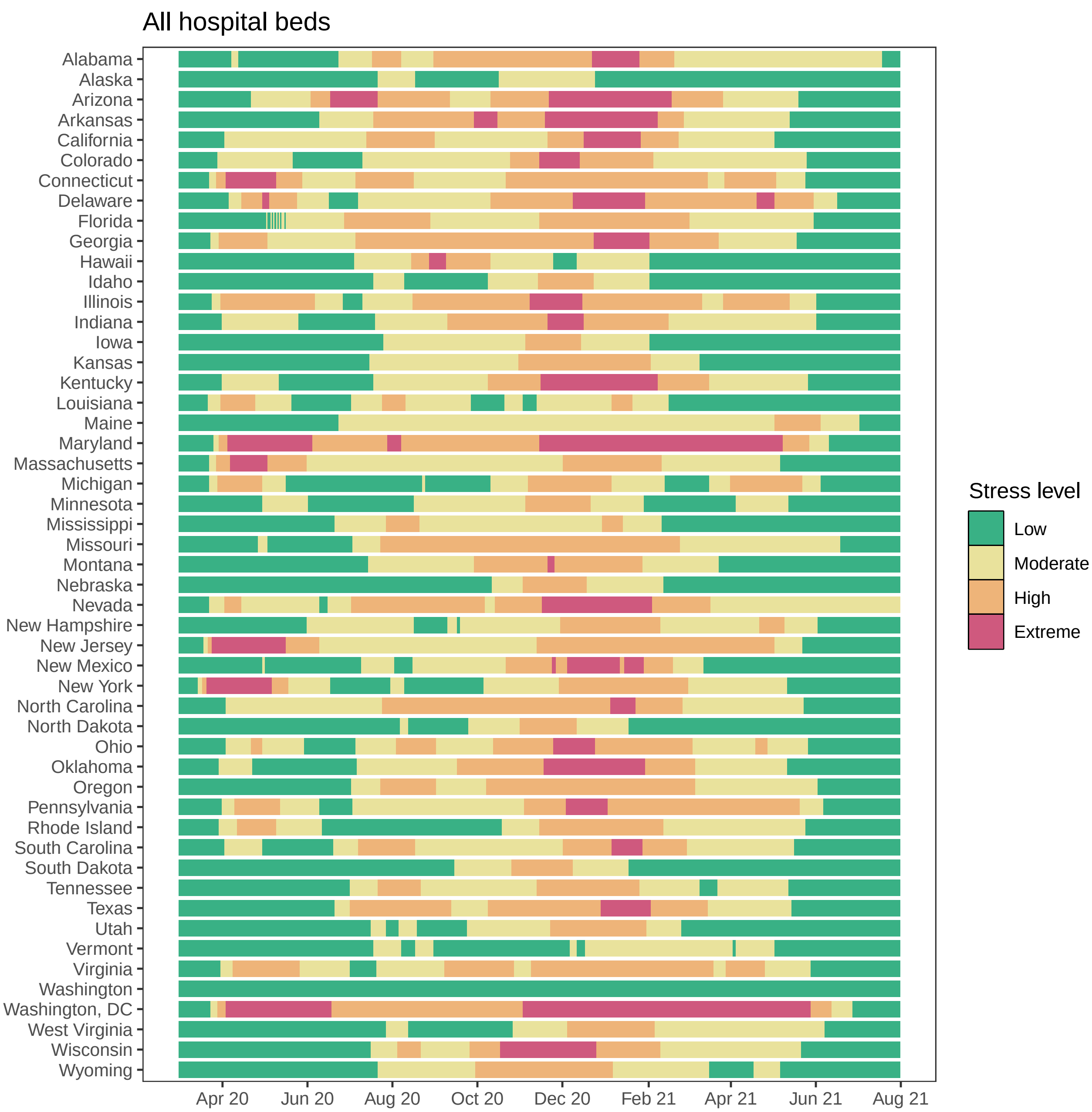
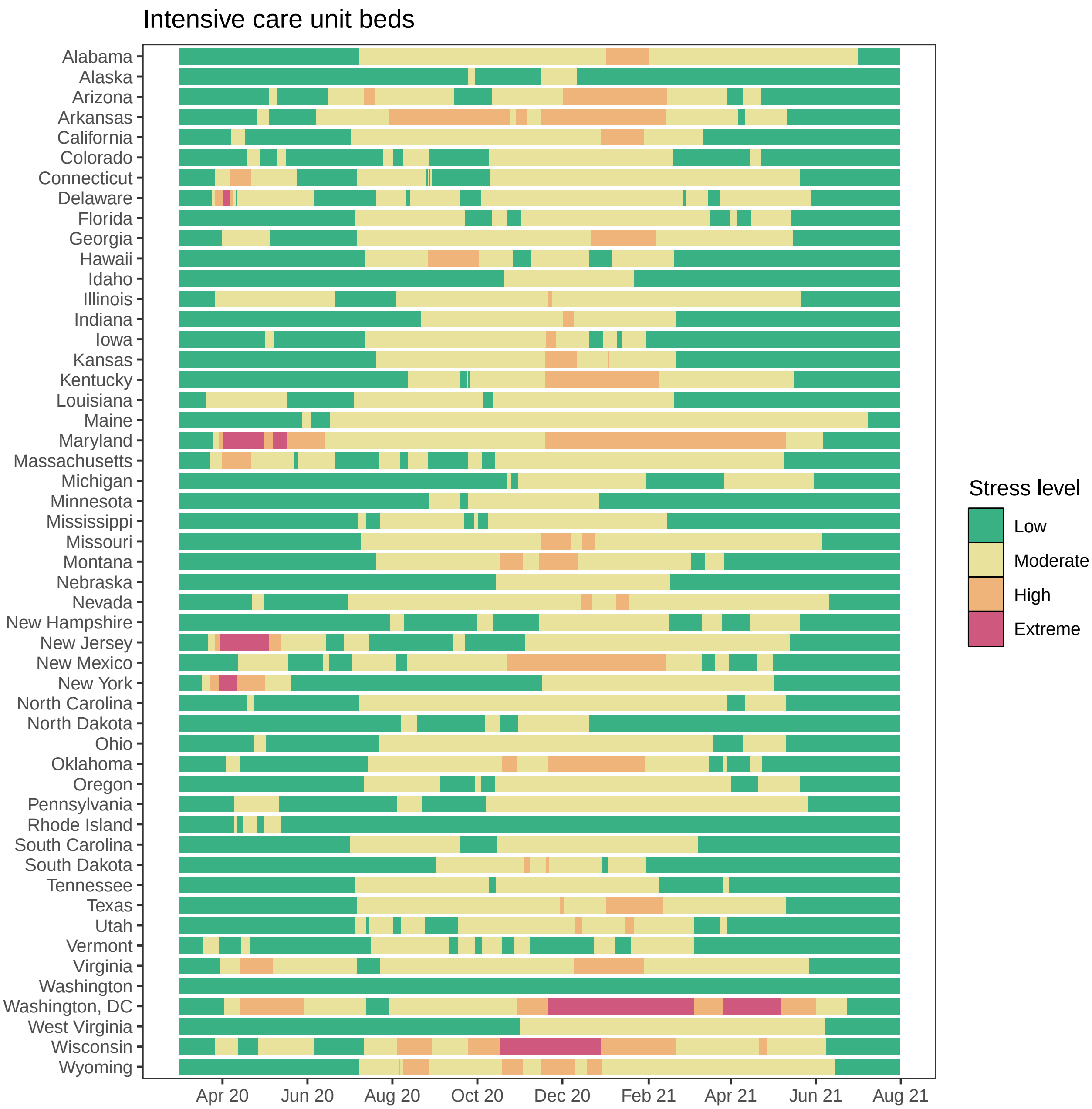


Figure 24. The estimated intensive care unit (ICU) usage is shown over time. The percent of ICU beds occupied by COVID-19 patients is color coded based on observed quantiles of the maximum proportion of ICU beds occupied by COVID-19 patients. Less than 10% is considered *low stress*, 10-29% is considered *moderate stress*, 30-59% is considered *high stress*, and greater than 60% is considered *extreme stress*.



More information

Data sources:

Mask use data sources include Premise; Facebook Global Symptom Survey (This research is based on survey results from University of Maryland Social Data Science Center) and the Facebook United States Symptom Survey (in collaboration with Carnegie Mellon University); Kaiser Family Foundation; YouGov COVID-19 Behaviour Tracker survey.

Vaccine hesitancy data are from the COVID-19 Beliefs, Behaviors, and Norms Study, a survey conducted on Facebook by the Massachusetts Institute of Technology (https://covidsurvey.mit.edu/).

Vaccine hesitancy data are from the Facebook Global Symptom Survey (This research is based on survey results from University of Maryland Social Data Science Center), the Facebook United States Symptom Survey (in collaboration with Carnegie Mellon University), and from the Facebook COVID-19 Beliefs, Behaviors, and Norms Study conducted by the Massachusetts Institute of Technology.

Genetic sequence and metadata are primarily from the GISAID Initiative. Further details available on the COVID-19 model FAQ page.

A note of thanks:

We wish to warmly acknowledge the support of these and others who have made our COVID-19 estimation efforts possible.

More information:

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.