STATUS UPDATE: COVID-19 EPIDEMIC TRENDS AND SCENARIO PROJECTIONS IN OREGON

Results as of 7-29-2021, 3pm

PURPOSE OF THIS STATUS UPDATE

This report uses numerous measures to create the most accurate picture of past COVID-19 transmission and incidence of infection over time in Oregon, and it projects possible trends over the next month assuming different scenarios. This report complements the extensive epidemiologic data (e.g., demographic trends in cases, testing patterns) for Oregon available at the Oregon Health Authority (OHA) COVID-19 webpage.

RESULTS UPDATED EVERY 3-4 WEEKS

Please note that the COVID-19 data used for the modeling are continually being updated. (For daily up-to-date information, visit the OHA COVID-19 webpage.) The results in this brief will be updated every three to four weeks as more data become available, the science to inform the model assumptions expands, and modeling methods continue to be refined. The model serves as a useful tool for summarizing trends in COVID-19 transmission in Oregon and for understanding the potential impact of different future scenarios. Point estimates should be interpreted with caution, however, due to considerable uncertainty behind COVID-19 model assumptions and limitations to the methods.

ACKNOWLEDGEMENTS

OHA wishes to thank the Institute for Disease Modeling (IDM) for their support. For this status update, Niket Thakkar at IDM provided the software, programming scripts, and technical assistance. This report is based on aspects of IDM's technical reports (IDM COVID Reports) and Washington State Department of Health's COVID-19 Situation Reports (WA Situation Reports), adapted for Oregon.

METHODS

For this status update, we used the COVID-19 modeling software Rainier. Rainier is software designed by the Institute for Disease Modeling (IDM) to algorithmically estimate the effective reproduction number (R_e) over time based on local data and to conduct simple projections. Rainier fits a stochastic SEIR (susceptible – exposed – infectious – recovered) model to testing, hospitalization, and mortality time series. This software has been used to generate regular situation updates for the State of Washington overall and by two regions within Washington (Example WA Report).

Results are based on COVID-19 data compiled July 28 from the Oregon Pandemic Emergency Response Application (Opera) on COVID-19 testing, total diagnosed cases,[1] hospitalized cases, and deaths among people living in Oregon. To account for delays in reporting, diagnosed cases with a specimen collection date after July 20 were not used; we used the same cutoff date for hospital admissions and deaths.[2] In the model, cases tested on July 20 reflect exposures that occurred around July 14.

RESULTS

Effective reproduction number (R_e)

From the model results (Figure 1), it is clear the statewide R_e -- the average number of secondary cases that a single case generates -- has fluctuated up and down over time, with dramatic shifts often happening quickly.

After remaining below or around 1 since late April, the best-estimate R_e increased sharply starting in late June. Over the week ending July 14, the best estimate R_e averaged 1.58. On the date of July 14, the statewide R_e was likely between 1.26 and 2.08, with a best estimate of 1.67.

[1] Total diagnosed cases include confirmed (positive test) and presumptive cases (symptoms with epidemiologic link).
[2] This date reflects the cutoff through when individuals had a test specimen collected, were admitted to a hospital, or died. Any of these events may have been reported to OHA at a later date.

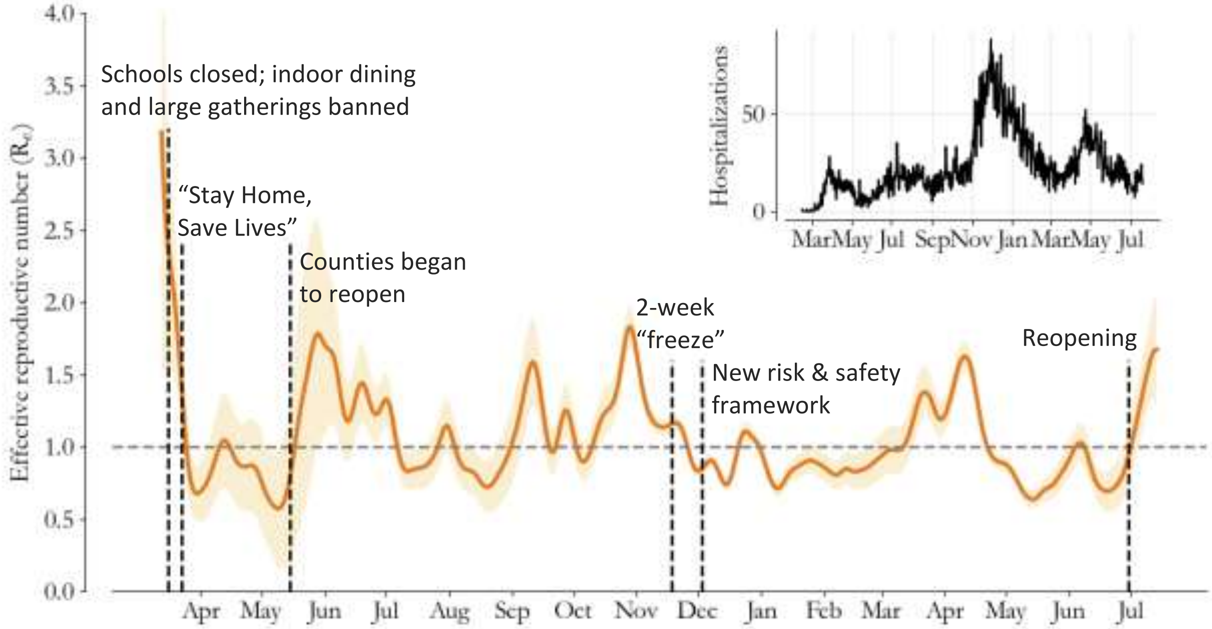

Figure 1: *R_e estimates over time for Oregon, with shaded 95% confidence interval.*[3] *Graph insert is the number of new hospitalizations over time in Oregon, a key input for the estimates. R_e = 1 is the threshold for declining transmission.*

It is important to note that the changes in R_e over time may be due to some combination of changing behaviors, changes in opportunities for potential exposure as counties' interventions become more or less stringent, changes in variants, and/or immunity (either from vaccination or recovering from infection). This recent increase in R_e corresponds to the increase in the Delta (B.1.617.2) variant among cases in Oregon (OHA Variant Dashboard), as well as state reopening on June 30th.

Our best estimate of the R_e for the week ending July 14 (1.58) is higher than recent estimates[4] from Harvard, Yale, and Stanford (1.34) and Covid Act Now (1.23).

Recent case trends

Our R_e estimates are based on a model that used data on diagnosed cases, hospitalized cases, and deaths, while taking into account changes in testing volume and

[3] Our R_e confidence interval may be narrower at times because of how we estimated specimen collection dates for negative tests (and thus positive test rate for each day), as described in Appendix 1.
[4] Model R_e estimates are dated July 14, 2021. All were accessed on July 27, 2021. An exact estimate from CMMID was not available, but it appeared to be approximately 1.2. The latest estimate from Institute for Health Metrics and Evaluation, 1.08, is for July 8.

practice. Examination of these outcomes (Figure 2) helps explain the recent trends in the estimated R_e. The 7-day rolling averages of diagnosed cases and hospitalizations had been generally decreasing from late April through June, but both began to increase in early July (reflecting increasing transmission beginning in late June). The number of deaths has been relatively flat since mid-June, though death data are more subject to reporting delays than other metrics.

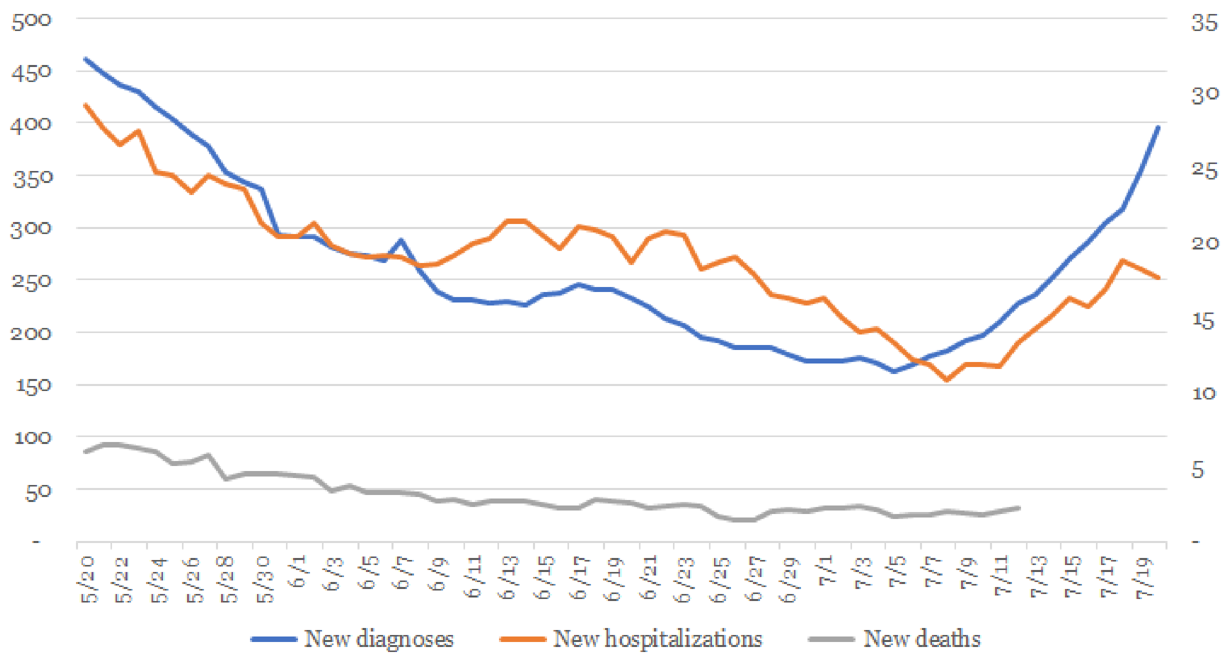

Figure 2: *Seven-day rolling average numbers of new diagnosed cases (left axis), new hospitalizations (right axis), and new deaths (right axis) due to COVID-19. Dates reflect when individuals had a test specimen collected (diagnosed cases), were admitted to the hospital, or when they died.*

Model fit to Oregon COVID-19 data

Figure 3 shows how the transmission model captures trends in the daily Oregon COVID-19 outcomes over time.

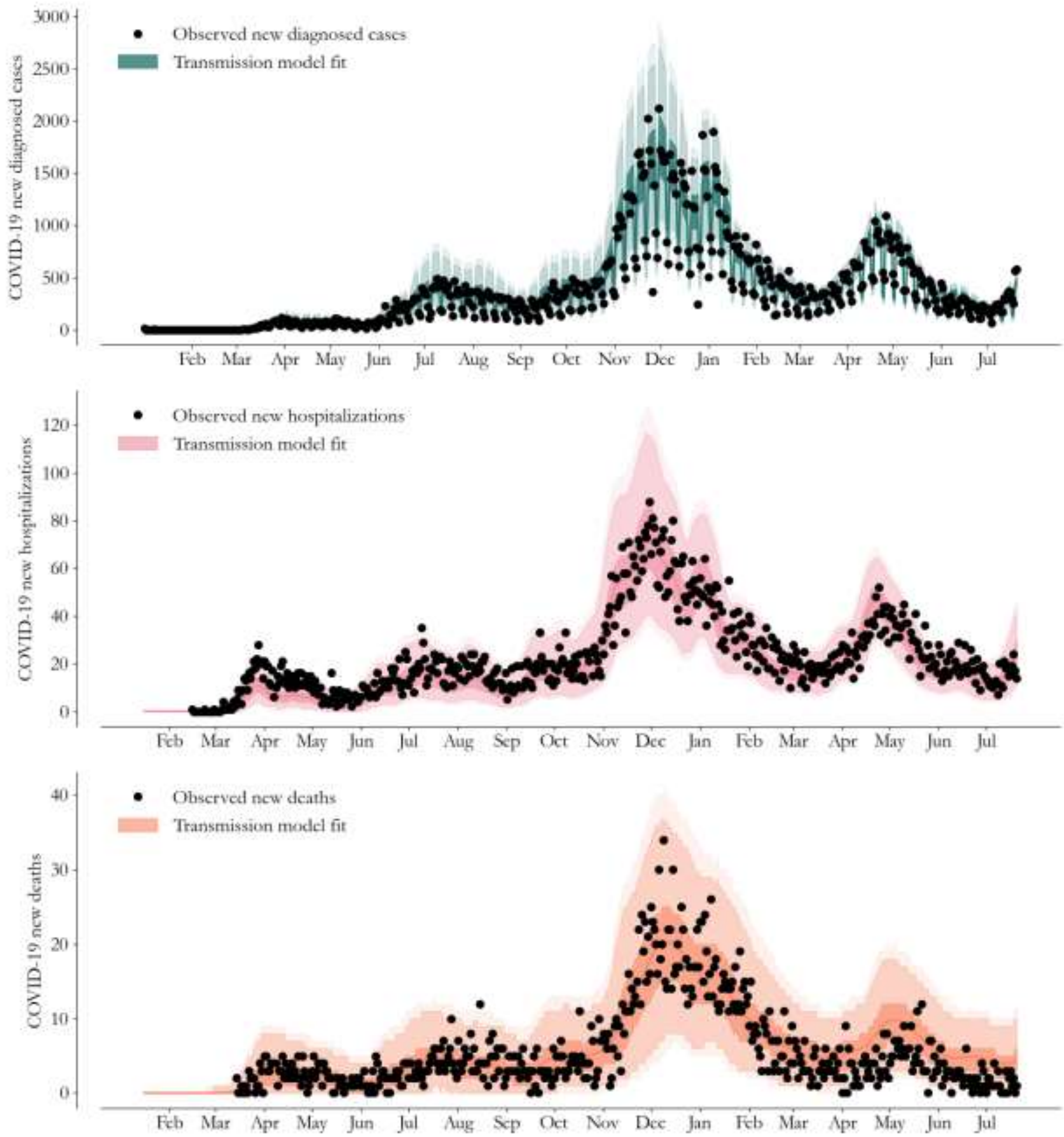

Figure 3: *Fitting the transmission model to Oregon's COVID-19 data on diagnosed cases, hospitalizations, and deaths. The lines represent the mean of 10,000 runs; the 25th-75th percentiles are given in dark shaded areas, 2.5th-97.5th percentiles in the lighter shade, and 1st-99th percentiles the lightest shade. The black dots are observed data. Top panel: Modeled cases (teal) capture the trend in observed, daily new diagnosed cases based on R_e estimates and a free number of importations on January 20, 2020 and February 1, 2020. Middle panel: Simultaneously, the model (pink) captures the trend in observed daily new hospitalizations by assuming hospitalizations are independent of testing volume. Bottom panel: With its time-varying infection fatality ratio, the model (orange) captures the observed trend in daily deaths.*

Population-level immunity

Figure 4 includes estimates of population-level immunity from SARS-CoV-2 infection over time.

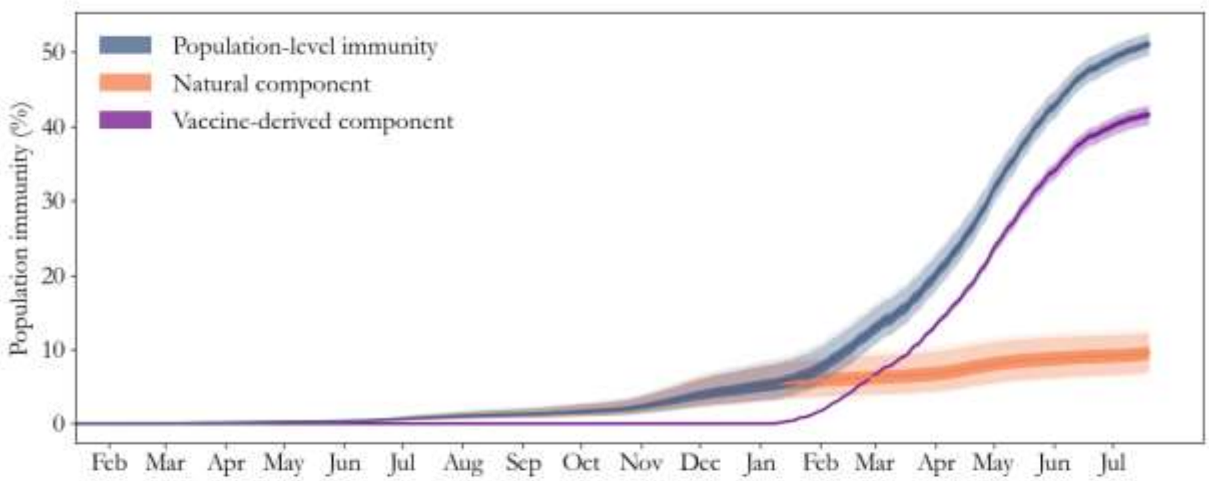

Figure 4: *Estimated population-level immunity to SARS-CoV-2 infection over time. The "natural component" consists of people who developed and then recovered from COVID-19. The "vaccine-derived component" consists of people who were not previously infected, but who achieved immunity from a vaccination dose administered 21 days prior.*

Rainier estimates that as of July 20, the population-level immunity to SARS-CoV-2 was 51.1% (95% confidence interval: 49.6% - 52.5%). The estimated immunity from vaccination (41.6%) is over four times the estimate for natural immunity (9.5%).

Vaccine immunity is helping prevent further spread of COVID-19. If we remove all of those who have immunity from the model calculations and look at the rate of infection, we see each infection spreading on average to 3.18 other people over the week ending on July 14. That is to say, without any immunity (largely due to vaccination), our estimated population R_e would be 3.18 instead of 1.58, and new infections would be increasing at a much faster rate.

COVID-19 trends after the data cutoff

Since we did not include COVID-19 outcome data occurring after July 20 in our modeling dataset due to reporting delays, we examined counts of Oregon COVID-19 hospital occupancy to see if trends have changed more recently. Data from HOSCAP indicate that hospital occupancy increased by 77% between July 20 and July 28.

Scenario Projections

With the fitted model, we can explore outcomes under future scenarios. That is, we do short-term projections to compare what *would* happen if we assume particular future scenarios, rather than specific forecasting about what *will* happen. More about this distinction is described here. Some forecasts of COVID-19 trends generated by others are summarized in Appendix 2.

For the current report, we modeled only one scenario: what would happen to case and hospitalization trends if the recent transmission rate continued.[5] This scenario assumes recent vaccination levels will continue in the upcoming weeks. Figures 5 and 6 illustrate what would happen over the next month if the transmission rate for the week ending July 14 persisted:

- We would see a continued exponential increase in diagnosed cases. For the two-week period between August 4 and August 17, the projected number of new diagnosed cases would increase to 390 per 100,000 people. This rate translates to a daily average of 1,170 cases.
- New hospitalizations would increase to 95 per day by August 17.

The highly-infectious Delta (B.1.617.2) variant comprised approximately 80% of recently genetically-sequenced viral samples in Oregon since the week of July 4 (OHA Variant Dashboard). If we were to assume the Delta variant increased from 80% to 95% of specimens (and people's protective measures stayed the same), the projected increases are slightly higher. In contrast, if people were to adopt more protective measures (e.g., vaccinations, mask wearing indoors in public places), the increase in hospitalizations could be curbed (IHME report). Oregon Health & Science University (OHSU) models assume people's behavior follow a "fear" (more protective measures) and "fatigue" (less protective measures) cycle (OHSU report). With the additional statewide recommendations in mask wearing and large increases in hospitalizations, it

[5] On the week ending July 14, the average estimated rate of transmission corresponded to an *Re* of 1.58. However, a given transmission rate will result in slower growth in cases over time (and lower R_e) as the population immunity increases, because people who are infected becomes less and less likely over time to encounter someone not immune.

is possible people may decide to adapt more protective behaviors and help stop the large increases in hospitalizations.

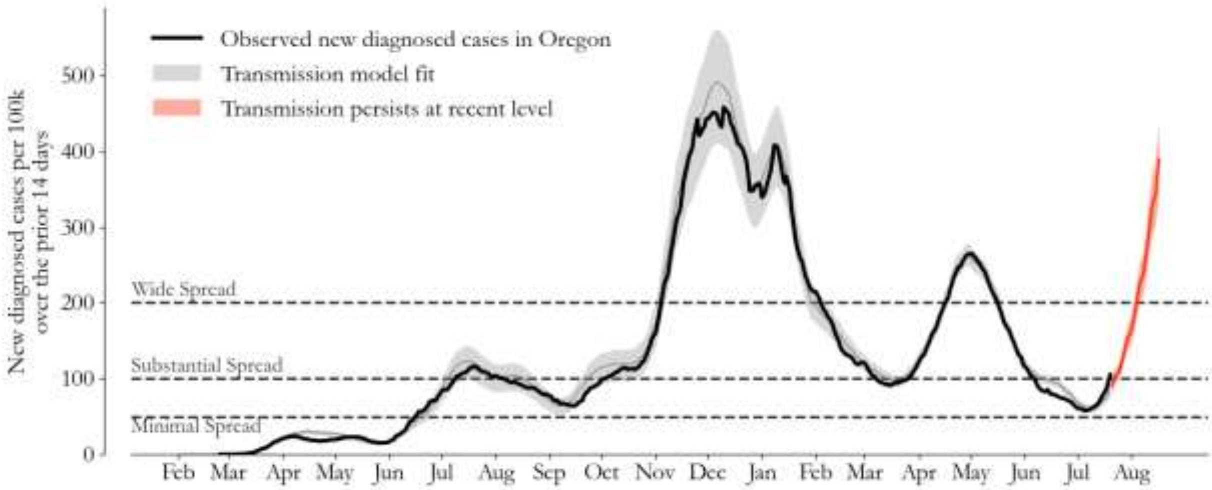

Figure 5: *Observed diagnosed cases (per 100k population over the previous 14 days) for Oregon and projection scenario. The black line shows observed cases, while the red line shows diagnosed cases projected if the transmission rate estimated for the week ending July 14 persists. Shaded areas: 25th-75th percentile ranges of the model fit. The dashed horizontal lines correspond to levels of [Oregon Community Spread](#).*

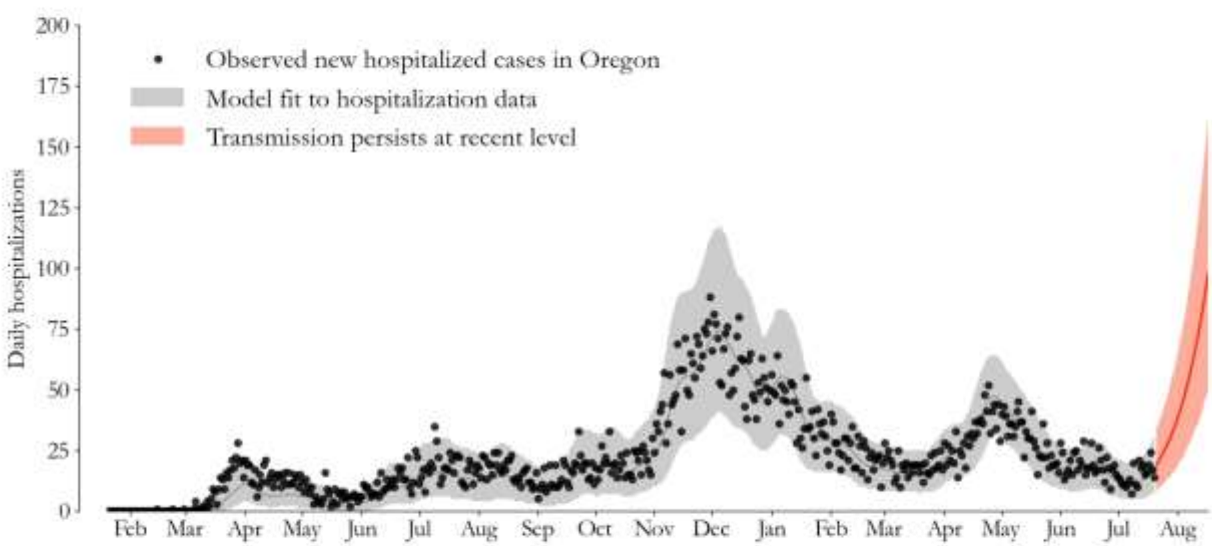

Figure 6: *Observed hospitalized cases for Oregon and projection scenario. Black dots show observed daily counts, while the grey line shows model fit. The red line shows hospitalizations projected if the transmission rate estimated for the week ending July 14 persists. Shaded areas: 2.5th-97.5th percentile ranges.*

Discussion

Oregon's COVID-19 cases and hospitalizations have increased significantly over the past month as the Delta variant has become the dominant strain and protective measures have declined. Consistent with our scenario projection assuming transmission remains at the current level, forecasts from OHSU and compiled by the CDC suggest that COVID-19 cases and hospitalizations in Oregon will continue to increase in the month ahead (Appendix 2).

These models and ours, however, are based on statewide overages, yet the rate of increasing cases and hospitalizations vary dramatically by county (OHA County Dashboard), race, ethnicity, and age (COVID-19 Weekly Report). As an example, in Figures 7 and 8 we present case and hospitalization trends for counties with higher vaccination coverage versus those with less. Counties with at least 60% of the adult population vaccinated have slower increases, on average, in cases and even more so in hospitalizations. The difference in these trends could be due to a combination of vaccination coverage and adherence to recommendations for preventive behaviors (e.g., mask wearing indoors), among other factors.

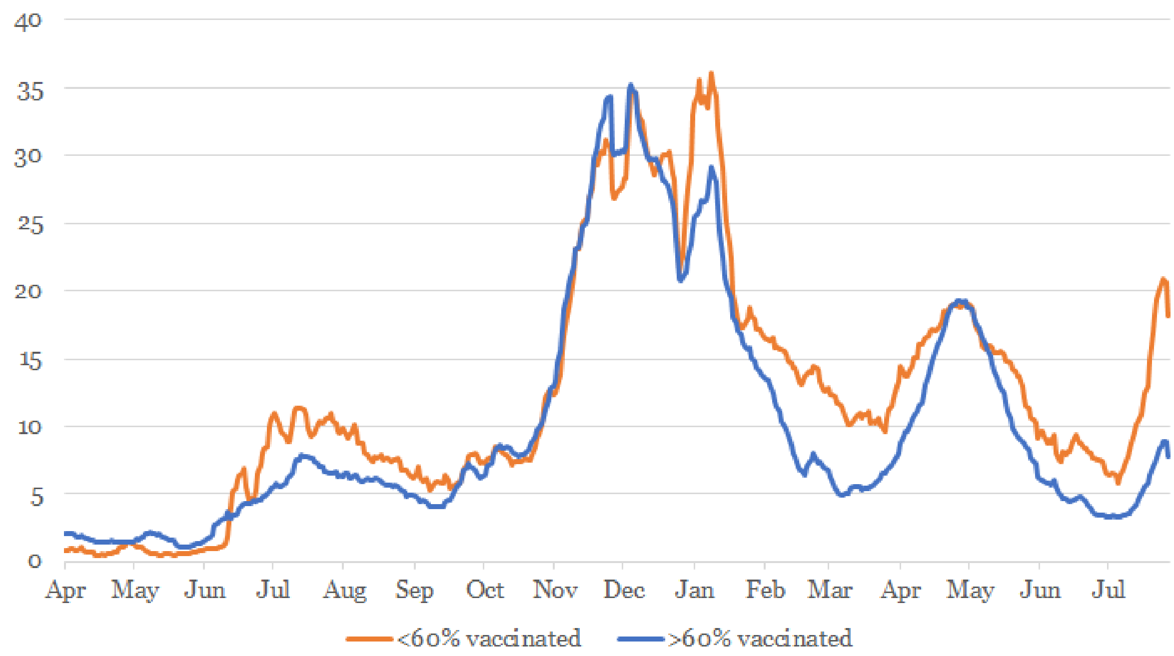

Figure 7: *Seven-day rolling average numbers of new diagnosed cases per 100,000 population, by county vaccination status (below or above 60% of adults with at least one shot, as of July 28, 2021). Dates reflect when individuals had a test specimen collected.*

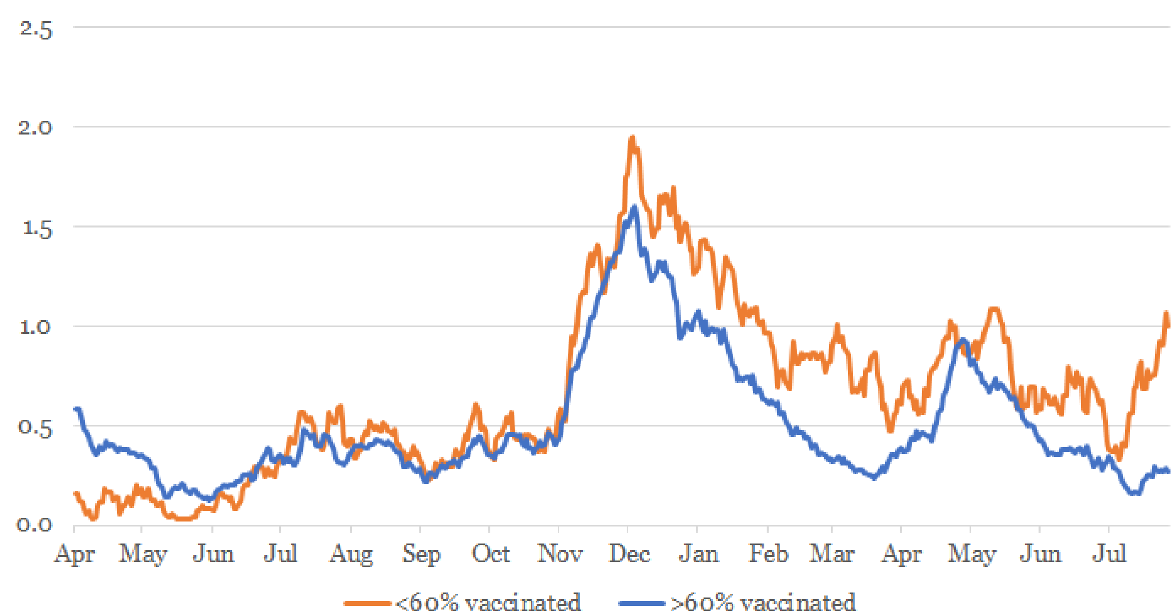

Figure 8: *Seven-day rolling average numbers of new COVID-19 hospital admissions per 100,000 population, by county vaccination status (below or above 60% of adults with at least one shot, as of July 28, 2021). Dates reflect when individuals were admitted to the hospital.*

Appendix 1: Additional assumptions and limitations

We used a COVID-specific transmission model fit to Oregon data on testing, confirmed COVID-19 cases, hospitalized cases, and deaths to estimate the effective reproduction number (R_e) over time. The key modeling assumption is that individuals can be grouped into one of four disease states: susceptible, exposed (latent) but non-infectious, infectious, and recovered.

- For an in-depth description of our approach to estimating R_e and its assumptions and limitations, see IDM's technical report for detailed methods information, as well as the November 23 WA Situation Report for methodology updates.
- As described previously, estimates of R_e are based on an adjusted epidemiologic curve that accounts for changing test availability, test-positivity rates, and weekend effects, but all biases may not be accounted for.
- We included only diagnosed cases, hospitalized cases, and deaths occurring at least 8 days before our Opera data file extract to account for delays in reporting. If reporting delays are longer than that, the last few days of our model input data may undercount COVID-19 events.
- In calculating the proportion of the population with natural immunity, Rainier assumes all people infected and recovered have remained immune, so this might be an overestimate. CDC's latest estimate of proportion infected in Oregon based on commercial laboratory data is lower than our estimate (4.3% vs 9.5%), but their seroprevalence tests might not detect antibodies among all those previously infected.
- Estimates of R_e describe average transmission occurring across Oregon. This report does not separate case clusters associated with known super-spreading events from diffuse community transmission. This report also does not estimate R_e separately for specific populations, who might have higher risk of exposure because of their occupation, living arrangements, access to health care, etc.
- We assumed free / undefined numbers of importations occurring on 1/20/20 and 2/1/20, and specified changes in testing volumes occurring around dates in 2020 (4/1, 6/23, 9/29, 11/1, 11/28, 12/15, 12/27) and 2021 (1/15, 3/7, 4/10, 4/22, 5/21).
- Our age-specific infection fatality ratio (IFR) assumptions are based on those referenced by CDC's Planning Scenarios. We used population fatality rate data from Opera to compute IFRs for the age groups used by Rainier.
- Our age-specific infection hospitalization ratio (IHR) assumptions were computed by dividing each age-specific IFR by the corresponding death-to-hospitalization ratio using data from Opera.
- We assume that COVID-19 reported cases reflect a higher detection rate among symptomatic infections than asymptomatic infections, and that the symptomatic infection rate increases with age. We used age-specific % symptomatic

assumptions as estimated here and adjusted our weekly case distribution to reflect these detection assumptions (without affecting the total number of cases detected).

- We use test specimen collection date for new cases but have only lab report date for negative tests. To better align these two outcomes, we redistributed negative test counts. These counts were reallocated among the laboratory report day and the two days prior, according to distribution of positive cases (by specimen date) occurring over those same three days. Because Rainier's R_e uncertainty is partially based on variation in percent positive, this redistribution of negative cases may cause the R_e confidence intervals to narrow.
- Point estimates should be interpreted with caution due to considerable uncertainty behind COVID-19 model assumptions and limitations to the methods.

Rainier takes vaccination data into account -- both in estimating historical R_e and in scenarios projecting future counts of diagnosed and hospitalized cases (assuming specified COVID-19 transmission rates). Detailed documentation of the model's vaccination component is being prepared by the Institute for Disease Modeling. We describe those methods briefly here.

- For this report, Rainier assumed[6] that a proportion of vaccinated individuals would be protected from SARS-CoV-2 infection 21 days after each vaccine dose: on average 58.0% of those vaccinated after the first dose, and an additional 24.4% after the second dose (for a total of 82.4%). Among vaccinated people not protected from SARS-CoV-2 infection, Rainier assumes roughly 20% to be protected from experiencing severe COVID-19 symptoms (i.e., hospitalization or death) but still able to transmit the virus.
- Rainier's estimate of immunity from vaccination may be conservative – that is, slightly lower at any given point in time because it assumes no immunity develops until three weeks following a dose.
- Another limitation is Rainier's use of these same assumptions for all the vaccines; hence, for this report the single-shot Johnson & Johnson vaccine was considered equivalent to first-doses of the Pfizer or Moderna vaccines. This limitation is not expected to have a large influence on results since the Johnson and Johnson vaccines currently constitute under 4% of total vaccine doses administered to-date in Oregon (Vaccine Dashboard). However, this vaccine may be modeled separately in the future as it becomes more frequently administered.

[6] Dagan, Noa, et al. "BNT162b2 mRNA Covid-19 vaccine in a nationwide mass vaccination setting." *New England Journal of Medicine* (2021). Available online at https://www.nejm.org/doi/pdf/10.1056/NEJMoa2101765

Appendix 2: Summary of External COVID-19 Forecasts

CDC compiles state-level forecasts from numerous national modelers, and produces an ensemble forecast. For Oregon, CDC's ensemble forecast for diagnosed cases predicts case counts will increase through late August, from about 3,350 to 3,650 per week. CDC's ensemble forecast for hospitalizations predicts that Oregon daily admissions will increase through late August, from about 23 to 36 per day,[7] which is considerably lower than our estimates from the scenario projection assuming transmission remains at mid-July levels.

Institute for Health Metrics and Evaluation's July 22 forecast for Oregon estimates that without universal mask use, daily new infections will continue to increase through late-November.

Oregon Health and Science University produces a weekly COVID-19 forecast for Oregon, available here. They present projections under various scenarios. Their forecast (referred to as "primary scenario") suggests hospital occupancy will continue to increase in the coming weeks.

[7] CDC ensemble forecasts are dated July 26, 2021; accessed on July 28, 2021.