

COVID-19 in Colorado, 2/16/2022

Prepared by the Colorado COVID-19 Modeling Group

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Key Messages

- SARS-CoV-2 infections and COVID-19 hospitalization demand continue to decline statewide, and we anticipate continued decline in the weeks ahead, consistent with prior projections in the January 25, 2022, report.
- We estimate 1 in every 69 Coloradans (1.4%) is currently infected.
- Most (90%) Coloradans are immune to the Omicron variant and most are protected against severe disease.
- Vaccine- and infection-acquired immunity will fade over the months to come but will remain high into the start of the summer.
- Key uncertainties include the timing and characteristics of future variants and the timing and target population for the next vaccine dose.

Introduction

Like most of the United States, Colorado experienced an unprecedented surge of COVID-19 in January 2022 due to the Omicron variant. Since late January, reported cases, COVID-19 hospital demand and percent positivity have been declining rapidly since the Omicron peak. The 7-day average number of reported cases in Colorado has fallen from 13,800 on January 10 to 1,500 on February 16th. Similarly, the number of people hospitalized with COVID-19 has fallen from 1,676 on January 18 to 641 on February 16th. The percent of COVID-19 tests that are positive has dropped from 29% to 6.9% (7-day average).

The purpose of this report is to evaluate the likely course of SARS-CoV-2 in the coming months. We focus on three key questions

1. How quickly will COVID-9 hospitalizations and SARS-CoV-2 infections decline?
2. What percent of the Colorado population is estimated to be immune to infection and how will this figure change over time?
3. What percent of the Colorado population is estimated to be protected against severe disease and how will percentage this change over time?

To answer these questions, we use COVID-19 hospital, vaccination, and case data and a mathematical model of the epidemic of the virus tailored to Colorado. We also conducted a review of the scientific

literature on the degree of protection offered by infection and vaccination as well as how rapidly immunity wanes over time. We updated our model assumptions to reflect the latest scientific information. The scientific evidence on immunity will continue to evolve as we monitor what is happening over time and we will update our assumptions accordingly.

Key message 1: infections and hospital demand are falling rapidly and should continue to fall in the coming weeks.

The decline in hospital demand has followed our second-most optimistic projection in the [January 25, 2022 report](#). Figure 1 shows the number of Coloradans hospitalized with confirmed COVID-19 over the months of the Delta and Omicron surges and our projections of future COVID-19 hospital demand, as generated in late January. These projections, starting on January 23, were generated under a range of assumptions concerning the level of transmission control in Colorado. Transmission control increased modestly during the Omicron wave. These scenarios reflect various possible drops in the level of transmission control (TC) in the state as Omicron receded, and people relaxed control measures. The actual decline, shown as a black line in the figure, aligns directly with the orange line corresponding to a 5% drop in transmission control. On that curve of decline, the number hospitalized is projected to drop below 250 by the end of February. Even if the curve proceeds in the scenarios with greater reductions in transmission control, the other projections all reach 250 by month's end.

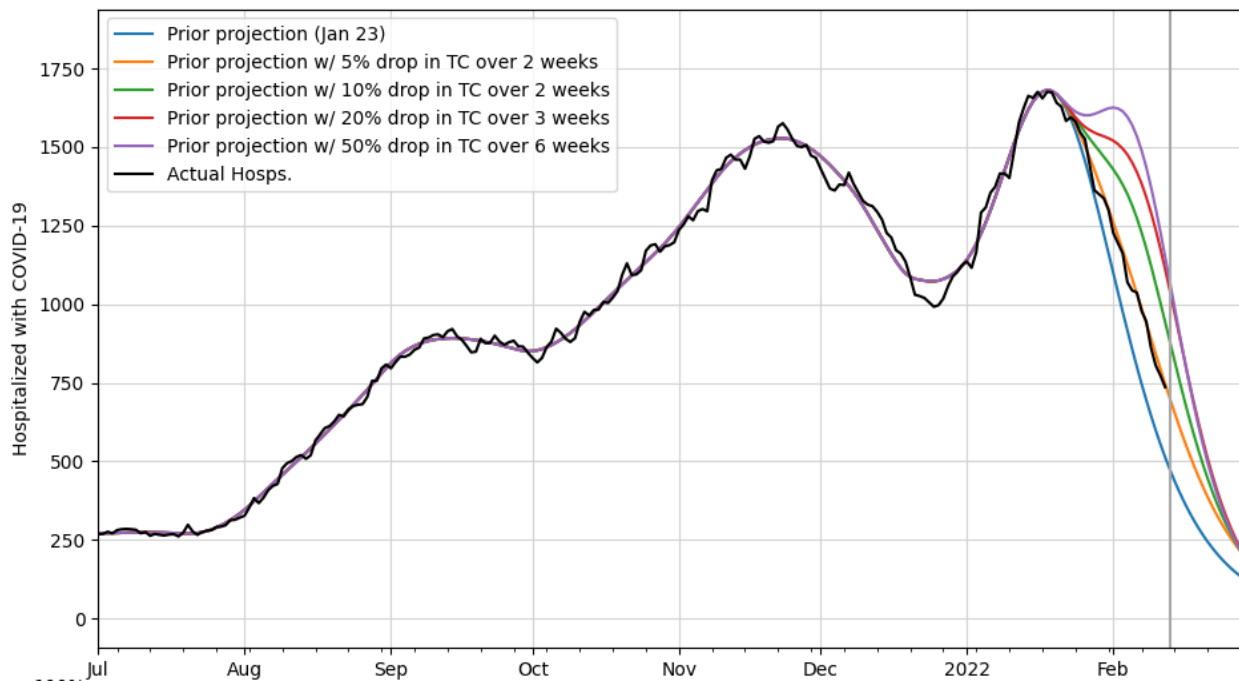
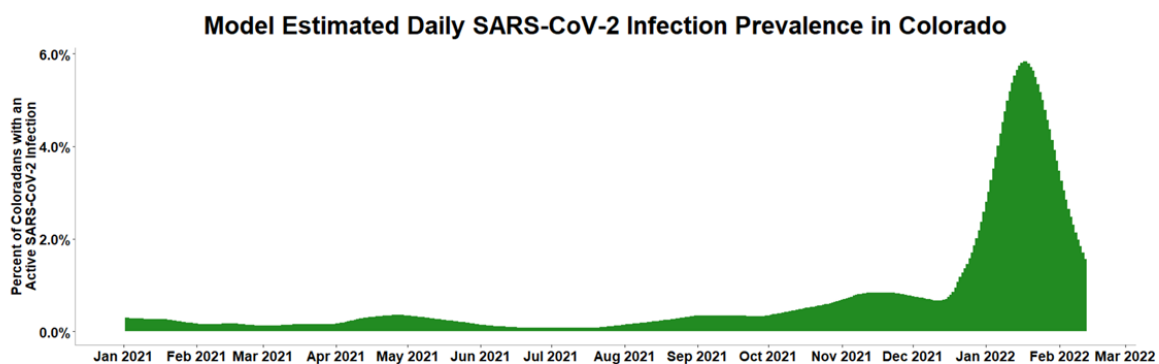
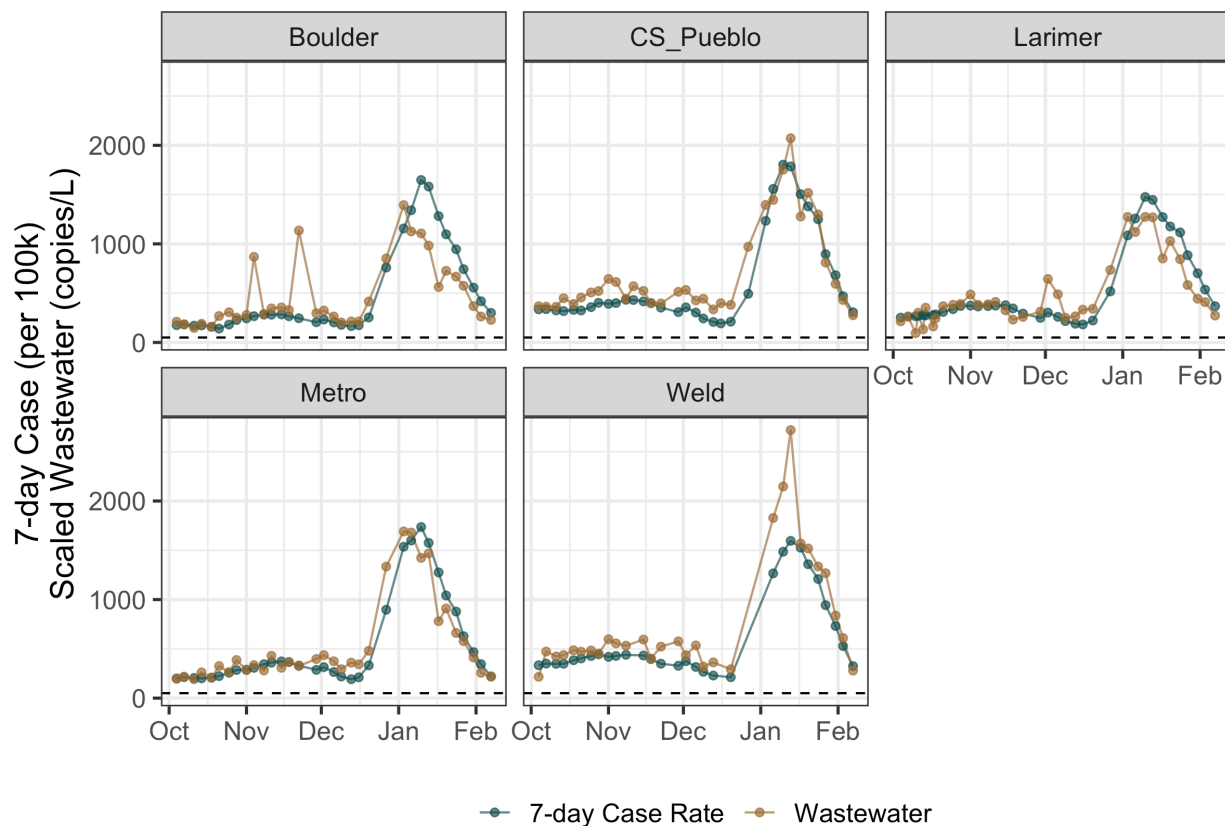


Figure 1. Projected daily COVID-19 hospital demand in Colorado through the end of February, based on model simulations generated on January 23. Black line shows actual daily COVID-19 hospital demand through February 14, 2022. To account for uncertainties, projections were generated assuming Colorado remained on the current trajectory (blue line), as well as accounting for possible relaxation in transmission control over two to six weeks (orange, green, red and purple lines).

Infections are also declining rapidly, as indicated by our model and wastewater surveillance. We track the estimated percentage of Coloradans who are infected with the SARS-CoV-2 variant (Omicron at present) as another indicator of the status of the pandemic in the state. **We estimate that 1 in 69 Coloradans (about 1.4%) are infected with SARS-CoV-2 as of February 13 (Figure 2).** This estimate is well below that in the January 25 report, which was 1 in 19 or about 5%. There is considerable uncertainty around the estimation of infection prevalence; however, all evidence indicates infection prevalence has declined substantially from the peak in January 2022. (We note in the latest model simulations, we now estimate peak prevalence was 6%, due to updates to model assumptions discussed in the appendix, and more complete data on Omicron in Colorado). The proportion of the population infected is still high relative to prior lows, but we anticipate that decline will continue parallel to that projected for hospitalization. With this level of infection in Colorado, there is still a risk of encountering someone with SARS-CoV-2.



The concentration of SARS-CoV-2 in wastewater is another useful indicator of the status of the epidemic and useful for surveillance purposes. Wastewater analyses measure the number of SARS-CoV-2 copies per liter in wastewater samples obtained at various sites across the state (Figure 3). To examine the SARS-CoV-2 concentrations in wastewater, we first average readings across multiple sites within a region or county. Figure 3 shows the 7-day moving average of daily concentrations at these sites. The moving average is taken to smooth the data and reduce the inherent variation of the daily measurements. The wastewater data is then rescaled to units comparable to 7-day case rates per 100,000. For comparison, the figure also includes the 7-day case rate. The wastewater virus concentrations show a rise and fall comparable to that for reported cases, further confirming that the Omicron wave has declined greatly. The close relationship between case rate and virus concentration supports the continued use of wastewater as a surveillance tool.



Data as of 2022-02-07
 Dashed line indicates 7-day case rate of 50 per 100k

Key message 2. Immunity to infection and protection against severe disease is high in the Colorado population and expected to remain high in the coming months.

To address how immunity changes after vaccination or infection, we conducted a rapid literature review, synthesizing the most important, recent studies on the topic. Evidence from the identified studies shows vaccine-derived immunity is strong against hospitalization for those infected with Omicron. Specifically, recent evidence supports strong protection against hospitalization and death for individuals who received two doses of an mRNA vaccine and a booster (UK HSA 2022; Moss 2022; Keeton 2022). The UK Health Security Agency estimates 90% of individuals have protection against hospitalization after receiving two-doses of the Pfizer vaccine and a booster. Individuals evaluated 10 to 14 weeks after their booster had 75% vaccine effectiveness against hospitalization (UK HSA 2022). Similarly, individuals receiving a Moderna booster had 90-95% vaccine effectiveness against hospitalization for up to 9 weeks following their booster. Vaccine-derived immunity against hospitalization also remains high across all variants (UK HSA 2022).

While protection against hospitalization remains high over time, vaccine-derived immunity against symptomatic disease declines more quickly over time. Recent analysis of vaccine effectiveness against symptomatic disease from Delta and Omicron variants found that after 2-doses of Pfizer or Moderna vaccine effectiveness drops from 65-70% to 10% by week 25 after the second dose ([UK HSA 2022](#)). Vaccine effectiveness against symptomatic infection was 60-75% roughly two to four weeks after individuals received a booster of Pfizer or Moderna, but dropped to 25-40% 15 weeks or more following the booster dose ([UK HSA 2022](#)).

Studies on infection-derived immunity also show high levels of protection against hospitalization upon reinfection ([Pilz 2022](#); [Léon 2022](#)). In a study in Qatar, individuals who had been previously infected had 90% lower odds of hospitalization or death compared to initial infections ([Abu-Raddad 2021](#)). However, similar to vaccination, given rates of reinfection during the Omicron surge, there is evidence that protection from infection is low ([Andeweg 2022](#)). More research is needed to address questions regarding the duration of protection derived from Omicron infection and the rate at which immunity from Omicron infection wanes.

We used the findings of the literature search to update the epidemic model for Colorado and generate estimates of the percent of the Colorado population that is estimated to be immune to infection (Key question 2) and protected against severe disease (Key question 3). We updated model assumptions concerning immunity for those who are vaccinated and for those who have been infected with SARS-CoV-2, including both initial levels of protection and the rate of decay, to reflect the latest scientific evidence (details of these assumptions are provided in the Appendix). We then ran model simulations to generate estimates of the current level of immunity in the population and how it may decay over time.

We estimate that the level of immunity against Omicron infection is high in Coloradans, presently about 90% (Figure 4). Vaccination had a major role in reaching high levels of immunity (immunity due to vaccination is shown as the orange line) as did the high number of infections during the Omicron surge. We anticipate immunity to Omicron infection to decline gradually in the months ahead, and to remain at high levels through the spring, declining to approximately 80% by June 2022. Due to unknowns about the rate of immune decay over long periods, there is considerable uncertainty about population immunity more than two months into the future. We will be monitoring the literature closely in the months ahead.

We estimate that the level of protection against severe disease is above 90% in the Colorado population and we anticipate this will remain above 90% through the spring (Figure 4). As above, due to unknowns about the rate of immune decay over long periods, there is considerable uncertainty about population immunity more than two months into the future.

At present, almost all Coloradans are protected against infection with the Omicron variant. Immunity will wane over time. Nonetheless, we expect immunity to be high and the vast majority of Coloradans protected against severe disease up to the start of summer when the projection ends.

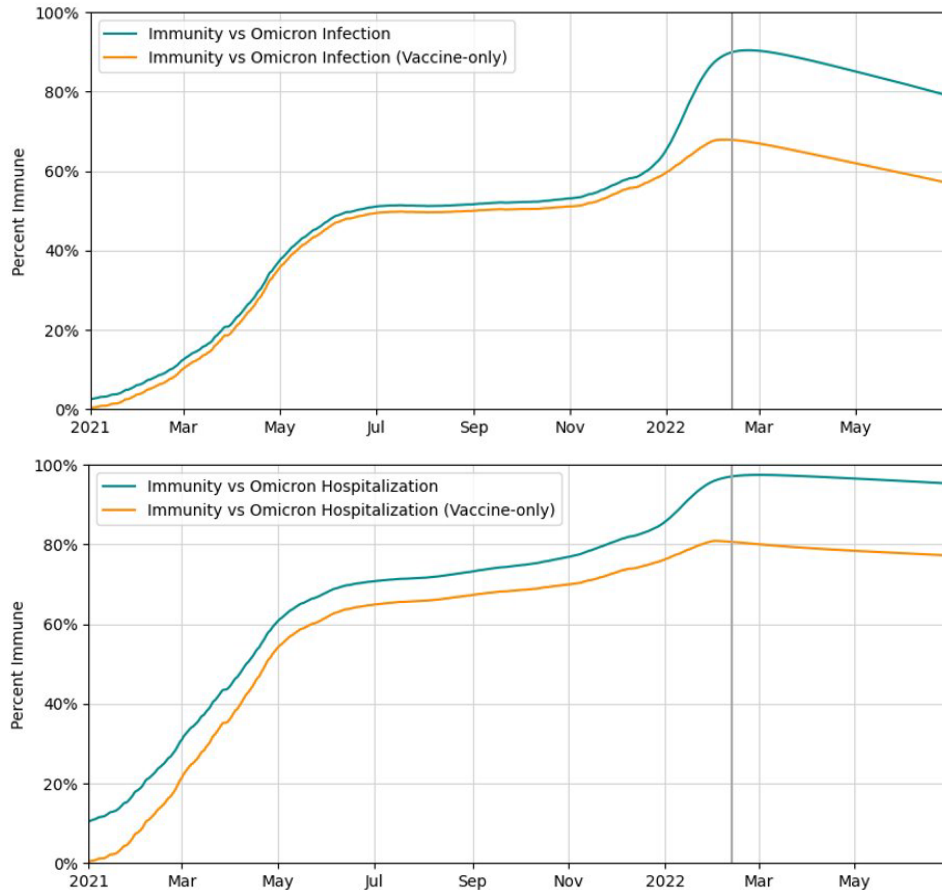


Figure 4. Estimated percent of the Colorado population with immunity to Omicron infection (top panel) and the percent of the population protected against severe disease (bottom panel). Estimates are generated using our mathematical model of SARS-CoV-2 in Colorado and model assumptions have been updated to reflect the latest scientific evidence regarding vaccine- and infection-acquired immunity. The percentages refer to the overall population of Colorado and the vertical line marks February 13.

Estimates of the future of the SARS-CoV-2 pandemic in Colorado based on our model are similar to estimates from other groups. The [Covid-19 ForecastHub ensemble model](#) (used by the CDC) and models from the [Institute for Health Metrics and Evaluation \(IHME\)](#) also predict the steady decline in new daily cases, hospitalizations, and deaths to continue in the coming weeks.

Conclusions. SARS-CoV-2 infections and COVID-19 hospital demand are falling rapidly. The current risk of exposure to SARS-Cov-2 remains relatively high. We anticipate this risk will continue to fall over the month of February towards prior low levels. We estimate most (90%) Coloradans are immune to Omicron and protected against severe disease. This immunity will fade over the months to come but will remain high into the start of the summer. Key uncertainties include the timing and characteristics of future variants and the timing and target population for the next vaccine dose.

Given high levels of population immunity, we anticipate limited outbreaks of SARS-CoV-2 infections and severe COVID-19 in the months ahead. The areas of greatest concern include regions with low vaccination uptake. We note that 28% of Coloradans are currently eligible for a booster but have not yet been boosted, and that vaccination coverage varies widely across the state (Figure 5). While it remains unknown what the next variant will look like, to date the unvaccinated and under-vaccinated have faced greater risks of severe disease than those up to date on their vaccinations.

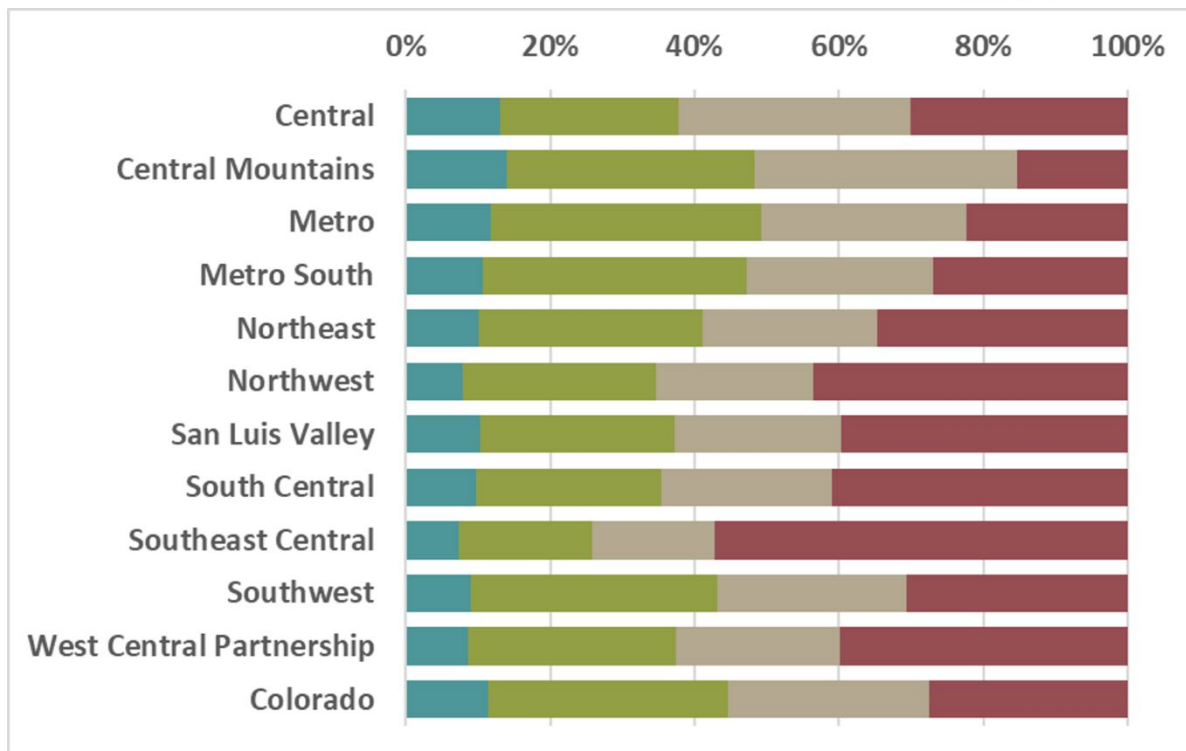
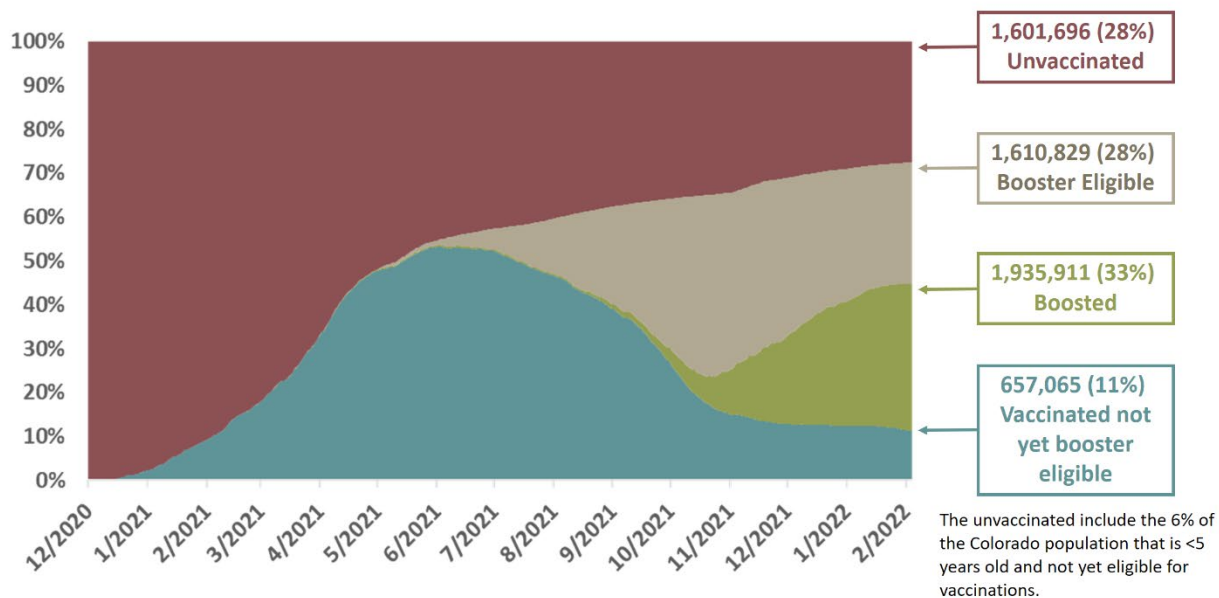


Figure 5. Vaccination status in the total Colorado population over time (top panel) and by region as of February 4, 2022. Percent of the total population that is vaccinated and not yet booster eligible (teal), boosted (green), booster eligible (brown) and unvaccinated (red).

Appendix

The model is an age-structured SEIRV (susceptible-exposed-infected-recovered-vaccinated) infectious disease transmission model that has been calibrated to Colorado-specific data whenever possible. For example, the length of time that a COVID-19 patient is assumed to spend in the hospital varies by age and over time and is based on data provided by Colorado hospitals. Model details and a listing of recent model updates are provided in the Appendix at the end of this report.

This report is based on COVID-19 hospitalization data through 2/14/2022 and vaccination data through 2/04/2022. In our model simulations, we estimate that Omicron is more infectious and has greater immune escape than Delta. We also estimate that Omicron is less severe, reducing both the probability of infection and the length of hospital stay among those hospitalized with COVID-19.

Code is available on Github at <https://github.com/CSPH-COVID/covid-models>.

Recent model updates

Omicron characteristics. Based on the latest literature and latest data from Colorado, we have adjusted Omicron's epidemiological characteristics as follows:

- Omicron infectiousness is slightly reduced, but still much more infectious than all prior variants.
- Omicron immune escape vs prior infection (with a non-Omicron variant) is increased.
- Omicron severity is reduced.

Vaccine and prior infection immunity characteristics. Based on the latest literature and latest data from Colorado, we've adjusted the impact of prior infection and vaccination as follows:

- Immunity from prior infection declines more quickly, increasing the chance of reinfection after 6+ months.
- Reinfections now have a reduced chance of severe disease.
- Immunity from a third vaccine dose now provides additional protection against Omicron, substantially greater than from a second dose.
- Immunity from a third vaccine dose now decays more slowly than immunity from a second vaccine dose.

Hospitalization data used for fitting. To better capture the true burden of severe disease over time, we are now using an additional data source to account for backfilled hospitalization data. Previously, the model relied exclusively on EMResource to determine the number of individuals hospitalized with COVID-19 on any given day. We have integrated data from COPHS with EMResource to account for additional hospitalizations that have been backfilled or that we expect to be backfilled in the coming months, leading to higher overall estimates for the number of individuals hospitalized with COVID-19.