COVID Model Projections

January 19, 2022

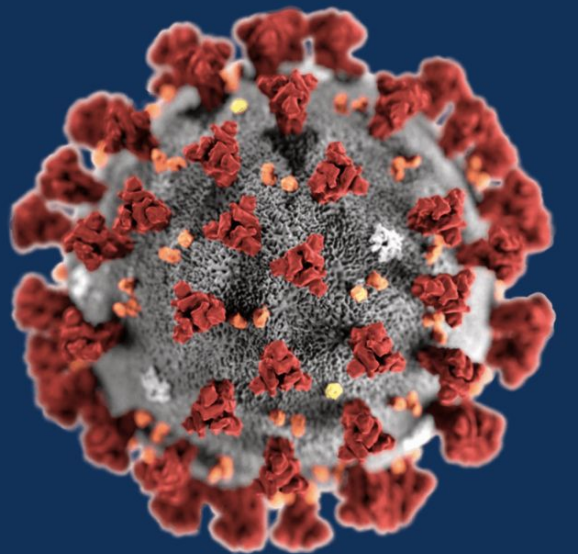
BC COVID-19 Modelling Group

@bcCOVID19group

About BC COVID-19 Modelling Group

The BC COVID-19 Modelling Group works on rapid response modelling of the COVID-19 pandemic, with a special focus on British Columbia and Canada.

The interdisciplinary group, working independently from Government, includes experts in epidemiology, mathematics, and data analysis from UBC, SFU, UVic, and the private sector, with support from the Pacific Institute for the Mathematical Sciences.



https://bccovid-19group.ca

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Independent and freely offered advice, using a diversity of modelling approaches.

Overview

Omicron is causing rapid growth in health care demands in BC

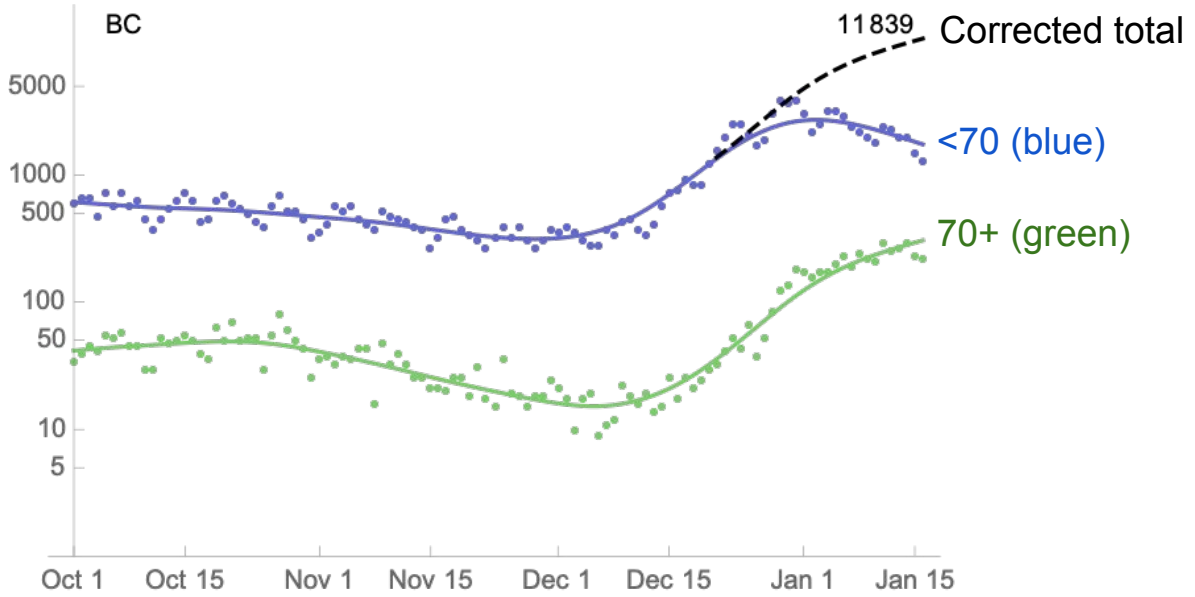
- General BC case data are no longer useful to track the growth, due to testing capacity limits and changes in testing policy for BC.
- Case data for those over 70 and hospital data suggest the growth rate declined from about 20% per day to about 10% per day.
- In the absence of reliable case data, hospital admissions can provide a good measure to track the pandemic and its impact, as it has less lag than hospital occupancy data. Currently, hospital admission data is updated at irregular intervals.
    - Access to accurate, timely, and consistent daily hospital admission data would allow for better projections of health care demands. We ask BC to make such data public.
- With the reduced growth rate, the projected peak in hospital demands is lower and delayed until February, if we continue with current restrictions.
- BC projected hospital demands similar to those experienced recently in US.

Age-corrected case counts: British Columbia

As testing reached its limits, people under 65 without health issues were discouraged from testing in BC.

We can thus use trends in older age cohorts (green) to correct for limited testing in younger groups (blue).

The black dashed curve gives the expected total number of cases, applying growth of the older age group to all ages and assuming the fraction of cases >70 has remained the same as its Dec 21 value (see Appendix).



→ Using this age correction, the estimated number of cases that would have been detected on January 16 is **~12000** had testing limits not been exceeded, **compared to the 1509** reported.**

Source (S. Otto; BC COVID-19 Modelling Group) *New cases per day in 10-year age groups were downloaded from the **BCCDC COVID-19 data portal**. Cubic spline fits to log-case data were obtained (curve) and estimates for those <70 obtained by applying the fits for those 70+, shifted up to match the projection for that age class on 21 December 2022 when testing limits were initially reached in many parts of BC. **From the daily BC Gov News reports.

Age-corrected case counts: Health Authority

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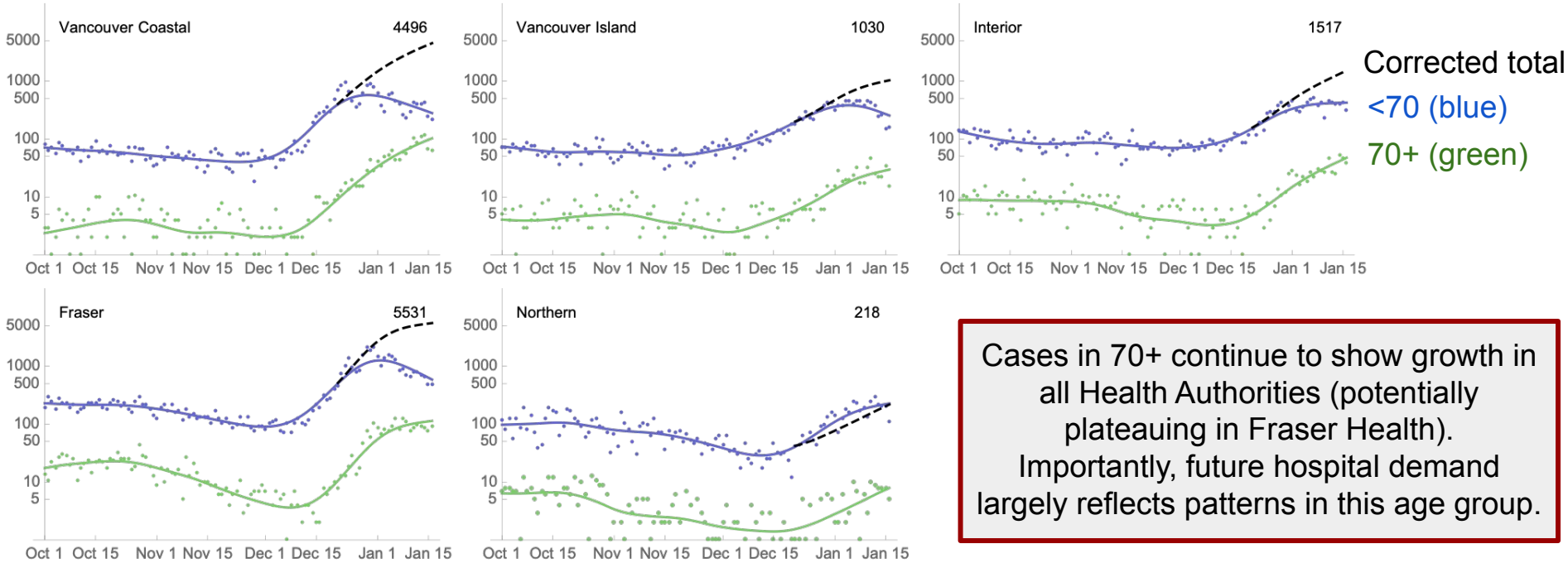
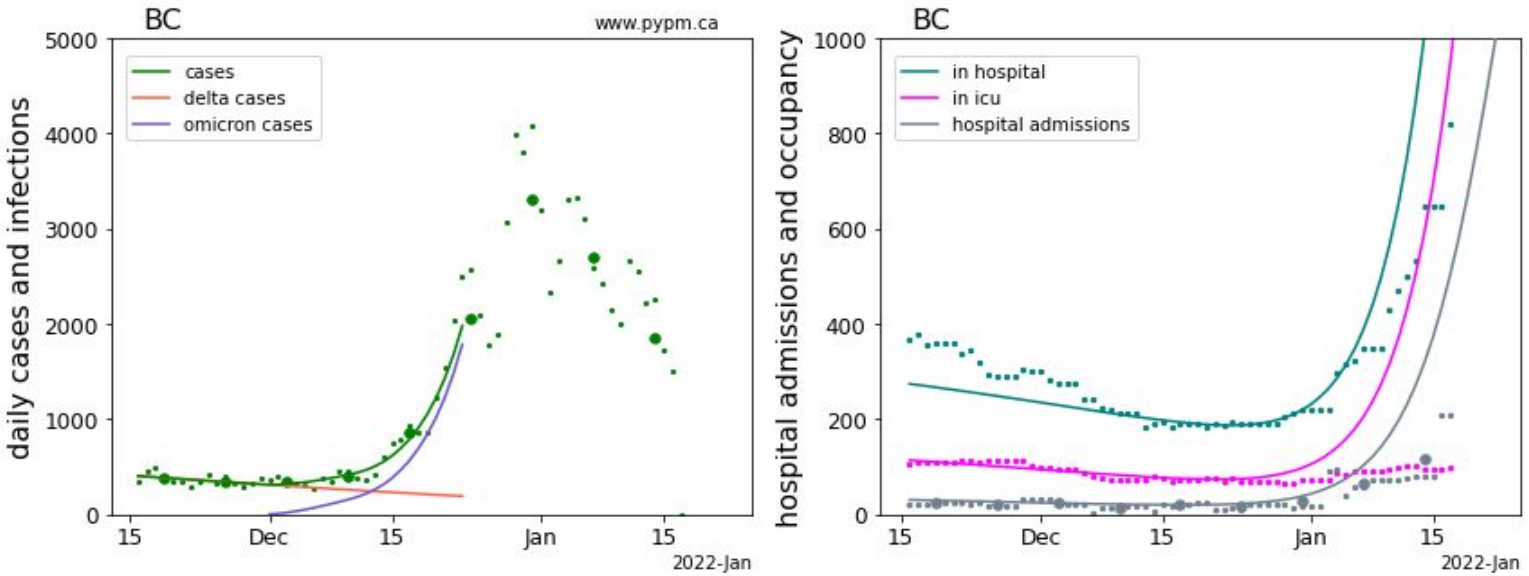


Cases in 70+ continue to show growth in all Health Authorities (potentially plateauing in Fraser Health). Importantly, future hospital demand largely reflects patterns in this age group.

→ Applying to each Health Authority accounts for more spatial heterogeneity and predicts even more cases (~**13000** on January 16).

Source (S. Otto) *New cases per day in 10-year age groups were downloaded from the **BCCDC COVID-19 data portal**. Cubic spline fits to log-case data were obtained (curve) and estimates for those <70 obtained by applying the fits for those 70+, shifted up to match the projection for that age class on 21 December 2022 when testing limits were initially reached in many parts of the province. **From the daily BC Gov News reports.

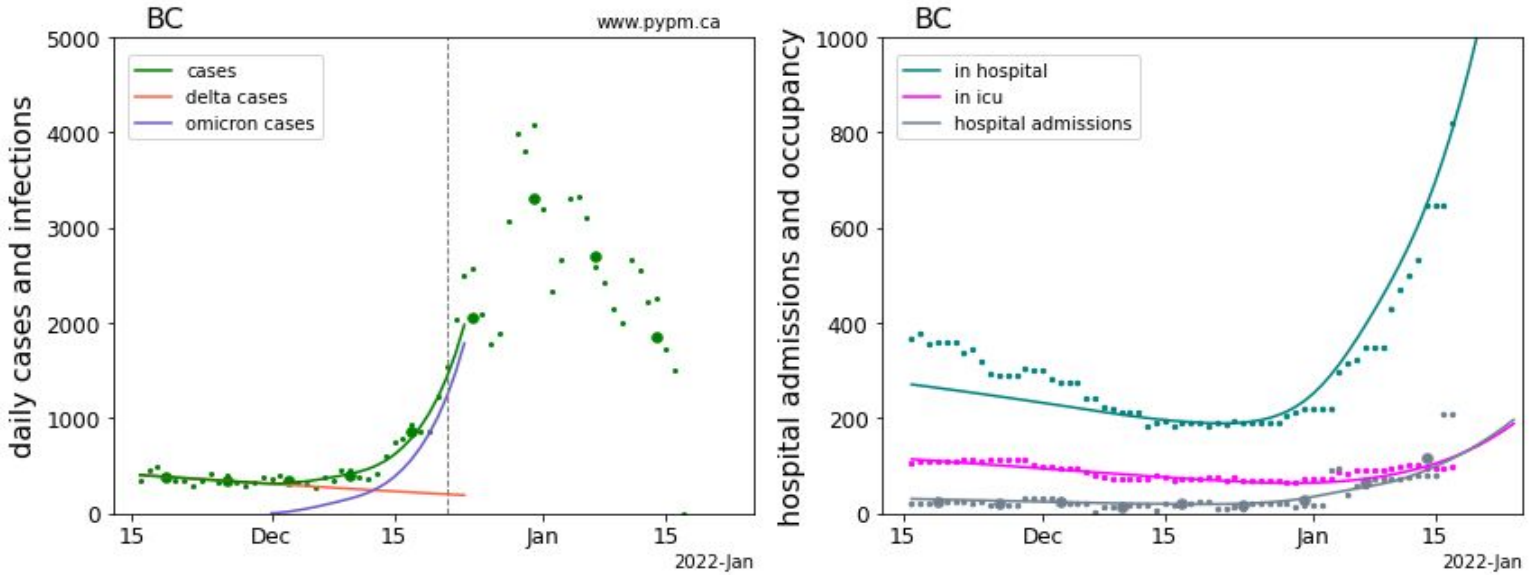
January 6 projection for BC (with updated data)



→ Daily hospital admissions have grown more slowly than projected. This suggests that the Omicron transmission rate declined sometime in December.

Source (D. Karlen). See www.pypm.ca. The larger dots show weekly averages.

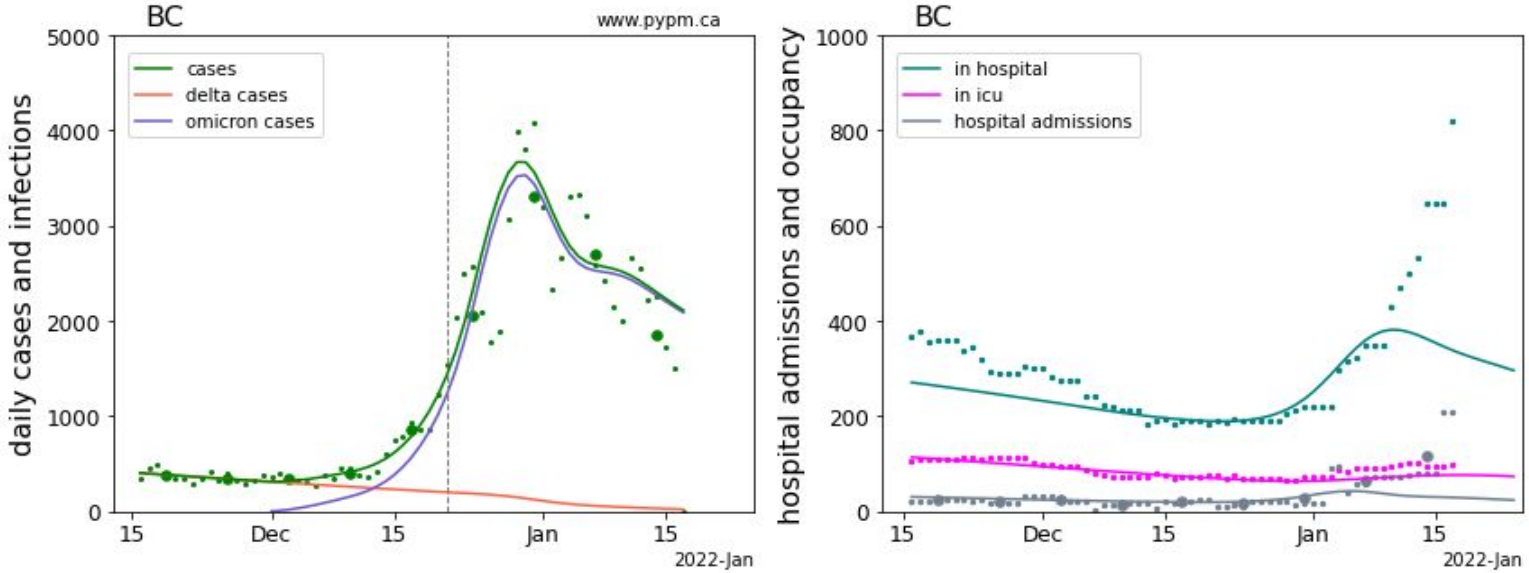
Updated projection for BC



- Dashed vertical line shows the date where a transition to a lower Omicron transmission rate is included to match daily hospital admission data. → **Reduced growth rate from about 20%/day to about 10%/day.**
- Duration of hospital stays for Omicron admissions increased (in accord with our study of US states)
    - ICU rates and duration for Omicron infections not well estimated: large uncertainty
- Hospital data back in agreement with projection

Source (D. Karlen). See www.pypm.ca. The larger dots show weekly averages.

Significant drop in Omicron infection rate? No.

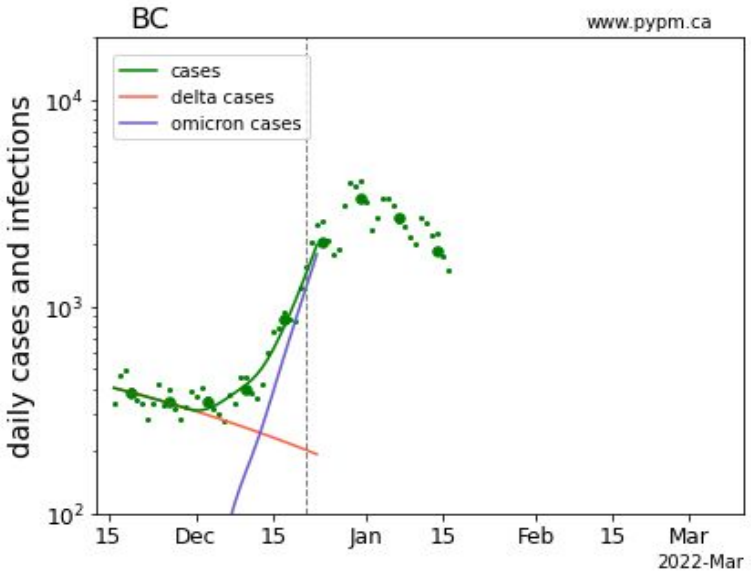


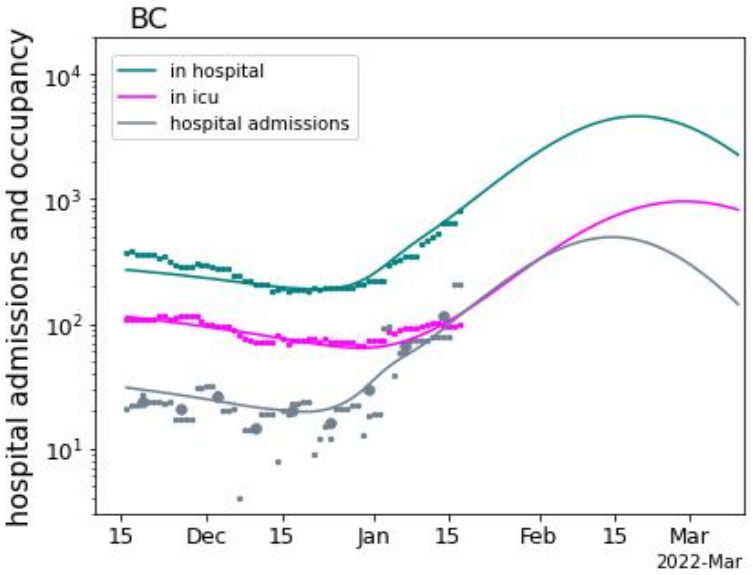
- Transition to much lower Omicron transmission rate in December in order to match all case data.
- This possibility is ruled out by hospital admission and hospital census data.

→ Using case data (without accounting for testing limits) would imply a significant drop in infection rates, but this does not match hospitalization data.

Source (D. Karlen). See www.pypm.ca. The larger dots show weekly averages.

Longer term projection

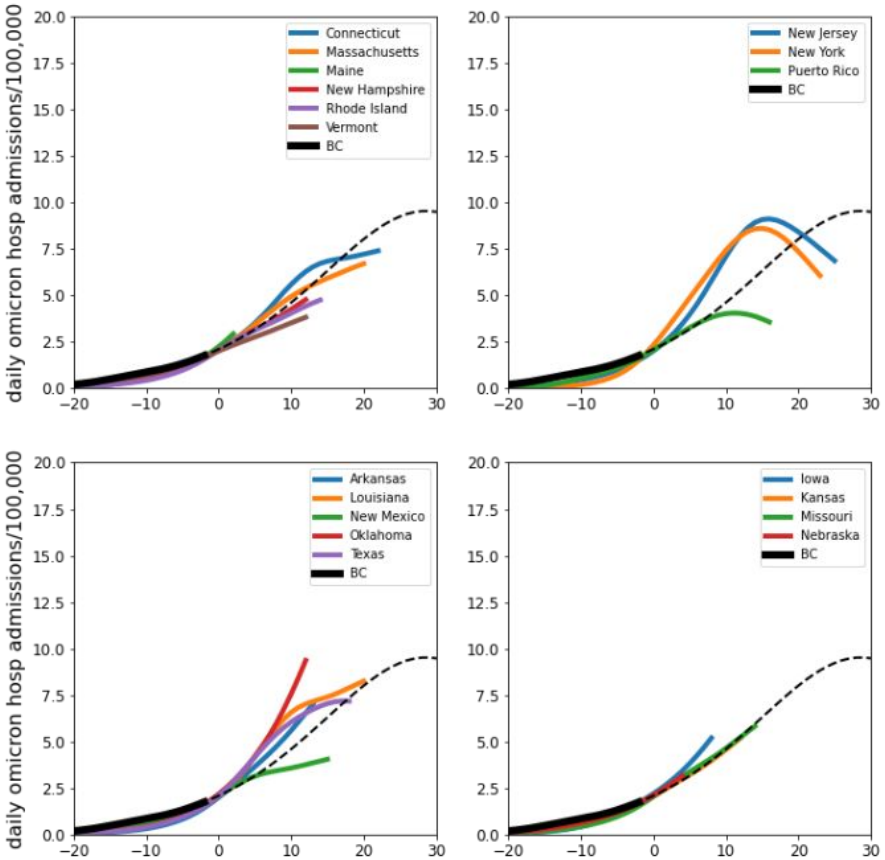




- With reduced transmission rate, peak in demand for daily COVID hospital admissions is delayed until mid-February and lowered to about 500.
    - Note: hospital capacity limits not included in projections
    - Note: ICU occupancy projections have large uncertainty
- Definition of “COVID hospital admission” recently changed - cannot compare going forward?

Source (D. Karlen). See www.pypm.ca. The larger dots show weekly averages.

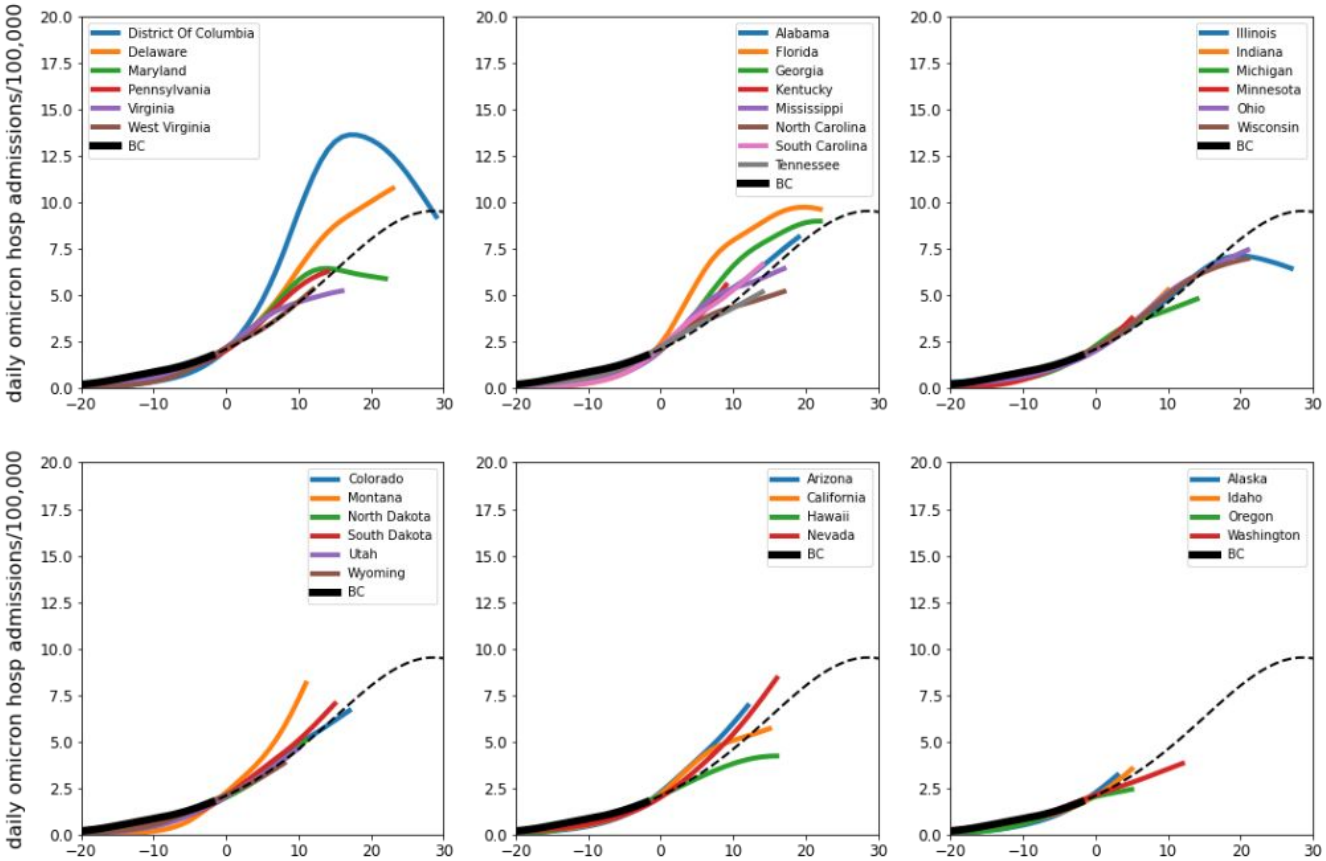
Comparing longer term BC projection with US



- In our study of US states, models are independently fit for each state to data on
  - Omicron and Delta strains
  - Case and hospitalization data
- Daily hospital admissions due to Omicron infections are estimated from model fits and shown in figure as proportion of population
  - States grouped by region
- Data are aligned on the day that the state first exceeded two Omicron admissions per 100,000 inhabitants (day 0)
  - Curves end on current date
- BC projection is overlaid in black for comparison
  - Solid curve ends on current date
  - Dashed curve shows projection

Source (D. Karlen). See www.pypm.ca.

Comparing longer term BC projection with US



- The BC projection, assuming the current growth rate is maintained, is similar to that experienced by many US states.
- Relaxing measures in BC will cause peak hospital demand to increase.

Age-based model projections with Omicron

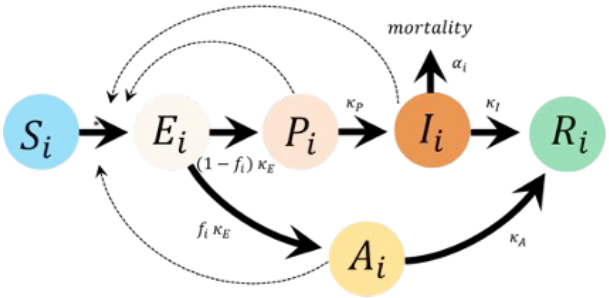
The following slides show model projections for the daily number of cases and number in hospital due to Omicron, using BC data for vaccination status and hospitalization rates by age. Updates:

- **Vaccines:** Vaccine status of BC population updated to that on January 14, 2022 (allowing time for their immunity to build), including % of boosters by age.
- **Severity**: Risk of hospitalization per case is lower for Omicron (estimated as 76% as severe among unvaccinated by Ferguson et al. and 33% as severe by UK Technical Briefing). A range is explored.

Remaining parameters as in previous report:

- **$VE_{infection}$**: Vaccine Effectiveness against infection set to 10% for unboosted individuals and 75% for boosted individuals (UK Technical Briefing 33).
- **P_{severe}** (Hazard Ratio): Omicron is 34% as severe among vaccinated relative to unvaccinated infected individuals (Ferguson et al.)

The growth rate of Omicron was set to 20% per day, matching case numbers in December. Length of stay in hospital was halved to 6 days for Omicron. Slides assume ~1/4 of all infections in BC were detected (Hamadeh et al.) before testing limits were reached.



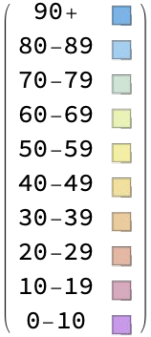
SEAPIR Model (Day et al. 2020)

10 age classes

{0-9,10-19,...80-89,90+}

2 immune classes

- Vaccinated (or recovered)
- Susceptible



Source (S. Otto). Modified from model analyses reported by CoVaRR-Net Pillar 6, modified to focus on predictions for the population of BC and adjusting the initial number of cases to account for an observed incidence of ~1000 Omicron cases on December 21, alongside 300 cases and 192 hospitalizations for Delta (not modeled explicitly). Data from Ferguson et al. use their corrected numbers (P_{severe} =26/76, assuming two doses of Pfizer vs unvaccinated, Table 3).

Projected Omicron infections by age

FEW INFECTIONS DETECTED (25%)
Only infections with moderate symptoms

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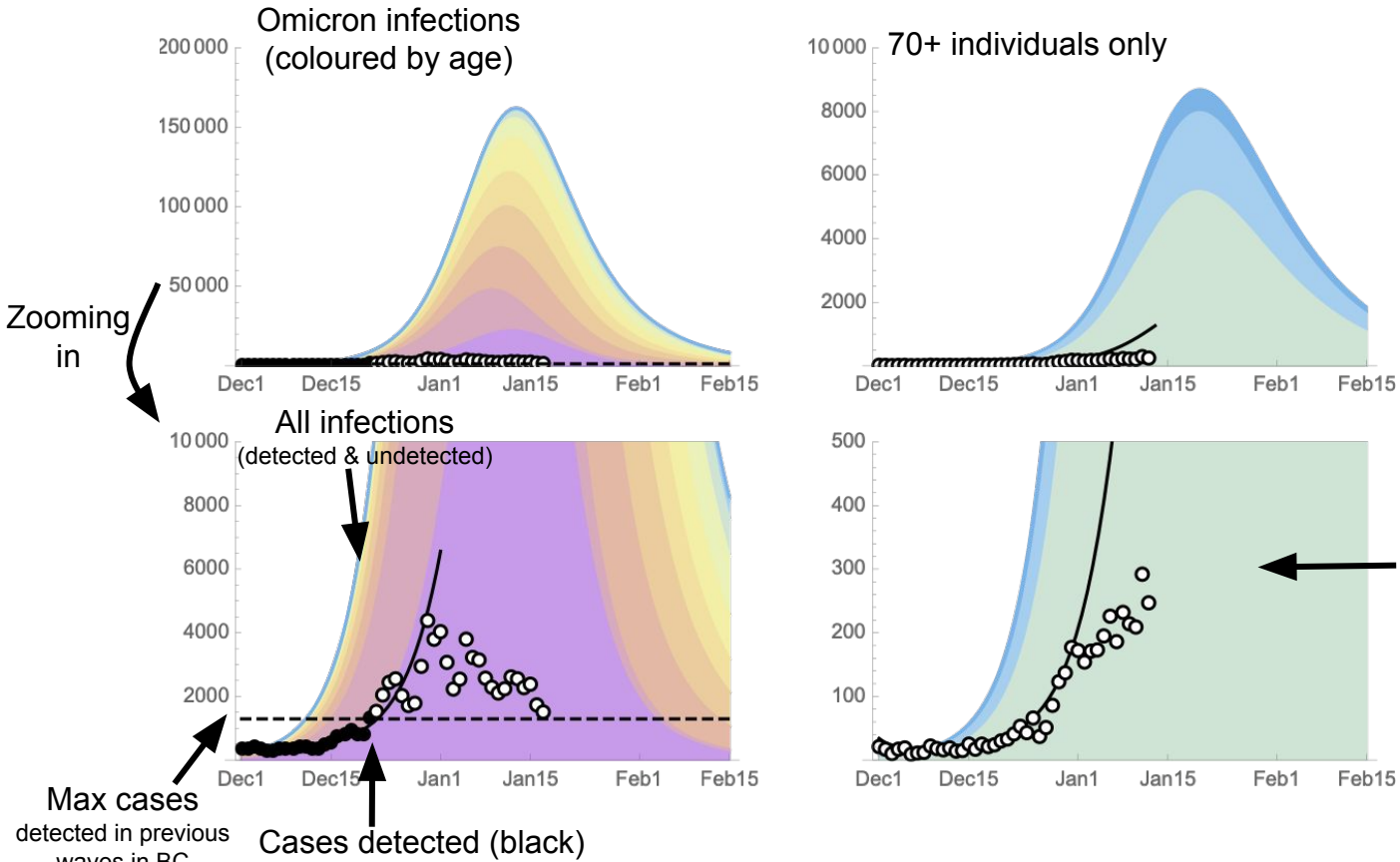

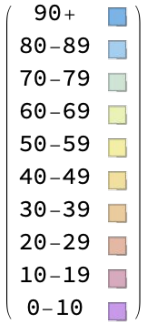

Cases in 70+ should be less affected by testing limits.
Circles show slower growth in this age group than predicted.
Possible explanations:
(1) Older individuals have restricted contacts more and/or (2) Omicron growth slowed following restrictions in late December.

These alternatives are explored in following slides.

Detected cases were used to fit model through December 21 (solid circles); empty circles not used for fitting.

Projected Omicron infections by age

(1) Reducing contacts in 70+

FEW INFECTIONS DETECTED (25%)
Only infections with moderate symptoms

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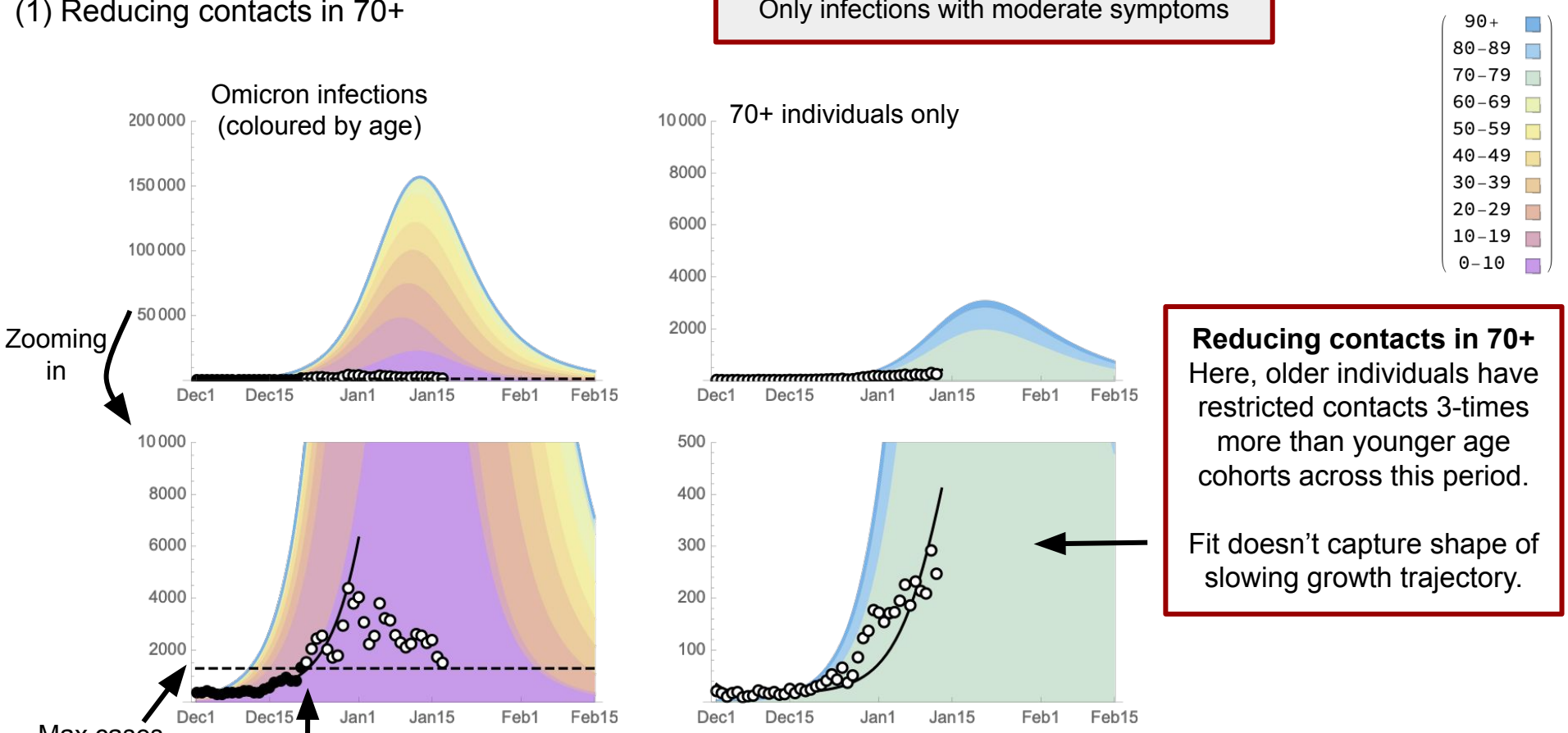

Reducing contacts in 70+
Here, older individuals have restricted contacts 3-times more than younger age cohorts across this period.

Fit doesn't capture shape of slowing growth trajectory.

Detected cases were used to fit model through December 21 (solid circles); empty circles not used for fitting.

Projected Omicron infections by age

(2) Reducing growth rate of Omicron

FEW INFECTIONS DETECTED (25%)
Only infections with moderate symptoms

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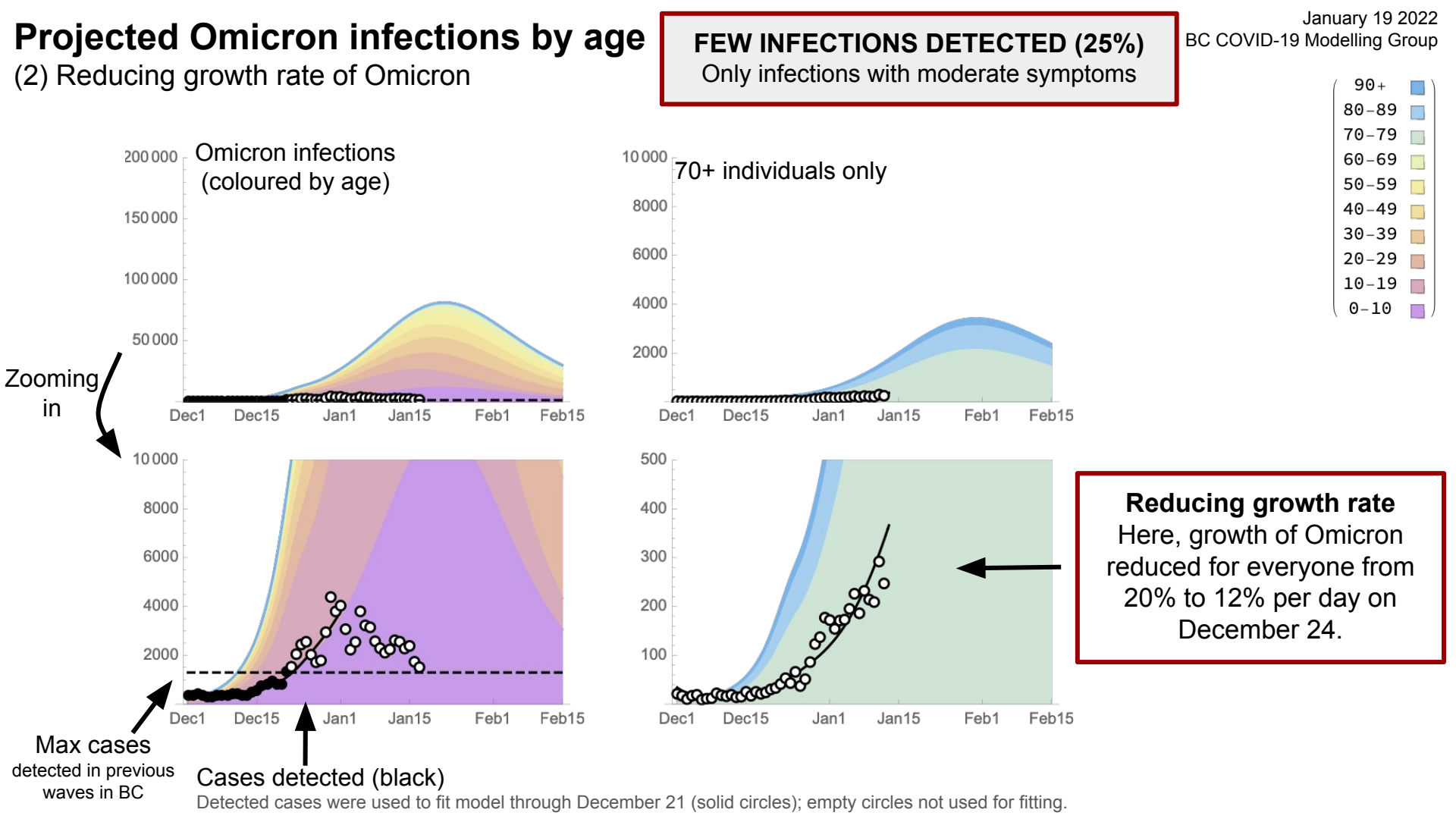

Reducing growth rate
Here, growth of Omicron reduced for everyone from 20% to 12% per day on December 24.

Max cases
detected in previous waves in BC

Cases detected (black)

Detected cases were used to fit model through December 21 (solid circles); empty circles not used for fitting.

Projected hospitalizations under two scenarios (REVISED)

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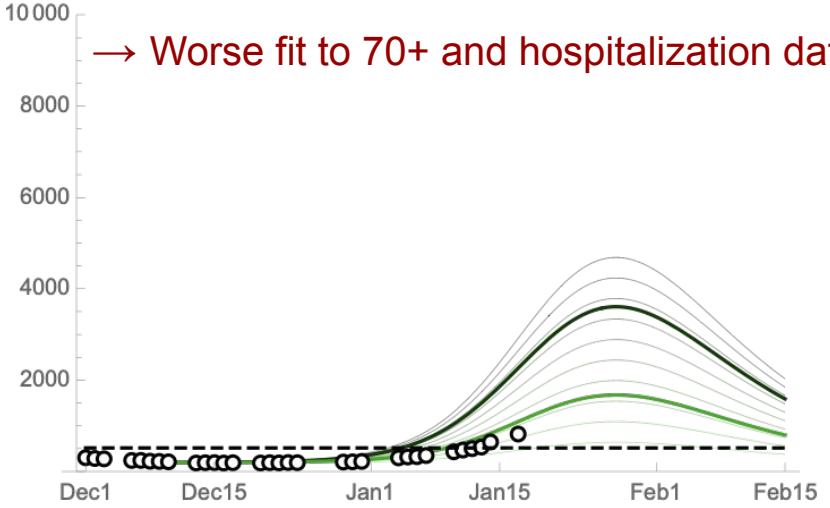
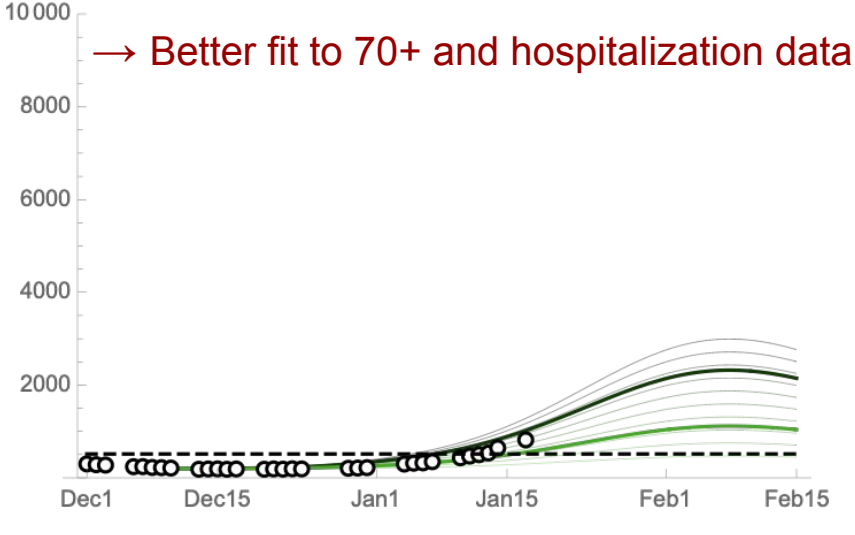
Scenario 1: Reduced contacts in 70+
Fits the hospitalization data only if Omicron severity is reduced relative to UK

→ Worse fit to 70+ and hospitalization data



Scenario 2: Reduced growth of Omicron
Fits the severity data from the UK and predicts a later and shallower peak hospital demand IF lower Omicron growth rate is maintained

→ Better fit to 70+ and hospitalization data

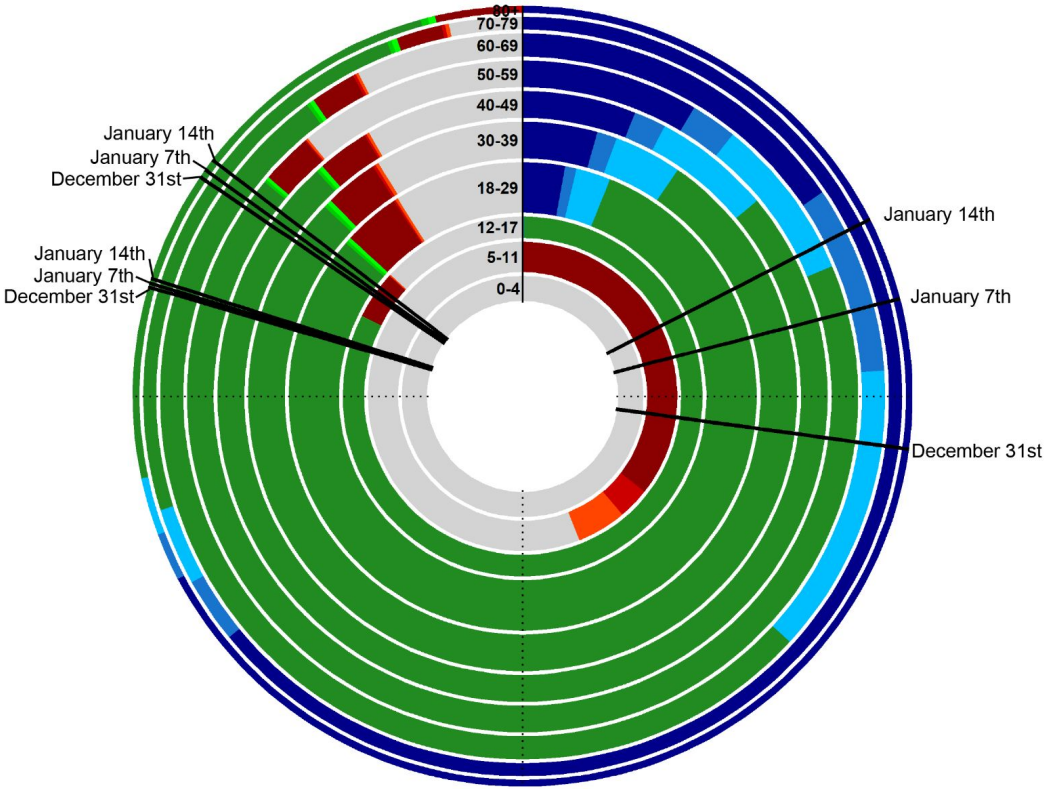


Severity: Varied from 0.1 (light green) to 0.9 (light black) for the risk of hospitalization per case for Omicron relative to previous variants for unvaccinated individuals. Estimated of 76% from Ferguson et al. is thicker black curve; estimate of 33% from UK Technical Briefing is thicker green curve.

Vaccination status by age

January 14th update includes data through January 8th

The fraction of BC's entire population with one or two doses increased **0.5%** and **0.2%** respectively over the past week



Booster Progress

The fraction of BC's entire population with three doses increased **6.2%** over the past week

Single vaccinated before:
- January 8th
- January 1st
- December 25th

Double vaccinated before:
- January 8th
- January 1st
- December 25th

Triple vaccinated before:
- January 8th
- January 1st
- December 25th

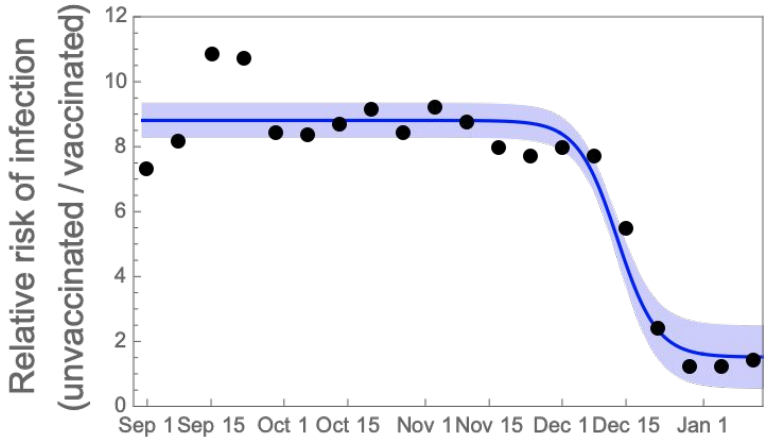
Unvaccinated

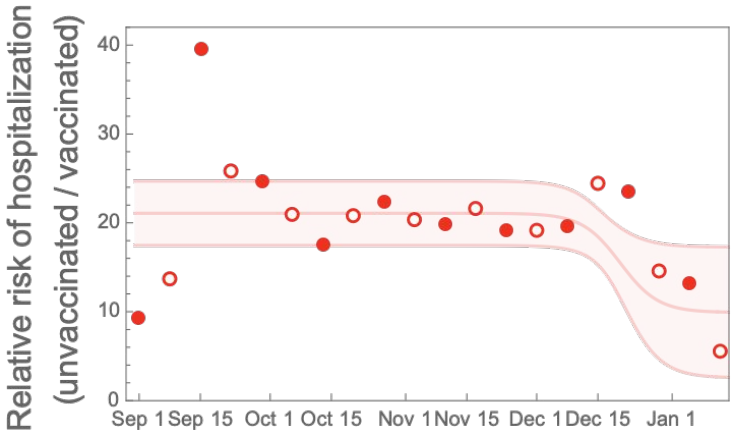
Source (B. Wiley). Design by Blake Shaffer (https://blakeshaffer.shinyapps.io/app_vaccines/) BC Vaccination data for first and second doses from https://health-infobase.canada.ca/covid-19/vaccination-coverage/, with area of each circle segment proportional to BC's population in that age class. Data for third doses from http://www.bccdc.ca/health-info/diseases-conditions/covid-19/data. BC 2022 Population projections for vaccination percentages from BC Stats: https://www2.gov.bc.ca/gov/content/data/statistics/people-population-community/population/population-projections

Changing immunity with Omicron

The risk of COVID-19 for an unvaccinated person relative to a fully vaccinated person has declined rapidly with the spread of Omicron in BC. Being unvaccinated increased the relative risk of infection by an average of 8.8-fold before Omicron, but this has declined to only 1.5-fold with Omicron (left). The risk of hospitalization has fallen less, from 21.1-fold before Omicron to 9.9 (right).

[Relative risks are for an average person (age corrected) and do not reflect patterns in specific ages or given specific types and dates of vaccination.]





Source (S. Otto) Risks for an unvaccinated person relative to a fully vaccinated person (age corrected) were obtained from the daily BC Gov News reports. Because risk of infection is calculated across the past week, we use data from only one day per week (Wednesday) and fit $a\,(1–p_t) + b\,p_t$, where p_t is the frequency of Omicron (inferred by D. Karlen in Dec 22 report, slide 7). Risk of hospitalization is calculated over the past two weeks of data, so we fit to a model of Omicron frequency seven days ago $a\,(1–p_{t-7}) + b\,p_{t-7}$ to account for the lag in hospitalizations, using data from every other week (analysing solid and hollow points separately) and averaging the results.

Key messages

State of the Omicron wave in BC:

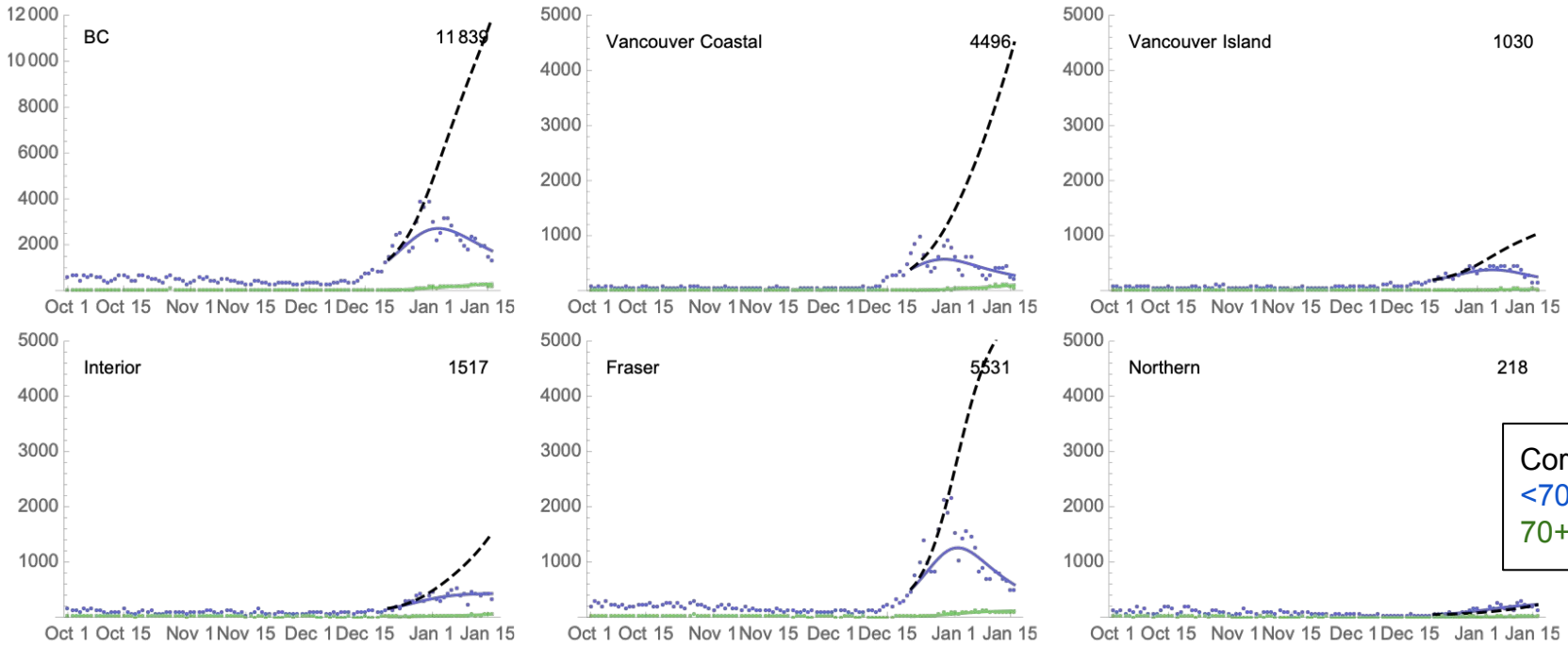
- Cases in individuals >70 in age are continuing to rise across the province. This is important because hospital demand depends disproportionately on cases in this age class.
- The drop in total cases is restricted to those <70 in age and is therefore likely due to shifts in testing policies, with younger and healthy individuals discouraged from testing.
- A model fit to hospitalization data and a model fit to cases for those over 70 years both indicate that BC has bent the Omicron curve substantially, from roughly 20% daily growth in infections to 10% daily growth.
- Bending down the curve substantially lowers and delays the peak hospital occupancy.
- If current behaviour continues, infections are expected to peak in late January/early February, with hospital occupancy peaking later in February.

Addressing data gaps would help reduce uncertainty:

- Rapid antigen test results would help assess trends in infection rates in BC (not available).
- Wastewater data would also help assess trends in infection rates in BC, but these need to be normalized to account for the total flow of water per day or against another virus (e.g., PMMoV in vegetables). Currently, BC data is not normalized (concentration in virus per mL).
- Accurate, timely, and consistent daily hospital admission data would allow for better projections of health care demands in the future.

Appendix: Age-corrected case counts

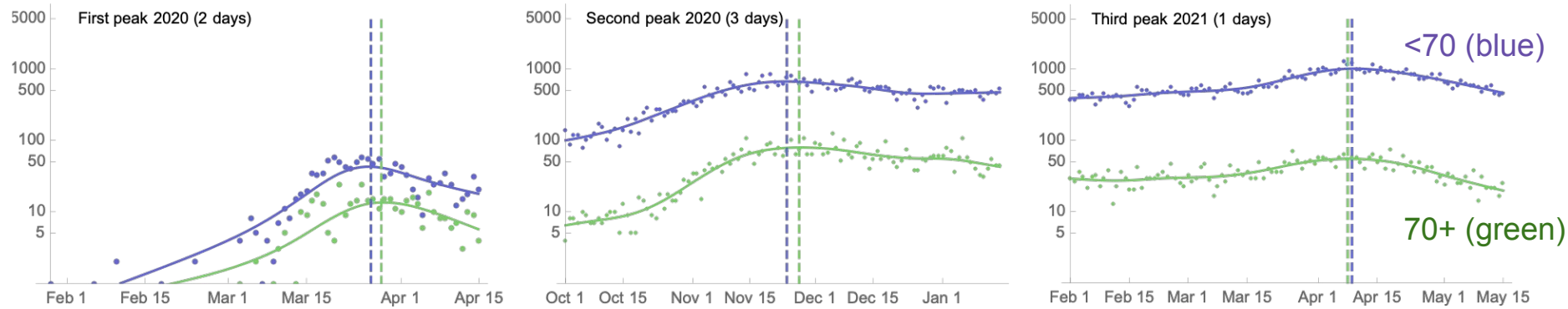
Same data and projections for total case numbers as in main slides but on a linear scale (y-axis)



Source (S. Otto; BC COVID-19 Modelling Group) New cases per day in 10-year age groups were downloaded from the **BCCDC COVID-19 data portal**. Cubic spline fits to log-case data were obtained (curve), using a curvature penalty of l=3. The fourth (Delta) wave did not have a distinct peak, with similar case counts over a ~two month period before the Omicron wave.

Appendix: Age-corrected case counts

As a check, we compare the peaks of previous waves for people 70+ (green dashed) and for people <70 (purple dashed). Cubic spline fits are similar in shape and exhibit peaks within 1-3 days of each other for the two age groups.

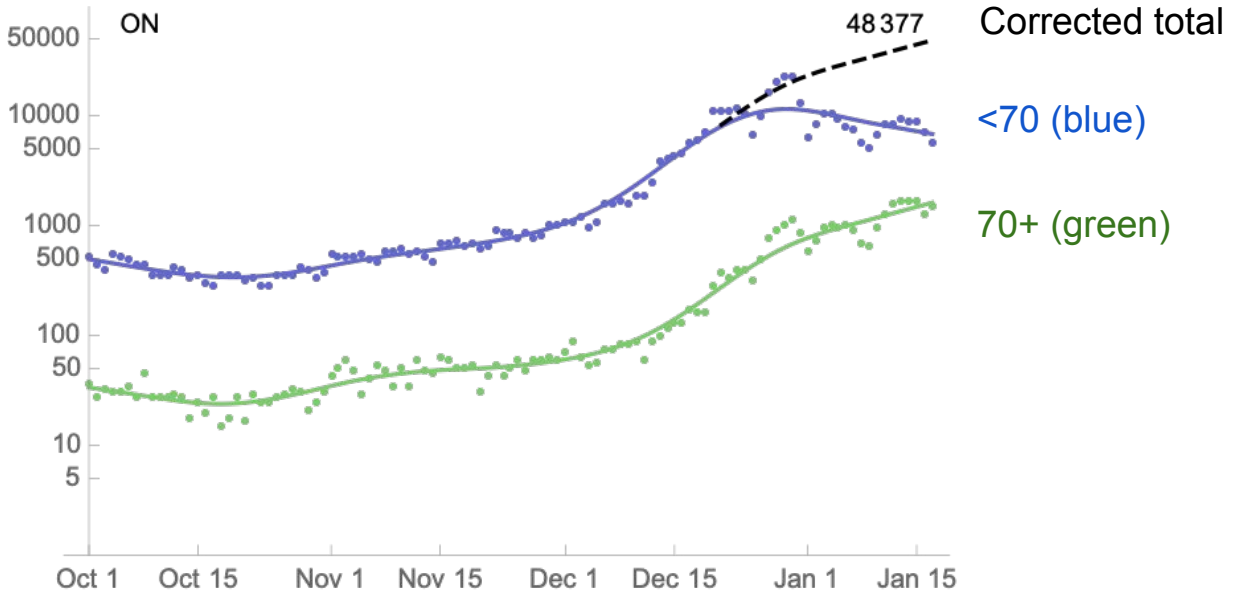


Source (S. Otto; BC COVID-19 Modelling Group) New cases per day in 10-year age groups were downloaded from the **BCCDC COVID-19 data portal**. Cubic spline fits to log-case data were obtained (curve), using a curvature penalty of l=3. The fourth (Delta) wave did not have a distinct peak, with similar case counts over a ~two month period before the Omicron wave.

Age-corrected case counts: Ontario

Similar patterns are found in other provinces, such as Ontario, with case reporting in younger individuals plateauing when testing limits are reached.

Cases in 70+ continue to show growth and have not peaked in ON. Importantly, future hospital demand will largely reflect patterns in this age group.



→ Using this age correction, the estimated number of cases that would have been detected on January 18 is ~**48000** had testing limits not been exceeded, **compared to the 7086** reported.**

Source (S. Otto) *New cases per day in 10-year age groups were downloaded from Ontario Data Catalogue ("Accurate_Episode_Date"). Cubic spline fits to log-case data were obtained (curve) and estimates for those <70 obtained by applying the fits for those 70+, shifted up to match the projection for that age class on 21 December 2022. **From Ontario Case Numbers and Spread. As line list information from the Catalogue is continuously updated, recent days are missing many cases. Totals from the last week were thus adjusted to match the reported number of cases (similar results obtained by trimming).