

COVID Model Projections

December 22, 2021

[BC COVID-19 Modelling Group](#)

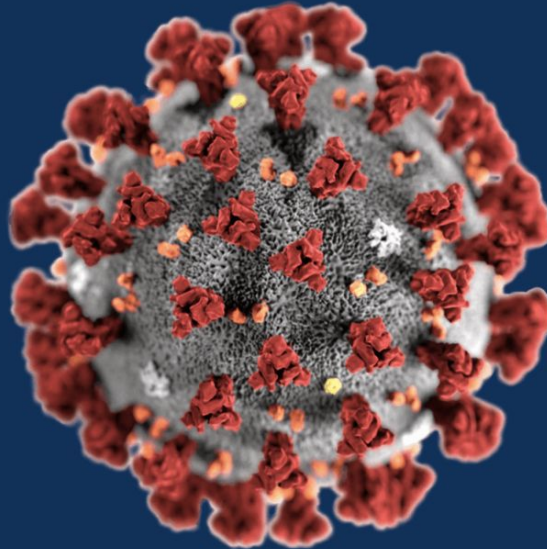
[@bcCOVID19group](#)



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>

Contributors to report

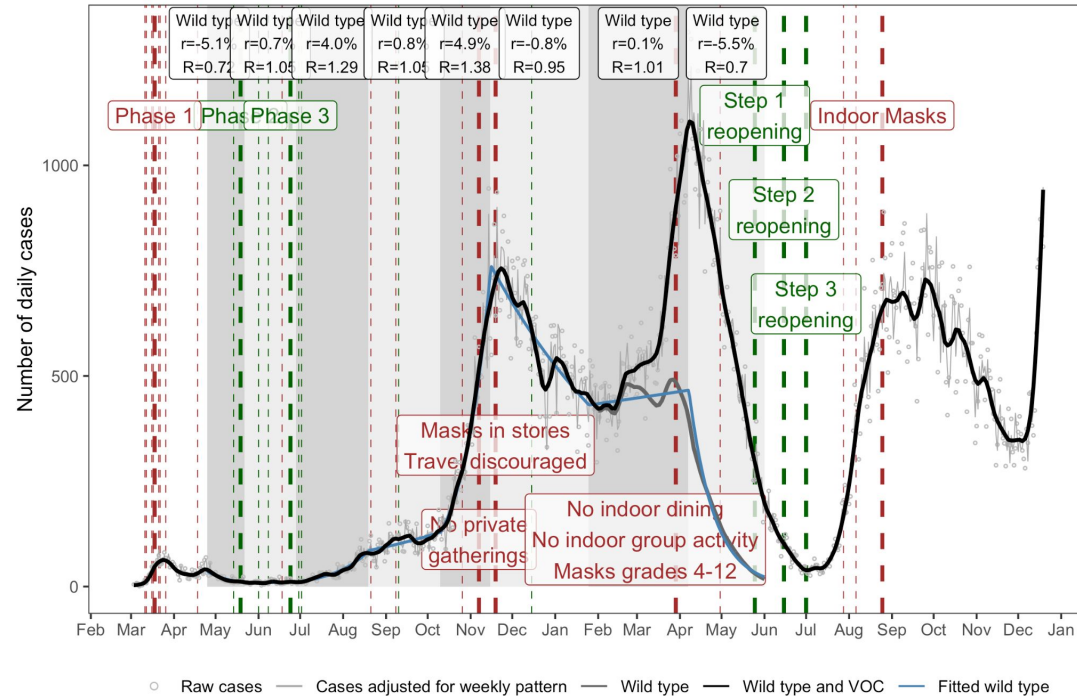
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*Independent and freely offered advice,
using a diversity of modelling approaches.*

State of the COVID-19 Pandemic in BC

Covid-19 daily new cases in British Columbia (up to Sun Dec 19)

Timeline of **closure** and **reopening** events



MountainMath, Data: BCCDC

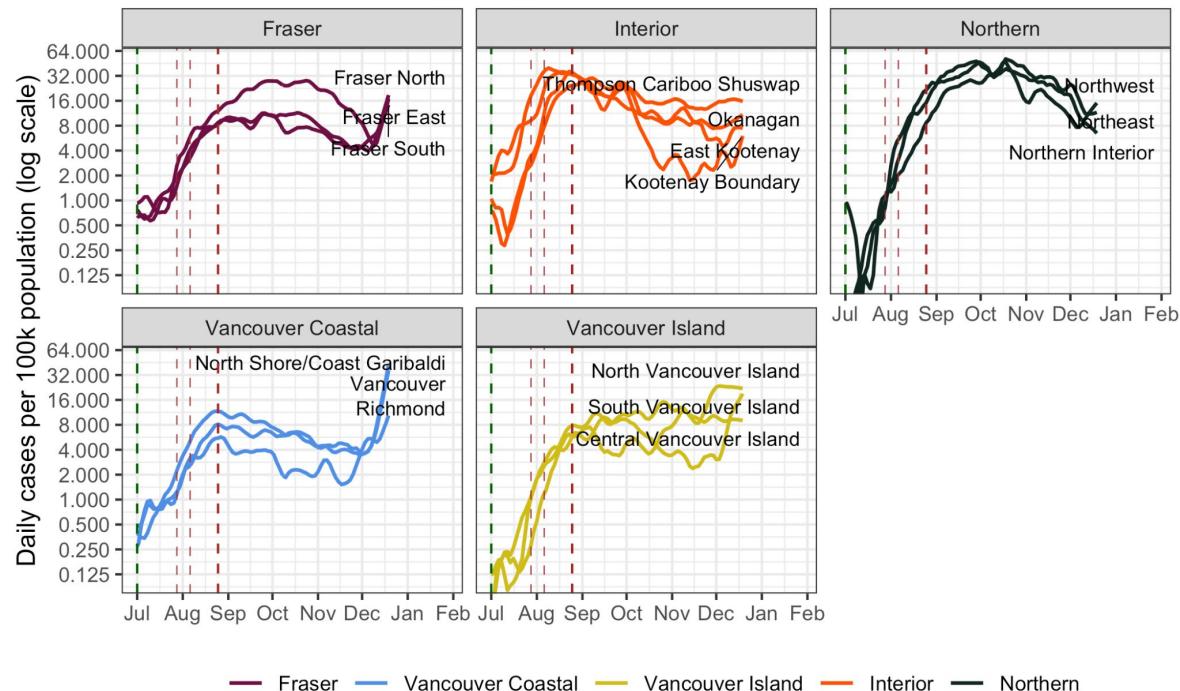
After the long decline in cases we saw since September, the establishment of Omicron has lead to a dramatic increase over the past two weeks.

Source (J. von Bergmann) Case data from BC COVID-19 Database (<http://www.bccdc.ca/health-info/diseases-conditions/covid-19/data>). Vertical lines give dates of public health measures (major as thick lines, minor as thin lines). Grey dots are raw case counts, grey lines is cases abused for weekly pattern, black STL trend line and blue fitted periods of constant exponential growth. *Central Okanagan – July 29: masks, August 6: restrictions on group gatherings; [Interior](#) – August 21: masks; August 23: some restrictions on group gatherings. BC – August 25 mask mandate; BC's Vaccine Card to come into effect on September 13 (first dose) and October 24 (second dose)

COVID-19 in BC Health Regions

Covid-19 daily new cases trend lines in British Columbia (up to Sun Dec 19)

Timeline of **closure** and **reopening** events



MountainMath, Data: BCCDC, BC Stats

We don't have timely surveillance data for Omicron, so we are left to infer Omicron from the change in case trajectories.

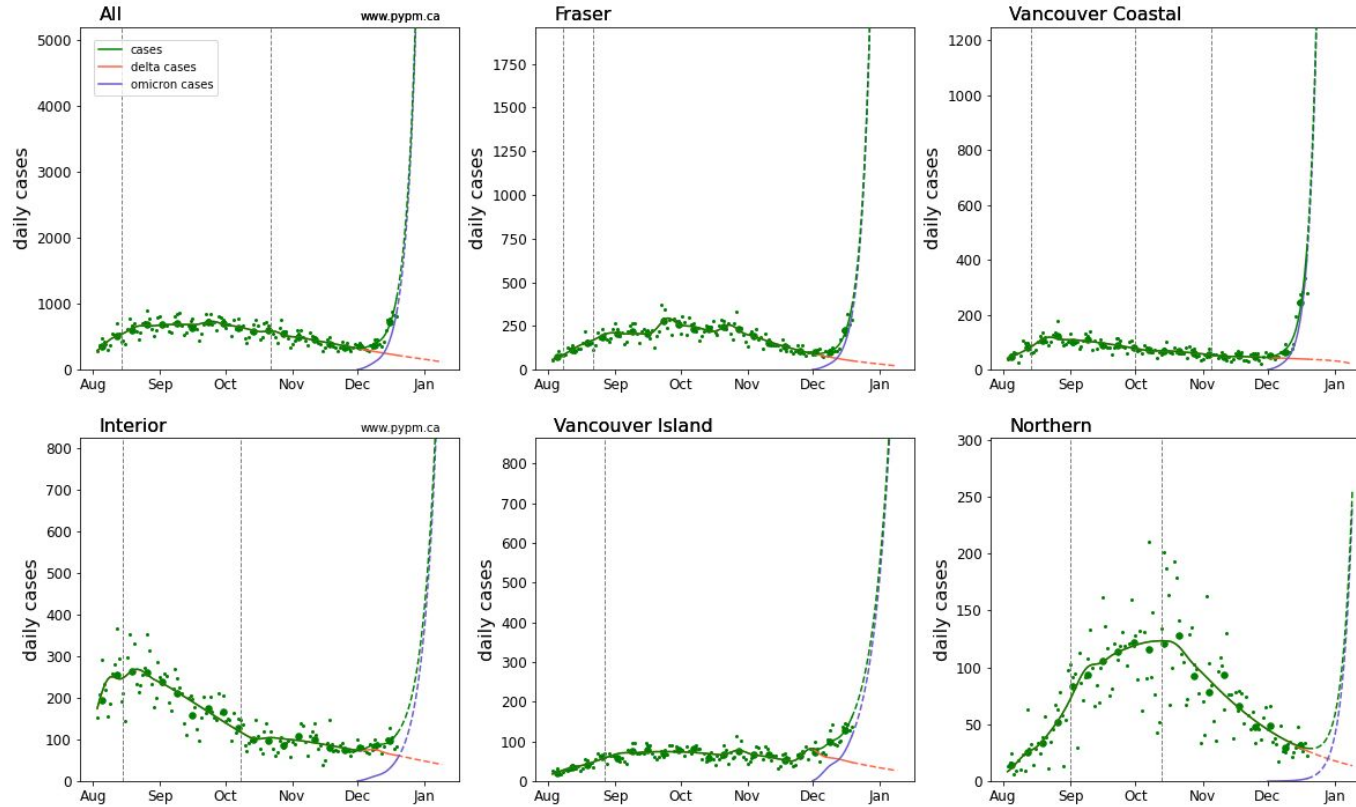
All Vancouver and Fraser Health Regions show a clear upward trend, as does South Vancouver Island. We can be fairly certain that Omicron is established in communities there.

Overview

Omicron is now established and spreading within BC:

- Case rates...
- New information about Omicron
- Projections...
- Hospitalization capacity
- Communities that are highly vaccinated have much lower COVID rates [This should stop being true but may still be due to the lag...]
 - 95% vaccinated communities have 3.4 times fewer cases than those with 75% vaccinated (12+)
- Rapid spread means we have little time to respond, but we can slow the spread of Omicron in BC as we did with previous variants: **getting vaccinated, wearing tight fitting masks, improving ventilation, avoiding large indoor gatherings, and improving testing and contact tracing**
- Slowing the spread of Omicron buys time to **deliver booster shots**, which raise the immune protection against Omicron. Models indicate that a fast roll out of booster shots is one of the most effective ways to lower peak hospital demand from Omicron.

Omicron model fits to BC data



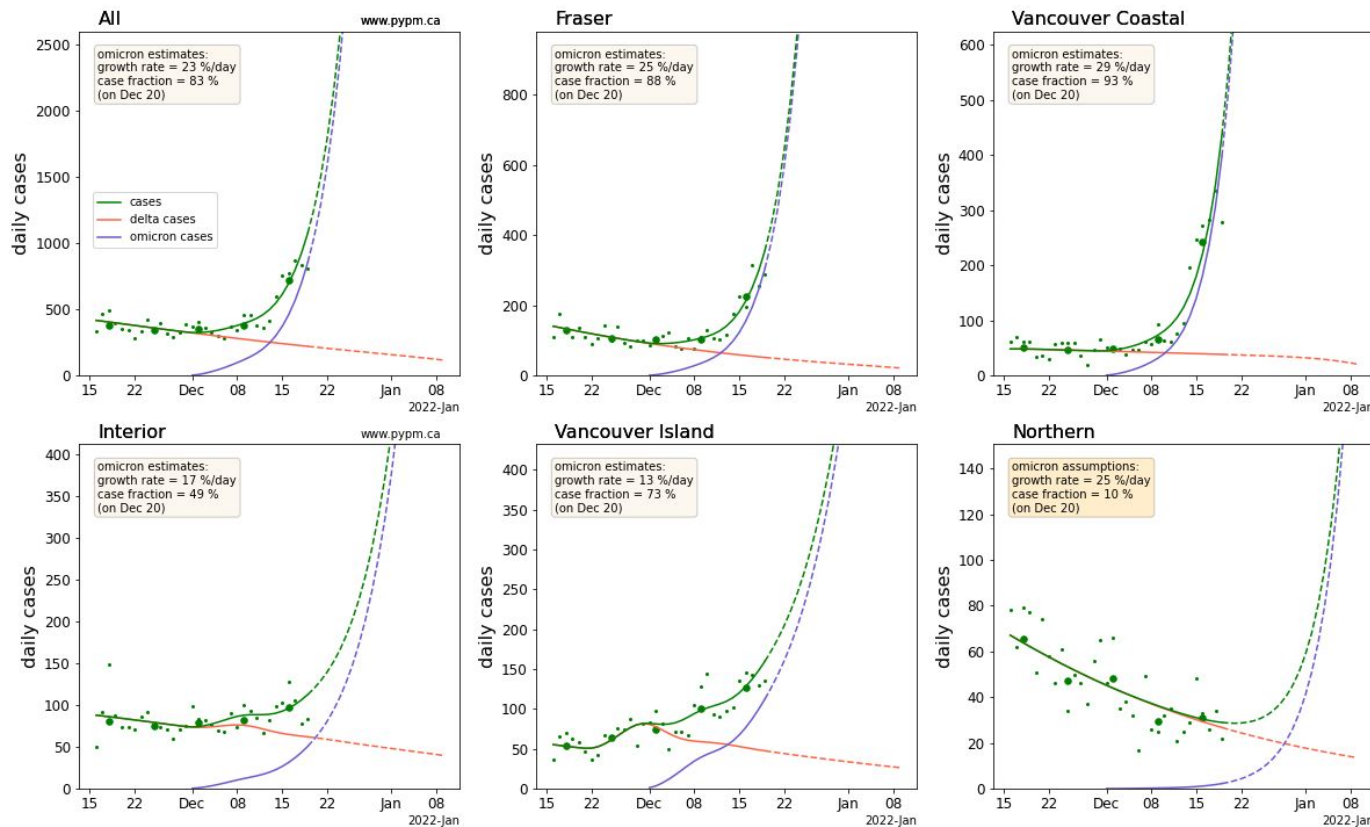
Maximum vertical axis corresponds to daily case rate of 100 per 100,000.

If transmission rates are not reduced, all HA will reach that level in the coming weeks.

Northern HA does not yet show growth arising from omicron

Source (D. Karlen). See www.pymp.ca. These models include vaccination but have no age structure. Vertical lines show fitted dates for transmission rate changes. The larger dots show weekly averages.

Omicron model fits to BC data (zoomed in)

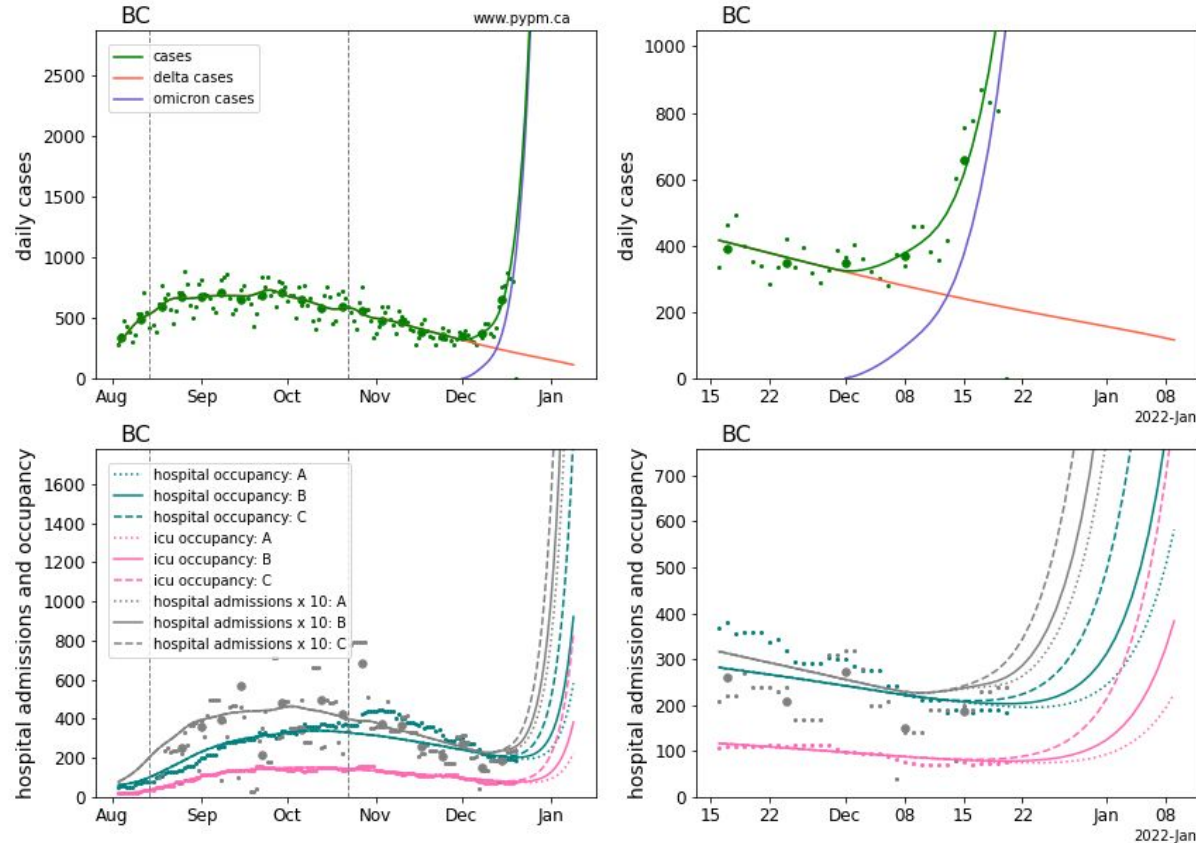


Maximum vertical axis corresponds to daily case rate of 50 per 100,000.

Interior and Island HA data difficult to interpret. More data are needed to better estimate the omicron parameters. Northern HA does not yet show growth arising from omicron, so parameters are set to hypothetical values.

Source (D. Karlen). See www.pympm.ca. These models include vaccination but have no age structure. The larger dots show weekly averages.

Omicron model projections for health care demands



Three severity levels are considered:

- **A:** Probability for an immunized person to need hospitalization is reduced by the multiplicative factor of 0.3 and the probability of death is reduced by that factor squared. The length of hospital stays for all infected by omicron are reduced by the same factor of 0.3.
- **B:** The severity factor is 0.5, instead of 0.3.
- **C:** The severity factor is 1. In other words, there is no reduction in severity as compared to delta infections.

It is too soon to judge which, if any, of these severities are supported by data. All the levels considered lead to rapid growth in hospital demands, far in excess of capacity.

The small points are daily data and the larger circles are weekly averages to help guide the eye. The curves show model projections of demand: no capacity limits are imposed.

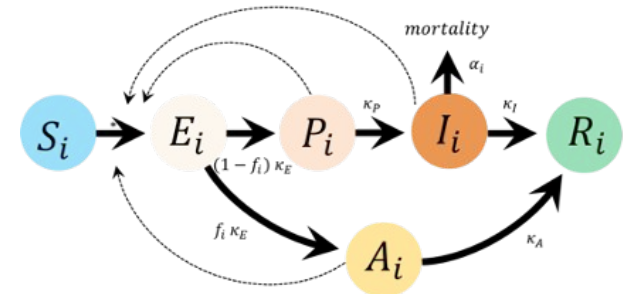
Accounting for uncertainty with Omicron

Given that vaccine effectiveness against infection ($VE_{\text{infection}}$) and the probability of a severe case among infected individuals who are vaccinated relative to unvaccinated ($P_{\text{severe vac}}$) **are unknown**, we can use models to explore the impact of these unknowns.

Using a different model, we can explore uncertainty in Models were used to determine the impact of Omicron on case numbers and hospitalization rates per million Canadians, accounting for age, vaccination status, and prior exposure.

A growth rate of 20% per day was assumed, which is similar to or lower than reported in other jurisdictions (doubling time of 3.5 days).

Given that vaccine effectiveness against infection ($VE_{\text{infection}}$) and the probability of a severe case among infected individuals who are vaccinated relative to unvaccinated ($P_{\text{severe vac}}$) **are unknown**, these



SEAPIR Model (Day et al. 2020)

S: susceptible

E: exposed

A: asymptomatic (less infectious)

P: pre-symptomatic (infectious)

I: symptomatic (infectious)

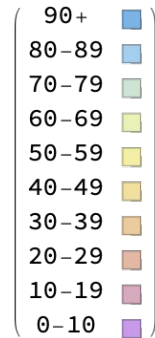
R: recovered

10 age classes

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

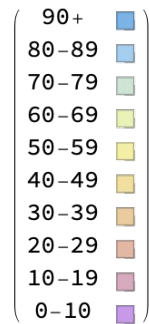
2 immune classes

- Vaccinated (or recovered)
- Susceptible

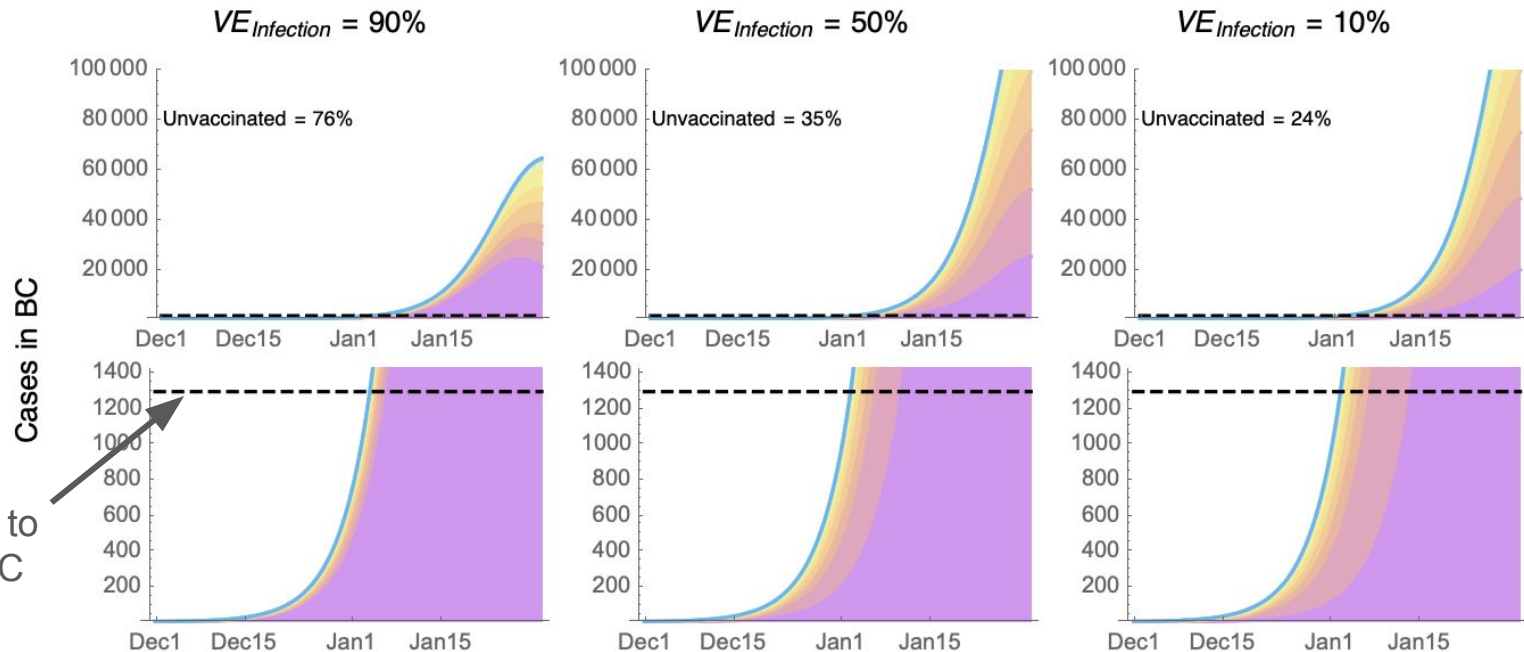


Projected cases: uncertainty in vaccine effectiveness

Doubling every 3.5 days



Zooming in



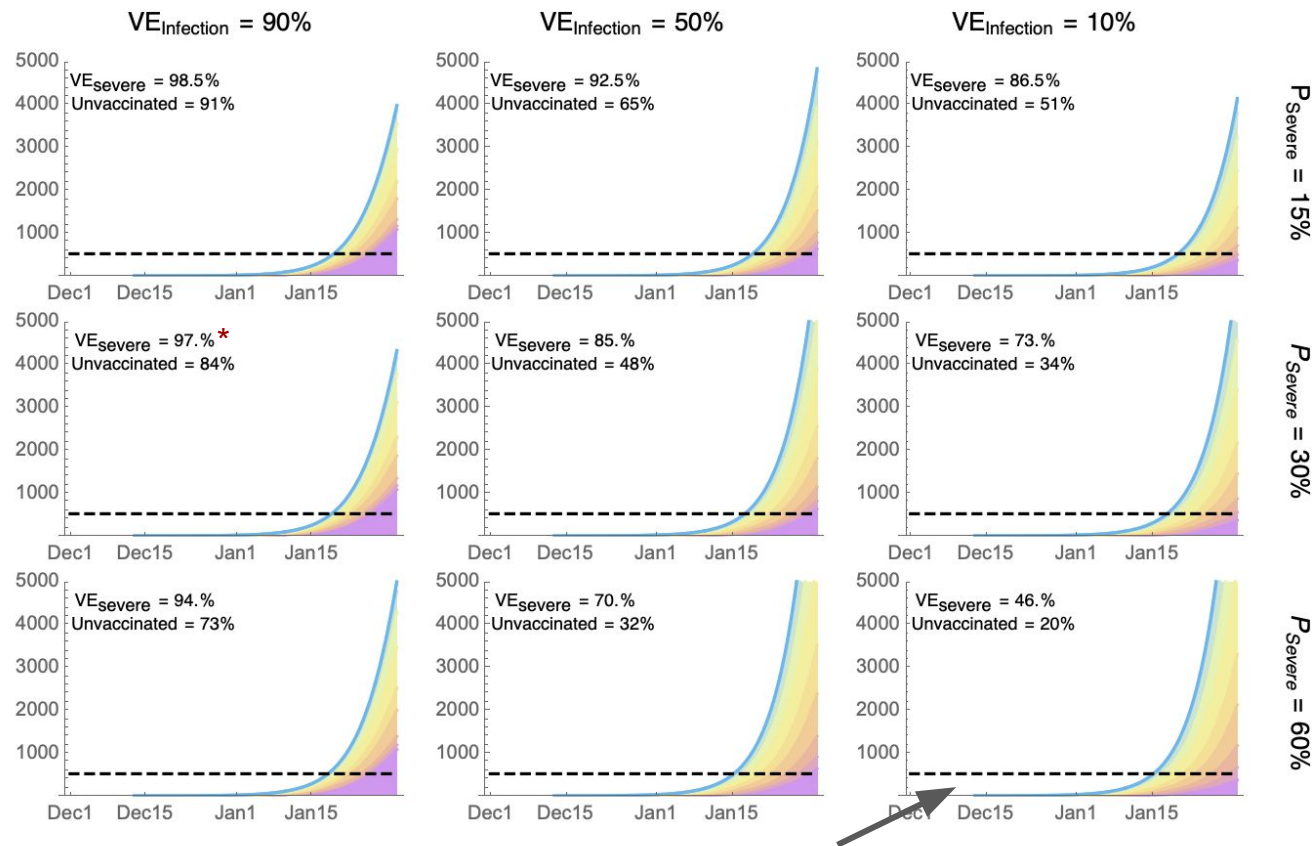
If most of Omicron's advantage comes from being more transmissible and vaccine effectiveness against infection remains high, most cases will be among the unvaccinated.

Regardless, case numbers exceed levels yet seen in the pandemic by early January.

If most of Omicron's advantage comes from being able to infect and spread among vaccinated individuals, a smaller portion of cases will be among the unvaccinated.

Projected number in hospital with a daily growth rate of 0.2

Hospital occupancy in BC



*Consistent with VE against Delta

Maximum to date

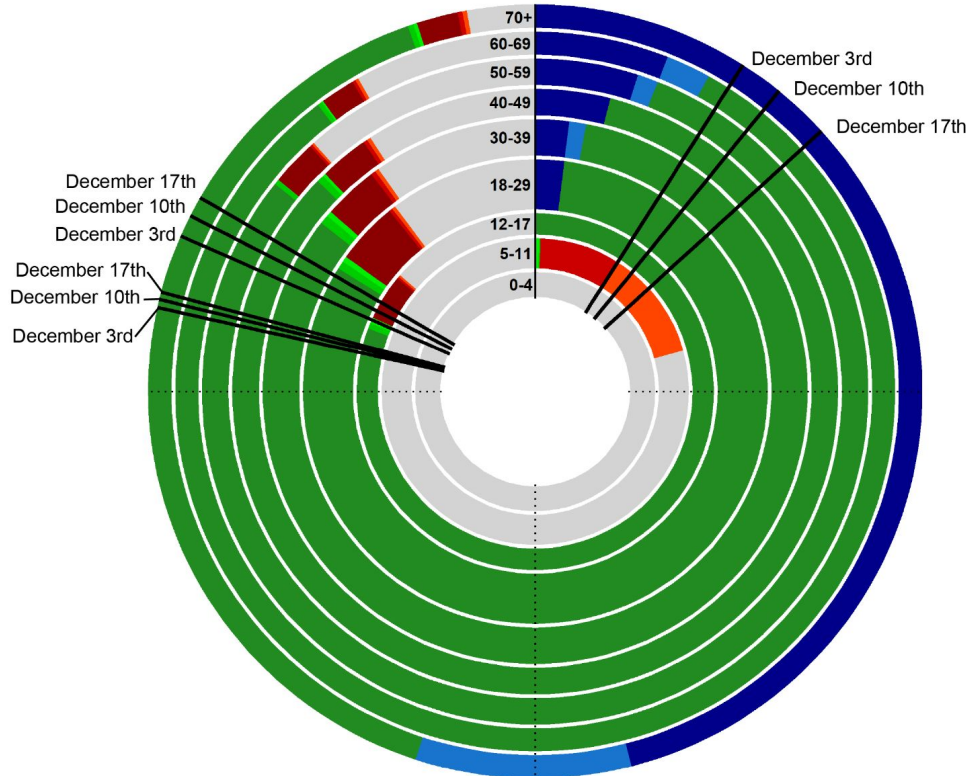
If Omicron grows at a rate of 20% per day and severity among the unvaccinated remains the same, we expect hospitals to exceed capacity regardless of vaccine effectiveness (columns) and severity among the vaccinated (rows).

Probability of a severe case among infected individuals who are vaccinated compared to unvaccinated.

Closing the circle: Vaccination status by age

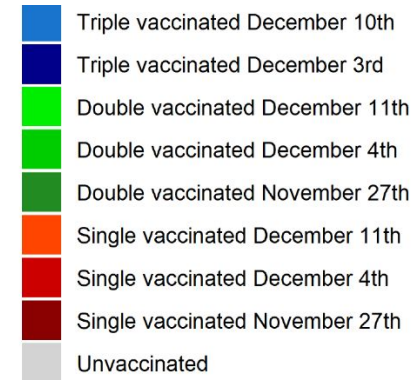
December 17th update includes data through December 11th

The fraction of BC's entire population with one or two doses increased **0.85%** and **0.31%** respectively over the past week



Booster Progress

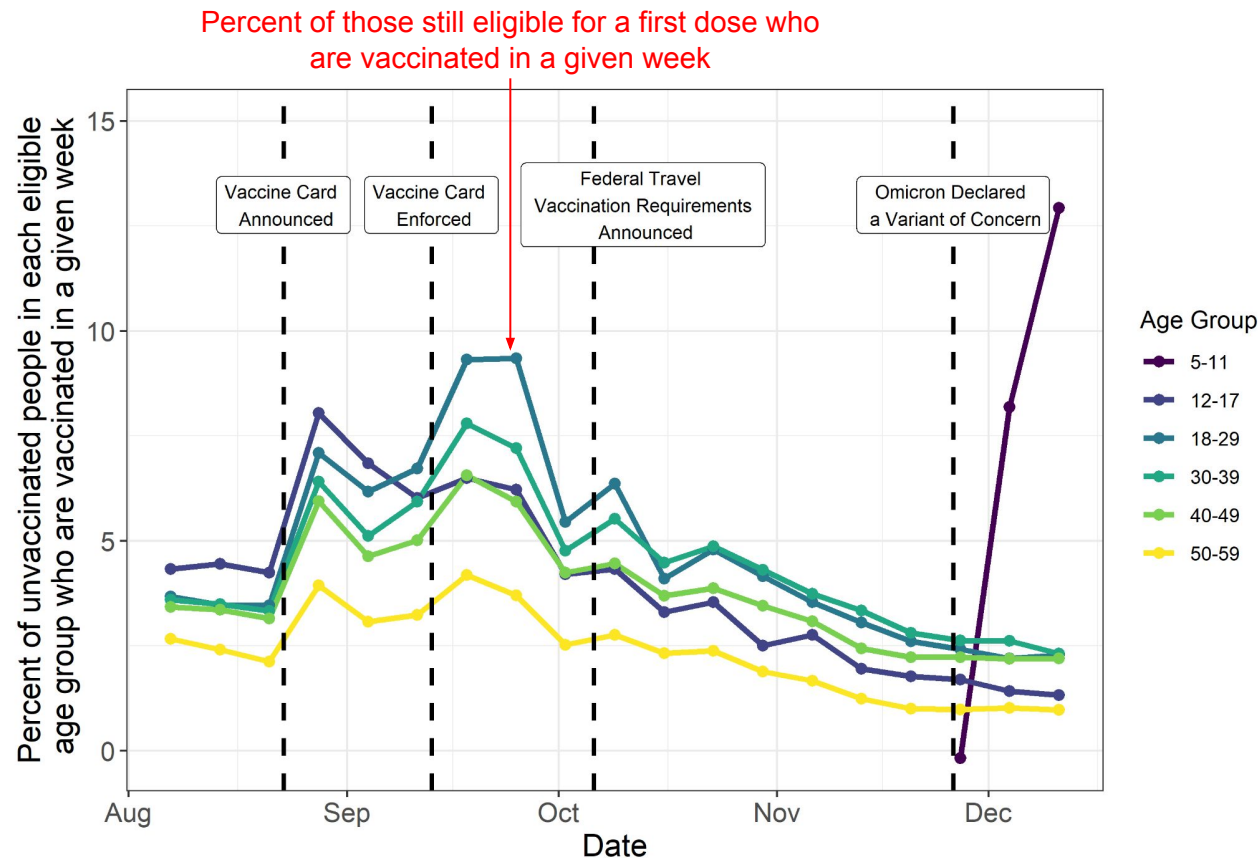
The fraction of BC's entire population with three doses increased **2.4%** over the past week



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 2021 Population projections for vaccination percentages from BC Stats: <https://www2.gov.bc.ca/gov/content/data/statistics/people-population-community/population/population-projections>

Slow movement on vaccinations for ages 12+

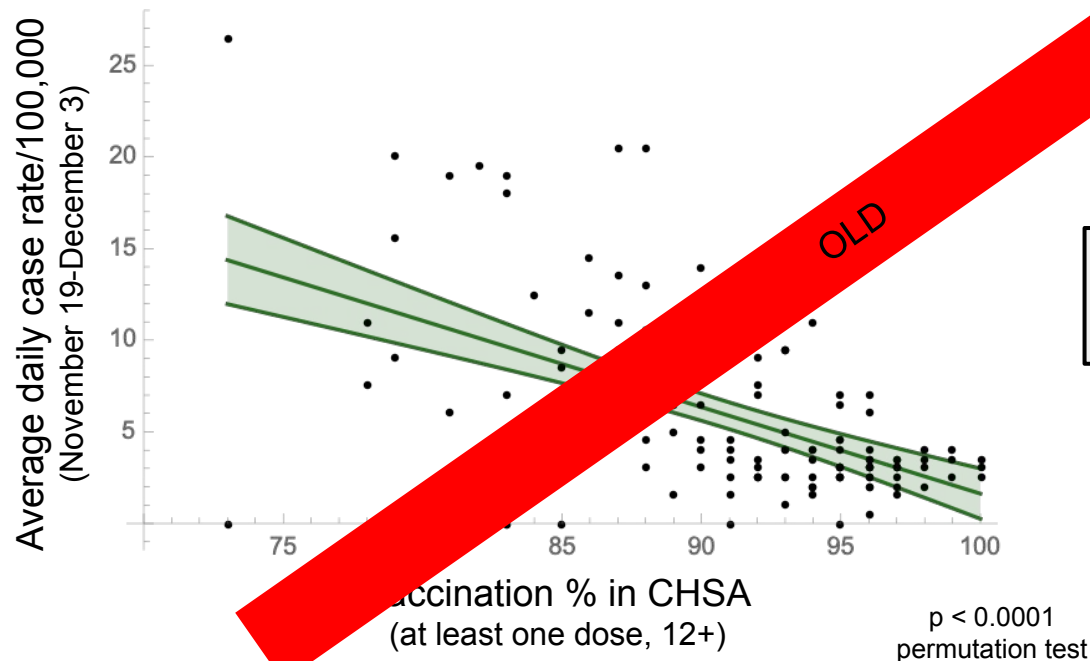
Continued slow progress for ages 12+



Source (B. Wiley). BC Vaccination data from <https://health-infobase.canada.ca/covid-19/vaccination-coverage/>. BC 2021 Population projections for vaccination percentages from BC Stats: <https://www2.gov.bc.ca/gov/content/data/statistics/people-population-community/population/population-projections>

A pandemic of the unvaccinated: Communities at risk

We continue to see a major effect of vaccination levels across Community Health Service Areas (CHSA). For the most recent two-weeks of cases, communities with 95% of eligible people vaccinated have **3.4 times** fewer COVID-19 cases than those with 75% vaccination.



Vaccinations protect communities, as well as protecting individuals.

A Primer on Omicron

How fast will Omicron spread in Canada?

This question **cannot be answered**, because we do not know how much of Omicron's advantage comes from transmitting better to those with no prior exposure, how much comes from reinfecting those who have had COVID-19 (Omicron reinfection rates are about double that of Delta, [Pulliam et al.](#)), and how much comes from transmitting among vaccinated people.

What we do know:

- Fewer South Africans than Canadians have been fully vaccinated (25% vs 76% of the entire populations)
- More South Africans have had COVID-19 (~40% accounting for 3M known cases and [8 fold underreporting](#))
- Globally, many fully vaccinated travellers have caught Omicron
- Anecdotal evidence of airborne transmission between fully vaccinated participants at gatherings
- A lab study with the virus finds [neutralizing antibody protection](#) from vaccines drops but is not lost

→ **Substantial risk of rapid spread in Canada, even among vaccinated**

A Primer on Omicron

How fast will Omicron spread in Canada?

If Omicron spreads approximately as rapidly in Canada as seen in South Africa and UK, with selection per day between 10% (low) and 20% (high), all provinces would see rapid growth in cases, with Omicron dominating in the next month.

	BC	AB	SK	MB	ON	QC	NB
Recent growth per day	-0.01	-0.06	-0.05	+0.01	+0.02	+0.01	+0.03
...with Omicron (low)	+0.07	+0.04	+0.05	+0.11	+0.12	+0.11	+0.13
...with Omicron (high)	+0.17	+0.14	+0.15	+0.21	+0.22	+0.21	+0.23
Doubling time (low)	10 days	17 days	14 days	6 days	6 days	6 days	5 days
Doubling time of O (high)	4 days	5 days	5 days	3 days	3 days	3 days	3 days

A Primer on Omicron

How fast will Omicron spread in Canada?

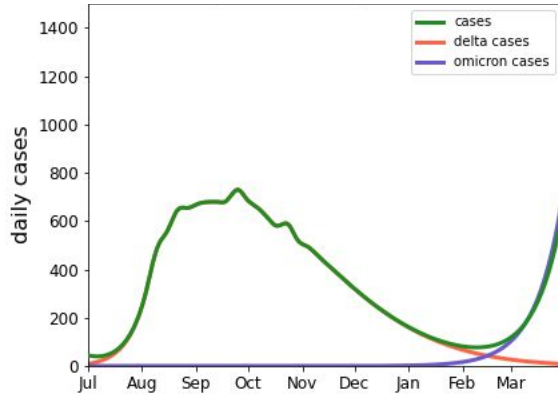
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	BC	AB	SK	MB	ON	QC	NS	PE	NT
Recent growth per day	+0.03	+0.03	+0.03	+0.03	+0.03	+0.03	+0.03	+0.03	+0.03
...with Omicron (low)	+0.07	+0.07	+0.07	+0.07	+0.07	+0.07	+0.07	+0.07	+0.07
...with Omicron (high)	+0.17	+0.14	+0.15	+0.21	+0.22	+0.21	+0.23	+0.23	+0.23
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Doubling time of O (high)	4 days	5 days	5 days	3 days	3 days	3 days	3 days	3 days	3 days

What would these growth rates per day mean for the pandemic in BC?

BC projections for Omicron with daily growth of 10% and 17%

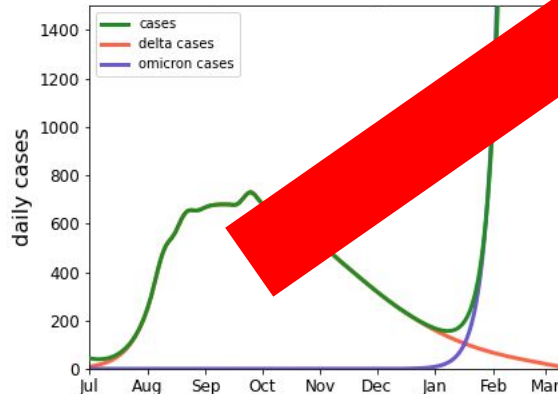
7% (linear scale)



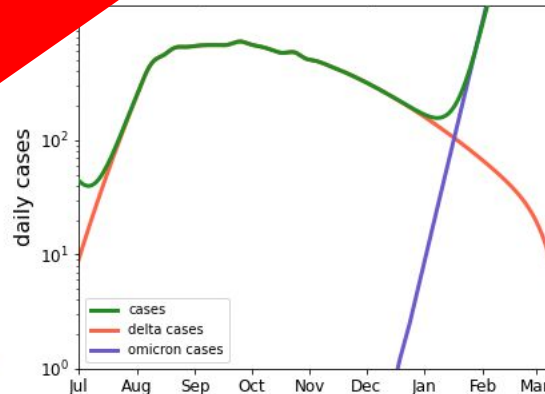
7% (log scale)



17% (linear scale)



17% (log scale)



Model assumptions:

- Maintain current health measures
- Community transmission of Omicron starting in mid-December

Findings:

- 7% daily growth would be similar to the start of the fourth wave (July/August)
- 17% daily growth would give little time to respond with additional measures

The fraction of cases leading to hospitalization and deaths is unknown. If unchecked, health care demands will grow rapidly, as seen in South Africa.

A Primer on Omicron

What does Omicron mean for our health?

Very preliminary data indicates that COVID-19 with Omicron:

- may be associated with mild symptoms, especially among vaccinated individuals
- may be more common in children
- has led to a rise in hospitalized cases in South Africa, predominantly among unvaccinated individuals

→ **Getting vaccinated now, including eligible children, trains the immune system and will help avoid severe disease, even with Omicron.**

→ **A rapid rise in cases will inevitably increase the number of severe cases, especially among the unvaccinated, and will impact the medical care system.**

The uncertain future of the pandemic in BC with Omicron

Data on Omicron is scant and should be interpreted cautiously

- Rates of spread in highly-vaccinated populations in Canada may differ from those observed in South Africa and elsewhere
- Risks of *severe disease, hospitalization, and death* are not yet well-defined for this variant. It may take many weeks before adequate data is compiled to estimate these risks and distinguish between vaccinated vs unvaccinated people, different age groups and co-morbidities, etc.
- Nonetheless, we believe there is a significant risk of a new wave of infection. We will monitor the situation over the next weeks with the goal of providing the best possible forecasting for BC.

Our best protection against Omicron is to use the tools that we have already learned: **get vaccinated, wear tight fitting masks, avoid large gatherings, isolate when sick, improve ventilation, increase testing, & trace contacts to limit spread of Omicron.**

Key messages

State of the Omicron wave in BC:

- The omicron wave is clearly underway in BC, with infections growing at a rate of about 23% per day.

Unknowns:

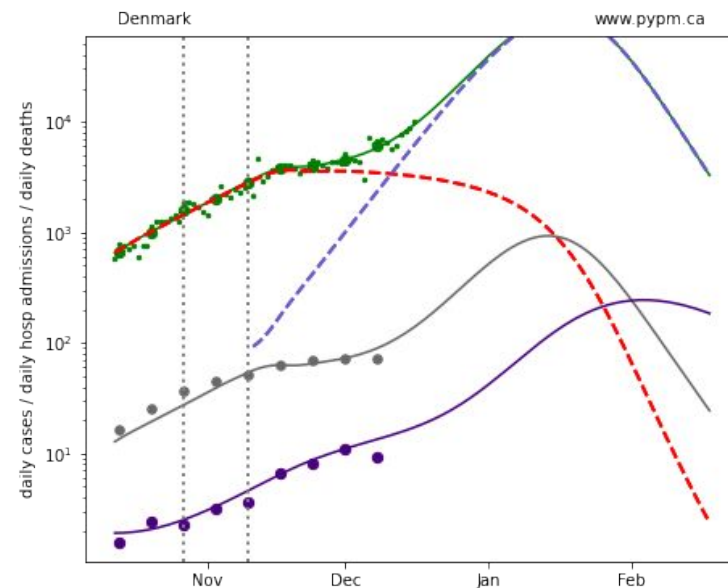
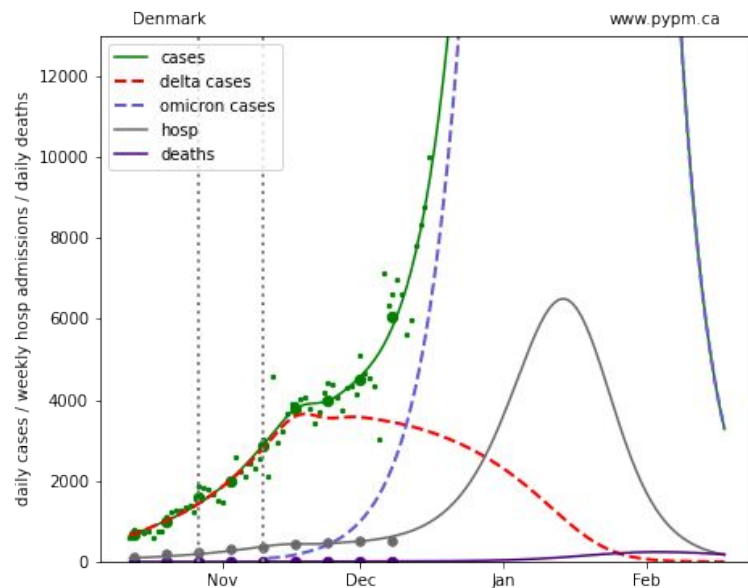
- Successful strategies to stop the growth in omicron infections

Challenges:

- Monitoring will be difficult: unable to track growth rates once testing and hospitals reach capacity
- Action to reduce transmission cannot be delayed until hospitals are in crisis

Possible saviour: If a large fraction of infections produced by omicron are asymptomatic and go undetected, herd immunity is developing more quickly than we think, and the overall impact of omicron is reduced. Herd immunity comes about when the fraction of the population susceptible to infection is so low, that new infections do not make up for the reduced number of contagious people (through recovery or isolation). See the next slides using data from Denmark to illustrate the effect.

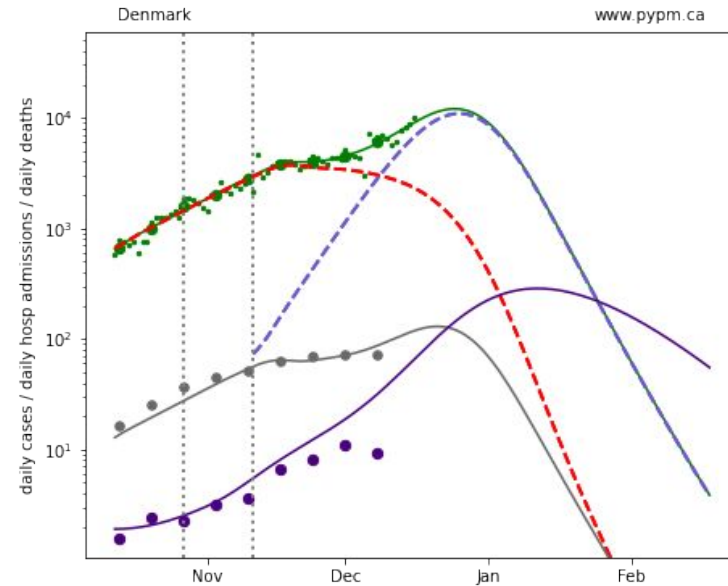
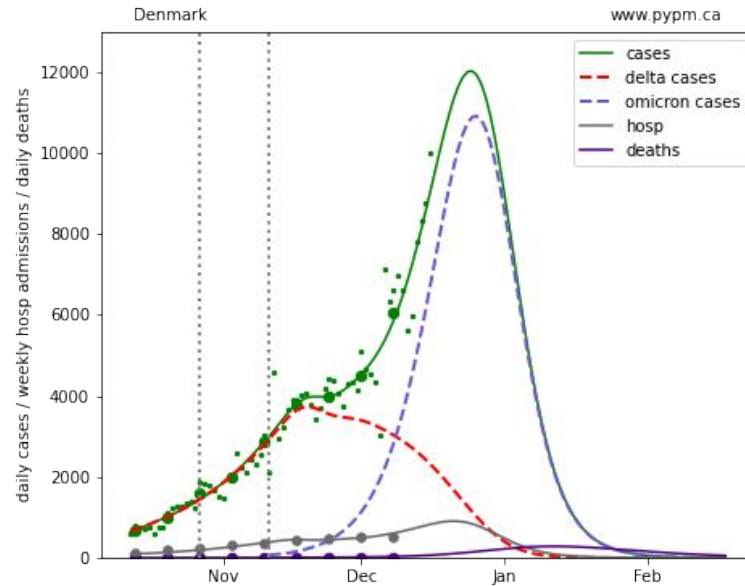
Omicron model fit to Denmark data (symptomatic factor = 1)



This is the omicron model fit to Denmark data, assuming that the fraction of infections leading to symptoms (and therefore reported as cases) is the same for omicron as it is for delta.

Source (D. Karlen). See www.pypm.ca. These models include vaccination but have no age structure. The vaccine effectiveness against omicron is assumed to be 20%. The larger dots show weekly averages.

Omicron model fit to Denmark data (symptomatic factor = 0.1)



This is the omicron model fit to Denmark data, assuming that the fraction of infections leading to symptoms (and therefore reported as cases) is 10 times smaller for omicron than for delta.

Source (D. Karlen). See www.pymp.ca. These models include vaccination but have no age structure. The vaccine effectiveness against omicron is assumed to be 20%. The larger dots show weekly averages.

Is this a realistic possibility, or wishful thinking?

It is difficult to ascertain the fraction of omicron infections that are asymptomatic

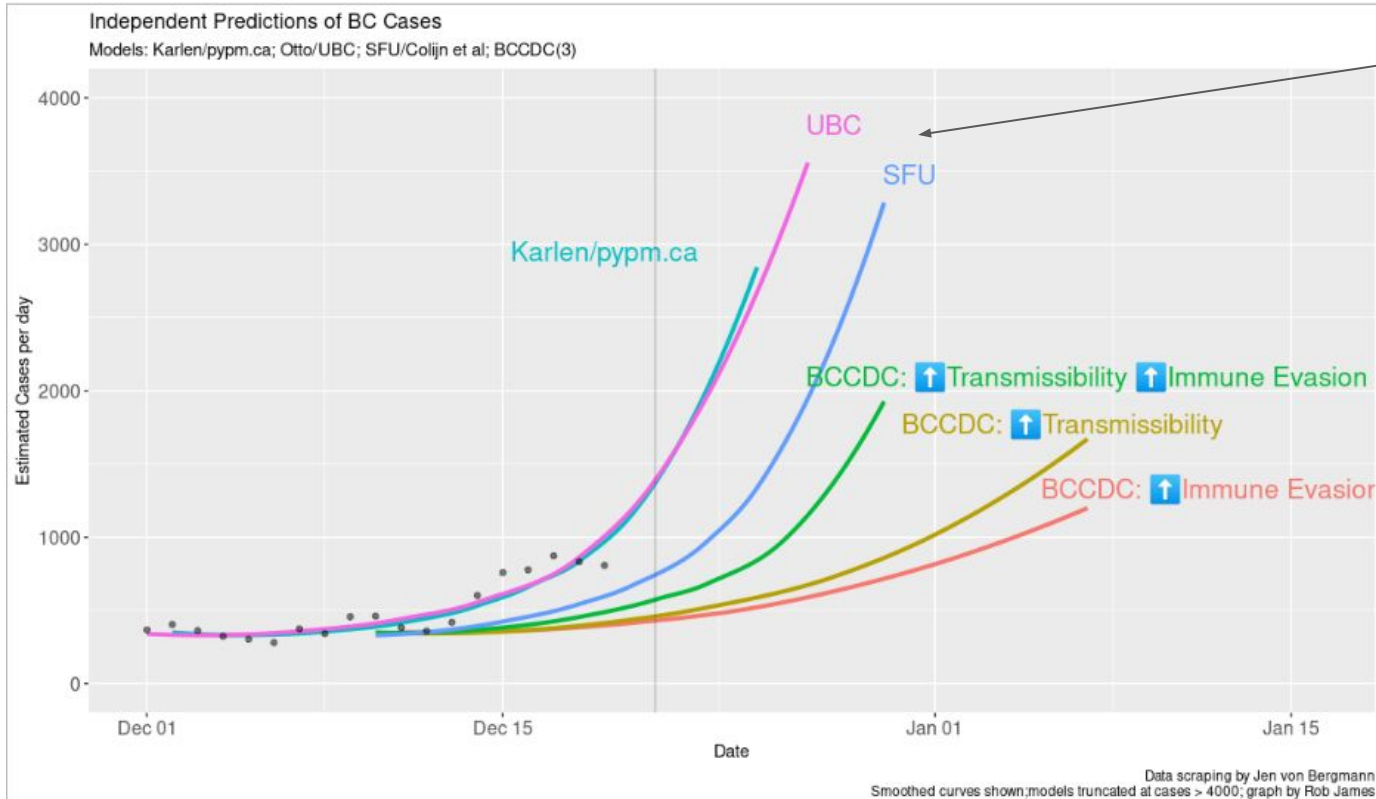
- Some ?studies? suggest omicron and delta may be similar, but there are large uncertainties

A reduction in the symptomatic fraction by a factor of 10 may be overly optimistic

- With a less favorable factor, the effect can still help. When combined with measures to reduce transmission, herd immunity can be reached and infection rates turned around with much less impact on health care systems.

It is important to reduce transmission, even with such a rapidly spreading variant.

BC Case Projections



UBC, SFU and Karlen models generated more recently that BCCDC; various methods

BCCDC models likely generated on ~9 Dec Released on 14 Dec.

BCCDC Confidence intervals not shown