

# Update on COVID-19 in Canada: Epidemiology and Modelling

*December 10, 2021*

[Canada.ca/coronavirus](https://Canada.ca/coronavirus)

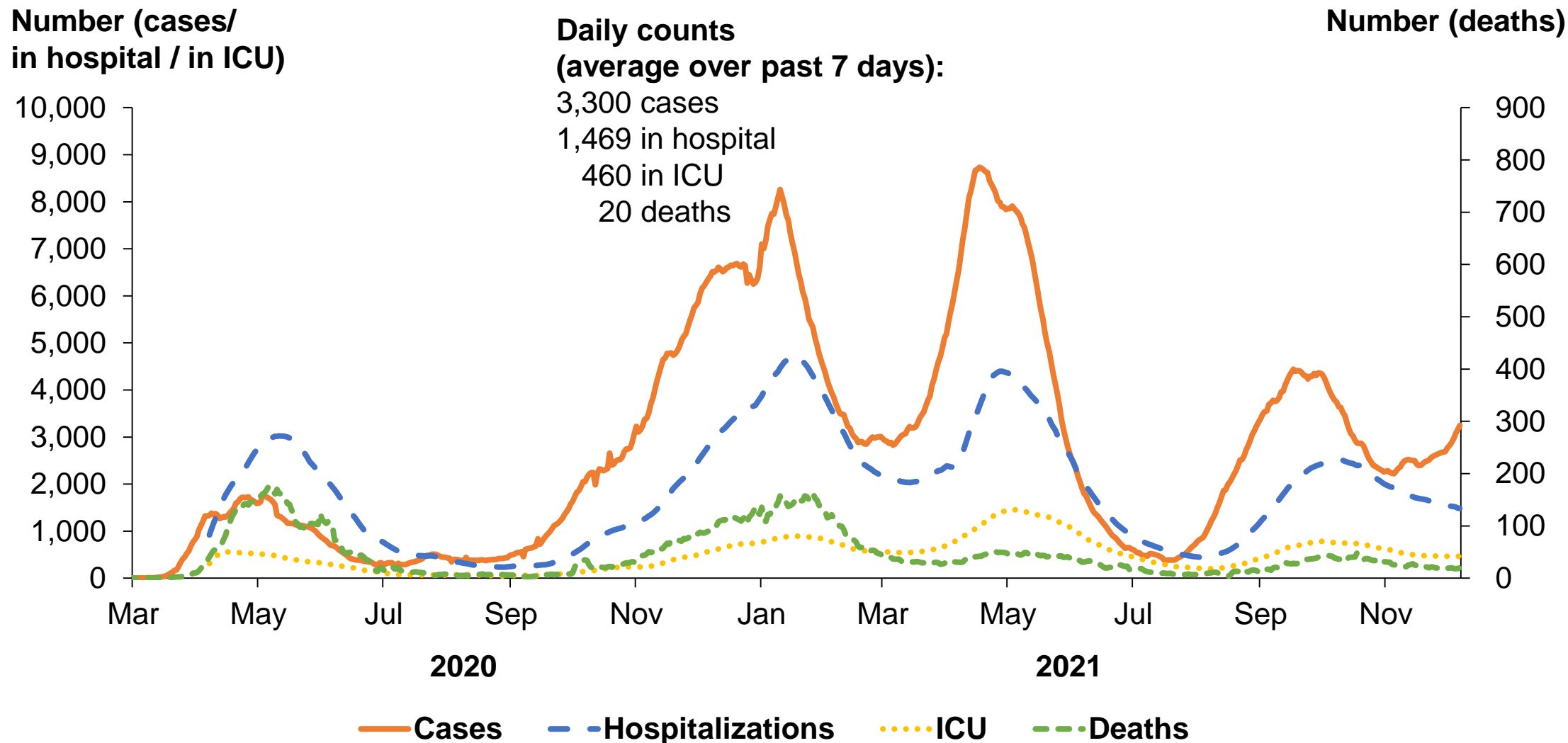


Public Health  
Agency of Canada

Agence de la santé  
publique du Canada

Canada

# Nationally, COVID-19 disease activity is increasing and severity could begin to rise if this trend continues



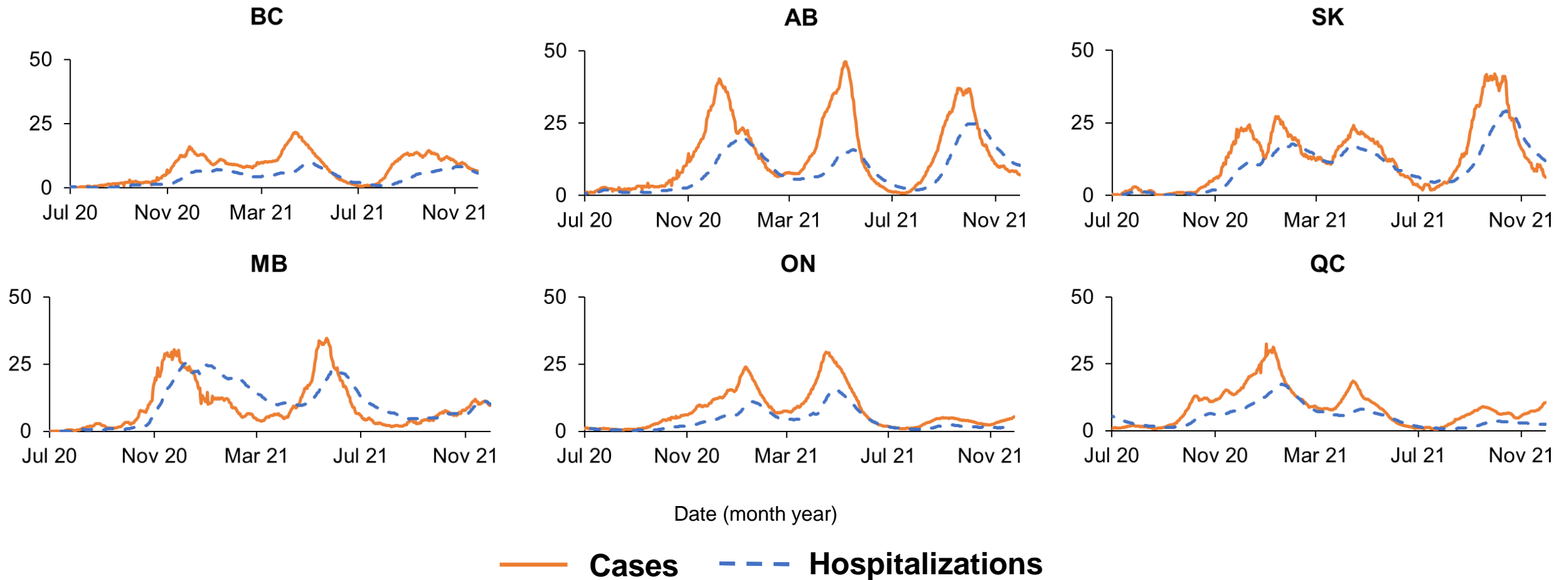
Data as of December 8, 2021

**Note:** Trend lines reflect 7-day moving averages. Total hospitalizations and ICU admissions include all people in hospital and in ICU on that day. Hospitalizations and ICU counts include data from nine of thirteen Canadian provinces and territories.



# COVID-19 activity is increasing nationally, primarily driven by epidemic growth in Ontario and Quebec

Number cases / in hospital per 100,000 population

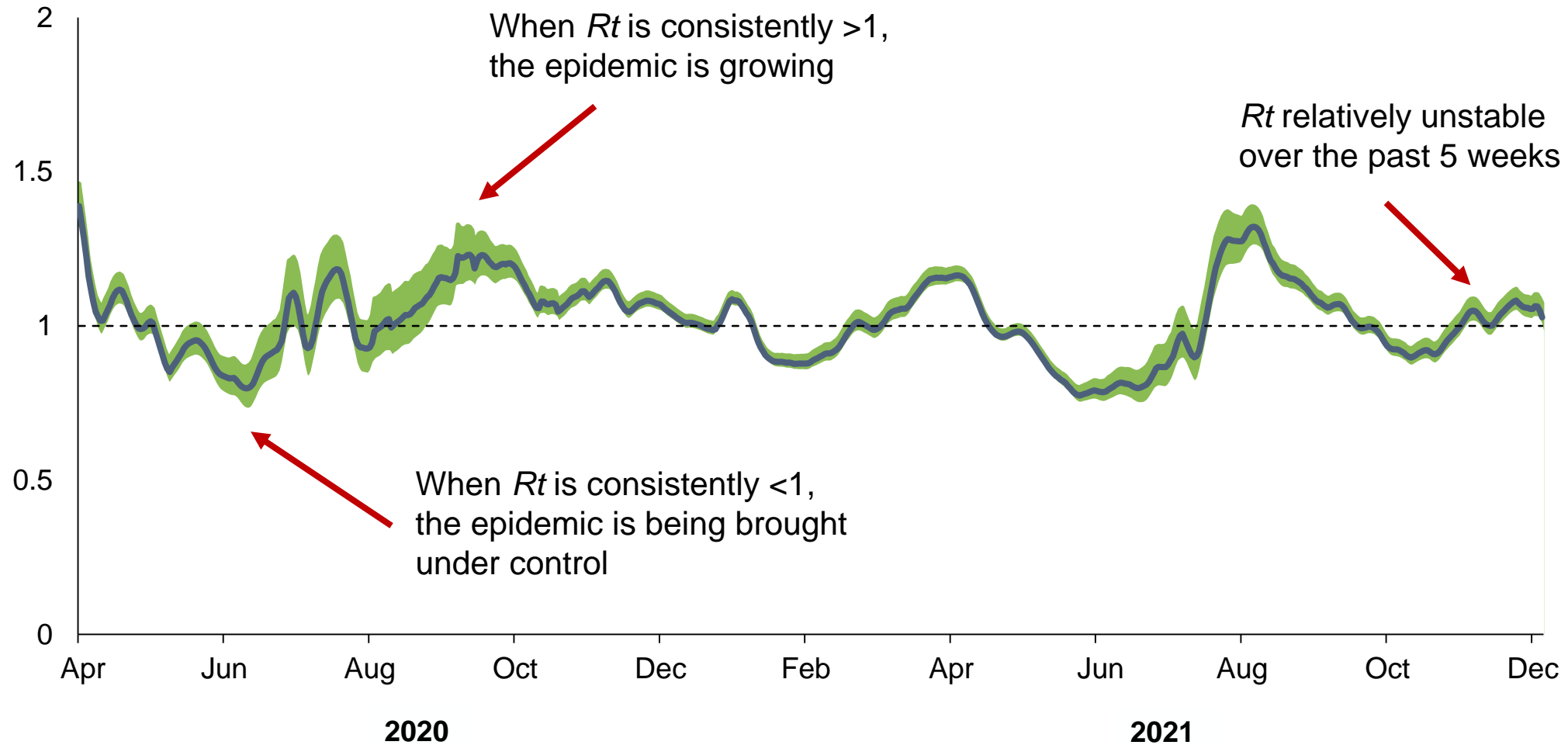


Data as of December 7, 2021

**Note:** Daily cases trend lines reflect 7-day moving averages. Total number in hospitals include all people in hospital on that day.

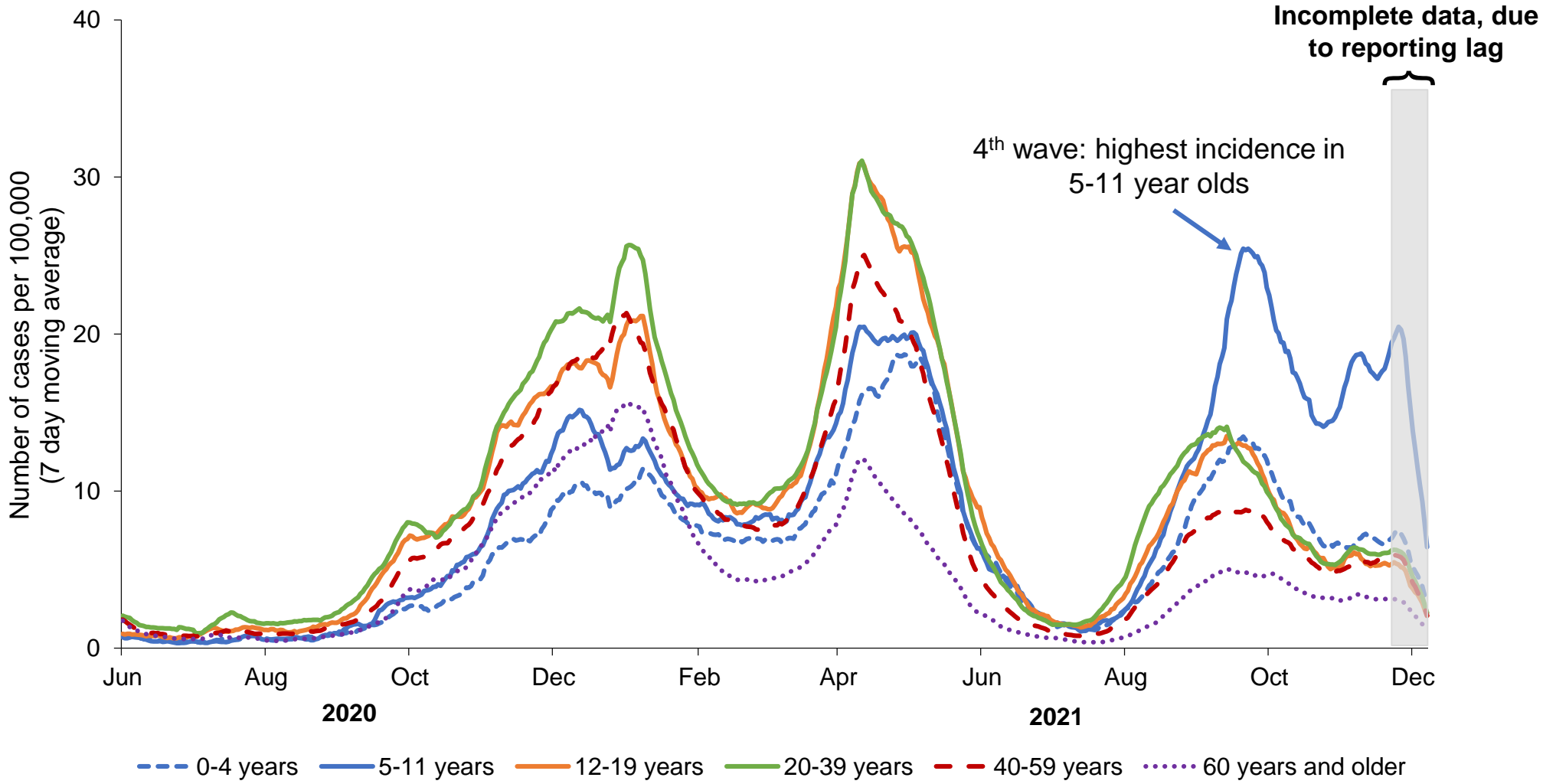


# Canada's $R_t$ has been relatively unstable, but above 1 over the past 5 weeks, indicating the epidemic is in a growth pattern nationally, with considerable regional variation



Data as of December 6, 2021  
Note: 7-day moving average.

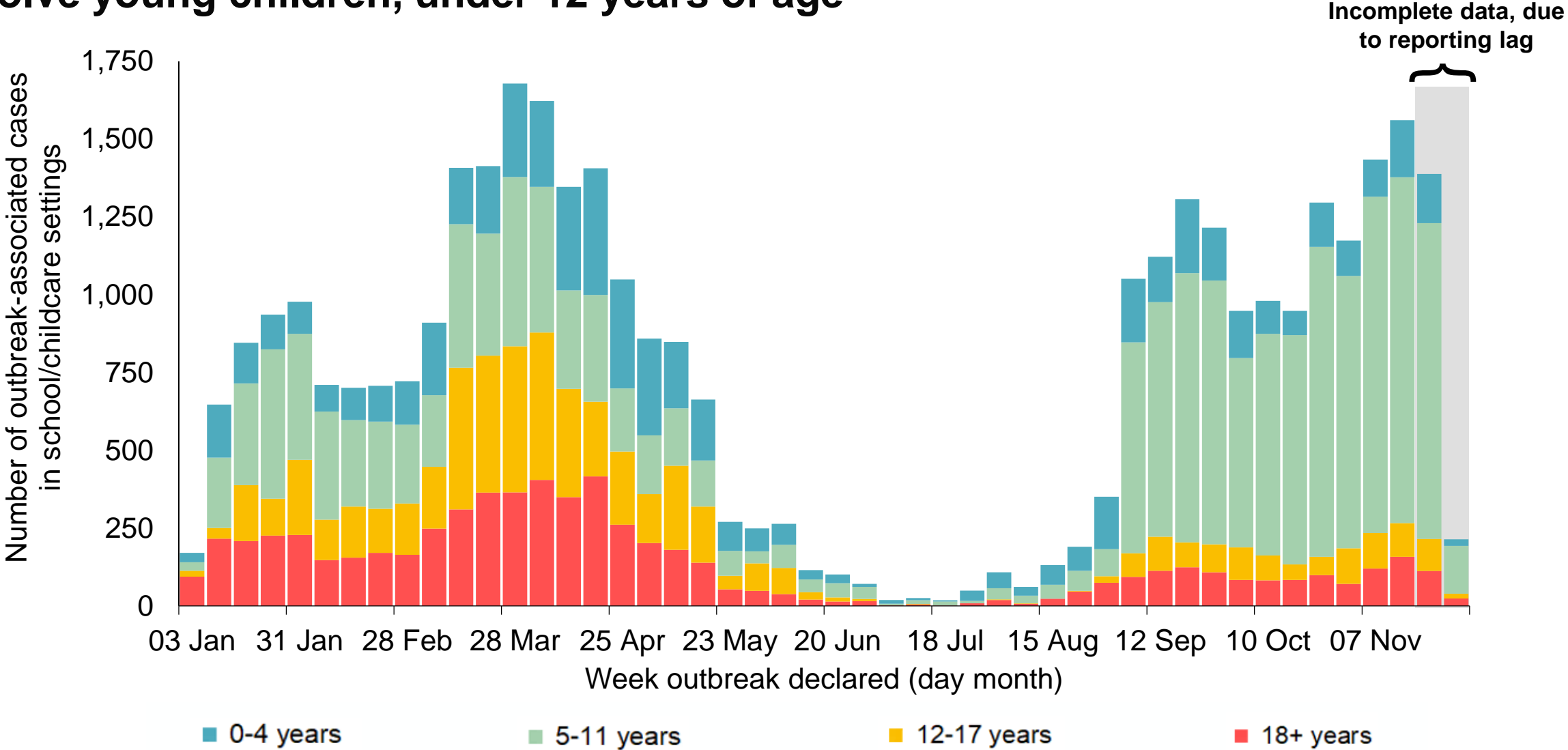
# Nationally, incidence rates remain highest among children under 12 years of age, with the large majority of people aged 12 years or older now fully vaccinated



Data as of December 7, 2021  
 Source: Detailed case data submitted to PHAC by the provinces and territories. Shaded area represents period of accumulating data.  
 Date is the earliest of symptom onset date, lab specimen collection date, lab result date, date reported to province or territory, and date reported to PHAC.



# Outbreaks in school and childcare settings remain small in size and predominantly involve young children, under 12 years of age



Incomplete data, due to reporting lag



Data as of December 4, 2021 based on COVID-19 outbreaks and cases in school and childcare settings reported from Ontario and Quebec.

# Delta variant continues to predominate in Canada and globally, while spread of the Omicron variant has increased

## Omicron (B.1.1.529) preliminary data suggest:

### Transmissibility



- Potential to spread faster than the highly transmissible Delta
- South Africa: cases have risen much quicker with Omicron compared to previous waves
- Greater transmissibility or reduced protection from prior infection/vaccination could drive resurgence

### Severity



- Not known whether higher or lower risk of severe illness and death
- Some types of current treatments may be less effective
- Larger numbers of cases could impact healthcare capacity

### Immunity

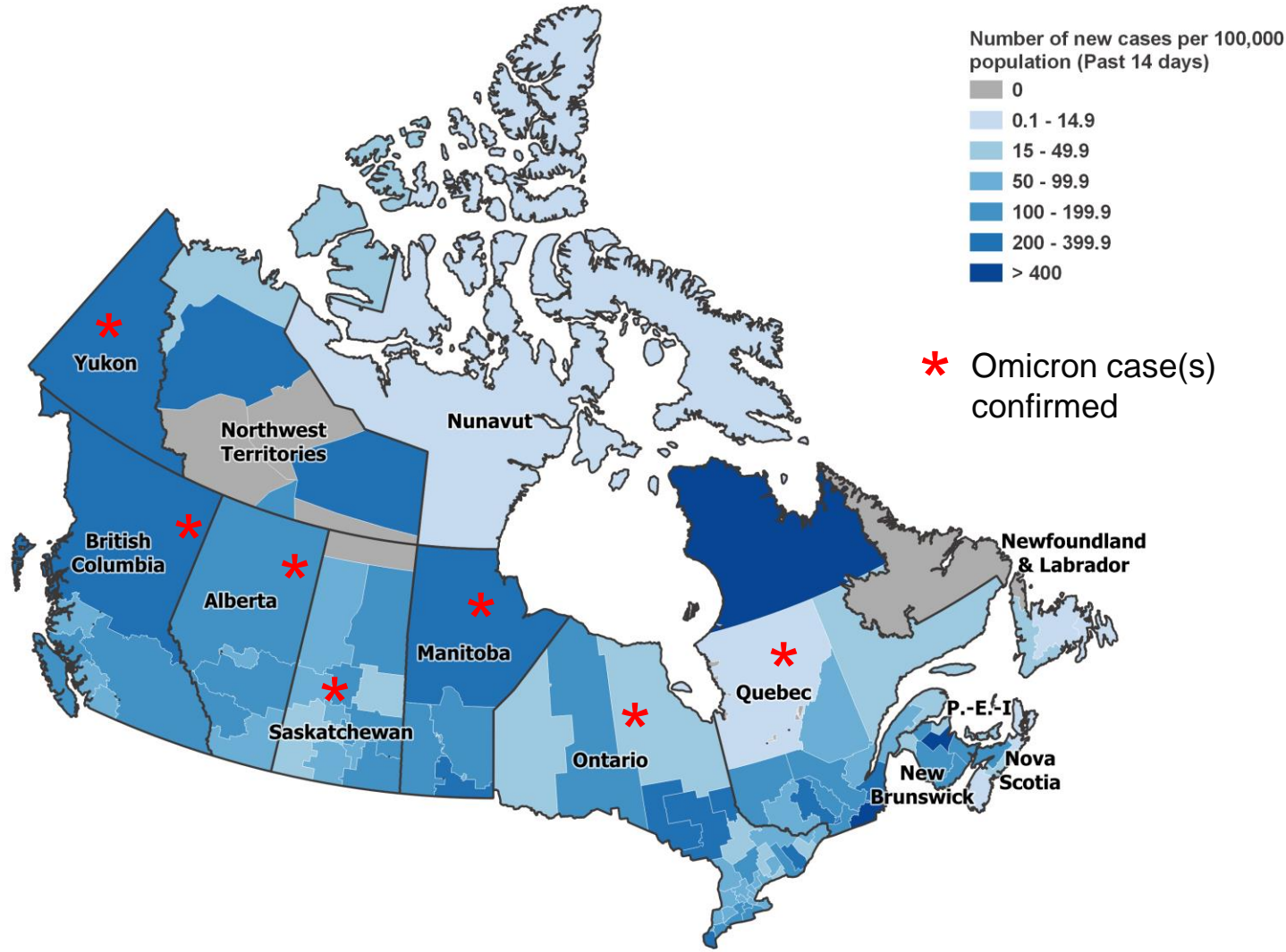


- Vaccine effectiveness under investigation; may decrease vaccine protection against infection, but some level of protection against severe disease likely to remain
- May be able to escape immunity from prior infection
- Canada/worldwide: cases detected in both vaccinated and unvaccinated people

**Vaccination, in combination with public health measures and individual protective practices continue to help control COVID-19 spread, including for Omicron and the predominating Delta variant**



# Despite recent detection of the Omicron variant in multiple jurisdictions, Delta continues to predominate in widespread but variable disease activity across Canada



## Status of Omicron in Canada as of December 9, 2021:

- Cases confirmed in seven jurisdictions
- Majority linked to international travel or close contact with travelers
- Some suspected community transmission
- Asymptomatic or mild

Health region level incidence data as of December 7, 2021.

Note: Map only shows COVID-19 cases where health region had been attributed in source data.

Data sources: COVID-19 Canada Open Data Working Group. Epidemiological Data from the COVID-19 Outbreak in Canada.

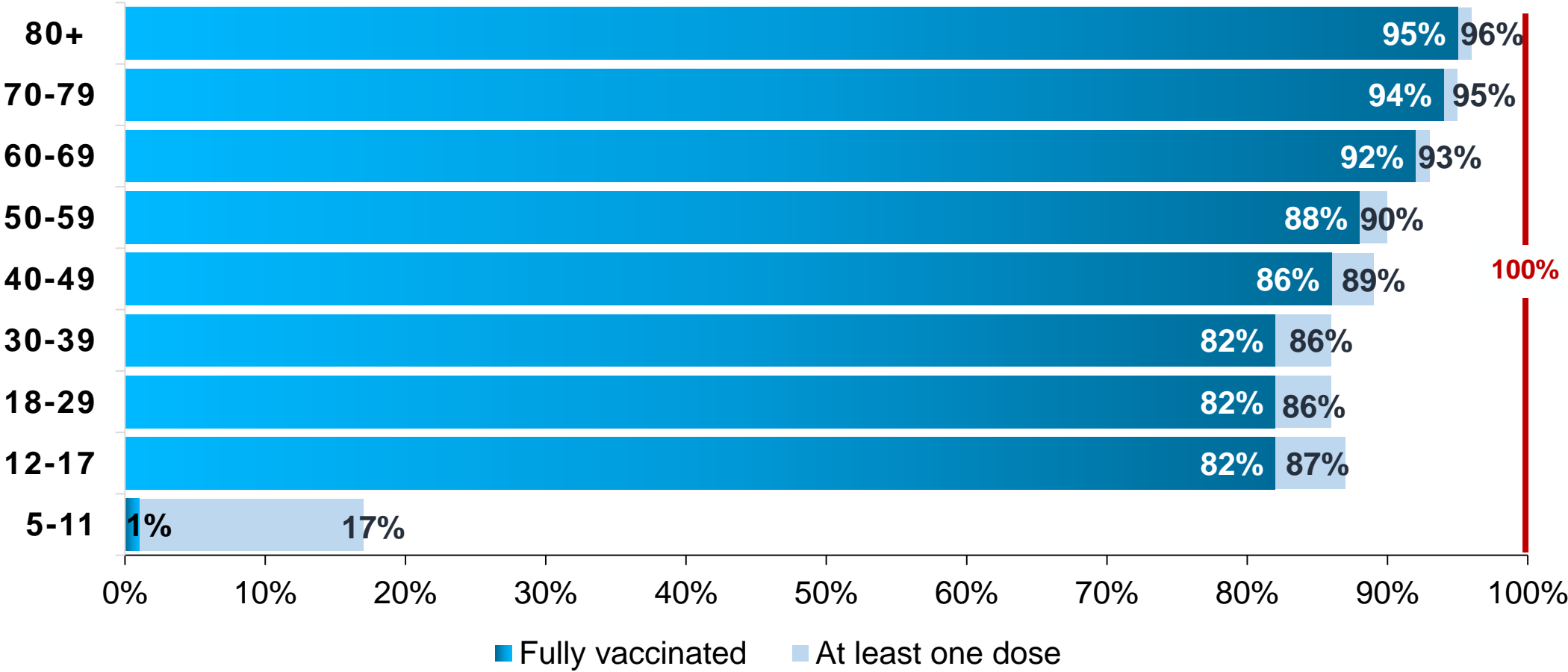
Statistics Canada. Table 17-10-0134-01 Estimates of population (2016 Census and administrative data), by age group and sex for July 1st, Canada, provinces, territories, health regions (2018 boundaries) and peer groups.





# 95% of Canadians now eligible for COVID-19 vaccines; >81% of the total population have at least one dose and >76% are fully vaccinated as coverage continues to increase

Percentage of eligible people (≥ 5 years) with at least one dose and fully vaccinated by age group, as of December 4<sup>th</sup>, 2021



Data as of December 4, 2021

**Note:** Data obtained from the Canadian COVID-19 Vaccination Coverage Surveillance System. With the addition of some 11 year olds who turn 12 in 2021 -- and received off-label vaccinations as part of the 12-17 year old program -- the 5 to 11 year age group has already achieved 17% coverage with at least one dose and 1% are fully vaccinated.



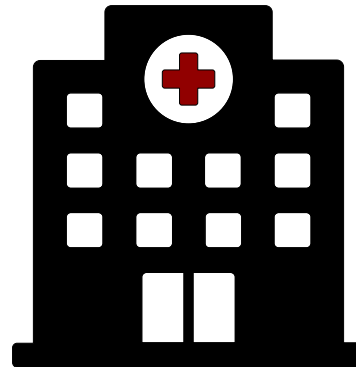
# Fully vaccinated people are at significantly lower risk of being hospitalized with COVID-19

*While COVID-19 vaccines continue to provide excellent protection against severe illness in all age groups, the relative difference in rates between unvaccinated and fully vaccinated people is even greater for youth and younger adults who are at lower overall risk of hospitalization*

Among youth and adults  
aged 12 to 59 years,  
unvaccinated people were

**32** times

more likely to be hospitalized  
with COVID-19 than  
fully vaccinated people



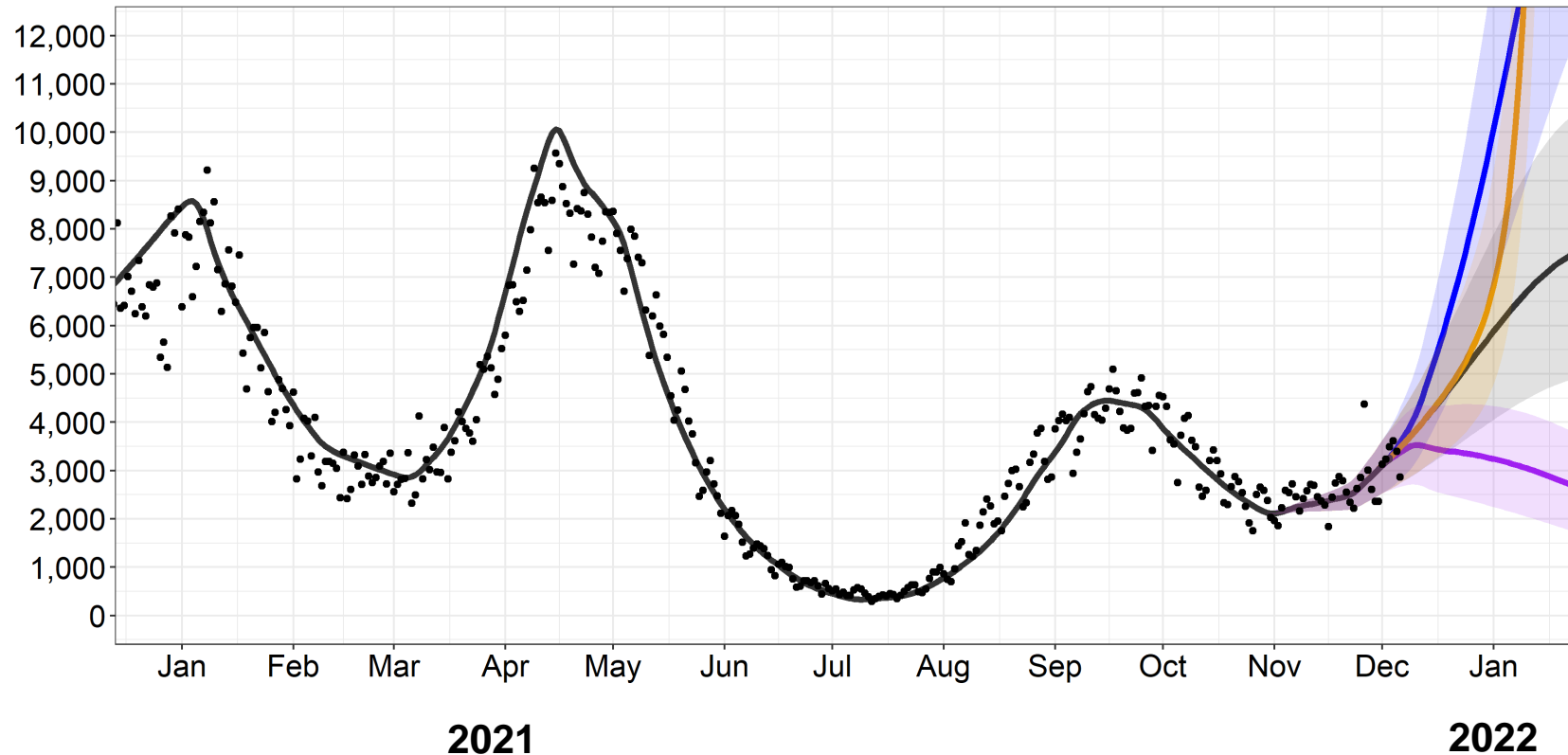
Among older adults  
aged 60 years or older,  
unvaccinated people were

**16** times

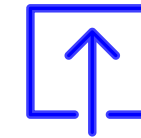
more likely to be hospitalized  
with COVID-19 than  
fully vaccinated people

# Resurgence is forecast for Canada and could be further accelerated if Omicron replaces Delta in the coming weeks

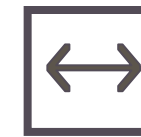
## Reported cases



## DELTA Predominant



If transmission **increases** by 15%



If we **maintain** the current levels of transmission



If public health measures **reduce** transmission by 15% today

## OMICRON Replacement



If we maintain the current levels of transmission and Omicron successfully establishes\*

\*Underestimate - accounts for only increased transmissibility but not immune evasion

Data as of December 6, 2021

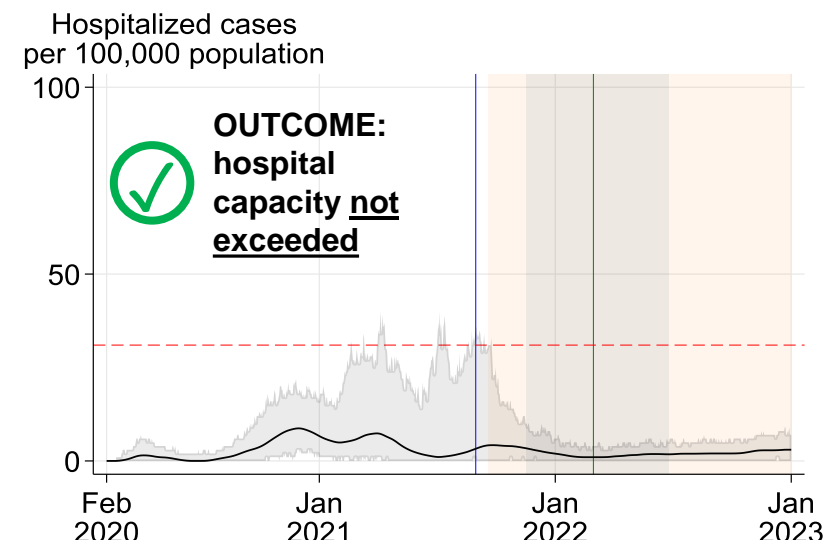
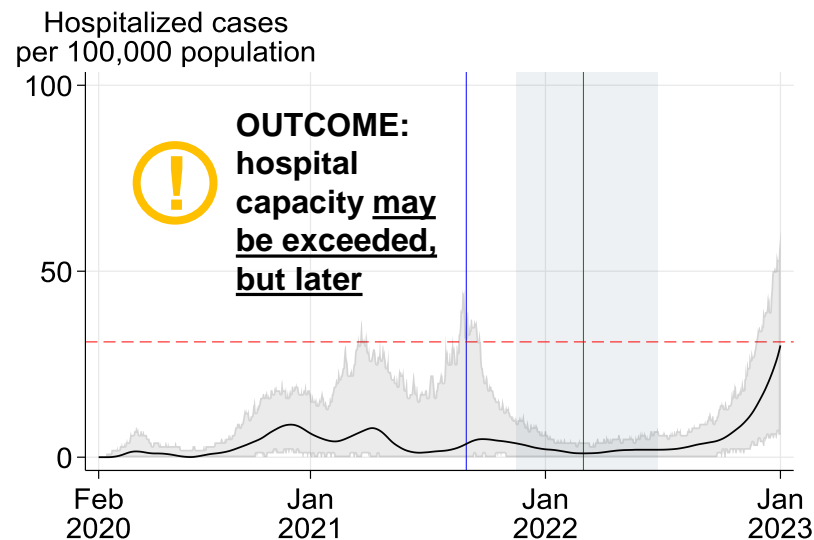
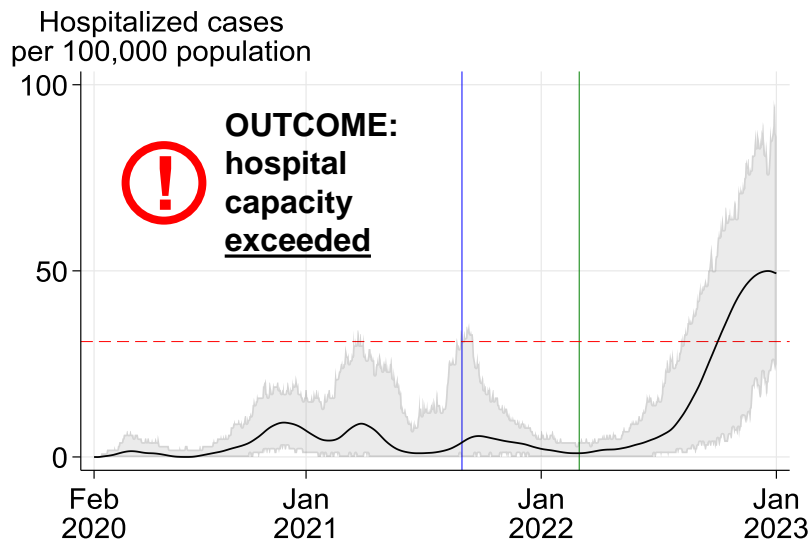
**Note:** Output from PHAC-McMaster model. Model considers impact of vaccination and increased transmissibility of VOCs, refer to annex for detailed assumptions on modelling.

# With the possibility of waning protection of vaccines, vaccinating children and providing booster doses to adults could help reduce the impact through 2022

- 5-11 vaccination
- Boosters for 18+

- 5-11 vaccination
- Boosters for 18+

- 5-11 vaccination
- Boosters for 18+



--- Hospital capacity for COVID-19 patients  
 — Median hospitalization prevalence

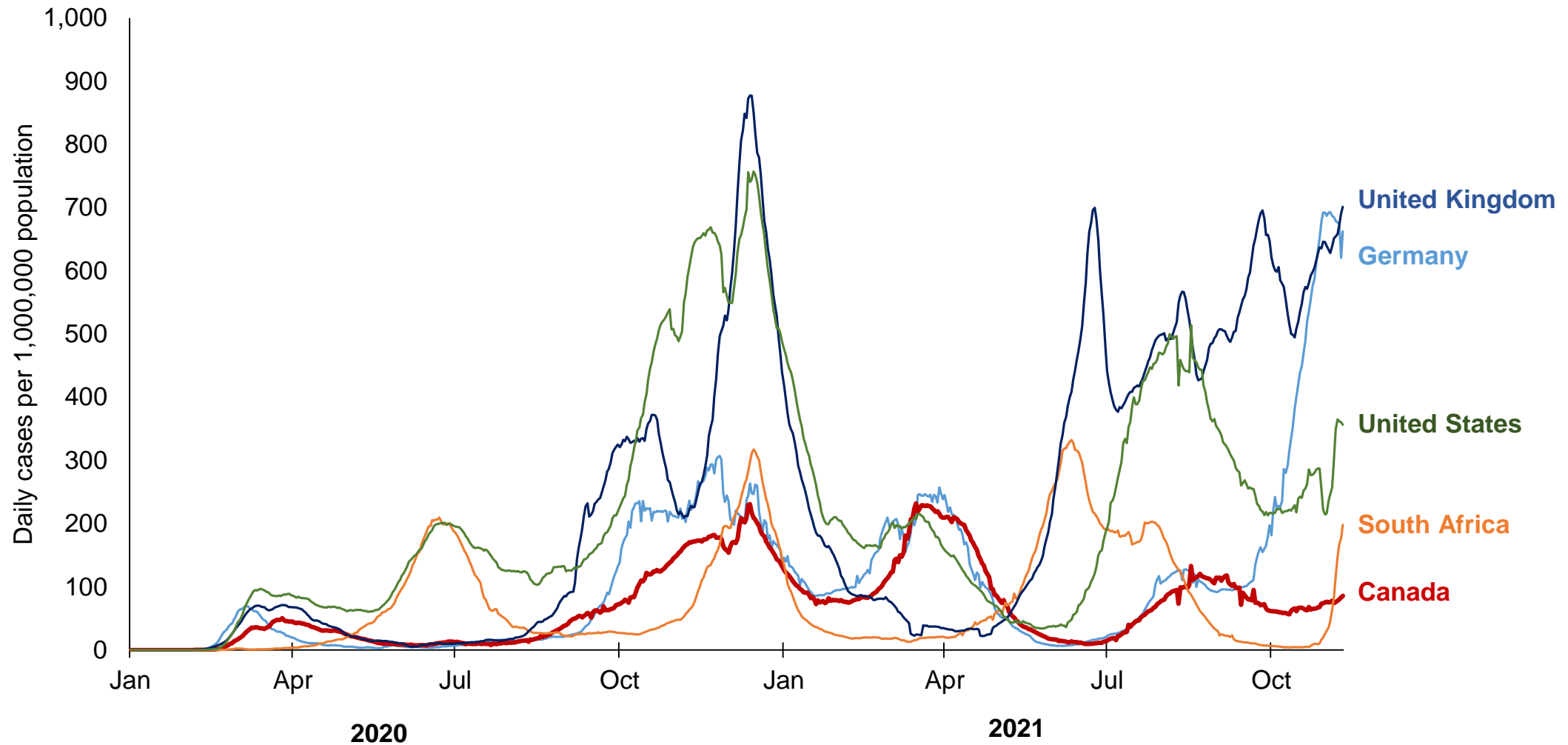
— Restrictive closures lifted  
 — Personal physical distancing lifted

■ Vaccination of 5-11 year olds  
 ■ Booster administration

**Note:** The grey shaded area represents the range of outcomes of model realisations; the black line represents the median value. The shaded blue area represents the vaccination rollout period for children aged 5-11 and the shaded light orange area represents the vaccination rollout period for booster doses. The overall vaccine coverage varies between 79 and 85% depending on the scenario in the total population. The two vertical lines are: lifting of restrictive PH measures (solid blue line, September 1, 2021), lifting of personal physical distancing (solid green line, March 1, 2022). The red dashed horizontal line represents the Canadian hospital bed limit (31 beds per 100,000, updated January 25, 2021 from Health Canada data), this limit assumes 40% of all beds available for COVID-19 patients but will vary across provinces and territories. Includes potential impact of waning immunity. Includes impact of Alpha and Delta, but not Omicron. See annex for detailed assumptions.



# International experience shows the need for continued vigilance and timely response to emerging risks



Data as of December 7, 2021  
Source: Our World in Data

# Challenges remain, but with continued vigilance, expansion of vaccination programs, and layers of protection we can celebrate the holidays more safely

- **Despite the challenges ahead**, we have more and better protections going into this holiday and winter season than previously.
- **Canada's approved vaccines provide substantial protection to dampen the severity** of the virus and improved layers of protection can reduce the risk of infection and spread in our homes and community settings.
- **Looking to the holidays and weeks ahead, caution is still warranted**, but with better protection and more choices we can celebrate more safely:
  - **Safer when all who are eligible get fully vaccinated + get a booster dose** as recommended
  - **And, regardless of our vaccination status, we can stay safer over the holidays by:**
    - **keeping up with public health advice** as the situation evolves, and
    - **using the best available layers of protection**, particularly if indoors with others outside of our immediate household, including:
      - wear a well-constructed and well-fitting face mask
      - keep gathering sizes small, improve ventilation
      - maintain hand and cough hygiene
      - stay home and away from others in the event of any symptoms
      - get tested, especially if symptomatic or as recommended

Canada is Better Protected  
with COVID-19 vaccines

62 M+ COVID-19 vaccines given

29 M+ fully vaccinated!

2 M+ 3rd doses given

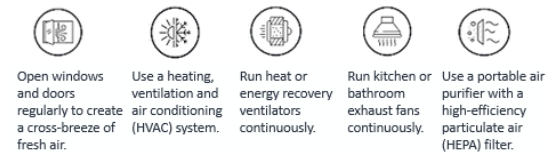


Lowering the risk with layers

Choose and wear a well-fitted and well-constructed mask



Improve ventilation and air filtration in your home



Winterize your layers for better protection now; learn more about:

- COVID-19 Vaccines and Booster Doses: <https://www.canada.ca/en/public-health/services/diseases/coronavirus-disease-covid-19/vaccines.html>
- Well-constructed, well-fitting face masks <https://www.canada.ca/en/public-health/services/publications/diseases-conditions/types-masks-respirators.html>
- Improving indoor ventilation: <https://www.canada.ca/en/public-health/services/publications/diseases-conditions/ventilation-helps-protect-against-spread-covid-19.html>

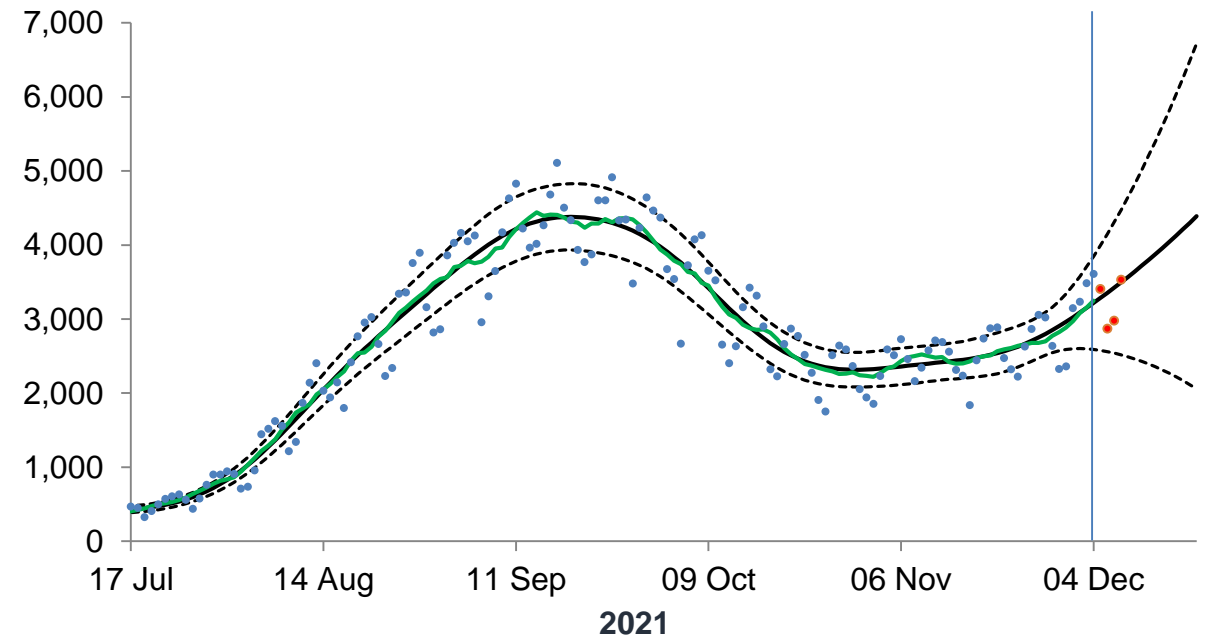
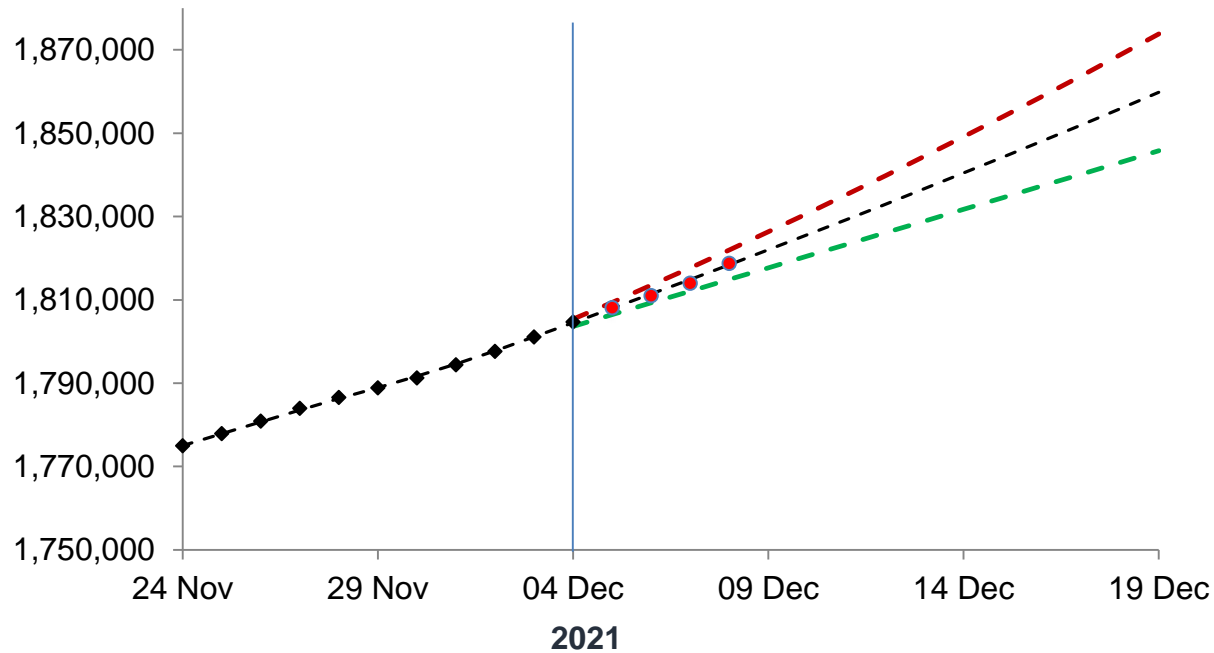


# ANNEX

# Short-term forecast predicts accelerated increase in cumulative cases corresponding to the increase of daily cases

Cumulative cases predicted to December 19, 2021:  
**1,845,770 to 1,873,780**

Daily cases predicted to December 19, 2021:  
**2,050 to 6,720**



- ◆ Cumulatively reported cases in Canada by Dec. 4
- Prediction to Dec.19 with plausible range
- Cases added since Dec. 4 when the predictions were made

- Daily numbers as reported
- 7-day running average
- Prediction of the 7-day running average with range
- Daily numbers reported after the prediction was made

Data as of December 4, 2021

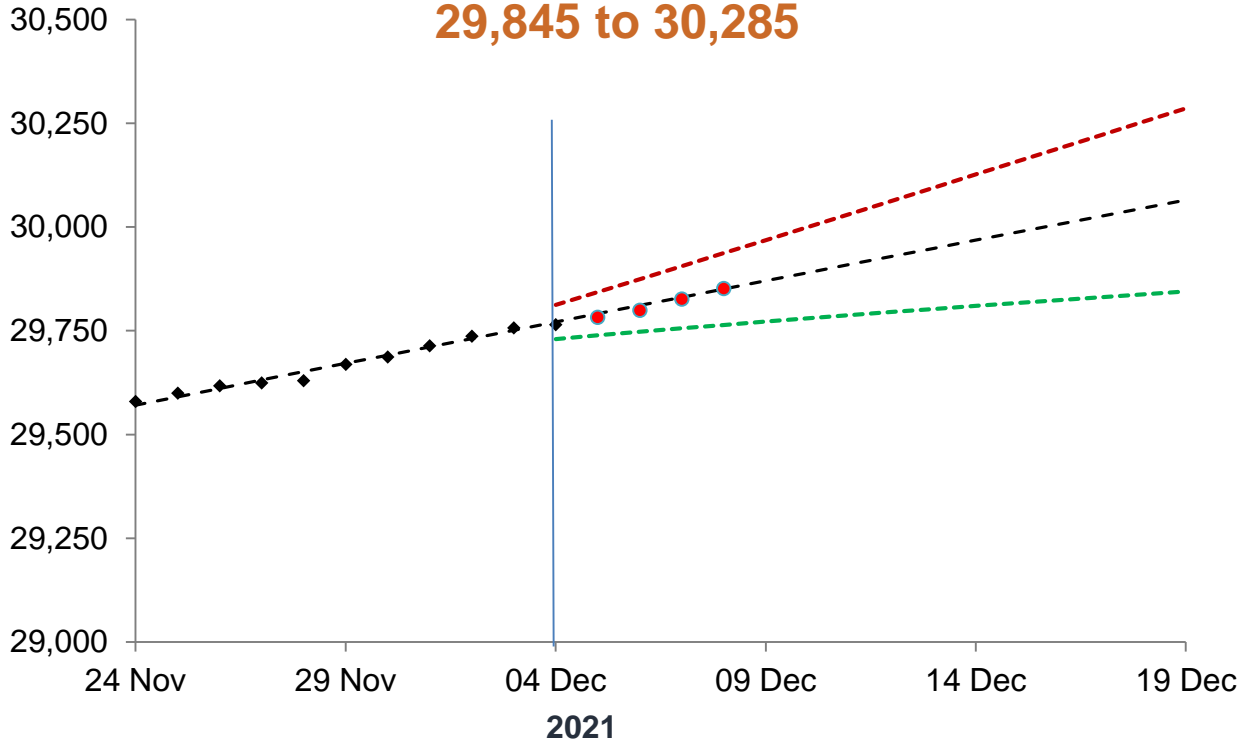
**Note:** Extrapolation based on recent trends using a forecasting model (with ranges of uncertainty).



# Short-term forecast predicts steady increase in cumulative deaths corresponding to the predicted steady trend of average daily deaths

**Cumulative deaths predicted to December 19, 2021:**

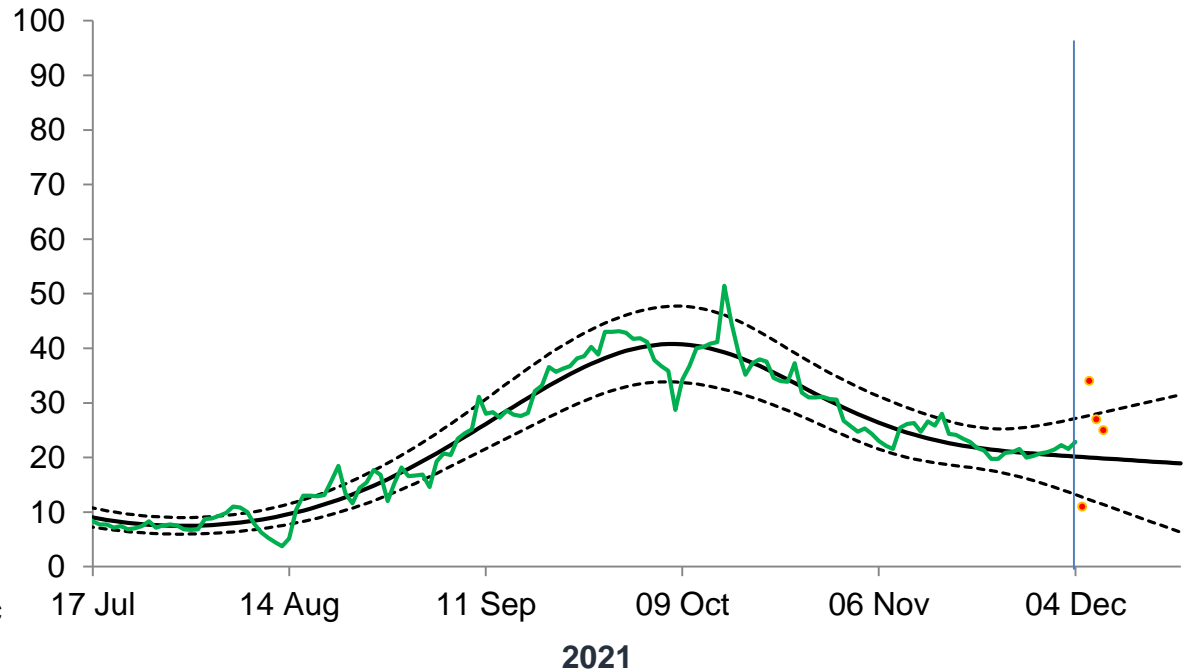
**29,845 to 30,285**



- ◆ Cumulatively reported deaths in Canada by Dec. 4
- Prediction to Dec.19 with plausible range
- Cases added since Dec. 4 when the predictions were made

**Daily deaths predicted to December 19, 2021:**

**6 to 30**



- Daily numbers as reported
- 7-day running average
- Prediction of the 7-day running average with range
- Daily numbers reported after the prediction was made

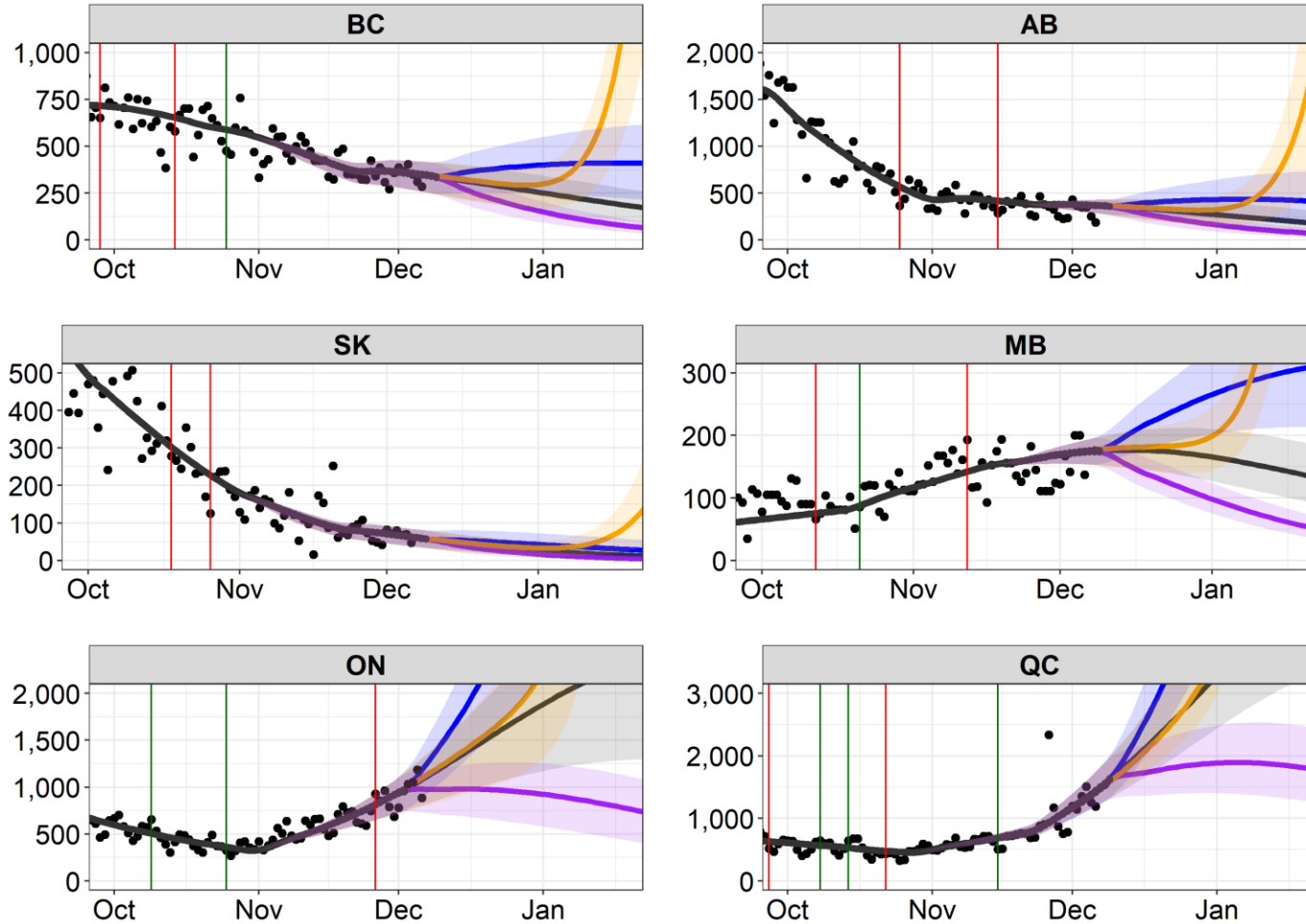
Data as of December 4, 2021

**Note:** Extrapolation based on recent trends using a forecasting model (with ranges of uncertainty).

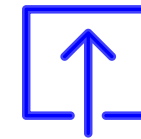


# Resurgence is currently forecast for Ontario and Quebec, and possibly other jurisdictions if Omicron replaces Delta

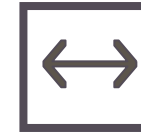
## Reported cases



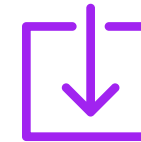
## DELTA Predominant



If transmission **increases** by 15%



If we **maintain** the current levels of transmission



If public health measures **reduce** transmission by 15% today

## OMICRON Replacement



If we maintain the current levels of transmission and Omicron successfully establishes\*

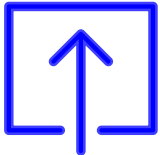
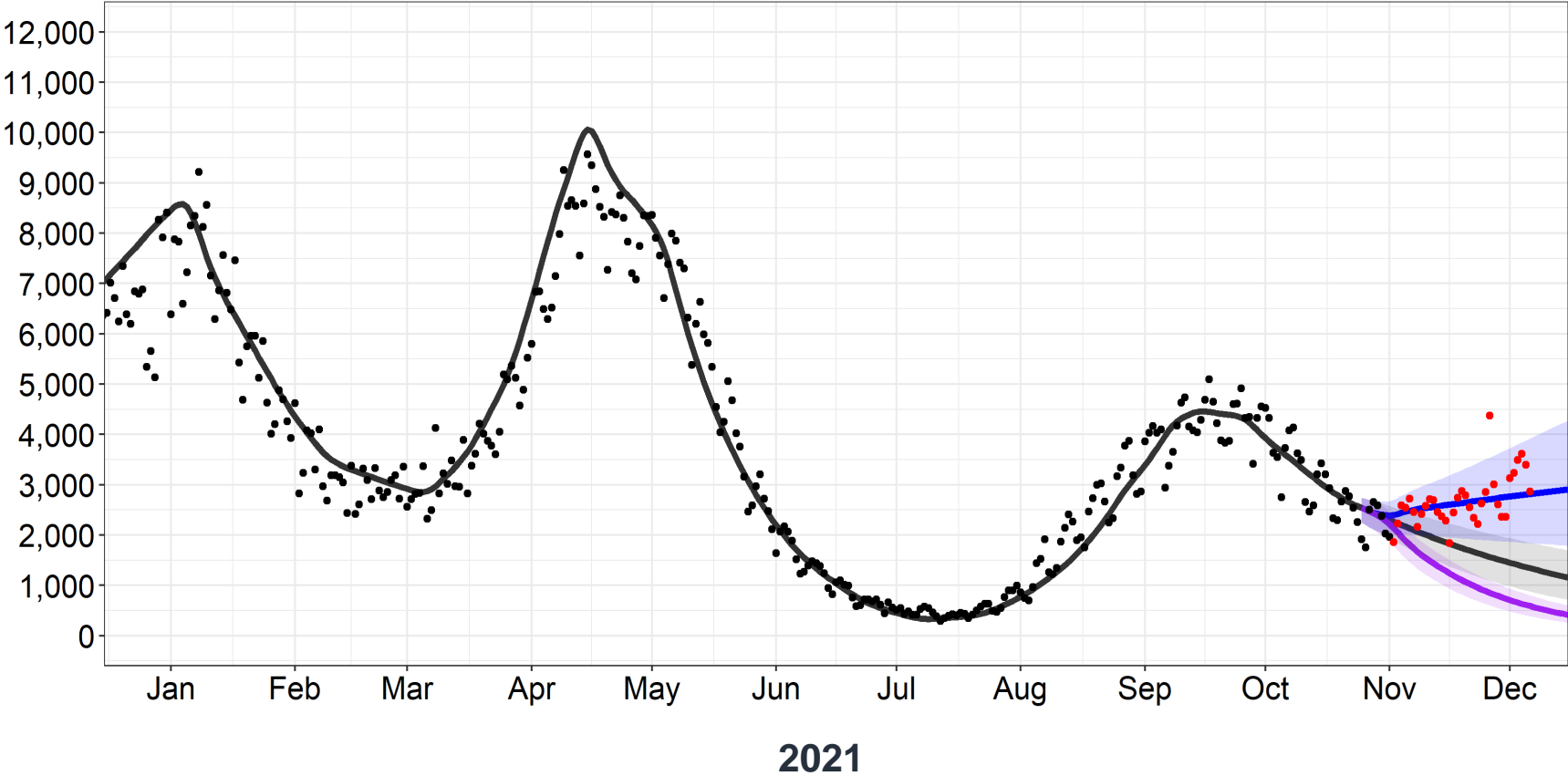
\*Underestimate - accounts for only increased transmissibility but not immune evasion

Data as of December 6, 2021

**Note:** Output from PHAC-McMaster model. Model considers impact of vaccination and increased transmissibility of VOCs, refer to annex for detailed assumptions on modelling. In provincial plots, dark green vertical lines represent reopening/lifting measures, red vertical lines represent reimplementation/reinforcement of measures.

# Since November 5<sup>th</sup> forecast, cases have risen along the increased transmission trajectory (blue)

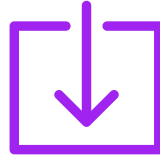
Reported cases



If transmission increases by 15%



If we maintain the current levels of transmission



If public health measures reduce transmission by 15%

**Red points** – Surveillance data after the forecast from November 2<sup>nd</sup> to December 6<sup>th</sup>

Model data as of November 1<sup>st</sup>, 2021. Surveillance data as of December 6<sup>th</sup>, 2021.

**Note:** Output from PHAC-McMaster model. Model considers impact of vaccination and increased transmissibility of VOCs (including Delta but not including Omicron), refer to annex for detailed assumptions on modelling.

# Types of models used to inform decision making

## Statistical forecast models:

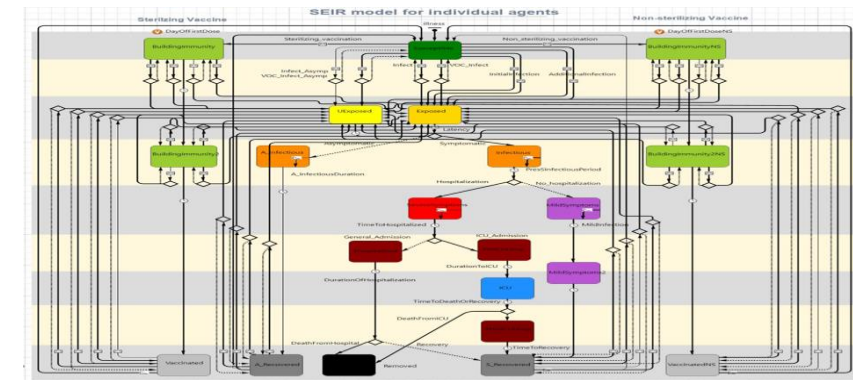
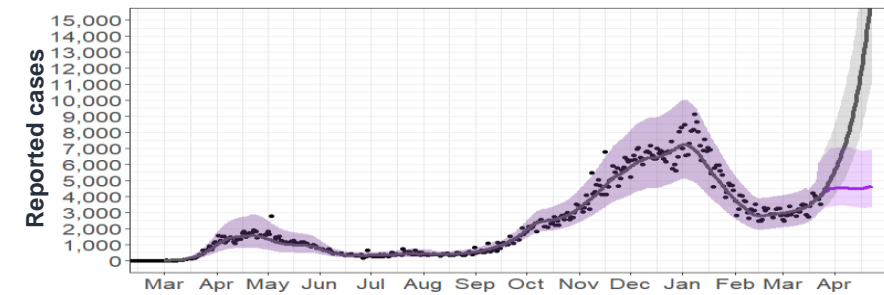
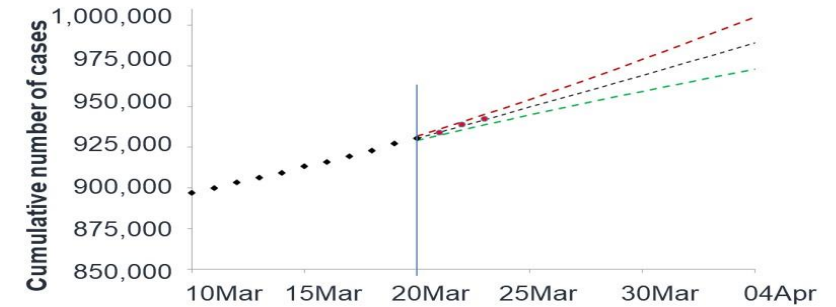
- Short-range forecast of expected cases given recent incidence

## Long-range forecast models:

- Dynamic compartment model adapted to project near-future given recent incidence and scenarios for control/release/variants of concern

## Models to explore scenarios of opening up:

- More complex models
  - Deterministic, age structured compartment model
  - Agent-based model
- Initially developed to model control measures needed
- Recently adapted to model effects of vaccination and transmission of VOC





# Longer-range forecasting model assumptions

- The forecast uses compartmental models reflecting the biology of COVID-19 and public health response developed by PHAC in collaboration with McMaster University. It projects the near future given recent incidence of COVID-19 and scenarios for public health measures, variants of concern and vaccination.
- The model assumes that the B.1.617.2 (Delta) VOC is 50% more transmissible compared to B.1.1.7 (Alpha). This value is used to estimate the rate at which VOCs replace existing strains. Ongoing virus evolution is not accounted for and at this stage effects of the B.1.1.529 (Omicron) VOC are included in only one of the forecasts.
- Delta is considered to have been introduced in mid-March at very low prevalence, with provincial variations. The proportion of cases due to VOCs are indirectly fitted when calibrating to data.
- A simplified approach to modelling the Omicron variant is utilized for one forecast in which it is assumed that i) combined transmissibility and immune escape effects result in transmissibility 3x that of Delta; ii) Omicron replaces Delta at the rate seen in Gauteng, Republic of South Africa; and iii) 0.1% infections on Dec 3<sup>rd</sup> were Omicron.
- The national forecast includes four scenarios for changes in the effective transmission rate as of Nov 15<sup>th</sup> as no additional reopening/lifting plans are scheduled. This includes three scenarios showing expected change without Omicron replacing Delta: if effective transmission rates do not increase (grey line); if effective transmission increases by 15% (blue line); and if effective transmission decreases by 15% (purple line). The fourth scenario shows expected change if Omicron replaces Delta and effective transmission rates do not increase (orange line). There are uncertainties with the amount of transmission which propagates forward in the forecasting scenarios.
- The forecast includes current vaccine roll-out, assumes that vaccinations are 60% effective against infection after one dose and 90% after the second dose for all variants except for Delta (against which effectiveness is 30% after one dose and 80% after the second dose). The vaccine projections assume 8% for first dose and 10% for second dose hesitancy of the eligible population (ages 5+). Waning of immunity is not accounted for.

# Assumptions for the PHAC agent-based model

- The vaccine is 60% effective at preventing infection and 80% effective at preventing hospitalization after one dose, and 92% effective at preventing infection and 96% effective at preventing hospitalization after two doses;
- A VOC modelled on B.1.1.7 (Alpha) was introduced in December 2020 and is 50% more transmissible and 40% more virulent than the wild-type strain, but does not have immune escape from vaccines; A second VOC modelled on B.1.617.2 (Delta) was introduced in March 2021 and is 100% more transmissible and 80% more virulent than the wild-type strain with immune escape from vaccines causing a 33% reduction in protection against infection after the first dose and a 6% reduction in protection against infection after the second dose. B.1.1.529 (Omicron) variant is not included in the model;
- Hospital bed capacity available for COVID-19 patients in Canada is estimated at 31 per 100,000;
- The vaccination period begins Dec 14, 2020 and varies by scenario (Dec 2021 – no children or booster vaccination, June 2022 – with children vaccination only and March 2023 – with children and booster vaccination). The website COVID-19 Tracker Canada - Vaccination Tracker ([covid19tracker.ca](https://covid19tracker.ca)) is used to calculate current and expedited vaccination rates +/- 1% of the real time rates. Vaccine acceptance is from the November 18, 2021 Canadian Immunization Centre report which contains data for vaccination including, and up to, November 13, an additional 1% to 4.5% of vaccine coverage is projected for age groups up to 69 years of age because these groups are currently actively receiving the vaccine.
- Vaccine coverage is an estimated 90.3% in the population 12 years and over, and 78.8% in the total population for scenarios without vaccination of children or boosters. Vaccination coverage is 89.5% in the eligible population (5 years and over) and 84.8% in the total population for scenarios with vaccination of children or boosters. Vaccination roll-out for 12+ proceeds in order of priority groups with a 4-month interval between doses starting from March 4, 2021. The 4-month delay progressively decreases to a 28-day interval by June. Vaccination roll-out for 5 to 11 years proceeds using an 8-week delayed dose interval.
- Boosters are administered in the same order of priority as the 1<sup>st</sup> and 2<sup>nd</sup> doses and at a minimum of six months after the receipt of the 2<sup>nd</sup> dose. Boosters are imperfect and provide protection against infection, symptoms, hospitalisations and deaths up to the level acquired by the 2<sup>nd</sup> dose, time to waning immunity is reset providing another six months period in which immunity is retained before waning begins;
- Following vaccination or infection, after a six month period, protection against re-infection wanes but protection against hospitalisation and death persist and do not wane. The rate of waning occurs faster in individuals 65 years and over (complete waning over two years versus complete waning over three years for under 65);
- Infection-acquired immunity and vaccine-acquired immunity wanes within the same time period and protection against infection, hospitalisation and death from infection is assumed to be the same as protection provided by two full doses of the vaccine. Individuals who are infected twice or are infected and fully vaccinated confer life-long immunity.
- For all scenarios, a two-step gradual approach to lifting public health measures was modelled. Restrictive measures are lifted gradually in early summer (when at least 75% of those 12 and over have received their first dose and approximately 15% have received their second dose). The easing of personal protective measures occurs in mid-summer (when at least 80% of those 12 and over have received their first dose and approximately 50% have received their second dose), with return to approximately 100% of pre-pandemic contact rates by March 1, 2022.
- Reopening of the Canadian border to travellers commences on July 5, 2021 (Stage 1), August 2 (Stage 2) and September 7 (Stage 3), these stages correspond with varying estimates of imported cases as estimated from the PHAC importation risk model. Prior to Stage 1 reopening, the number of imported cases was estimated to be 2 per 100,000 per week (one transient and one permanent case). Prior to lifting of public health measures, the epidemic is controlled by a combination of restrictive closures, case detection and isolation, contact tracing and quarantine, and physical distancing.