

## ENHANCED EPIDEMIOLOGICAL SUMMARY

# Severe Outcomes among Confirmed Cases of COVID-19 Following Vaccination in Ontario: December 14, 2020 to April 23, 2023

As of May 5, 2023, PHO has discontinued monthly reporting of severe outcomes among confirmed cases of COVID-19 following vaccination. This report will be updated in the future on an ad hoc basis.

Due to the changes in COVID-19 testing (effective December 31, 2021) driven by increasing COVID-19 cases related to the Omicron variant, case counts of COVID-19 are an underestimate of the true number of infected individuals in Ontario. As a result, the report focuses on severe (i.e. hospitalized and fatal) cases where testing is still recommended.

## Purpose

This report describes severe outcomes among confirmed cases of coronavirus disease 2019 (COVID-19) following COVID-19 vaccination. Data in this report include the most current information extracted from COVaxON as of April 24, 2023 at approximately 7:00 a.m. and CCM as of April 25, 2023 at 1:00 p.m. The report includes COVID-19 vaccinations and cases reported up to April 23, 2023. **This report is updated every 4 weeks.**

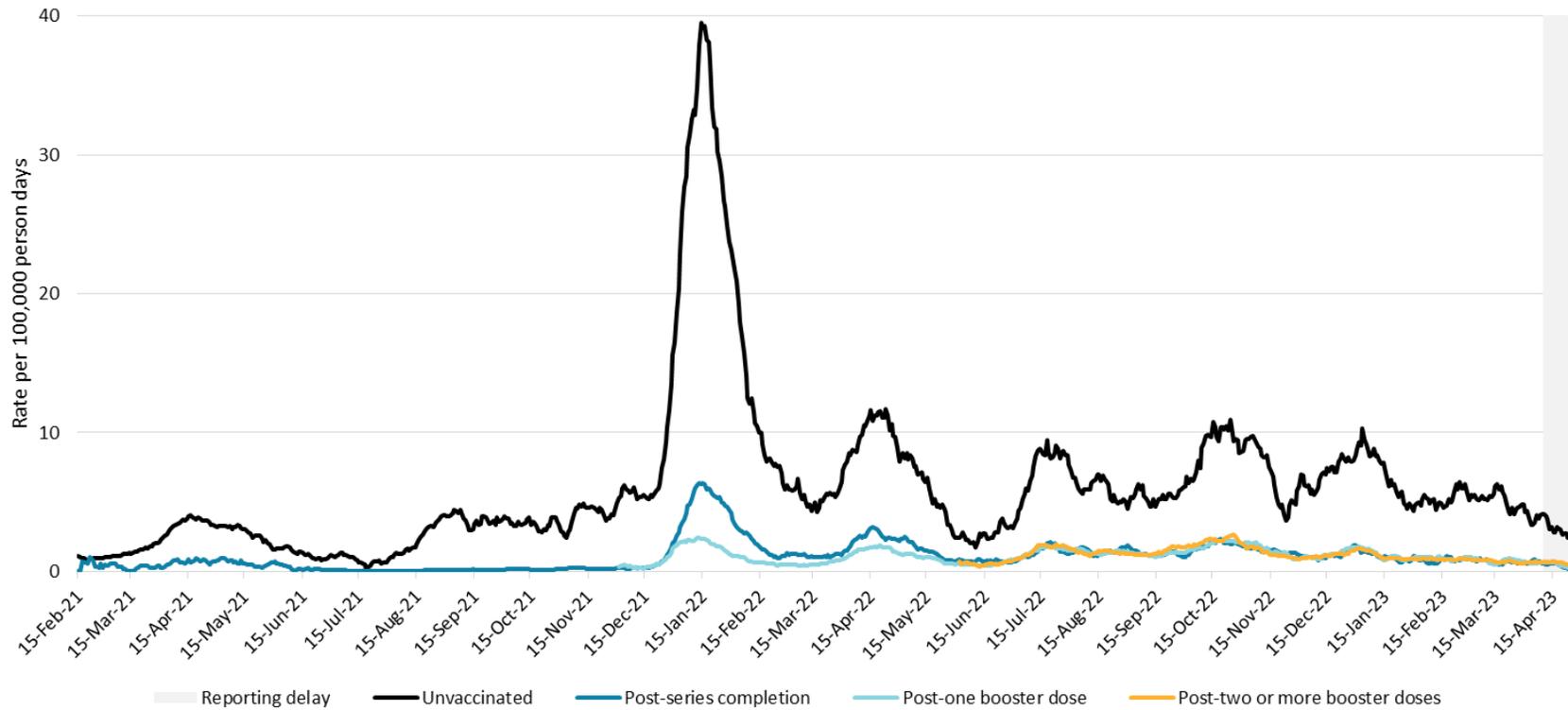
For additional information on COVID-19 vaccine uptake in the province, please visit the interactive [Ontario COVID-19 Data Tool](#), which includes vaccination uptake data by public health unit, age group and trends over time. The weekly report on [COVID-19 Vaccine Uptake in Ontario](#) further describes vaccine uptake across the province.<sup>1</sup>

## Highlights

- The rates of COVID-19-related hospitalizations were higher among unvaccinated individuals compared to those that have completed their primary vaccine series, as well as those that have completed their primary vaccine series and received one, or two or more, booster doses (Figure 1 and Figure 3).
  - In the previous 120 days, older adults that completed their primary vaccine series and received one booster dose only were more likely to be hospitalized due to COVID-19 compared to those that had completed their series and received two or more booster doses, suggesting an added benefit of additional booster doses in preventing hospitalizations (Table 1).
- Similar trends were observed for COVID-19-related deaths, with higher rates of deaths among unvaccinated individuals, in particular older unvaccinated adults, compared to those that have completed their primary vaccine series, as well as those that have completed their primary vaccine series and received one booster dose (Figure 2 and Figure 4).

## Rates of Severe Outcomes by Vaccination Status

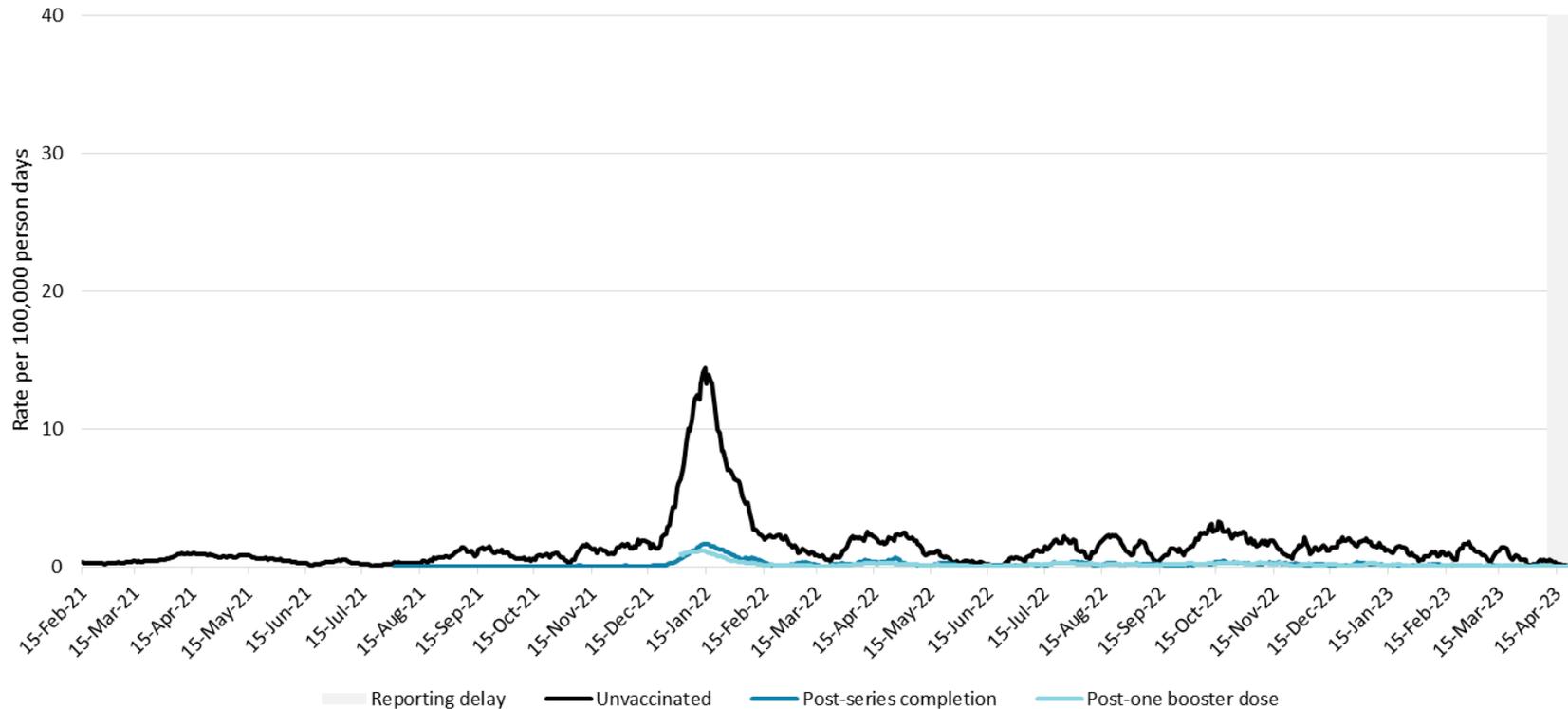
**Figure 1. Seven-Day Average Rate of COVID-19 Hospitalization per 100,000 Person Days among Individuals 60 Years of Age and Older by Vaccination Status: Ontario**



**Notes:**

1. Due to instability from small counts, unvaccinated and post-series completion rates are shown from February 15, 2021 onwards, post-one booster dose rates are shown from December 1, 2021 onwards, and post-two or more booster doses rates are shown from June 1, 2022 onwards.

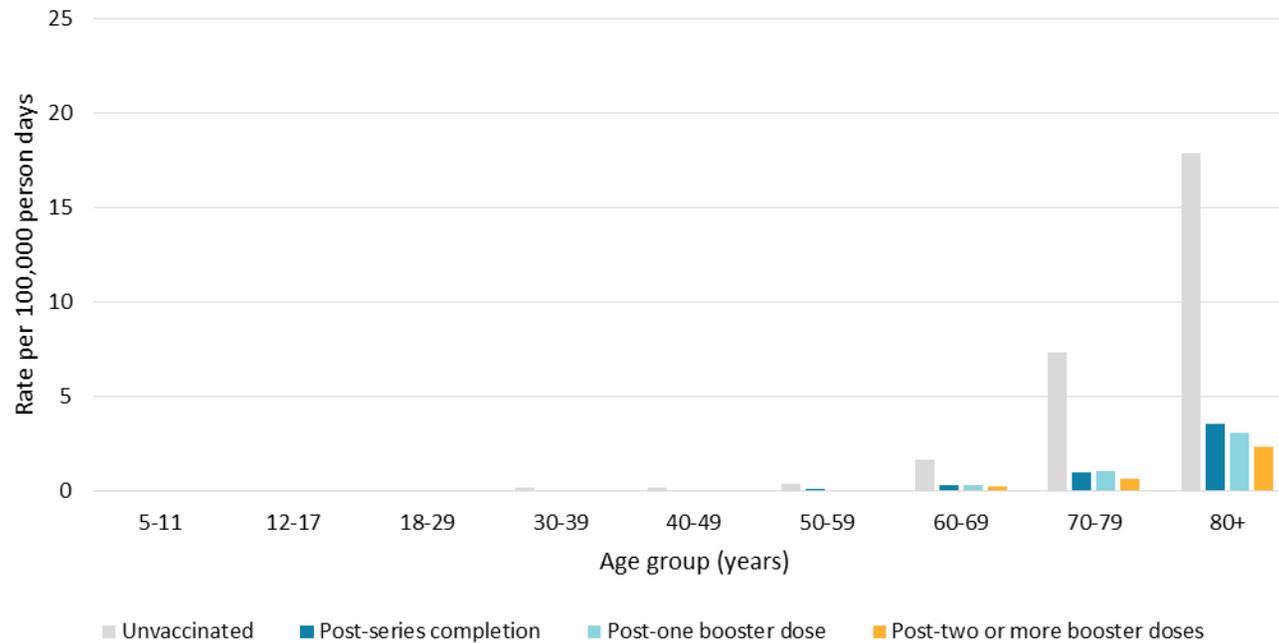
**Figure 2. Seven-Day Average Rate of COVID-19 Deaths per 100,000 Person Days among Individuals 60 Years of Age and Older by Vaccination Status: Ontario**



**Notes:**

1. Due to instability from small counts unvaccinated and post-series completion rates are shown from February 15, 2021 onwards, post-one booster dose rates are shown from January 1, 2022 onwards, and rates for post-two or more booster doses are not shown.

**Figure 3. Rate of COVID-19 Hospitalizations per 100,000 Person Days by Vaccination Status and Age Group in the Previous 120 Days: Ontario**



**Notes:**

1. Rates for post-one booster dose are not shown for children 5-11 years of age due to instability arising from small counts.
2. Rates for post-two or more booster doses are not shown for individuals under 60 years of age due to instability arising from small counts, as well as limited second booster eligibility in children.

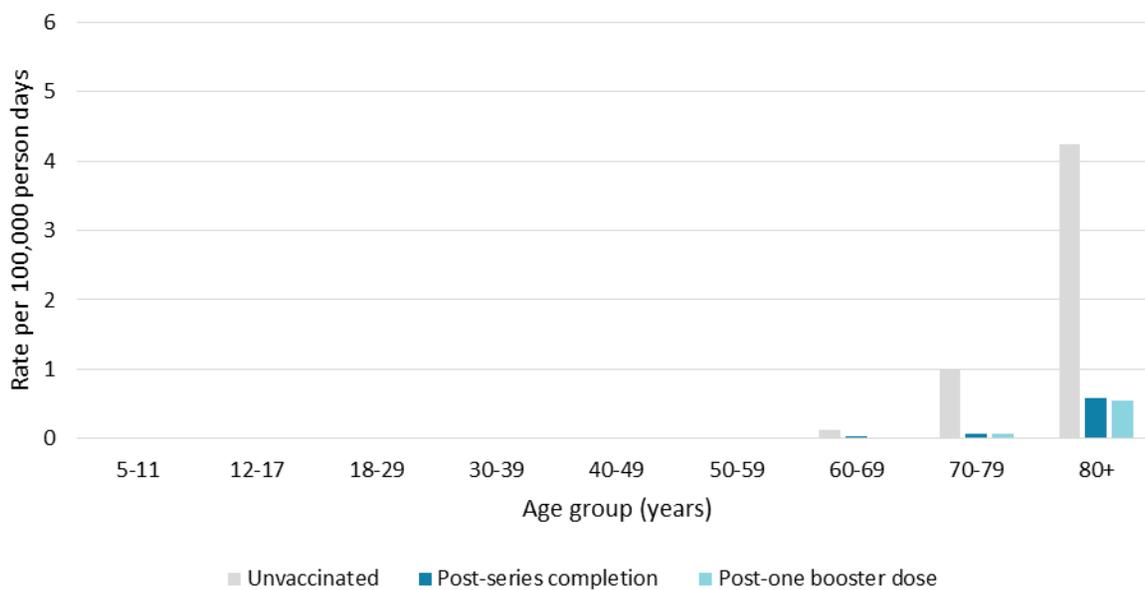
**Table 1. Rate of COVID-19 Hospitalizations per 100,000 Person Days by Vaccination Status and Age Group in the Previous 120 Days: Ontario**

Age group (years)	Rate per 100,000 person days: Unvaccinated	Rate per 100,000 person days: Post-series completion	Rate per 100,000 person days: Post-one booster dose	Rate per 100,000 person days: Post-two or more booster doses	Rate ratio: Unvaccinated/Post-series completion	Rate ratio: Unvaccinated/Post-one booster dose	Rate ratio: Unvaccinated/Post-two or more booster doses	Rate ratio: Post-series completion/Post-one booster dose	Rate ratio: Post-one booster dose/Post-two or more booster doses
5-11	0.03	0.01	N/A	N/A	3.00	N/A	N/A	N/A	N/A
12-17	0.02	0.02	0.00	N/A	1.00	N/A	N/A	N/A	N/A
18-29	0.08	0.02	0.03	N/A	4.00	2.67	N/A	N/A	N/A
30-39	0.18	0.04	0.04	N/A	4.50	4.50	N/A	N/A	N/A
40-49	0.21	0.05	0.06	N/A	4.20	3.50	N/A	N/A	N/A
50-59	0.41	0.11	0.09	N/A	3.73	4.56	N/A	N/A	N/A
60-69	1.70	0.30	0.30	0.27	5.67	5.67	6.30	1.00	1.11
70-79	7.36	0.99	1.07	0.67	7.43	6.88	10.99	0.93	1.60
80+	17.92	3.55	3.12	2.37	5.05	5.74	7.56	1.14	1.32

**Notes:**

1. Rates for post-one booster dose are not shown for children 5-11 years of age due to instability arising from small counts.
2. Rates for post-two or more booster doses are not shown for individuals under 60 years of age due to instability arising from small counts, as well as limited second booster eligibility in children.
3. For ratios showing the rate of COVID-19 hospitalizations in unvaccinated individuals compared to vaccinated individuals, a value greater than 1 represents a higher risk in unvaccinated compared to vaccinated. For ratios showing the rate of COVID-19 hospitalizations in post-series completion compared to post-one booster dose, a value greater than 1 represents a higher risk in post-series completion compared to post-one booster dose. For ratios showing the rate of COVID-19 hospitalizations in post-one booster dose compared to post-two or more booster doses, a value greater than 1 represents a higher risk in post-one booster dose compared to post-two or more booster doses.

**Figure 4. Rate of COVID-19 Deaths per 100,000 Person Days by Vaccination Status and Age Group in the Previous 120 Days: Ontario**



**Notes:**

1. Rates for post-one booster dose are not shown for children 5-11 years of age due to instability arising from small counts.
2. Rates for post-two or more booster doses are not shown due to instability arising from small counts.

**Table 2. Rate of COVID-19 Deaths per 100,000 Person Days by Vaccination Status and Age Group in the Previous 120 Days: Ontario**

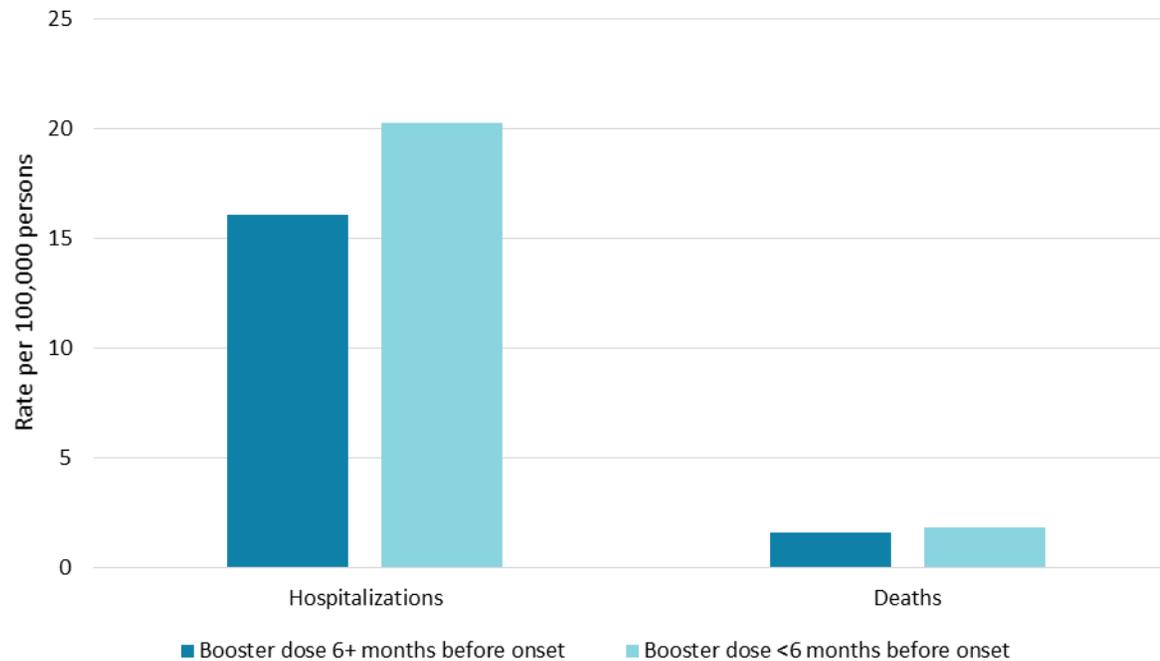
Age group (years)	Rate per 100,000 person days: Unvaccinated	Rate per 100,000 person days: Post-series completion	Rate per 100,000 person days: Post-one booster dose	Rate ratio: Unvaccinated/Post-series completion	Rate ratio: Unvaccinated/Post-one booster dose
5-11	0.00	0.00	N/A	N/A	N/A
12-17	0.00	0.00	0.00	N/A	N/A
18-29	0.00	0.00	0.00	N/A	N/A
30-39	0.01	0.00	0.00	N/A	N/A
40-49	0.01	0.01	0.00	N/A	N/A
50-59	0.02	0.00	0.01	N/A	2.00
60-69	0.12	0.03	0.02	4.00	6.00
70-79	0.98	0.07	0.06	14.00	16.33
80+	4.24	0.58	0.54	7.31	7.85

**Notes:**

1. Rates for post-one booster dose are not shown for children 5-11 years of age due to instability arising from small counts.
2. Rates for post-two or more booster doses are not shown due to instability arising from small counts.
3. For ratios showing the rate of COVID-19 deaths in unvaccinated individuals compared to vaccinated individuals, a value greater than 1 represents a higher risk in unvaccinated compared to vaccinated.

## Rates of Severe Outcomes by Booster Dose Status

**Figure 5. Rates of COVID-19 Hospitalizations and Deaths per 100,000 Persons among Individuals 60 Years of Age and Older by Booster Dose Status in the Previous 30 Days: Ontario**



**Notes:**

1. Methods for calculating the rates of COVID-19-related severe outcomes among individuals that received any booster dose 6 months or more or less than 6 months prior to illness onset differ from the methods used above to describe the rates of COVID-19-related severe outcomes among unvaccinated cases, cases post-series completion, etc. As a result, rates for unvaccinated, post-series completion, etc. are not comparable to rates reported for individuals that received any booster dose 6 months or more or less than 6 months prior to illness onset.
2. The observation of higher rates among individuals that received a booster dose less than 6 months prior to illness onset compared to those who received a booster dose 6 months or more prior to illness onset may be attributable to instability of rates due to small numbers of events or differences in the risk of COVID-19 severity among the two groups (i.e. individuals at higher risk of severe outcomes may be more likely to have received a recent booster dose).<sup>2</sup>

**Table 3. Rates of COVID-19 Hospitalizations and Deaths per 100,000 Persons among Individuals 60 Years of Age and Older by Booster Dose Status in the Previous 30 Days: Ontario**

<b>Severe outcome</b>	<b>Rate per 100,000 persons: Booster dose 6 months or more before onset</b>	<b>Rate per 100,000 persons: Booster dose less than 6 months before onset</b>	<b>Rate ratio: Booster dose 6 months or more before onset/Booster dose less than 6 months before onset</b>
<b>Hospitalizations</b>	16.09	20.27	0.79
<b>Deaths</b>	1.60	1.80	0.89

**Notes:**

1. Methods for calculating the rates of COVID-19-related severe outcomes among individuals that received any booster dose 6 months or more or less than 6 months prior to illness onset differ from the methods used above to describe the rates of COVID-19-related severe outcomes among unvaccinated cases, cases post-series completion, etc. As a result, rates for unvaccinated, post-series completion, etc. are not comparable to rates reported for individuals that received any booster dose 6 months or more or less than 6 months prior to illness onset.
2. The observation of a higher rates among individuals that received a booster dose less than 6 months prior to illness onset compared to those who received a booster dose 6 months or more prior to illness onset may be attributable to instability of rates due to small numbers of events or differences in the risk of COVID-19 severity among the two groups (i.e. individuals at higher risk of severe outcomes may be more likely to have received a recent booster dose).<sup>2</sup>

# Technical Notes

## Definition of Terms

The following definitions are used to describe COVID-19 infection following vaccination.

### POST-VACCINATION CASES

- **Cases not yet protected from vaccination:** Cases with a symptom onset date that was 0 to <14 days following the first dose of a Health Canada authorized COVID-19 vaccine. This time period from vaccination is not sufficient to develop immunity, therefore these cases are not considered protected from vaccination and are grouped with unvaccinated cases.
- **Cases post-series initiation (i.e. cases following initiation but not completion of their primary series):** Cases with a symptom onset date that was 14 or more days following the first dose of a two-dose series of a Health Canada authorized COVID-19 vaccine or 0 to <14 days after receiving the second dose of a two-dose Health Canada authorized COVID-19 vaccine series.
- **Cases post-series completion (i.e. cases following the completion of their primary series):** Cases with a symptom onset date that was 14 or more days following the receipt of the first dose of a one-dose series or the second of a two-dose series of a Health Canada authorized COVID-19 vaccine (including mixed series of HC-authorized vaccine products), or 0 to <14 days after receiving a Health Canada authorized booster dose following their primary series.
- **Cases post-one booster dose (i.e. cases following completion of their primary series and one booster dose):** Cases with a symptom onset date 14 or more days following receipt of a Health Canada authorized COVID-19 booster dose following their Health Canada authorized primary series, or 0 to <14 days after receiving a second Health Canada authorized booster dose following their primary series.
- **Cases post-two or more booster doses (i.e. case following completion of their primary series and two or more booster doses):** Cases with a symptom onset date 14 or more days following receipt of a second or third, etc. Health Canada authorized COVID-19 booster dose following their Health Canada authorized primary series.
- **Cases that received any booster dose 6 months or more before onset:** Cases that received any Health Canada authorized booster dose (one booster dose, two booster doses, etc.) 6 months or more before their symptom onset date.
- **Cases that received any booster dose less than 6 months before onset:** Cases that received any Health Canada authorized booster dose (one booster dose, two booster doses, etc.) less than 6 months before their symptom onset date.

## Data Sources

- COVID-19 case data were based on information successfully extracted from the Ontario Ministry of Health's CCM application as of:
  - April 25, 2023 at 1:00 p.m. for cases reported in waves 6 and 7 (March 1, 2022 onwards)
  - April 10, 2023 at 9:00 a.m. for cases reported in waves 4 and 5 (August 1, 2021 to February 28, 2022)
  - April 10, 2023 at 9:00 a.m. for cases reported in waves 1, 2 and 3 (up to July 31, 2021)
- COVID-19 vaccination data were based on information successfully extracted from the Ontario Ministry of Health's COVaxON application as of April 24, 2023 at approximately 7:00 a.m.
- Ontario population projection data for 2022 were sourced from the Ministry of Finance.<sup>3</sup>

## Data Caveats

- COVaxON and CCM are dynamic reporting systems, which allow ongoing updates to data previously entered. As a result, data extracted from COVaxON and CCM represent a snapshot at the time of extraction and may differ from previous or subsequent reports.
- The data represent vaccinations and case information reported and recorded in COVaxON and CCM, respectively. As a result, all counts may be subject to varying degrees of underreporting due to a variety of factors.
  - Hospitalization and death data may be incomplete or missing for records where information was not gathered, reported to public health units, or entered in CCM.
- Only cases meeting the confirmed case classification as listed in the MOH [COVID-19 Case Definition](#) are included.<sup>4</sup>
- Linking COVaxON and CCM data is dependent on availability of personal identifiers reported in both databases. For example, if a client was reported in both COVaxON and CCM, but personal identifiers (e.g. health card number, date of birth) were not available, then insufficient information would have been available to identify the client and the client would not have been included in the linkage.
- Analyses presented in this report may differ from other reports for various reasons, including differing extracts and differing methodologies.
- The time interval between doses was not assessed to determine if subsequent doses were administered as per the product-specific recommended minimum interval.
- High coverage, particularly in older age group (e.g. 60+ year olds), and small numbers of unvaccinated individuals has resulted in unstable rates and rate ratios in unvaccinated individuals over time.
- Rates in younger age groups (e.g. 5-11 year olds) where the number of hospitalizations and/or deaths are low should be interpreted with caution due to instability arising from small counts.

- Asymptomatic cases were included in the analysis. The timing of infection (i.e. date of infection approximated with symptoms onset date) relative to vaccination (i.e. date of dose administration) is unclear for these cases. Thus, it is possible some of these cases may have been infected prior to vaccination and are not post-vaccination cases.
- Age groups are informed by vaccine product recommendations and vaccine program eligibility.
- For certain populations (e.g. immunocompromised individuals) three doses are recommended to complete the primary series. Due to challenges in identifying these individuals in the COVaxON data, it was not possible to account for some three-dose primary series in the analysis.
- Trends in post-vaccination cases are a reflection of both trends in vaccine administration (increasing number of doses administered over time) and trends in COVID-19 incidence.
- Estimates of relative risk (i.e. rate ratios) may change over time.
- Rates are not adjusted for other factors (e.g. age) that may affect risk of COVID-19 infection, hospitalization, or death.

## Methods

### Data linkage and exclusion criteria

- In order to identify cases post-vaccination, vaccine uptake data extracted from the Ontario Ministry of Health's (MOH) COVaxON application was linked to case data extracted from the MOH's Public Health Case and Contact Management Solution (CCM).
  - Clients in COVaxON and CCM were linked using health care number as well as other personal identifiers, including name, date of birth, and postal code.
- Linkage was done using processed COVaxON and CCM data. Methods for processing COVaxON vaccine uptake data are described in the Technical Notes of the [COVID-19 Vaccine Uptake Report](#)<sup>1</sup> and methods for processing the CCM case data are described in the Technical Notes of the [COVID-19 Weekly Epidemiological Summary](#).<sup>5</sup>
- Demographic information (e.g. age) in this report is sourced from demographic fields in CCM. Further details on CCM case data are described in the Technical Notes of the [COVID-19 Weekly Epidemiological Summary](#).<sup>5</sup>
- Only cases that have received Health Canada authorized vaccines including Pfizer-BioNTech Comirnaty, Moderna Spikevax, AstraZeneca Vaxzevria/COVISHIELD, Novavax Nuvaxovid, Medicigo Covifenz and Janssen COVID-19 vaccines are included. Cases that received one or more doses of a non-Health Canada authorized vaccine are excluded.
- Counts for hospitalizations includes intensive care unit (ICU) admissions.
- Unvaccinated cases include cases that are not yet protected from immunization and are 0-13 days post-dose 1.

- Remote positive COVID-19 cases were excluded from the analysis.
  - Remote positive cases are defined as asymptomatic positive cases with a low pre-test probability (e.g. no epidemiologic link to a confirmed case or an outbreak) and a repeat test that is negative. For these cases, the timing of infection may be unclear.
- Individuals with unknown age are excluded from age-specific analyses.
- The temporal distribution of cases is shown using earliest (i.e. the first in time) of symptom onset or positive specimen collection date, then first available of symptom onset, positive specimen collection, or reported date.

### Rate calculations

- Definitions for individual-level denominators for rate calculation can be found in the Definition of Terms in the [COVID-19 Vaccine Uptake Report](#).<sup>1</sup>
- Individuals reported as deceased in COVaxON were excluded from denominators used in rate calculations.
- Age at the time of data extraction was calculated for COVaxON denominators using the client date of birth and date of data extraction. Note that the age at the time of illness is used for cases by vaccination status (numerator). An additional 14 days are incorporated following dose administration to allow for the immune response to vaccination. For example, an individual contributes time to the post-series completion group 14 days after they completed their series.
- Person-time rates (e.g. unvaccinated, post-series completion):
  - Person-time was used to calculate the time in days that an individual contributes to each vaccination category (denominator). At the start of the reporting period (December 14, 2020) all individuals were unvaccinated. As an individual's vaccination status changes (from post-series initiation to post-series completion to post-one booster dose, etc.) they contribute time to different denominators.
  - Aggregated population data were used to determine the number of unvaccinated individuals each day (i.e. the number of vaccinated individuals was subtracted from aggregated population estimates).
  - The rates of COVID-19 hospitalizations or deaths in a specific time period (e.g. the previous 120 days) were calculated by summing the daily number of hospitalizations or deaths (numerator) and person days for that time period (denominator) to determine a rate per 100,000 person days in each vaccination status category.

- Non-person time incidence (e.g. booster dose less than 6 months before onset):
  - 180 days is used as the 6-month interval for booster dose status.
  - Rates were calculated by summing the number of individuals in each booster category (numerator) in a specific time period (e.g. the previous 30 days). Denominators were the total number of individuals that received any booster dose in the previous 6 months at the time of data extraction or the total number of individuals that received any booster dose 6 months or more prior to the date of data extraction.
  - Potential misclassification may result using the approach described above as individuals in the numerator may not be represented in the denominator. For example, a case may have received any booster dose less than 6 months before symptom onset (numerator), but that case may have received the booster dose 6 months or more prior to the date of data extraction (denominator). In order to minimize the impact of this misclassification, rates for the previous 30 days are shown.

## References

1. Ontario Agency for Health Protection and Promotion (Public Health Ontario). COVID-19 data and surveillance: routine surveillance report: COVID-19 vaccine uptake in Ontario [Internet]. Toronto, ON: King's Printer for Ontario; 2023 [cited 2023 Jan 6]. Available from: <https://www.publichealthontario.ca/en/data-and-analysis/infectious-disease/covid-19-data-surveillance>
2. Ontario. Ministry of Health. COVID-19 vaccines [Internet]. Toronto, ON: King's Printer for Ontario; 2022 [modified 2023 Apr 18; cited 2023 Apr 24]. Available from: <https://ontario.ca/page/covid-19-vaccines>
3. Population Reporting. Population Projections Public Health Unit, 2021-2046 [data file]. Toronto, ON: Ministry of Finance [producer]; Toronto, ON: Ontario. Ministry of Health, IntelliHealth Ontario [distributor]; [data extracted 2022 Jan 13].
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5. Ontario Agency for Health Protection and Promotion (Public Health Ontario). COVID-19 data and surveillance: COVID-19 in Ontario [Internet]. Toronto, ON: King's Printer for Ontario; 2023 [cited 2023 Jan 6]. Available from: <https://www.publichealthontario.ca/en/data-and-analysis/infectious-disease/covid-19-data-surveillance>

## Citation

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