

ENHANCED EPIDEMIOLOGICAL SUMMARY

Severe Outcomes among Confirmed Cases of COVID-19 Following Vaccination in Ontario: December 14, 2020 to September 11, 2022

Purpose

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.

Data used for denominators in rate calculations has been updated as of August 14, 2022. As a result, rates and relative risk are not comparable to reports produced prior to the update.

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 September 12, 2022 at approximately 7:00 a.m. and CCM as of September 12, 2022 at 1:00 p.m. The report includes COVID-19 vaccinations and cases reported up to September 11, 2022.

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.¹

Highlights

- Since the COVID-19 vaccination program began on December 14, 2020 and up to September 11, 2022, a total of 12,176,392 individuals in Ontario have completed their primary vaccine series and 7,522,272 individuals have received their first booster dose¹.
- The rate of COVID-19-related hospitalizations was higher among unvaccinated individuals compared to those who have completed their primary vaccine series, as well as those that have completed their primary vaccine series and received their first booster dose or second booster dose (Figure 3 and Figure 5).
- In the previous 120 days, among older adults, the lowest rates of hospitalization were among those that received two booster doses (Table 1).

- In the previous 120 days, older adults that completed their primary vaccine series only were more likely to be hospitalized due to COVID-19 compared to those that had completed their series and received one booster dose, suggesting an added benefit of booster doses in preventing hospitalizations (Table 1).
- Similar trends were observed for COVID-19 related deaths, with higher rates of deaths among unvaccinated individuals, and in particular older unvaccinated adults, compared to those who have completed their primary vaccine series, as well as those that have completed their primary vaccine series and received their first booster dose (Figure 4 and Figure 6).

Severe Outcomes

Figure 1. Hospitalized Confirmed Post-Vaccination Cases of COVID-19 by Number of Days from Dose Administration to Symptom Onset by Vaccination Status: Ontario, December 14, 2020 to September 11, 2022

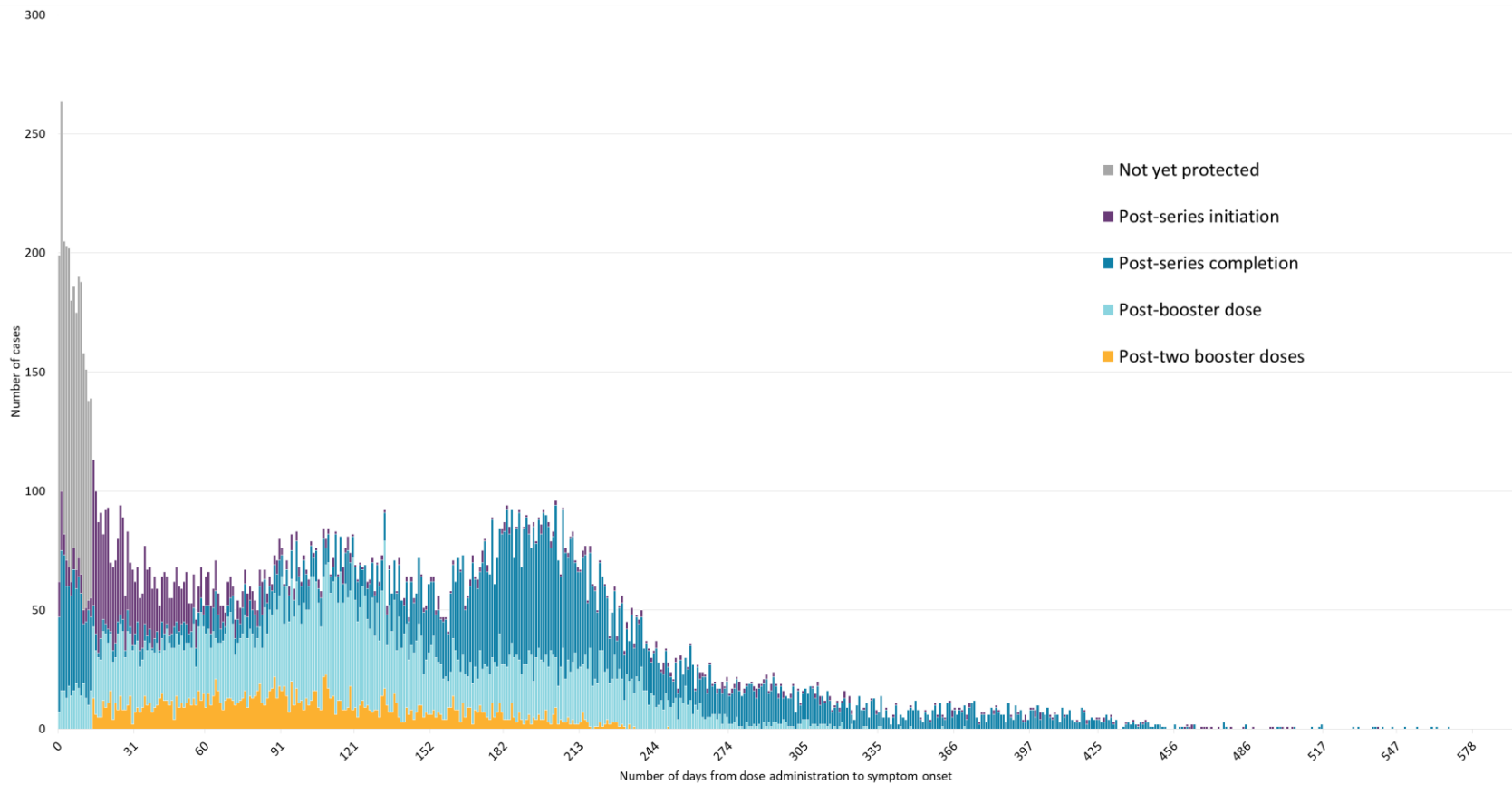


Figure 2. Hospitalized Confirmed Cases of COVID-19 by Symptom Onset Date by Vaccination Status: Ontario

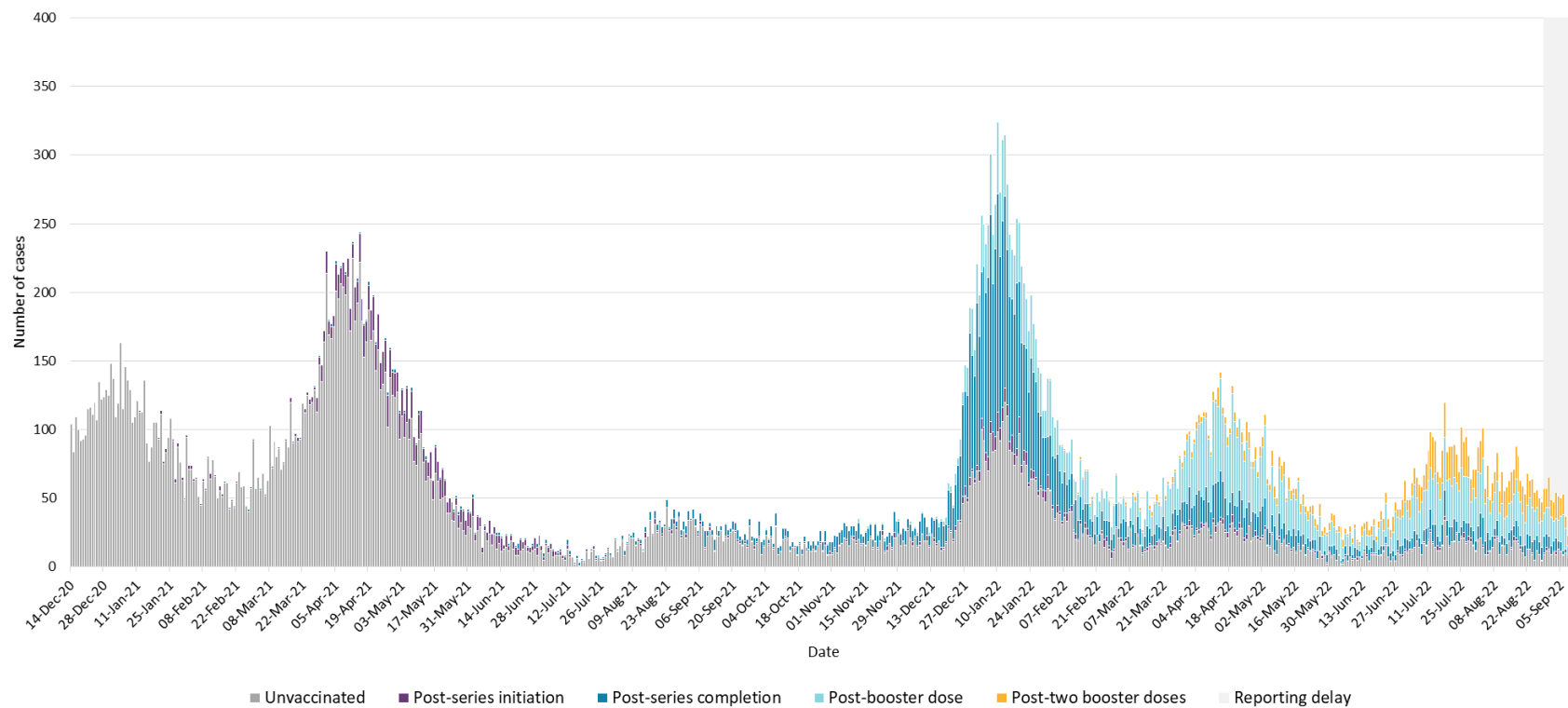
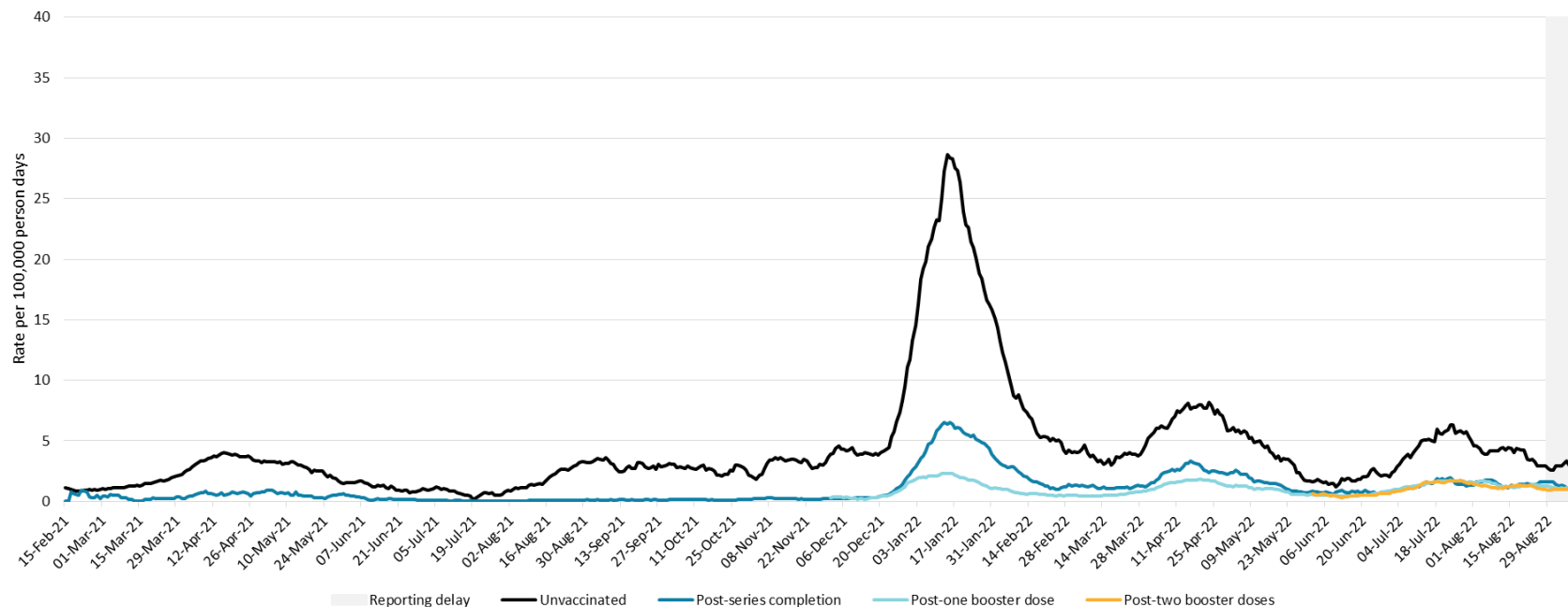


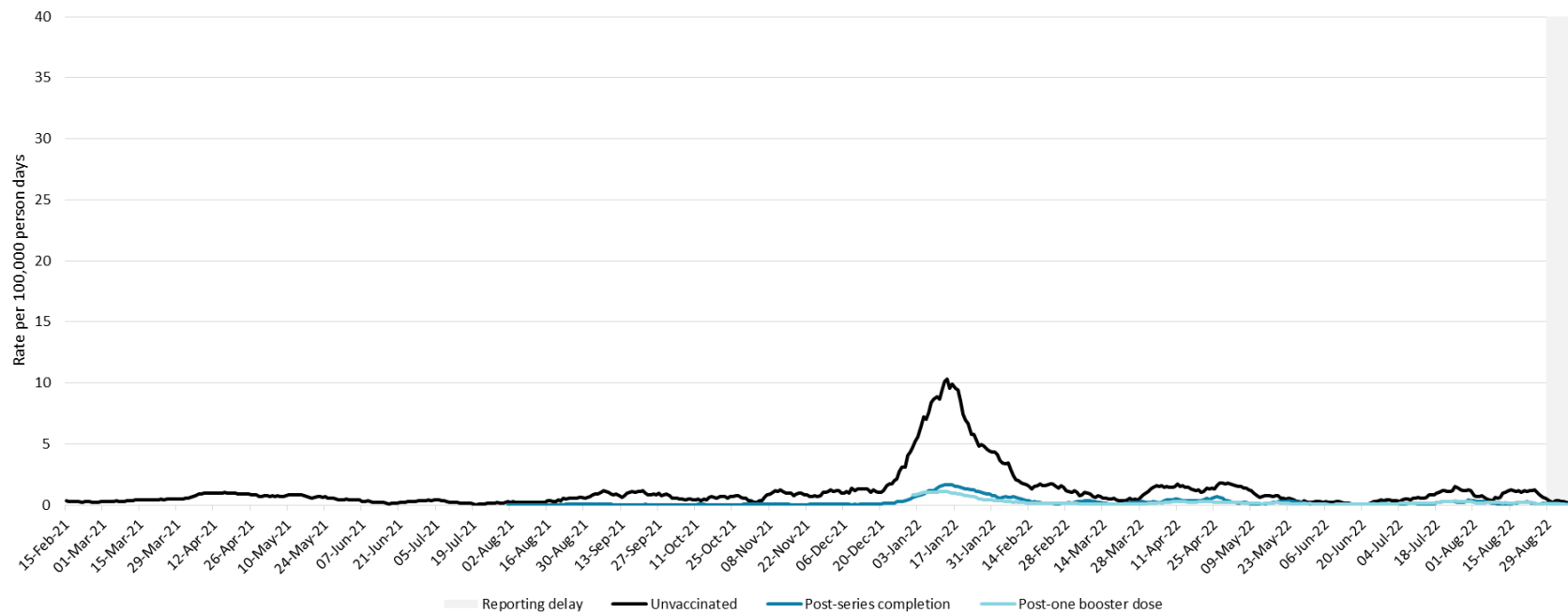
Figure 3. Seven-Day Average Rate of COVID-19 Hospitalization per 100,000 Person Days among Individuals 60 Years of Age and Older by Vaccination Status: Ontario



Notes:

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

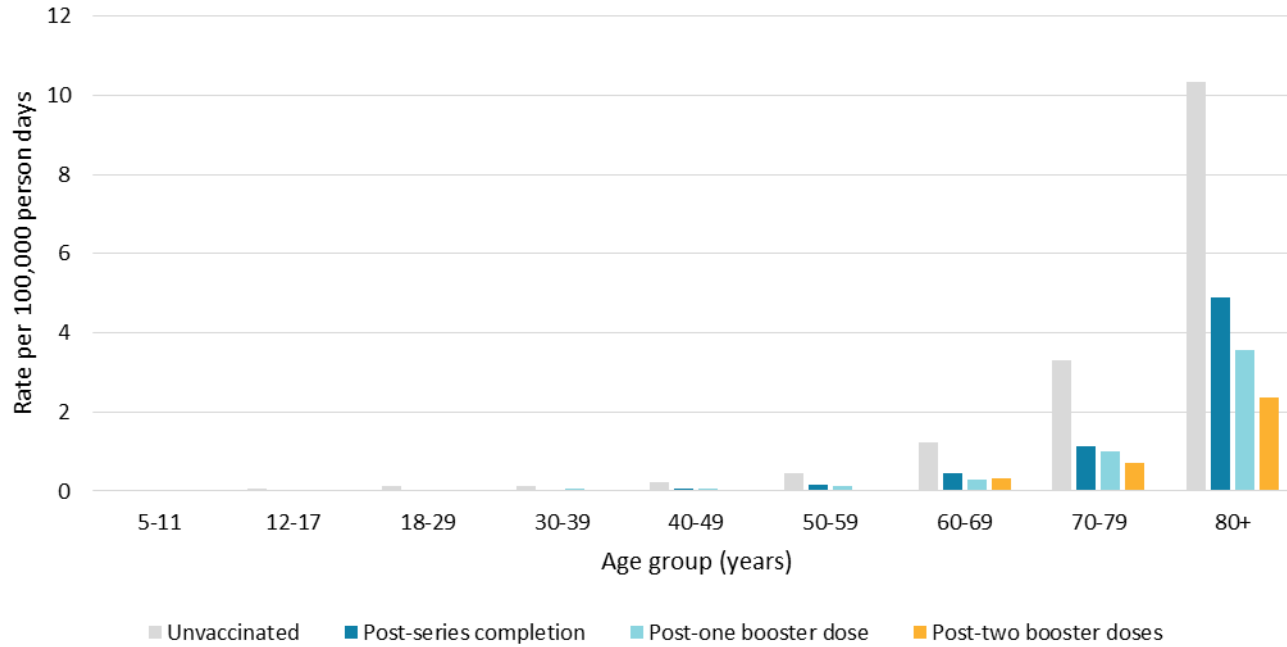
Figure 4. Seven-Day Average Rate of COVID-19 Deaths per 100,000 Person Days among Individuals 60 Years of Age and Older by Vaccination Status: Ontario



Notes:

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

Figure 5. 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 series completion and one booster dose are not shown for children 5-11 years of age due to instability arising from small numbers, as this age group only recently became eligible for a first booster dose.
2. Rates for series completion and two booster doses are not shown for individuals 18-59 years of age due to instability arising from small counts. With the exception of immunocompromised children 12-17 years of age, children 5-17 years of age are not eligible for a second booster dose.

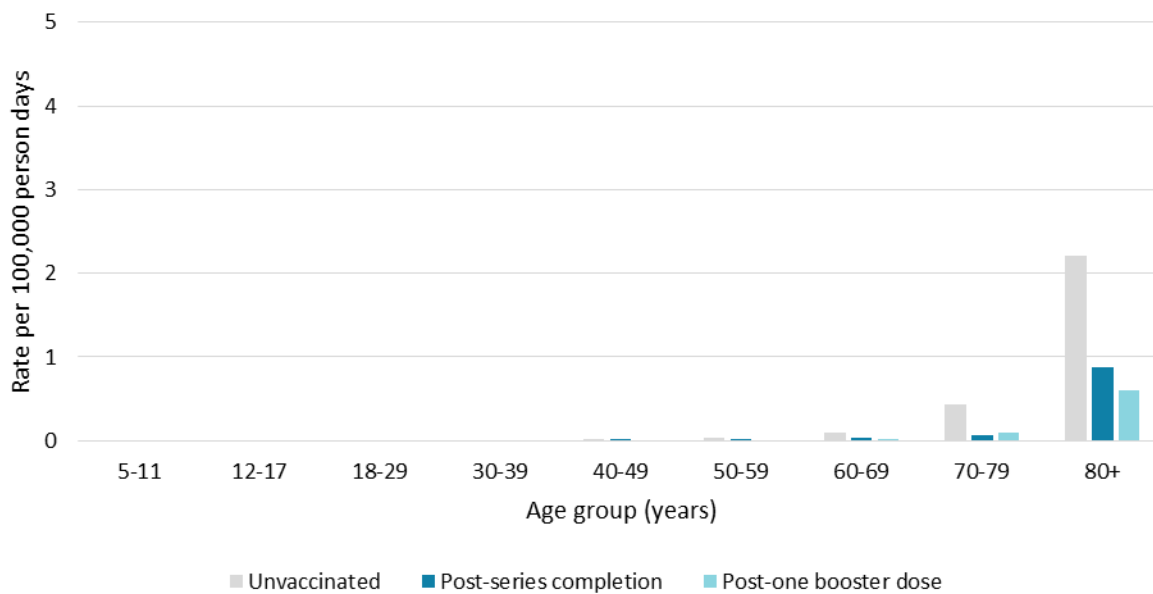
Table 1. Rate of COVID-19 Hospitalizations per 100,000 Person Days by Vaccination Status and Age Group in the Previous 120 Days: Ontario

Age group (years)	Rate per 100,000 person days: Unvaccinated	Rate per 100,000 person days: Post-series initiation	Rate per 100,000 person days: Post-series completion	Rate per 100,000 person days: Post-series completion and one booster dose	Rate per 100,000 person days: Post-series completion and two booster doses	Rate ratio: Unvaccinated /Post-series completion	Rate ratio: Unvaccinated /Post-series completion and one booster dose	Rate ratio: Unvaccinated /Post-series completion and two booster doses	Rate ratio: Post-series completion/ Post-series completion and one booster dose
5-11	0.03	0.02	0.02	N/A	N/A	1.50	N/A	N/A	N/A
12-17	0.07	0.02	0.01	0.02	N/A	7.00	3.50	N/A	N/A
18-29	0.13	0.06	0.03	0.04	N/A	4.33	3.25	N/A	N/A
30-39	0.13	0.10	0.04	0.06	N/A	3.25	2.17	N/A	N/A
40-49	0.24	0.08	0.07	0.06	N/A	3.43	4.00	N/A	N/A
50-59	0.46	0.18	0.16	0.14	N/A	2.88	3.29	N/A	N/A
60-69	1.24	0.64	0.44	0.30	0.31	2.82	4.13	4.00	1.47
70-79	3.30	1.51	1.13	0.99	0.72	2.92	3.33	4.58	1.14
80+	10.35	4.26	4.88	3.57	2.38	2.12	2.90	4.35	1.37

Notes:

1. Rates for series completion and one booster dose are not shown for children 5-11 years of age due to instability arising from small numbers as this age group only recently became eligible for a first booster dose.
2. Rates for series completion and two booster doses are not shown for individuals 18-59 years of age due to instability arising from small counts. With the exception of immunocompromised children 12-17 years of age, children 5-17 years of age are not eligible for a second booster dose.
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 series completion compared to series completion and one booster dose, a value greater than 1 represents a higher risk in series completion compared to series completion and one booster dose.

Figure 6. 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 series completion and one booster dose are not shown for children 5-11 years of age due to instability arising from small numbers, as this age group only recently became eligible for a first booster dose.
2. Rates for series completion and two 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-series completion and one booster dose	Rate ratio: Unvaccinated/Post-series completion	Rate ratio: Unvaccinated/Post-series completion and 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	0.00	0.00	0.00	N/A	N/A
40-49	0.01	0.01	0.00	1.00	N/A
50-59	0.04	0.01	0.00	4.00	N/A
60-69	0.09	0.04	0.02	2.25	4.50
70-79	0.43	0.07	0.10	6.14	4.30
80+	2.21	0.88	0.60	2.51	3.68

Notes:

1. Rates for series completion and one booster dose are not shown for children 5-11 years of age due to instability arising from small numbers, as this age group only recently became eligible for a first booster dose.
2. Rates for series completion and two booster doses are not shown due to instability arising from small counts.
3. For ratios showing the rate of COVID-19 fatalities in unvaccinated individuals compared to vaccinated individuals, a value greater than 1 represents a higher risk in unvaccinated compared to vaccinated.

Table 3. Hospitalized Confirmed Cases of COVID-19 by Vaccination Status: Ontario, December 14, 2020 to September 11, 2022

Age group (years)	Hospitalized unvaccinated cases: Number	Hospitalized cases post-series initiation: Number	Hospitalized cases post-series completion: Number	Hospitalized cases post-booster dose: Number	Hospitalized cases post-two booster doses: Number
5-11	193	45	27	1	0
12-17	186	12	90	11	2
18-29	1,216	48	292	118	3
30-39	1,953	75	313	139	8
40-49	2,602	108	411	212	13
50-59	4,232	180	695	482	65
60+	15,827	1,645	5,653	6,093	1,841
Total	26,212	2,113	7,481	7,056	1,932

Notes:

1. Cases with unknown age are included in column totals.
2. Children 5-11 years of age are not eligible for a first booster dose and children 5-17 are not eligible for a second booster dose. These cases are expected to be immunocompromised individuals eligible for a three dose primary series.

Table 4. Fatal Confirmed Cases of COVID-19 by Vaccination Status: Ontario, December 14, 2020 to September 11, 2022

Age group (years)	Fatal unvaccinated cases: Number	Fatal cases post-series initiation: Number	Fatal cases post-series completion: Number	Fatal cases post-booster dose: Number	Fatal cases post-two booster doses: Number
5-17	6	0	3	0	0
18-29	28	3	3	1	0
30-39	80	3	7	4	0
40-49	163	7	28	8	0
50-59	463	10	68	33	7
60+	5,347	407	1,219	1,290	499
Total	6,088	430	1,328	1,336	506

Notes:

1. Cases with unknown age are included in column totals.
2. Children 5-17 are not eligible for a second booster dose. These cases are expected to be immunocompromised individuals eligible for a three dose primary series.

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-booster dose (i.e. cases following completion of their primary series and a 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 booster doses (i.e. case following completion of their primary series and two booster doses):** Cases with a symptom onset date 14 or more days following receipt of a second Health Canada authorized COVID-19 booster dose following their Health Canada authorized primary series.

Data Sources

- COVID-19 case data were based on information successfully extracted from the Ontario Ministry of Health's CCM application as of:
 - September 12, 2022 at 1 p.m. for cases reported from January 1, 2022 onwards;
 - September 12, 2022 at 9 a.m. for cases reported from January 1, 2021 to December 31, 2021
 - June 24, 2022 at 9 a.m. for cases reported up to December 31, 2020.
- COVID-19 vaccination data were based on information successfully extracted from the Ontario Ministry of Health's COVaxON application as of September 12, 2022 at approximately 7:00 a.m.

- Ontario population projection data for 2022 were sourced from Statistics Canada. Population projections 2021-2046: Table 1 annual population estimates by age and sex for July 1, 2021 to 2046, health regions, Ontario [unpublished data table]. Ottawa, ON: Government of Canada; 2022 [received May 9, 2022].

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 or CCM, respectively. As a result, all counts may be subject to varying degrees of underreporting due to a variety of factors.
 - Hospitalization 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.²
- 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 sufficient information would not 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 a small number 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 maybe 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 a 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.
- Trends over time in hospitalizations and deaths should be interpreted with caution as hospitalization and/or death data may be incomplete or missing for case records where information was not gathered, reported to public health units or entered in CCM.
- Rates are not adjusted for other factors (e.g. age) that may affect risk of COVID-19 infection, hospitalization, or death.

Methods

- 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, gender, 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](#)¹ and methods for processing the CCM case data are described in the Technical Notes of the [COVID-19 Weekly Epidemiological Summary](#).³
- Demographic information (sex, age, public health unit of residence) in this report are 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](#).³
- 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. For rates and rate ratios, person-time rates were calculated by vaccination status. A person-time rate is a measure of incidence that incorporates the amount of time a person is at risk in the denominator. In this report, person-time is used to calculate the time in days that an individual contributes to each vaccination category. At the start of the reporting period (December 14, 2020) all individuals were unvaccinated. As an individual's vaccination status changes (from series initiation to series completion to series completion and one booster dose, etc.) they contribute time to different denominators.
 - Risk of COVID-19 hospitalization or death 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 vaccine status category.
 - Data extracted from COVaxON was used to determine the daily number of individuals in each vaccination status. Aggregated population data was used to determine the number of unvaccinated individuals each day (i.e. the number of vaccinated individuals was subtracted from aggregated population estimates).
 - Individuals reported as deceased in COVaxON were excluded from denominators used in rate calculations.
 - 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 series completion group 14 days after they completed their series.
 - Individuals that completed their primary series and received two booster doses are accounted for in the methodology, however rates are not shown in some analyses due to instability arising from small counts.
 - Age at the time of data extraction was calculated for COVaxON denominators used in rate calculations. Age at the time of data extraction was calculated 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).
- Definitions for individual-level denominators for rate calculation can be found in the Definition of Terms in the [COVID-19 Vaccine Uptake Report](#).¹

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: Queen's Printer for Ontario; 2021 [cited 2021 Nov 23]. Available from: <https://www.publichealthontario.ca/en/data-and-analysis/infectious-disease/covid-19-data-surveillance>
2. Ontario. Ministry of Health; Ontario. Ministry of Long-Term Care. COVID-19: guidance for the health sector: case definition [Internet]. Toronto, ON: Queen's Printer for Ontario; 2021 [cited 2021 Apr 29]. Available from: https://www.health.gov.on.ca/en/pro/programs/publichealth/coronavirus/2019_guidance.aspx
3. Ontario Agency for Health Protection and Promotion (Public Health Ontario). COVID-19 data and surveillance: COVID-19 in Ontario [Internet]. Toronto, ON: Queen's Printer for Ontario; 2021 [cited 2022 Jul 6]. Available from: <https://www.publichealthontario.ca/en/data-and-analysis/infectious-disease/covid-19-data-surveillance>

Citation

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For more information, email ivpd@oahpp.ca.

