

ENHANCED EPIDEMIOLOGICAL SUMMARY

Confirmed Cases of COVID-19 Following Vaccination in Ontario: December 14, 2020 to September 18, 2021

Purpose

This report describes confirmed cases of coronavirus disease 2019 (COVID-19) following COVID-19 vaccination.

In order to identify cases with a symptom onset date after receipt of vaccine (i.e. post-vaccination cases), 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). Further details on the linkage are described in the Technical Notes. Data in this report include the most current information extracted from COVaxON as of September 20, 2021 at approximately 7:00 a.m. and CCM as of September 20, 2021 at 1:00 p.m. The report includes COVID-19 vaccinations and cases reported up to September 18, 2021.

For additional information on COVID-19 vaccine uptake in the province, please visit the interactive [Ontario COVID-19 Data Tool](#) to explore vaccination uptake data by public health unit, age group and trends over time. The weekly report on [COVID-19 Vaccine Uptake and Program Impact in Ontario](#) further describes vaccine uptake across the province as well as the impact of the vaccination program on COVID-19 cases and severe outcomes.

Background

This report provides a focused analysis on confirmed cases of COVID-19 infection following COVID-19 vaccination. While vaccines provide a high degree of protection from COVID-19 infection, it is expected that a small proportion of vaccinated individuals may become infected as no vaccine is 100% effective. Protection from COVID-19 infection does not occur immediately following vaccination. Immunity develops over time. Vaccine effectiveness (VE) is estimated to be 60-80% for preventing COVID-19 infection 3-4 weeks after receiving a single dose of Pfizer, Moderna, or AstraZeneca vaccines.^{1,2} Following the second dose, VE increases to greater than 85%. When COVID-19 cases occur following vaccination, there is evidence that vaccines reduce symptomatic infection, the severity of illness, as well as transmission.^{3,4} The VE for the prevention of serious outcomes such as hospitalizations and intensive care unit (ICU) admissions ranges between 70-90%. VE may also be impacted by COVID-19 variants of concern (VOC). Evidence to date for the B.1.1.7 (Alpha) variant suggests no significant impact on VE.⁵ However, the B.1.617.2 (Delta) variant, has been shown to impact VE against symptomatic infection, especially for individuals who have only had one dose of vaccine.⁶

Throughout the report, symptomatic post-vaccination cases are shown separately in addition to combined estimates for both symptomatic and asymptomatic post-vaccination cases. As vaccination reduces severity of infection, asymptomatic post-vaccination cases are expected. Asymptomatically infected post-vaccination cases also may be less likely to transmit infection compared to symptomatic post-vaccination cases. Further, since the timing of infection (i.e. date of infection, approximated by symptom onset date) relative to

vaccination (i.e. date of dose administration) is unclear for asymptomatic cases, it is possible that asymptomatic cases were infected prior to vaccination and may not be post-vaccination cases.

Definition of Terms

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

Post-vaccination Cases

- **Case not yet protected from vaccination:** Cases with a symptom onset date that was 0 to <14 days following the first dose of a COVID-19 vaccine. This time period from vaccination is not sufficient to develop immunity, therefore these cases are not considered protected from vaccination.
- **Partially vaccinated case:** Cases with a symptom onset date that was 14 or more days following the first dose of a 2-dose series COVID-19 vaccine or 0 to <14 days after receiving the second dose of a 2-dose COVID-19 vaccine series. This time period from vaccination may be sufficient to develop some degree of immunity, but these cases are not considered fully protected as they have not yet received the second dose or have only recently received the second dose.
- **Breakthrough (i.e., fully vaccinated) case:** Cases with a symptom onset date that was 14 or more days following receipt of the second dose of a 2-dose series COVID-19 vaccine or 14 or more days following the first dose of a COVID-19 vaccine product with a 1-dose schedule. These cases are considered fully protected from vaccination, however, as VE is not 100%, it is expected that a small number of cases will occur among fully vaccinated individuals.

Highlights

- Since the COVID-19 vaccination program began on December 14, 2020 and up to September 18, 2021, a total of 11,088,718 individuals in Ontario received at least one dose of vaccine including 10,301,653 individuals who are fully vaccinated. Of these individuals, only 19,616 became partially vaccinated cases and 8,264 became breakthrough (i.e. fully vaccinated) cases (Table 1).⁷
- The number of post-vaccination cases declines dramatically as time from vaccination increases (Figure 1).
 - 17.4% of cases post-vaccination occurred 14 or more days after dose 2 administration and are considered breakthrough cases (Table 1). While the overall number of breakthrough cases remains low, breakthrough cases have increased over time. This is expected as the population becomes more highly vaccinated. Even with a highly effective vaccine,, cases may occur among vaccinated individuals due to a larger proportion of the population being vaccinated than unvaccinated.
- The rate of COVID-19 in unvaccinated individuals is higher compared to fully vaccinated individuals. This trend has remained consistent over time (Figure 2).
 - In the past 30 days, unvaccinated individuals were approximately 7.3 times more likely to become a case of COVID-19 compared to fully vaccinated individuals (Figure 2).
- Among individuals 60 years of age or older, the rate of COVID-19-related hospitalizations was higher among unvaccinated individuals compared to fully vaccinated individuals. This trend has remained consistent over time (Figure 5).
 - In the past 30 days, unvaccinated adults 60 years of age or older were approximately 29.6 times more likely to be hospitalized due to COVID-19 compared to fully vaccinated adults 60 years of age and older (Figure 5).
- Trends in partially vaccinated and breakthrough cases are a reflection of both trends in vaccine administration (increasing number of doses administered over time) and trends in COVID-19 incidence (Figure 3).
- Unvaccinated cases accounted for the majority (93.6%) of COVID-19 cases reported since December 14, 2020 and up to September 18, 2021, with breakthrough cases accounted for only 1.9% (Figure 4).
 - Similar trends are observed for hospitalizations and deaths, with unvaccinated cases accounting for 92.0% of hospitalizations and 91.3% of deaths and breakthrough cases accounting for 1.4% of hospitalizations and 2.0% of deaths (Figure 4).
- Between February 3, 2021 (when routine mutation testing was implemented) and September 18, 2021, trends in variants of concern (VOCs) among vaccinated cases reflect trends in VOCs among all cases, with B.1.1.7 (Alpha) being the dominant strain from approximately March to June, and an increasing number of B.1.617.2 (Delta) reporting since May (Figure 7, Table 5). For additional information on VOCs among all COVID-19 cases, refer to the [COVID-19 Daily Epidemiological Summary](#).⁸

Cases By Time Since Vaccination

Figure 1. Confirmed post-vaccination cases of COVID-19 by number of days between dose administration and symptom onset: Ontario, December 14, 2020 to September 18, 2021

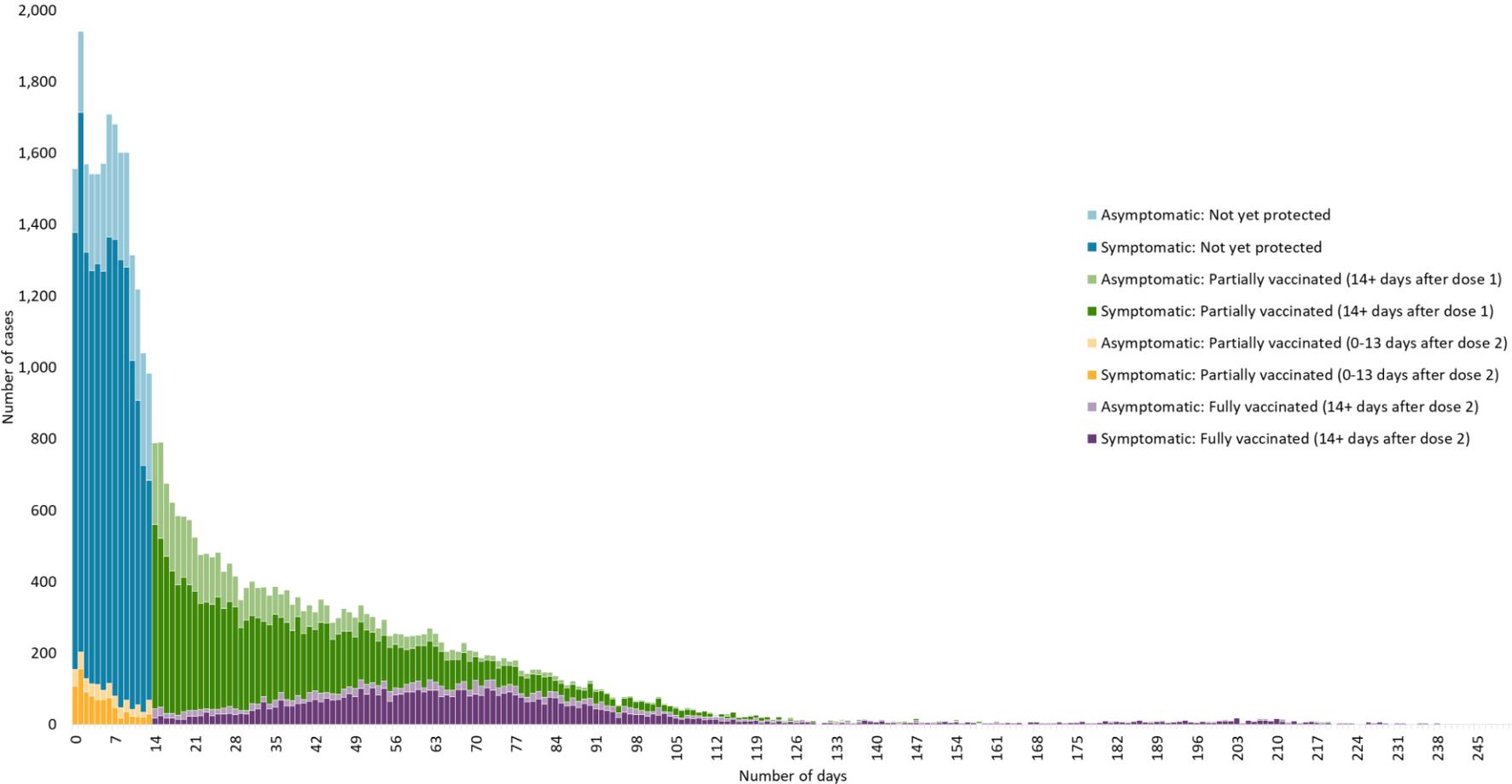
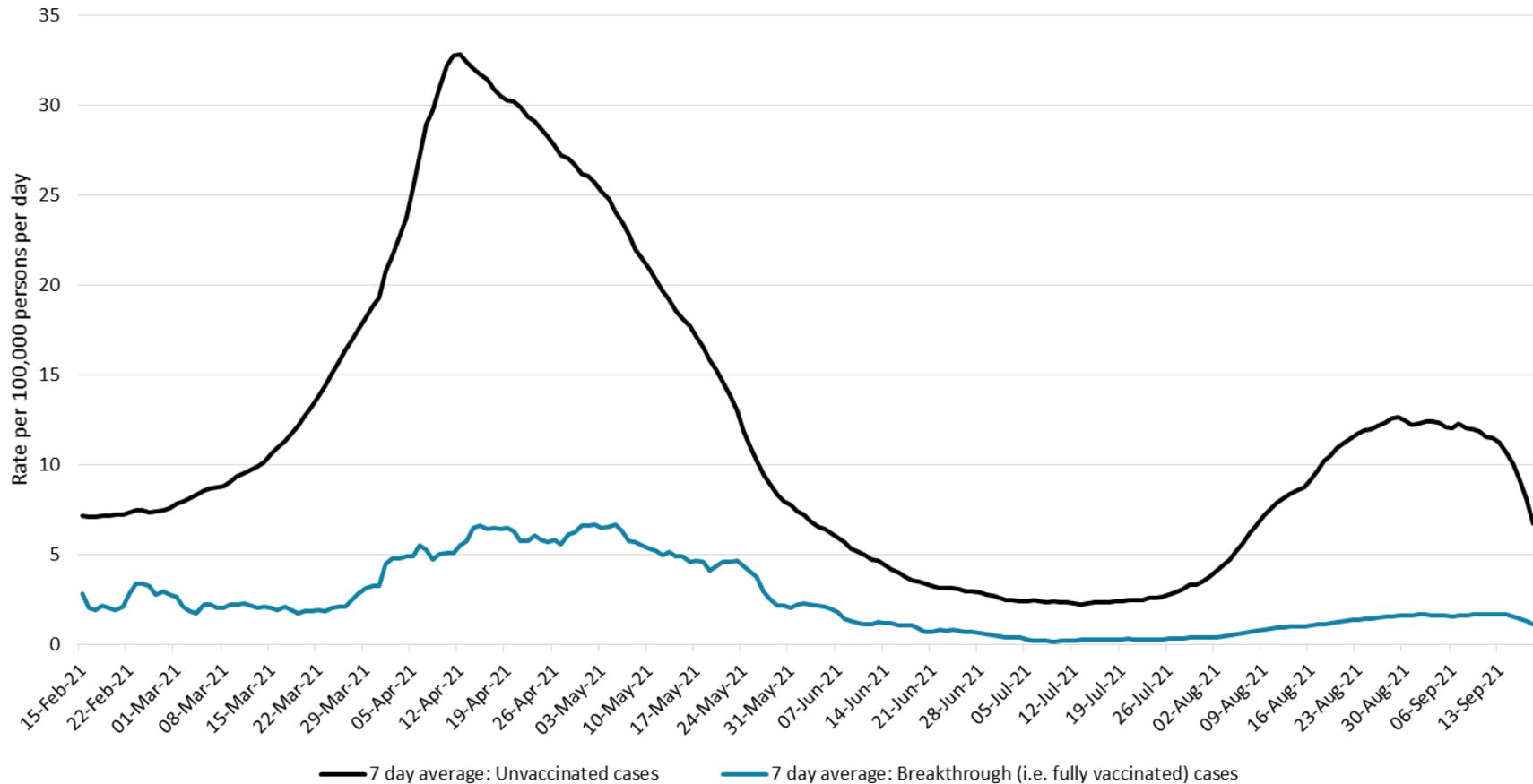


Table 1. Confirmed post-vaccination cases of COVID-19: Ontario, December 14, 2020 to September 18, 2021

	Not yet protected: 0-13 days after dose 1	Partially vaccinated: 14-27 days after dose 1	Partially vaccinated: 28+ days after dose 1	Partially vaccinated: 0-13 days after dose 2	Partially vaccinated: Total	Breakthrough: 14+ days after dose 2	Total
Symptomatic	15,562 (43.1%)	5,034 (14.0%)	8,327 (23.1%)	850 (2.4%)	14,211 (39.4%)	6,303 (17.5%)	36,076 (100.0%)
Asymptomatic	3,988 (35.1%)	2,329 (20.5%)	2,603 (22.9%)	473 (4.2%)	5,405 (47.6%)	1,961 (17.3%)	11,354 (100.0%)
Total	19,550 (41.2%)	7,363 (15.5%)	10,930 (23.0%)	1,323 (2.8%)	19,616 (41.4%)	8,264 (17.4%)	47,430 (100.0%)

Trends

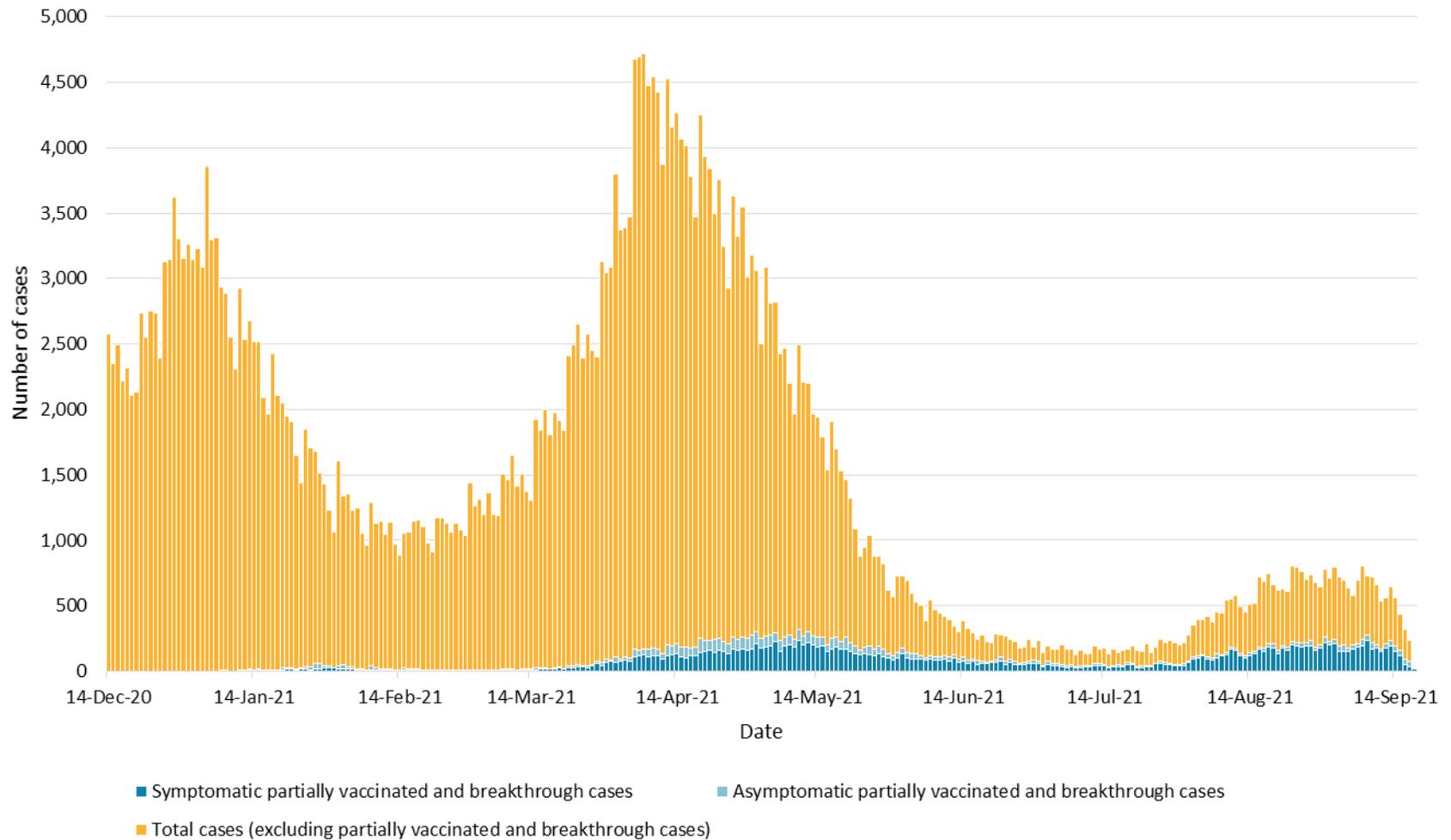
Figure 2. Seven-day average rate of COVID-19 per 100,000 person days among unvaccinated and fully vaccinated individuals by symptom onset date*: Ontario, February 15, 2021 to September 18, 2021



*Symptomatic breakthrough cases are shown by symptom onset date. Asymptomatic breakthrough cases are shown by the first available of specimen collection or reported date, as an approximation of symptom onset date. Unvaccinated COVID-19 cases showing using the first in time of symptom onset, specimen collection or reported date.
Note:

- Due to instability from small denominators as a result of lower vaccination coverage at the beginning of the immunization program, rates are shown from February 15, 2021 on.
- Trends in cases in the most recent weeks should be interpreted with caution due to delays in reporting.
- Unvaccinated cases include those that received dose 1 within 0 to 13 days of their onset and are not yet protected from immunization.
- Definitions for denominators (vaccination status of individuals) are included in the Technical Notes. Partially vaccinated individuals are not included in the figure.

Figure 3. Confirmed cases of COVID-19 by symptom onset date*: Ontario, December 14, 2020 to September 18, 2021

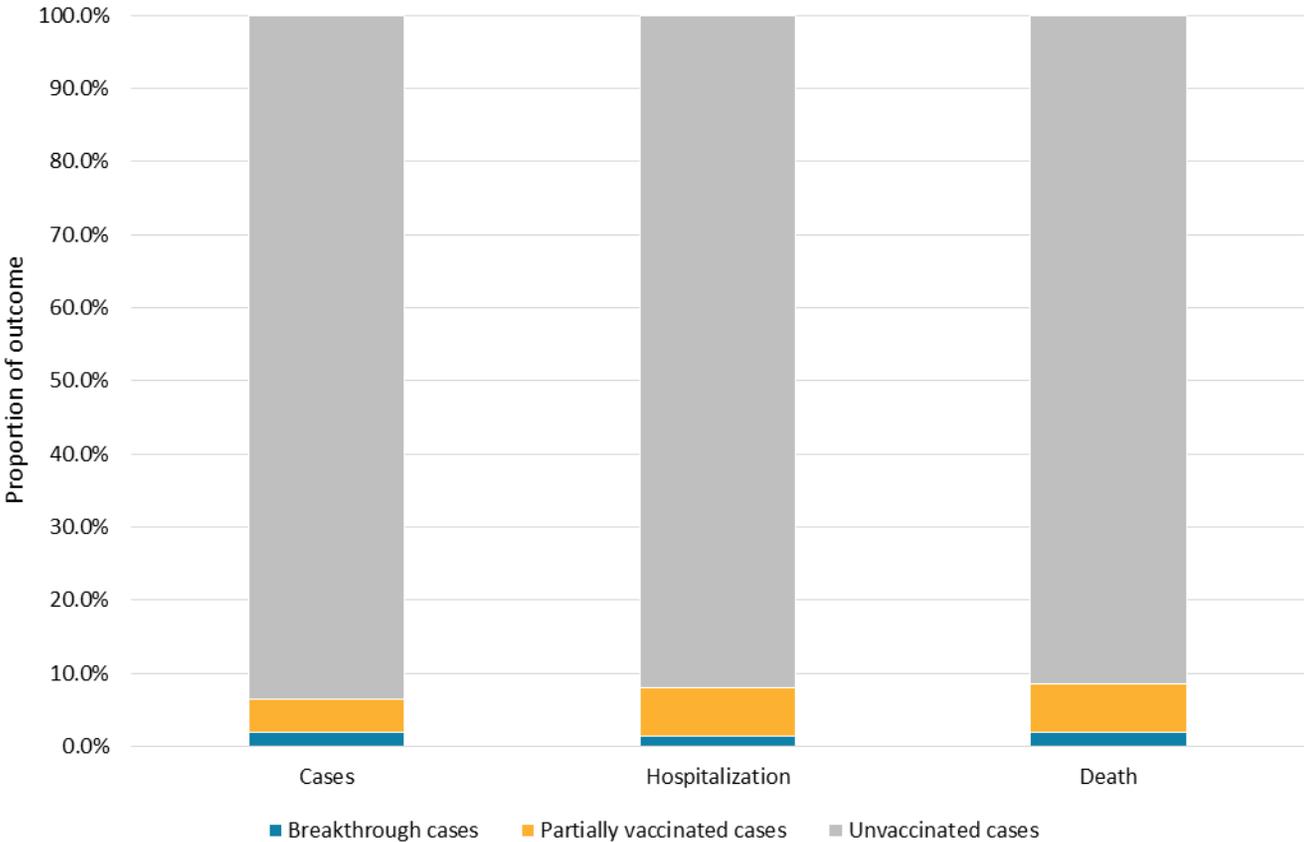


*Symptomatic partially vaccinated and breakthrough cases are shown by symptom onset date. Asymptomatic partially vaccinated and breakthrough cases are shown by the first available of specimen collection or reported date, as an approximation of symptom onset date. COVID-19 cases that are not partially vaccinated or breakthrough cases (indicated with yellow bars) are showing using the first in time of symptom onset, specimen collection or reported date.

Notes:

- Trends in partially vaccinated and breakthrough cases are a reflection of both trends in vaccine administration (increasing number of doses administered over time) and trends in COVID-19 incidence.
- Trends in cases in the most recent weeks should be interpreted with caution due to delays in reporting.
- Unvaccinated cases include those that received dose 1 within 0 to 13 days of their onset and are not yet protected from immunization.
- Definitions for denominators (vaccination status of individuals) are included in the Technical Notes. Partially vaccinated individuals are not included in the figure.

Figure 4. Proportion of confirmed COVID-19 cases, hospitalizations (including intensive care unit admissions), and deaths among unvaccinated, partially vaccinated, and breakthrough cases: Ontario, December 14, 2020 to September 18, 2021



Demographic Characteristics

Table 2. Demographic characteristics of partially vaccinated and breakthrough confirmed cases of COVID-19: Ontario, December 14, 2020 to September 18, 2021

Characteristic	Symptomatic partially vaccinated cases: Number (% of all cases)	Symptomatic breakthrough cases: Number (% of all cases)	Symptomatic and asymptomatic partially vaccinated cases: Number (% of all cases)	Symptomatic and asymptomatic breakthrough cases: Number (% of all cases)	All cases*: Number
Gender					
Female	7,984 (3.7%)	3,676 (1.7%)	10,751 (5.0%)	4,801 (2.2%)	214,089
Male	6,142 (2.8%)	2,570 (1.2%)	8,732 (4.0%)	3,378 (1.5%)	218,196
Age (years)					
12-17	275 (1.0%)	143 (0.5%)	380 (1.4%)	198 (0.8%)	26,355
18-29	2,462 (2.3%)	1,482 (1.4%)	3,079 (2.8%)	1,818 (1.7%)	108,580
30-39	1,920 (2.6%)	1,307 (1.8%)	2,423 (3.3%)	1,585 (2.2%)	72,668
40-49	1,947 (3.1%)	1,121 (1.8%)	2,527 (4.1%)	1,380 (2.2%)	62,265
50-59	2,388 (4.0%)	860 (1.4%)	3,209 (5.4%)	1,145 (1.9%)	59,619
60-69	2,534 (6.9%)	712 (1.9%)	3,633 (9.9%)	996 (2.7%)	36,882
70-79	1,441 (8.1%)	317 (1.8%)	2,273 (12.8%)	479 (2.7%)	17,746
80+	1,240 (8.6%)	361 (2.5%)	2,085 (14.4%)	663 (4.6%)	14,500
Total*	14,211 (3.3%)	6,303 (1.4%)	19,616 (4.5%)	8,264 (1.9%)	435,836

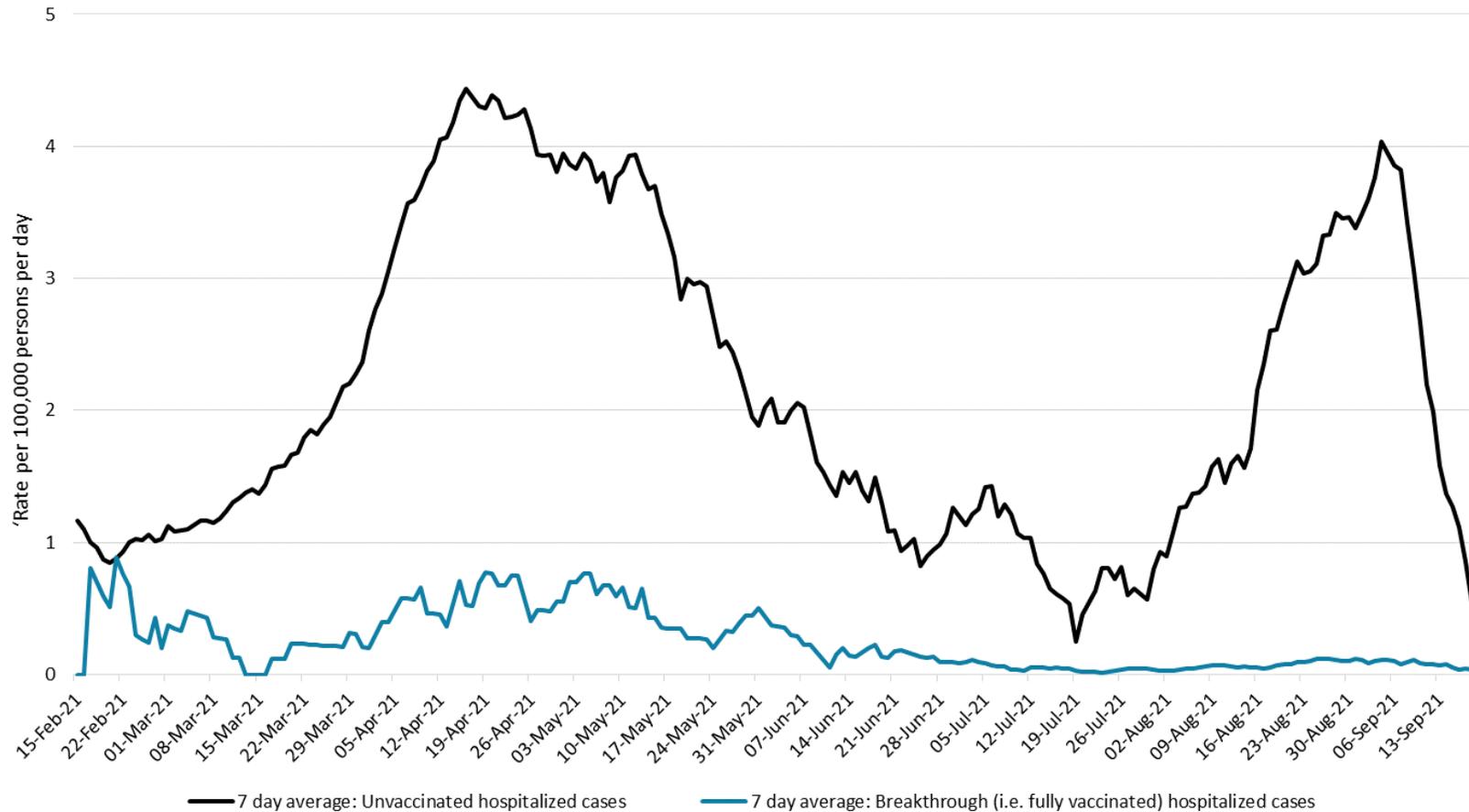
*Includes all confirmed COVID-19 cases (both vaccinated and unvaccinated, as well as both symptomatic and asymptomatic cases) since December 14, 2020.

**Individuals with unknown gender and/or age are excluded.

Note: Age groups are informed by vaccine product recommendations (i.e. no vaccine currently authorized or recommended in individuals <12 years of age) and sequencing of vaccine program eligibility in older adults which has progressed using decrements of 5 year age bands from 80 years of age.

Severe Outcomes

Figure 5. Seven-day average rate of COVID-19 hospitalization per 100,000 person days among unvaccinated and fully vaccinated individuals 60 years of age and older by symptom onset date*: Ontario, February 15, 2021 to September 18, 2021

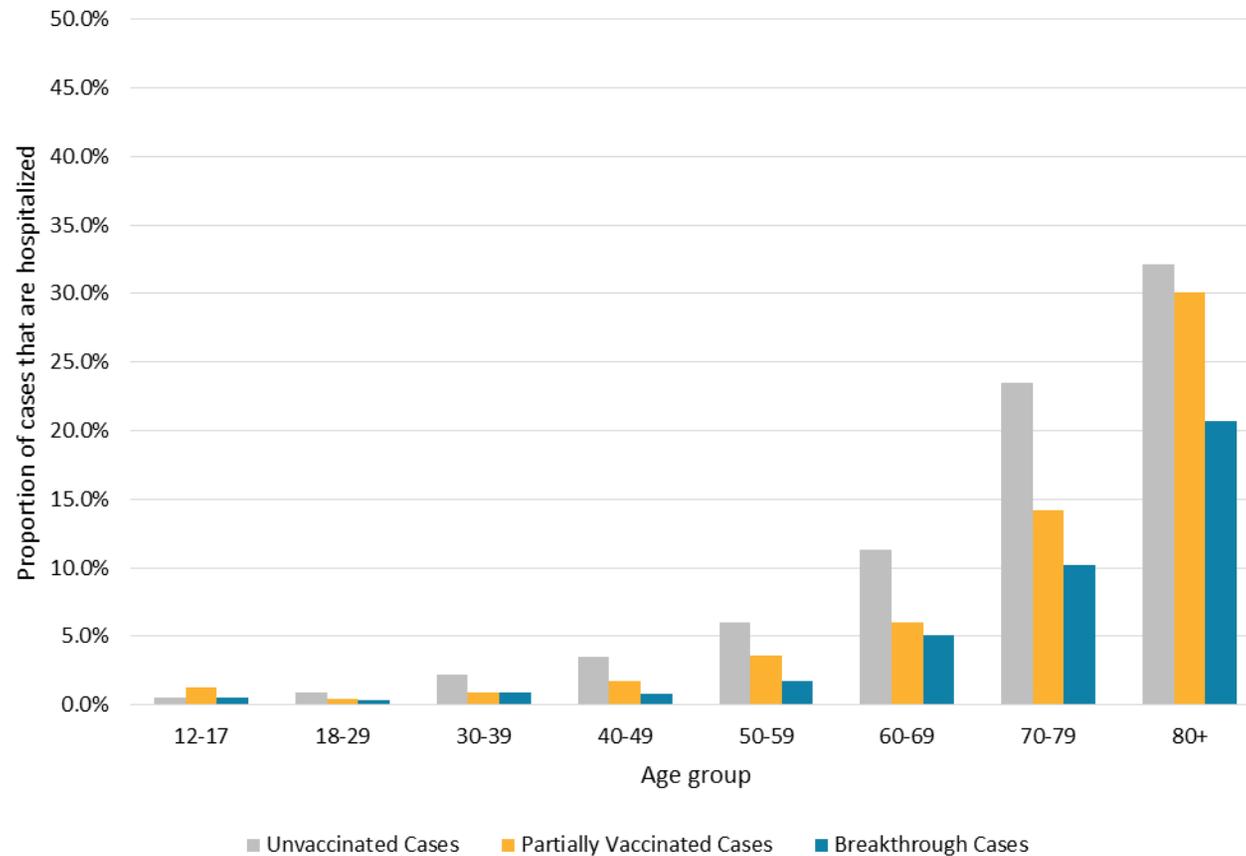


* Symptomatic breakthrough cases are shown by symptom onset date. Asymptomatic breakthrough cases are shown by the first available of specimen collection or reported date, as an approximation of symptom onset date. Unvaccinated COVID-19 cases showing using the first in time of symptom onset, specimen collection or reported date.

Notes:

- Due to instability from small denominators as a result of lower vaccination coverage at the beginning of the immunization program, rates are shown from February 15, 2021 on.
- Trends in hospitalizations in the most recent weeks should be interpreted with caution due to delays in reporting.

Figure 6a. Hospitalizations (including intensive care unit admissions) among unvaccinated, partially vaccinated and breakthrough confirmed cases* of COVID-19: Ontario, December 14, 2020 to September 18, 2021

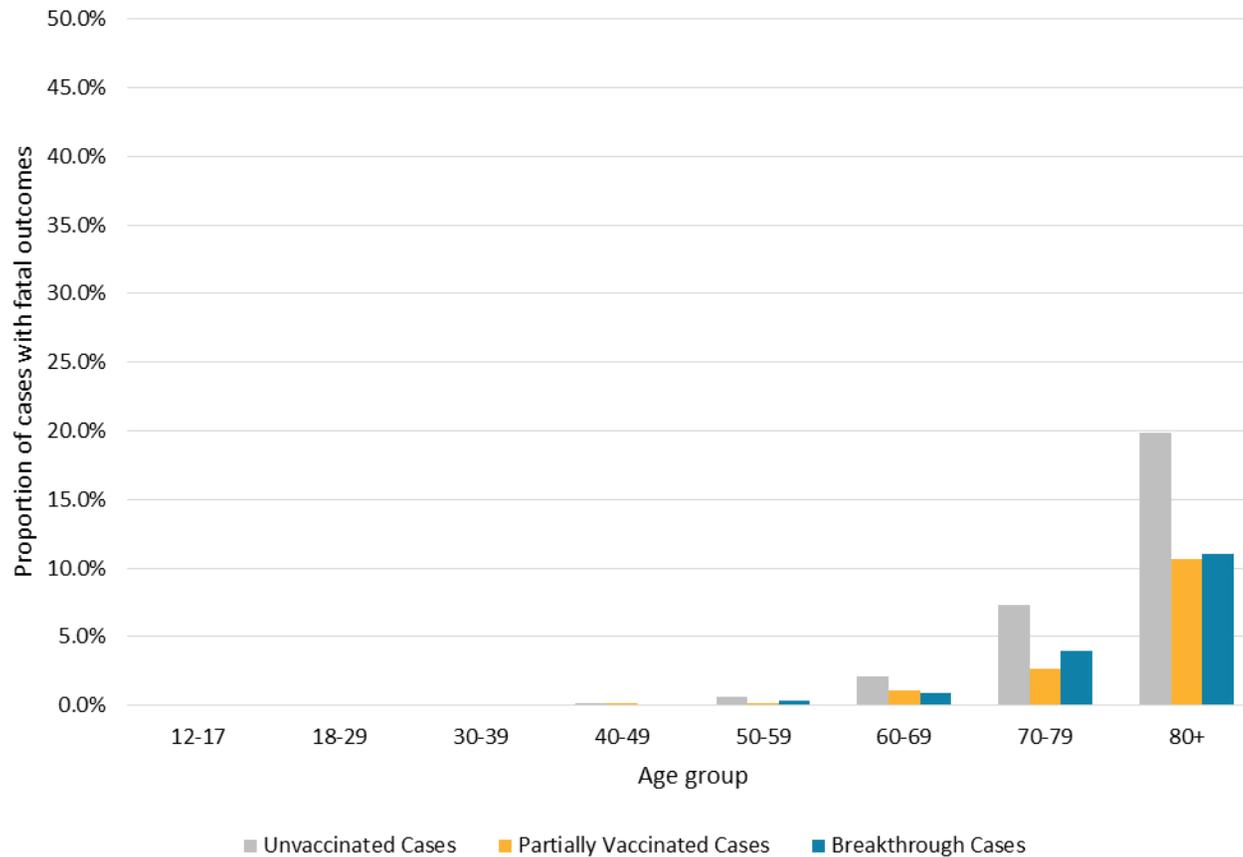


*Individuals with unknown age are excluded.

Notes:

- The denominators used to calculate the age-specific proportions for hospitalizations among partially vaccinated and breakthrough cases (i.e. the age-specific total of partially vaccinated and breakthrough cases) are provided in Table 2.
- Proportions for partially vaccinated and breakthrough cases (e.g. 12-17 age group) should be interpreted with caution due to instability caused by small denominators.
- Age groups are informed by vaccine product recommendations (i.e. no vaccine currently authorized or recommended in individuals <12 years of age) and sequencing of vaccine program eligibility in older adults which has progressed using decrements of 5 year age bands from 80 years of age.

Figure 6b. Fatalities among unvaccinated, partially vaccinated and breakthrough confirmed cases of COVID-19: Ontario, December 14, 2020 to September 18, 2021



*Individuals with unknown age are excluded.

Notes:

- The denominators used to calculate the age-specific proportions for fatalities among partially vaccinated and breakthrough cases (i.e. the age-specific total of partially vaccinated and breakthrough cases) are provided in Table 2.
- Proportions for partially and breakthrough cases should be interpreted with caution due to instability caused by small denominators.
- Age groups are informed by vaccine product recommendations (i.e. no vaccine currently authorized or recommended in individuals <12 years of age) and sequencing of vaccine program eligibility in older adults which has progressed using decrements of 5 year age bands from 80 years of age.

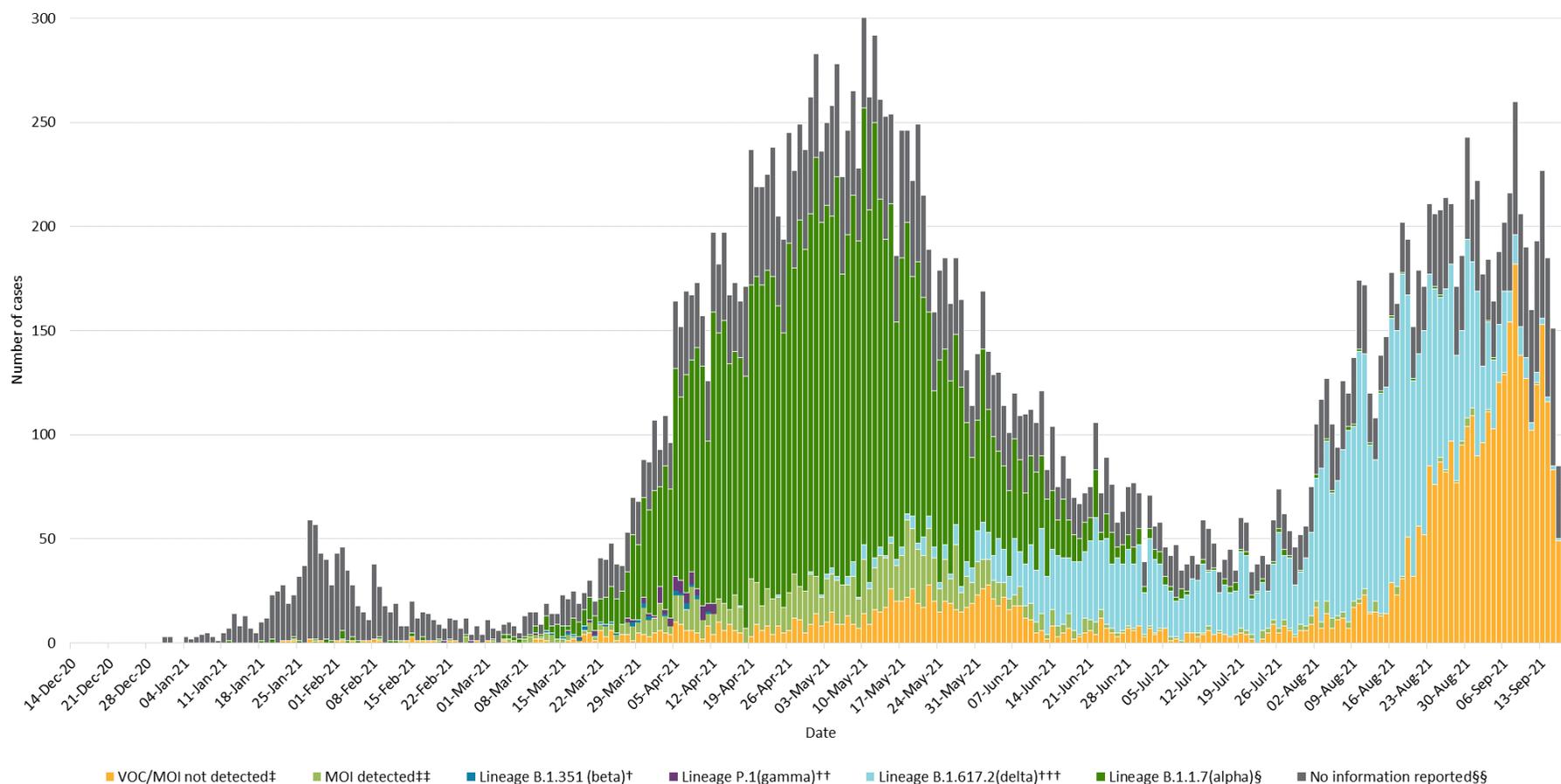
Outbreak Related Cases

Table 3. Partially vaccinated and breakthrough confirmed cases of COVID-19 linked to a confirmed outbreak: Ontario, December 14, 2020 to September 18, 2021

Age group	Symptomatic partially vaccinated cases linked to a confirmed outbreak: Number (%)	Symptomatic partially vaccinated cases: Total	Symptomatic breakthrough cases linked to a confirmed outbreak: Number (%)	Symptomatic breakthrough cases: Total	Asymptomatic partially vaccinated linked to a confirmed outbreak: Number (%)	Asymptomatic partially vaccinated cases: Total	Asymptomatic breakthrough cases linked to a confirmed outbreak: Number (%)	Asymptomatic breakthrough cases: Total
12-17	19 (6.9%)	275	7 (4.9%)	143	8 (7.6%)	105	11 (20.0%)	55
18-29	310 (12.6%)	2,462	119 (8.0%)	1,482	112 (18.2%)	617	50 (14.9%)	336
30-39	232 (12.1%)	1,920	96 (7.3%)	1,307	122 (24.3%)	503	36 (12.9%)	278
40-49	244 (12.5%)	1,947	73 (6.5%)	1,121	134 (23.1%)	580	39 (15.1%)	259
50-59	361 (15.1%)	2,388	80 (9.3%)	860	180 (21.9%)	821	71 (24.9%)	285
60-69	281 (11.1%)	2,534	73 (10.3%)	712	183 (16.7%)	1,099	72 (25.4%)	284
70-79	105 (7.3%)	1,441	58 (18.3%)	317	104 (12.5%)	832	40 (24.7%)	162
80+	277 (22.3%)	1,240	230 (63.7%)	361	292 (34.6%)	845	208 (68.9%)	302
Total	1,829 (12.9%)	14,211	736 (11.7%)	6,303	1,135 (21.0%)	5,405	527 (26.9%)	1,961

Variants of Concern

Figure 7. Symptomatic and asymptomatic partially vaccinated and breakthrough confirmed cases of COVID-19 by mutation of interest (MOI) or variant of concern (VOC) and symptom onset date*: Ontario, December 14, 2020 to September 18, 2021



* Symptomatic partially vaccinated and breakthrough cases are shown by symptom onset date. Asymptomatic partially vaccinated and breakthrough cases are shown by the first available of specimen collection or reported date, as an approximation of symptom onset date.

† Includes confirmed cases of wild type cases of SARS-CoV-2 COVID-19 where a VOC lineage or a MOI (specifically spike (S) gene mutations N501Y and E484K) were not detected, as well as cases where unspecified S gene mutations (other than MOIs N501Y and E484K) were detected. Further, the drop down value to indicate 'MOI not

detected' was not available in CCM prior to March 29, 2021. As a result, a 'MOI not detected' will only be reported for cases prior to March 29, 2021 if data were updated retrospectively.

^{††} Includes confirmed cases of COVID-19 where a MOI, specifically spike (S) gene mutations N501Y and/or E484K were detected. Mutations common to B.1.617.2 are not included in the current VOC mutation test.

[†] Includes B.1.351 cases identified by genomic analysis and those presumed to be B.1.351 based on 'Mutation K417N+ and N501Y+ and E484K+' in the Investigation Subtype field.

^{††} Includes P.1 cases identified by genomic analysis and those presumed to be P.1 based on 'Mutation K417T+ and N501Y+ and E484K+' in the Investigation Subtype field

^{†††} Includes B.1.617.2 cases identified by genomic analysis. Mutations common to B.1.617.2 are not included in the current VOC mutation test.

[§] Includes confirmed COVID-19 cases where lineage B.1.1.7 was identified by genomic analysis and those presumed to be B.1.1.7 based on positive N501Y and negative E484K mutation in the CCM Investigation Subtype field.

^{§§} Includes cases where subtype is blank or reported as 'COVID-19'.

Notes:

- Interpret the VOC and mutation trends with caution due to the varying time required to complete testing and/or genomic analysis following the initial positive test for SARS-CoV-2. Data for calculating the change in cases and the cumulative case count uses data from the Subtype field only. Data for cases with a B.1.1.7, B.1.351, P.1 and B.1.617.2 lineage detected or any of the mutations listed above are determined using the Investigation Subtype field only. Changes to the VOC testing algorithm may impact counts and trends. As of February 3, 2021 all PCR positive SARS-Co-V-2 specimens with CT values ≤ 35 are tested for a N501Y mutation. As of March 22, 2021, positive specimens with a Ct ≤ 35 are tested for both the N501Y and E484K mutation, with all E484K positive specimens with a Ct ≤ 30 forwarded for further genomic analysis. If found to be positive for the N501Y mutation only, no further genomic analysis are performed as these are presumed to be B.1.1.7. As of May 26, 2021, cases where an E484K mutation is detected will no longer be reflexed for sequencing as VOC testing labs switched to a representative sampling method where only a proportion of all positives with a Ct ≤ 30 are forwarded for further genomic analysis.
- The increasing trends in partially vaccinated and breakthrough cases are a reflection of both trends in vaccine administration (increasing number of doses administered over time) and trends in COVID-19 incidence.

Table 4. Partially vaccinated and breakthrough COVID-19 cases with mutation of interest or variant of concern: Ontario, February 3, 2021 to September 18, 2021

	Symptomatic and asymptomatic partially vaccinated cases	Symptomatic and asymptomatic breakthrough cases	Total symptomatic and asymptomatic partially vaccinated and breakthrough cases: Number (%)	Total cases+
No VOC or MOI detected¹	1,941	2,473	4,414 (16.7%)	26,373
Variant				
Lineage B.1.1.7 (Alpha)²	8,454	743	9,197 (6.3%)	145,800
Lineage B.1.351 (Beta)³	72	19	91 (6.1%)	1,490
Lineage P.1 (Gamma)⁴	299	30	329 (6.3%)	5,225
Lineage B.1.617.2 (Delta)⁵	2,513	2,361	4,874 (28.8%)	16,940
Not reported⁶	4,093	2,061	6,154 (7.4%)	83,048

*Includes all confirmed symptomatic COVID-19 cases (both vaccinated and unvaccinated) reported since February 3, 2021.

+Includes all confirmed symptomatic and asymptomatic COVID-19 cases (both vaccinated and unvaccinated, as well as both symptomatic and asymptomatic) reported since February 3, 2021.

¹ Includes confirmed cases of wild type cases of SARS-CoV-2 COVID-19 where a VOC lineage or a MOI (specifically spike (S) gene mutations N501Y and E484K) were not detected, as well as cases where unspecified S gene mutations (other than MOIs N501Y and E484K) were detected. Further, the drop down value to indicate 'MOI not detected' was not available in CCM prior to March 29, 2021. As a result, a 'MOI not detected' will only be reported for cases prior to March 29, 2021 if data were updated retrospectively. Mutations common to B.1.617.2 are not included in the current VOC mutation test.

² Includes confirmed COVID-19 cases where lineage B.1.1.7 was identified by genomic analysis and those presumed to be B.1.1.7 based on positive N501Y and negative E484K mutation in the Investigation Subtype field.

³ Includes B.1.351 cases identified by genomic analysis and those presumed to be B.1.351 based on 'Mutation K417N+ and N501Y+ and E484K+' in the Investigation Subtype field.

⁴ Includes P.1 cases identified by genomic analysis and those presumed to be P.1 based on 'Mutation K417T+ and N501Y+ and E484K+' in the Investigation Subtype field.

⁵ Includes B.1.617.2 cases identified by genomic analysis. Mutations common to B.1.617.2 are not included in the current VOC mutation test.

⁶ Includes cases where subtype is blank or reported as 'COVID-19'.

Note: Interpret the VOC and mutation trends with caution due to the varying time required to complete testing and/or genomic analysis following the initial positive test for SARS-CoV-2. Data for calculating the change in cases and the cumulative case count uses data from the Subtype field only. Data for cases with a B.1.1.7, B.1.351, P.1 and B.1.617.2 lineage detected or any of the mutations listed above are determined using the Investigation Subtype field only. Changes to the VOC testing algorithm may impact counts and trends. As of February 3, 2021 all PCR positive SARS-CoV-2 specimens with CT values ≤ 35 are tested for a N501Y mutation. As of March 22, 2021, positive specimens with a Ct ≤ 35 are tested for both the N501Y and E484K mutation, with all E484K positive specimens with a Ct ≤ 30 forwarded for further genomic analysis. If found to be positive for the N501Y mutation only, no further genomic analysis are performed as these are presumed to be B.1.1.7. As of May 26, 2021, cases where an E484K mutation is detected will no longer be reflexed for sequencing as VOC testing labs switched to a representative sampling method where only a proportion of all positives with a Ct ≤ 30 are forwarded for further genomic analysis.

Public Health Unit

Table 5. Partially vaccinated and breakthrough confirmed cases of COVID-19 by public health unit: Ontario, December 14, 2020 to September 18, 2021

Public Health Unit	Symptomatic partially vaccinated cases: Number (% cases)	Symptomatic breakthrough cases: Number (% cases)	Symptomatic and asymptomatic partially vaccinated cases: Number (% cases)	Symptomatic and asymptomatic breakthrough cases: Number (% cases)	Total cases*: Number
Algoma Public Health	15 (3.8%)	9 (2.3%)	27 (6.8%)	14 (3.5%)	399
Brant County Health Unit	123 (3.4%)	53 (1.5%)	184 (5.1%)	105 (2.9%)	3,598
Chatham-Kent Public Health	52 (2.9%)	40 (2.3%)	67 (3.8%)	45 (2.5%)	1,772
City of Hamilton Public Health Services	848 (4.3%)	414 (2.1%)	1,021 (5.2%)	511 (2.6%)	19,735
Durham Region Health Department	827 (3.9%)	311 (1.5%)	1,033 (4.9%)	394 (1.9%)	21,077
Eastern Ontario Health Unit	122 (3.2%)	42 (1.1%)	165 (4.3%)	66 (1.7%)	3,867
Grey Bruce Health Unit	115 (6.1%)	54 (2.9%)	154 (8.2%)	76 (4.1%)	1,870
Haldimand-Norfolk Health Unit	79 (3.7%)	37 (1.7%)	107 (5.0%)	51 (2.4%)	2,139
Haliburton, Kawartha, Pine Ridge District Health Unit	87 (4.4%)	24 (1.2%)	115 (5.8%)	33 (1.7%)	1,996
Halton Region Public Health	548 (3.9%)	277 (2.0%)	669 (4.7%)	345 (2.4%)	14,202
Hastings Prince Edward Public Health	64 (5.6%)	36 (3.2%)	84 (7.4%)	58 (5.1%)	1,133
Huron Perth Public Health	84 (5.0%)	37 (2.2%)	106 (6.3%)	51 (3.0%)	1,678
Kingston, Frontenac and Lennox & Addington Public Health	75 (5.8%)	48 (3.7%)	87 (6.7%)	52 (4.0%)	1,292

Public Health Unit	Symptomatic partially vaccinated cases: Number (% cases)	Symptomatic breakthrough cases: Number (% cases)	Symptomatic and asymptomatic partially vaccinated cases: Number (% cases)	Symptomatic and asymptomatic breakthrough cases: Number (% cases)	Total cases*: Number
Lambton Public Health	75 (2.3%)	30 (0.9%)	112 (3.4%)	42 (1.3%)	3,310
Leeds, Grenville & Lanark District Health Unit	41 (3.3%)	20 (1.6%)	52 (4.2%)	20 (1.6%)	1,252
Middlesex-London Health Unit	413 (3.5%)	180 (1.5%)	504 (4.3%)	224 (1.9%)	11,685
Niagara Region Public Health	551 (3.8%)	210 (1.4%)	742 (5.1%)	248 (1.7%)	14,684
North Bay Parry Sound District Health Unit	52 (8.1%)	20 (3.1%)	72 (11.3%)	22 (3.4%)	639
Northwestern Health Unit	17 (1.7%)	12 (1.2%)	40 (3.9%)	20 (2.0%)	1,013
Ottawa Public Health	563 (2.8%)	351 (1.7%)	810 (4.0%)	463 (2.3%)	20,210
Peel Public Health	2,556 (3.1%)	671 (0.8%)	3,384 (4.1%)	859 (1.1%)	81,604
Peterborough Public Health	91 (5.9%)	21 (1.4%)	114 (7.4%)	34 (2.2%)	1,542
Porcupine Health Unit	105 (5.1%)	37 (1.8%)	157 (7.6%)	82 (4.0%)	2,075
Public Health Sudbury & Districts	76 (3.6%)	26 (1.2%)	90 (4.2%)	38 (1.8%)	2,119
Region of Waterloo Public Health and Emergency Services	724 (4.9%)	225 (1.5%)	953 (6.4%)	320 (2.2%)	14,878
Renfrew County and District Health Unit	28 (4.8%)	3 (0.5%)	40 (6.8%)	5 (0.9%)	585
Simcoe Muskoka District Health Unit	336 (3.1%)	168 (1.6%)	444 (4.2%)	199 (1.9%)	10,695
Southwestern Public Health	128 (3.7%)	36 (1.0%)	155 (4.5%)	47 (1.4%)	3,443

Public Health Unit	Symptomatic partially vaccinated cases: Number (% cases)	Symptomatic breakthrough cases: Number (% cases)	Symptomatic and asymptomatic partially vaccinated cases: Number (% cases)	Symptomatic and asymptomatic breakthrough cases: Number (% cases)	Total cases*: Number
Thunder Bay District Health Unit	49 (1.7%)	19 (0.6%)	93 (3.2%)	28 (1.0%)	2,944
Timiskaming Health Unit	7 (3.8%)	1 (0.5%)	7 (3.8%)	1 (0.5%)	182
Toronto Public Health	3,293 (2.6%)	1,594 (1.3%)	5,183 (4.2%)	2,145 (1.7%)	124,298
Wellington-Dufferin-Guelph Public Health	313 (4.4%)	151 (2.1%)	408 (5.8%)	187 (2.7%)	7,053
Windsor-Essex County Health Unit	446 (3.1%)	462 (3.2%)	556 (3.8%)	583 (4.0%)	14,467
York Region Public Health	1,308 (3.1%)	684 (1.6%)	1,881 (4.4%)	896 (2.1%)	42,400
Ontario	14,211 (3.3%)	6,303 (1.4%)	19,616 (4.5%)	8,264 (1.9%)	435,836

*Includes all confirmed symptomatic and asymptomatic COVID-19 cases (both vaccinated and unvaccinated, as well as both symptomatic and asymptomatic) reported since December 14, 2020.

Note: Age groups are informed by vaccine product recommendations (i.e. no vaccine currently authorized or recommended in individuals <12 years of age) and sequencing of vaccine program eligibility in older adults which has progressed using decrements of 5 year age bands from 80 years of age.

Technical Notes

Data Sources

- COVID-19 case data were based on information successfully extracted from the Ontario Ministry of Health's CCM application as of September 20, 2021 at approximately 1:00 p.m. for cases reported from Feb 1, 2021 on and as of September 20, 2021 at approximately 9:00 a.m. for cases reported up to Jan 31, 2021.
- COVID-19 vaccination data were based on information successfully extracted from the Ontario Ministry of Health's COVaxON application as of September 20, 2021 at approximately 7:00 a.m. for vaccination records created on or after Jun 1, 2021 and September 16, 2021 at approximately 7:00 a.m. for vaccination records created up to May 31, 2021.
- Ontario population estimate data were sourced from Statistics Canada. Population estimates 2001-2020: Table 1 annual population estimates by age and sex for July 1, 2001 to 2020, health regions, Ontario [unpublished data table]. Ottawa, ON: Government of Canada; 2021 [received April 22, 2021].

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 vaccination and case information reported and recorded in COVaxON or CCM. As a result, all counts may be subject to varying degrees of underreporting due to a variety of factors.
- Only cases meeting the confirmed case classification as listed in the MOH [COVID-19 case definition](#) are included.⁹
- 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. such as 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.
- For breakthrough cases, the time interval between doses was not assessed to determine if the second dose was administered as per the product-specific recommended minimum interval.
- Cycle threshold (Ct) values were not available as part of this analysis.
- 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) unclear for these cases. Thus, it is possible some of these cases maybe have been infected prior to vaccination and are not post-vaccinations cases.

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, postal code, and phone number.
- 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](#)⁶ and methods for processing the CCM case data are described in the Technical Notes of the [COVID-19 Daily Epidemiological Summary](#).⁷
- Symptomatic cases were defined as those with a reported symptom onset date.
- Asymptomatic cases were defined as those where asymptomatic was reported as 'yes' and no symptom information (e.g. cough) was reported as well as cases where no onset date was reported.
- The re-positive and remote positive COVID-19 cases were excluded from the analysis.
 - Re-positive cases are defined as cases that test positive again after a negative test result based on an approved method or after being cleared/resolved (based on either time from symptom onset or having two negative tests). This may include cases that were asymptomatic at the time of the initial positive result and later developed symptoms which lead to subsequent testing. As a result, the timing of infection may be unclear.
 - 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.
- To determine daily COVID-19 rates, individuals were classified as fully vaccinated, partially vaccinated, and unvaccinated. Data extracted from COVAX was used to determine the number of fully and partially vaccinated individuals each day, and aggregated population data was used to determine the number of unvaccinated individuals each day (i.e. the number of fully and partially vaccinated individuals was subtracted from aggregated populations estimates).
 - Risks of COVID-19 infection and hospitalization were calculated by summing the rate per 100,000 person days and cases or hospitalizations in each vaccine status category (fully vaccinated, partially vaccinated, and unvaccinated)
 - All individuals in Ontario, including individuals under 12 years of age were included in the rate over time and risk calculation for COVID-19 cases.
 - Only individuals 60 years of age and older were included in the hospitalization rate over time and risk calculation for COVID-19 hospitalizations.
 - Rate are not adjusted for other factors (e.g. age) that may affect risk of COVID-19 infection or hospitalization.

- Estimates for risk may differ from other reports due to differing methodologies and data extracts; this includes estimates of VE.
- Estimates of relative risk for unvaccinated versus vaccinated individuals may change over time.
- Definitions for individual-level denominators for rate calculation were as follows:
 - **Unvaccinated individual** refers to individuals that have not received a dose of a COVID-19 vaccine, as well as individuals that are not yet protected from vaccination (0 to 13 days following dose 1 administration).
 - **Partially vaccinated individual** refers to individuals that have received only the first dose of a two-dose COVID-19 vaccine series and 14 or more days have elapsed following dose 1 administration.
 - **Fully vaccinated individual** refers to individuals that have received both doses of a two-dose COVID-19 vaccine series (i.e. dose two of two) or one dose of a one-dose COVID-19 vaccine product (i.e. dose one of one) and 14 or more days have elapsed following dose 2 administration. Reflects individuals that have completed a COVID-19 vaccine series.
- Description of variant of concern (VOC) detection and reporting are described in the Technical Notes section of the [COVID-19 Daily Epidemiological Summary](#).⁷

References

1. Chung H, He S, Nasreen S, Sundaram ME, Buchan SA, Wilson SE, et. al. Effectiveness of BNT162b2 and mRNA-1273 COVID-19 vaccines against symptomatic SARS-CoV-2 infection and severe COVID-19 outcomes in Ontario, Canada: test negative design study. *BMJ*. 2021 Aug 20 [cited 2021 Aug 25]. Available from: <https://www.bmj.com/content/374/bmj.n1943>
2. Ontario Agency for Health Protection and Promotion (Public Health Ontario). COVID-19 real-world vaccine effectiveness – what we know so far [Internet]. Toronto, ON: Queen’s Printer for Ontario; 2021 [cited 2021 Jun 04]. Available from: <https://www.publichealthontario.ca/-/media/documents/ncov/covid-wwksf/2021/04/wwksf-vaccine-effectiveness.pdf?la=en>.
3. Harris RJ, Hall JA, Zaidi A, Andrews NJ, Dunbar JK, Dabrera G. Impact of vaccination on household transmission of SARS-COV-2 in England [Internet]. London: Public Health England; 2021 [cited 2021 May 25]. Available from: <https://khub.net/documents/135939561/390853656/Impact+of+vaccination+on+household+transmission+of+SARS-COV-2+in+England.pdf/35bf4bb1-6ade-d3eb-a39e-9c9b25a8122a?t=1619601878136>
4. Shah ASV, Gribben C, Bishop J, Hanlon P, Caldwell D, Wood R, et al. Effect of vaccination on transmission of COVID-19: an observational study in healthcare workers and their households. *medRxiv* 21253275 [Preprint]. 2021 Mar 21 [cited 2021 May 25]. Available from: <https://doi.org/10.1101/2021.03.11.21253275>
5. Ontario Agency for Health Protection and Promotion (Public Health Ontario). COVID-19 B.1.1.7 (501Y.V1) variant of concern – what we know so far [Internet]. Toronto, ON: Queen’s Printer for Ontario; 2021 [cited 2021 Apr 29]. Available from: <https://www.publichealthontario.ca/-/media/documents/ncov/covid-wwksf/2020/12/what-we-know-uk-variant.pdf?la=en>
6. Public Health England. COVID-19 vaccine surveillance report - week 26 [Internet]. London: Crown Copyright; 2021 [cited 2021 July 02]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/998411/Vaccine_surveillance_report_-_week_26.pdf
7. Ontario Agency for Health Protection and Promotion (Public Health Ontario). COVID-19 vaccine uptake in Ontario: December 14, 2020 to April 17, 2021 [Internet]. Toronto, ON: Queen's Printer for Ontario; 2021 [cited 2021 Apr 29]. Available from: <https://www.publichealthontario.ca/-/media/documents/ncov/epi/covid-19-vaccine-uptake-ontario-epi-summary.pdf?la=en>
8. Ontario Agency for Health Protection and Promotion (Public Health Ontario). COVID-19 in Ontario – January 15, 2020 to April 27, 2021 [Internet]. Toronto, ON: Queen’s Printer for Ontario; 2021 [cited 2021 Apr 26]. Available from: <https://www.publichealthontario.ca/-/media/documents/ncov/epi/covid-19-daily-epi-summary-report.pdf?la=en>
9. 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

Appendix A

Table A1a. Hospitalizations (including intensive care unit admissions) among partially vaccinated and breakthrough confirmed cases of COVID-19: Ontario, December 14, 2020 to September 18, 2021

Age (years)*	Hospitalized symptomatic and asymptomatic partially vaccinated cases: Number (%)	Hospitalized symptomatic and asymptomatic breakthrough cases: Number (%)	Hospitalized unvaccinated cases: Number (%)	Unvaccinated cases
12-17	5 (1.3%)	1 (0.5%)	116 (0.5%)	25,777
18-29	12 (0.4%)	5 (0.3%)	922 (0.9%)	103,683
30-39	22 (0.9%)	14 (0.9%)	1,488 (2.2%)	68,660
40-49	44 (1.7%)	11 (0.8%)	2,040 (3.5%)	58,358
50-59	115 (3.6%)	20 (1.7%)	3,318 (6.0%)	55,265
60-69	217 (6.0%)	51 (5.1%)	3,658 (11.3%)	32,253
70-79	323 (14.2%)	49 (10.2%)	3,530 (23.5%)	14,994
80+	628 (30.1%)	137 (20.7%)	3,768 (32.1%)	11,752

*Individuals with unknown age are excluded.

Note: The denominators used to calculate the age-specific proportions for hospitalizations among partially vaccinated and breakthrough cases (i.e. the age-specific total of partially vaccinated and breakthrough cases) are provided in Table 2.

Note: Proportions for partially vaccinated and breakthrough cases should be interpreted with caution due to instability caused by small denominators.

Note: Age groups are informed by vaccine product recommendations (i.e. no vaccine currently authorized or recommended in individuals <12 years of age) and sequencing of vaccine program eligibility in older adults which has progressed using decrements of 5 year age bands from 80 years of age.

Table A1b. Intensive care unit (ICU) admissions among partially vaccinated and breakthrough confirmed cases of COVID-19: Ontario, December 14, 2020 to September 18, 2021

Age (years)*	ICU admissions among symptomatic and asymptomatic partially vaccinated cases: Number (%)	ICU admissions among symptomatic and asymptomatic breakthrough cases: Number (%)	ICU admissions among unvaccinated cases: Number (%)	Unvaccinated cases
12-17	0 (0.0%)	0 (0.0%)	16 (0.1%)	25,777
18-29	1 (<0.1%)	0 (0.0%)	116 (0.1%)	103,683
30-39	3 (0.1%)	3 (0.2%)	256 (0.4%)	68,660
40-49	5 (0.2%)	0 (0.0%)	440 (0.8%)	58,358
50-59	24 (0.7%)	2 (0.2%)	779 (1.4%)	55,265
60-69	50 (1.4%)	12 (1.2%)	1,001 (3.1%)	32,253
70-79	49 (2.2%)	10 (2.1%)	830 (5.5%)	14,994
80+	59 (2.8%)	5 (0.8%)	327 (2.8%)	11,752

*Individuals with unknown age are excluded.

Note: The denominators used to calculate the age-specific proportions for ICU admissions among partially vaccinated and breakthrough cases (i.e. the age-specific total of partially vaccinated and breakthrough cases) are provided in Table 2.

Note: Proportions for partially vaccinated and breakthrough cases should be interpreted with caution due to instability caused by small denominators.

Note: Age groups are informed by vaccine product recommendations (i.e. no vaccine currently authorized or recommended in individuals <12 years of age) and sequencing of vaccine program eligibility in older adults which has progressed using decrements of 5 year age bands from 80 years of age.

Table A1c. Fatalities among partially vaccinated breakthrough and confirmed cases of COVID-19: Ontario, December 14, 2020 to September 18, 2021

Age (years)*	Fatal symptomatic and asymptomatic partially vaccinated cases: Number (%)	Fatal symptomatic and asymptomatic breakthrough cases: Number (%)	Fatal unvaccinated cases: Number (%)	Unvaccinated cases
12-17	0 (0.0%)	0 (0.0%)	1 (<0.1%)	25,777
18-29	0 (0.0%)	0 (0.0%)	23 (<0.1%)	103,683
30-39	0 (0.0%)	0 (0.0%)	53 (0.1%)	68,660
40-49	5 (0.2%)	0 (0.0%)	123 (0.2%)	58,358
50-59	7 (0.2%)	3 (0.3%)	332 (0.6%)	55,265
60-69	39 (1.1%)	9 (0.9%)	677 (2.1%)	32,253
70-79	62 (2.7%)	19 (4.0%)	1,096 (7.3%)	14,994
80+	224 (10.7%)	73 (11.0%)	2,344 (19.9%)	11,752

*Individuals with unknown age are excluded.

Note: The denominators used to calculate the age-specific proportions for fatalities among partially vaccinated and breakthrough cases (i.e. the age-specific total of partially vaccinated and breakthrough cases) are provided in Table 2.

Note: Proportions for partially and breakthrough cases should be interpreted with caution due to instability caused by small denominators.

Note: Age groups are informed by vaccine product recommendations (i.e. no vaccine currently authorized or recommended in individuals <12 years of age) and sequencing of vaccine program eligibility in older adults which has progressed using decrements of 5 year age bands from 80 years of age.

Citation

Ontario Agency for Health Protection and Promotion (Public Health Ontario). Confirmed cases of COVID-19 following vaccination in Ontario: December 14, 2020 to September 18, 2021. Toronto, ON: Queen's Printer for Ontario; 2021.

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