

Measles surveillance in Canada

2020-2023



Public Health
Agency of Canada

Agence de la santé
publique du Canada

Canada

Measles Surveillance in Canada, 2020-2023

Authors: Ama A. Tweneboa Kodua¹, Joanne Hiebert², Disha Bhagat¹, Kashmeera Meghnath¹, Samar Ashfaq², Vanessa Zubach², Samara David¹, Marina I. Salvadori¹, Y. Anita Li¹

Affiliations:

¹Centre for Emerging Respiratory Infections and Pandemic Preparedness, Public Health Agency of Canada, Ottawa, ON

²National Microbiology Laboratory, Public Health Agency of Canada, Winnipeg, MB

Correspondence: vpd-mev@phac-aspc.gc.ca

His Majesty the King in Right of Canada, as represented by the Minister of Health, 2026

Published October 2026

Catalogue number: HP40-410/2026E-PDF

ISBN: 978-1-100-00840-0

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES	III
EXECUTIVE SUMMARY	1
INTRODUCTION.....	2
RESULTS	3
DISCUSSION	7
CONCLUSION	9
ACKNOWLEDGEMENTS.....	10
APPENDIX A: METHODS AND LIMITATIONS	11
REFERENCES.....	13

LIST OF FIGURES AND TABLES

Figures

FIGURE 1: Annual number and incidence rate (per 1 million population) of reported measles cases in Canada, 2020-2023 3

FIGURE 2: Number of measles cases reported in Canada by source of exposure and month and year of rash onset, 2020-2023 5

FIGURE 3: Maximum likelihood phylogenetic analysis of measles N450 sequences from cases occurring in Canada from 2020 to 2023 (n=15)^a 6

Tables

TABLE 1: Counts and incidence rates (per 1 million population) of reported measles cases in Canada by age group and year, 2020-2023 4

TABLE 2: Hospitalization status of reported measles cases in Canada by age group, 2020-2023 4

EXECUTIVE SUMMARY

INTRODUCTION

This report summarizes the epidemiology of measles cases in Canada from 2020 to 2023, which included the years of the COVID-19 pandemic.

KEY FINDINGS

- Between 2020 and 2023, 16 confirmed measles cases were reported in four provinces: 1 in 2020, 0 in 2021, 3 in 2022, and 12 in 2023.
- The annual incidence rates per 1 million population ranged between 0 to 0.3 cases. In the years with more than one reported case, infants under one year of age had the highest incidence rates, with 8.2 and 11.2 cases per one million population in 2022 and 2023, respectively.
- Genotype information was available for 15 cases: 9 were B3 and 6 were D8. 10 Distinct Sequence Identifiers were identified.

CONCLUSION

There was a resurgence of measles activity in Canada immediately in the first year following the easing of COVID-19 pandemic-related travel restrictions, mostly due to imported cases. These imported cases have the potential to result in outbreaks if gaps in vaccination aren't addressed.

INTRODUCTION

Measles is one of the most contagious diseases known, with over 90% of non-immune people contracting the disease after being exposed to an infectious person (1). Although measles is vaccine preventable, it remains a major cause of morbidity and mortality worldwide, particularly in children under five years of age who are at the highest risk of severe outcomes (2). In Canada, the introduction of the measles vaccine in 1963 and subsequent routine vaccination programs implemented by the provinces and territories have led to a greater than 99% decline in the incidence of measles (3).

Canada first achieved measles elimination status in 1998 following the pan-Canadian introduction of routine two-dose measles-mumps-rubella (MMR) vaccination and catch-up campaigns involving school-aged children and adolescents in 1996–1997 (4). The World Health Organization (WHO) defines measles elimination as the absence of endemic measles transmission in a defined geographic area for at least 12 months in the presence of a verified well-functioning surveillance system (5). Although endemic measles in Canada has been eliminated, the risk of imported measles remains due to travel to countries where the virus is circulating. These importations can lead to secondary cases and result in domestic outbreaks, especially among unvaccinated individuals (3).

Globally, efforts to eradicate measles showed notable progress between 2000 and 2016, with a substantial decline in reported cases (6) (7). However, between 2017 and 2019, there was a global resurgence of measles resulting in outbreaks in regions where measles had previously been declared eliminated (6) (7) (8). The highest global incidence rates during this period were reported in 2019, with 118.8 cases per 1 million population (6). In Canada, a total of 184 measles cases were reported between 2017 and 2019, with the highest incidence rate also occurring in 2019 (3.0 cases per 1 million population) (3). The global resurgence of measles threatens recent achievements in eliminating the measles virus, highlighting the importance of maintaining a high-quality surveillance system and implementing comprehensive vaccination strategies (9).

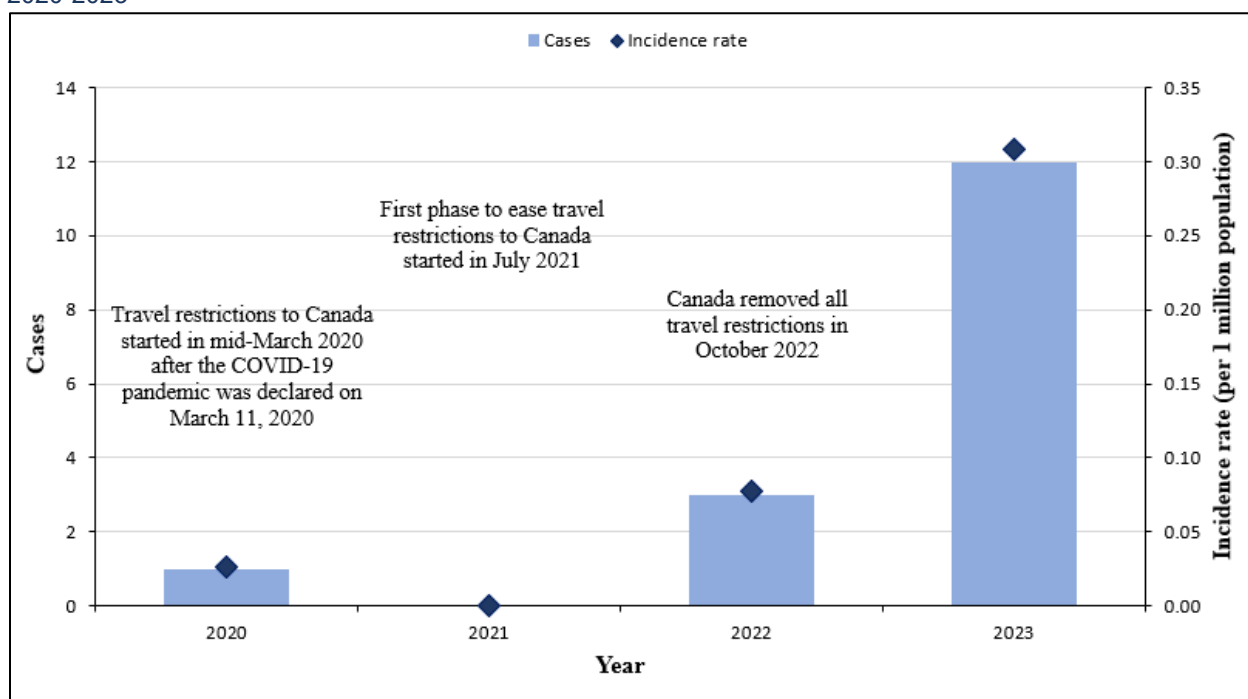
Canada has been able to maintain its elimination status for measles through provincial and territorial vaccination programs and a robust national surveillance system. Despite the global challenges posed by the COVID-19 pandemic, which impacted healthcare systems and public health priorities, measles surveillance in Canada was not interrupted. The objective of this report is to provide a comprehensive epidemiological summary of measles activity in Canada between 2020 and 2023, including the years of the COVID-19 pandemic. Full methods can be found in **Appendix A: Methods and Limitations**.

RESULTS

Incidence

Between 2020 and 2023, a total of 16 confirmed measles cases were reported in 4 provinces (Alberta, Nova Scotia, Ontario and Quebec) in Canada, with 1 in 2020, 0 in 2021, 3 in 2022, and 12 in 2023 (**Figure 1**). The annual incidence rates per 1 million population were <0.1 cases in 2020, 0 cases in 2021, 0.1 cases in 2022, and 0.3 cases in 2023 (**Figure 1**). No measles cases were reported during the period of March 2020 to July 2021 when the most restrictive travel restrictions were in place. All cases reported were laboratory confirmed, with one confirmed only by IgM serology.

FIGURE 1: Annual number and incidence rate (per 1 million population) of reported measles cases in Canada, 2020-2023



Case Demographics

As shown in **Table 1**, all 16 cases were under 55 years of age, of which 7 were infants under 1 year of age, 6 were 1-4 years of age, and 3 were 18-54 years of age. In the years with more than 1 reported case, infants under 1 year of age had the highest incidence rates, with 8.2 cases per 1 million population in 2022 and 11.2 cases per 1 million population in 2023. Of the 16 cases, 10 were males and 6 were females.

TABLE 1: Counts and incidence rates (per 1 million population) of reported measles cases in Canada by age group and year, 2020-2023

AGE GROUP (YEARS)	2020	2021	2022	2023
	Number of cases (Incidence rate)	Number of cases (Incidence rate)	Number of cases (Incidence rate)	Number of cases (Incidence rate)
< 1	0 (0)	0 (0)	3 (8.2)	4 (11.2)
1 to 4	1 (0.6)	0 (0)	0 (0)	5 (3.3)
5 to 17	0 (0)	0 (0)	0 (0)	0 (0)
18 to 54	0 (0)	0 (0)	0 (0)	3 (0.2)
≥ 55	0 (0)	0 (0)	0 (0)	0 (0)
All ages	1 (<0.1)	0 (0)	3 (0.1)	12 (0.3)

Vaccination Status

Among these 16 cases, 15 were unvaccinated and 1 had an unknown vaccination history.

Outcomes

Among the 16 cases, 5 (31%) were hospitalized, all of whom were under 5 years of age (**Table 2**). Two were infants under 1 year of age and 3 were children 1-4 years of age. No deaths were reported.

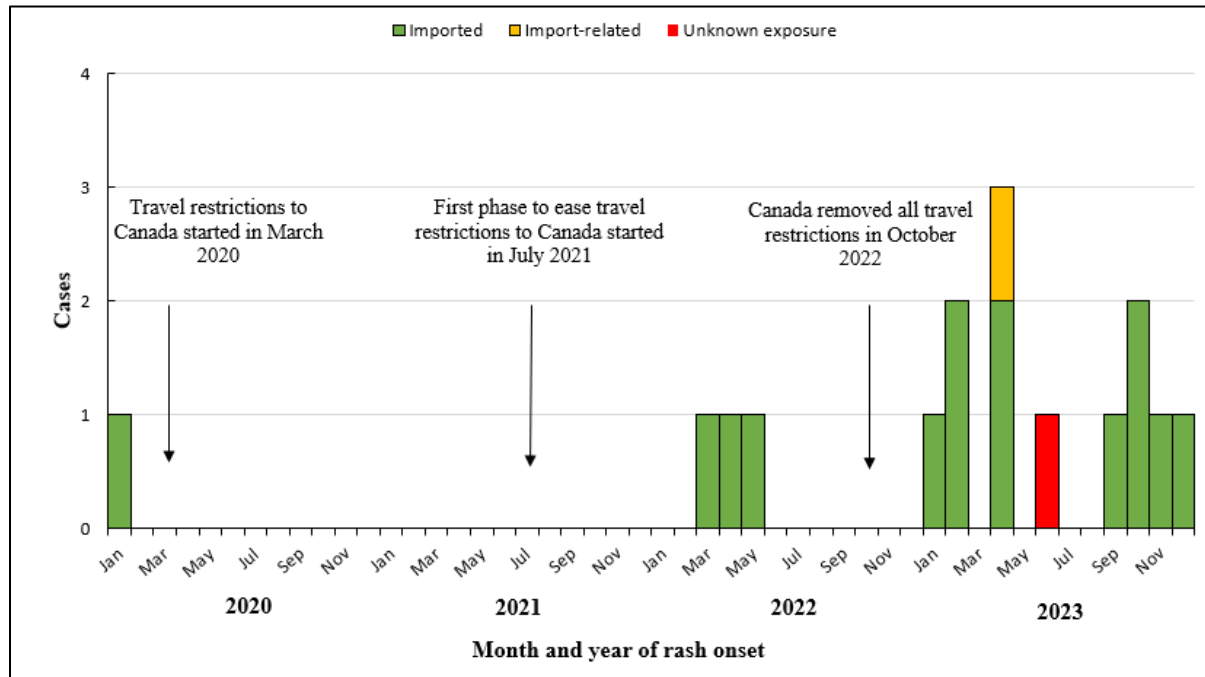
TABLE 2: Hospitalization status of reported measles cases in Canada by age group, 2020-2023

AGE GROUP (YEARS)	Number of cases	Number Hospitalized	% Hospitalized
< 1	7	2	28.5%
1 to 4	6	3	50%
5 to 17	0	0	0%
18 to 54	3	0	0%
≥ 55	0	0	0%
All ages	16	5	31%

Source of Exposure

Among the 16 cases, 14 were imported, 1 was import-related, and 1 had an unknown source of exposure (**Figure 2**). The imported cases reported travel to Afghanistan (n=1), Burundi (n=2), Cameroon (n=2), India (n=2), Pakistan (n=6) and Uruguay (n=1). The import-related case, occurring in 2023, was a household contact of an imported case who travelled to India.

FIGURE 2: Number of measles cases reported in Canada by source of exposure and month and year of rash onset, 2020-2023

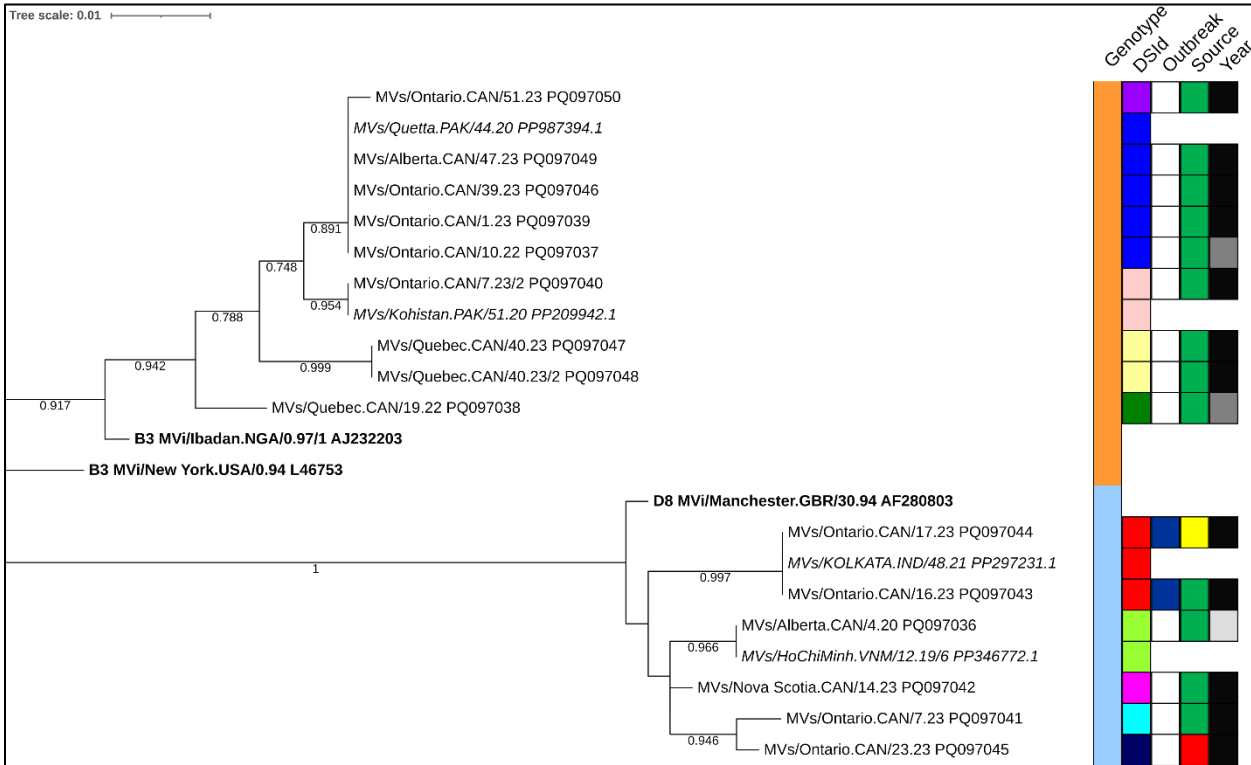


Genotyping

The measles genotype, as determined by the N450 sequence, was obtained for 15 of the 16 cases; 9 were B3 and 6 were D8 with a total of 10 unique DSIDs, 4 of which were designated as named strains (**Figure 3**). Of the 6 genotype D8 sequences, 4 were obtained from imported cases of measles, which occurred in 2020 (n=1) and 2023 (n=3). These cases had distinct N450 sequences, as reflected in their distinct DSIDs, which were also phylogenetically distinct, confirming that they were indeed independent, unrelated cases (**Figure 3**). One 2023 case led to an import-related case, and as expected, both had the same DSID (8251), which was designated as a WHO named strain (MV/KOLKATA.IND/48.21), as a result of its status as an internationally active strain. The only measles case of unknown source, occurring in 2023, was genotype D8 with a unique DSID (8479) not seen in other cases, and an N450 sequence that was phylogenetically distinct from the others (bootstrap value of 0.946), excluding a direct connection to any other contemporary Canadian case with an N450 sequence.

The 9 genotype B3 cases were all imported and all occurred in 2022 and 2023 (n=2 and 7 cases respectively). Only 5 DSIDs were identified for these 9 genotype B3 sequences with all 5 DSIDs having phylogenetically distinct sequences (**Figure 3**). The WHO named strain MVs/Quetta.PAK/44.20 (DSID 6418), which was one of the topmost detected strains globally in this time period (19), was detected in 5 independently imported cases. These cases were all imported from the WHO Eastern Mediterranean region which is where this strain is endemic. Three DSIDs were identified in the remaining 4 genotype B3 cases. Two cases, occurring in the same week, had the same DSID (identical N450). These two cases had travelled together and were plausibly exposed to the same source.

FIGURE 3: Maximum likelihood phylogenetic analysis of measles N450 sequences from cases occurring in Canada from 2020 to 2023 (n=15)^a



^aWHO genotype reference sequences (only those for B3 and D8 are included) and named strains are identified in the phylogenetic tree by bold and italic font respectively. All sequences are represented by their WHO sequence name (beginning with “MVs” or “MVi”) which is followed by the GenBank accession number. Bootstrap values >0.7 are displayed on their respective branches. The five colour strips to the right of the tree provide additional metadata, each strip corresponding to a different piece of information. The genotypes (B3 in orange and D8 in blue) are represented in the first strip. The 15 Canadian sequences have 10 unique DSIDs, represented by 10 different colours (second bar). The third bar indicates if the sequence was collected from a case associated with an outbreak (colour) or not (white); only 1 outbreak occurred in the dataset. The fourth column indicates the source of the measles case: imported (green), import-related (yellow) or unknown (red). The final column indicates the year in which the measles case occurred in greyscale from lighter (2020) to darker (2023).

DISCUSSION

The annual incidence rate reported between 2020 and 2022 is the lowest observed since measles was eliminated in Canada in 1998 (3) (20). This is presumably due to reduced international travel. Following WHO's declaration of the COVID-19 pandemic in March 2020, Canada implemented significant measures to reduce the importation of COVID-19 cases, including travel restrictions and border closures (21). Travel restrictions to Canada were enacted in mid-March 2020, with the first phase of easing these measures beginning in July 2021 (22) (23). Additionally, the implementation of public health measures in mid-March 2020 to reduce COVID-19 transmission, such as reduced social gatherings, physical distancing, improved ventilation and widespread mask use, likely contributed to the lack of measles transmission (24) (25). There were two cases that were likely exposed to measles in Canada, a household contact of an imported case and a case with unknown exposure, which indicates transmission occurring within the country. Both cases occurred in 2023, after public health measures were eased. This national decrease in measles activity between 2020 and 2022 paralleled the decrease observed in the region of the Americas and globally (6) (26) (27) (28).

Following the removal of COVID-19 pandemic-related travel restrictions in October 2022, the incidence rate observed in 2023 is comparable to those observed in pre-pandemic years (3) (29). The majority of reported cases were imported. Most of these imported cases had travelled to countries where measles is endemic. Although Canada has achieved measles elimination since 1998, measles has not been eliminated in all world regions. Therefore, the importation of measles cases is expected and will continue to arise as international travel occurs (3) (17).

Globally, only two of the 24 measles genotypes have been detected in recent years, B3 and D8, as a result of elimination efforts (19), and both were detected in the reported cases. The use of DSIDs helped to improve the resolution of the molecular epidemiology of the independently imported cases. However, additional sequencing methods are required when the same strain is imported multiple times, such as for the MVs/Quetta.PAK/44.20 named strain.

Young children who are unvaccinated are at the highest risk of acquiring measles and developing severe disease. Between 2020 and 2023, children under 5 years of age accounted for the majority of cases, had the highest incidence rates, and accounted for all measles hospitalizations. Additionally, all 13 cases in children under 5 were unvaccinated. In Canada, routine measles vaccination starts at 12 months of age, thus the 6 measles cases between 1 and 4 years of age were preventable (30). Additionally, according to the National Advisory Committee on Immunization's recommendations, the MMR vaccine can be given to infants as early as 6 months if they are travelling internationally to regions where measles is circulating (30). Six infant cases between 6 and 12 months of age may have been eligible for the early dose of the vaccine prior to international travel.

Globally, routine vaccinations were interrupted by the COVID-19 pandemic. In 2020, 24 measles immunization campaigns originally planned in 23 countries were postponed because of the COVID-19 pandemic (31). According to a report from WHO and the U.S. Centers for Disease Control and Prevention (CDC), nearly 40 million children globally missed a measles vaccine dose in 2021; 25 million children missed their first dose, and an additional 14.7 million children missed their second dose (32) (33). In Canada, the measles vaccine coverage of one dose among two-year-olds was similar in 2021 (91.6%) compared to 2019 (90.2%), but the coverage of two doses among seven-

year-olds decreased in 2021 (79.2%) compared to 2019 (83.3%) (34). Although there was a decrease in two dose completion, the laboratory and epidemiologic evidence provided in this report shows that endemic transmission of the measles virus was not re-established in Canada between 2020 and 2023, including the years of the COVID-19 pandemic. Jurisdictions have implemented catch-up programs to close gaps in immunization for both routine and school-based immunizations that were missed during the pandemic (35) (36) (37) (38).

CONCLUSION

Travel restrictions and public health measures implemented during the COVID-19 pandemic vastly reduced the importation of measles cases to Canada. The resurgence of measles activity immediately following the easing of these measures indicates that the importation of measles continues, which may result in outbreaks if gaps in vaccination aren't addressed. Vaccination is the best tool to reduce secondary transmission and prevent outbreaks. Maintaining high vaccination coverage rates with measles-containing vaccine requires a sustained public health effort in both Canada and abroad and is an essential part of the strategy for achieving and maintaining measles elimination.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the continued collaboration and efforts of provincial and territorial surveillance and laboratory partners in providing and validating data captured by the Canadian Measles and Rubella Surveillance System (CMRSS) and referring specimens for molecular surveillance (genotyping) and for their review of the report content.

APPENDIX A: METHODS AND LIMITATIONS

SURVEILLANCE DATA SOURCES

All Canadian provinces and territories report confirmed measles cases that meet the national case definition on a weekly basis, including zero reporting when there are no cases, to the Public Health Agency of Canada (PHAC) via the Canadian Measles and Rubella Surveillance System (CMRSS), a laboratory-epidemiologically linked case-based national surveillance system (10). In Canada, laboratory confirmation of measles cases is primarily done either by measles virus detection (reverse transcription polymerase chain reaction, RT-PCR), which detects the virus in samples such as respiratory swabs, or measles-specific IgM antibody (serology) (10). Data validation is conducted annually with all provinces and territories. For describing the distribution of cases over time, PHAC uses the epidemiological week defined by the Pan American Health Organization (11). All confirmed cases with a rash onset date between January 1, 2020, and December 31, 2023, were included in this report.

A case was considered to be vaccinated if the vaccination was documented. A case was considered to be hospitalized if they were admitted to the hospital due to measles or measles-related complications. However, if they were seen in the emergency department but were not admitted, they were not considered hospitalized. The exposure period was defined as 7 to 21 days prior to the date of rash onset.

The sources of exposure were classified as imported, when the case was exposed to the measles virus outside of Canada during the 7 to 18 days before the onset of fever or 7 to 21 days before the onset of a generalized rash; import-related, when the case was exposed in Canada and epidemiologically or virologically linked to an imported case; and unknown, when the case did not travel outside of Canada during the exposure period or did not have a known contact with a case.

MEASLES GENOTYPING

The National Microbiology Laboratory (NML) routinely performs measles virus genotyping for all laboratory confirmed cases where suitable viral specimens (respiratory swabs and/or urine) are available, in accordance with the WHO guidelines (12) (13). The 450 nucleotide sequence of the carboxy-terminus of the measles viral nucleoprotein gene (N450) are deposited in the WHO Measles Nucleotide Surveillance (MeaNS) database where it is assigned a distinct sequence identifier (DSId) and compared to designated named strains and to sequences deposited by other members of the global measles laboratory network (14). The sequences were deposited in the GenBank database with accession numbers PQ097036 to PQ097050. Maximum likelihood phylogenetic analysis, with 1000 bootstrap replicates, was conducted in MEGA X (15). The resulting Newick file was annotated in ITOL online annotator, version 6.9.1 (16).

ANALYSES

Descriptive epidemiologic analyses were conducted to characterize the demographic, clinical and laboratory features of the cases. Incidence rates were calculated using Statistics Canada population estimates, last updated in July 2024. Measles outbreaks, defined as two or more confirmed cases linked epidemiologically and/or virologically, were described based on available information (17).

Percentages were not used to describe the distribution of cases because of the small case counts (18). R software v4.2.2 and Microsoft Excel were used for the analyses.

LIMITATIONS

Enhanced measles surveillance only captures cases that seek health care in Canada and therefore may miss cases with mild symptoms, individuals who do not seek medical care, and visitors to Canada who are diagnosed in other countries. The CMRSS currently does not capture detailed information on morbidity factors (e.g., length of hospitalization) which limits the ability to describe the burden of illness caused by measles.

REFERENCES

- (1) Public Health Agency of Canada. Measles: for health professionals [Internet]. 2016 [cited 2024 Sep 13]. Available from: <https://www.canada.ca/en/public-health/services/diseases/measles/health-professionals-measles.html>
- (2) World Health Organization. Measles [Internet]. 2024 [cited 2024 Sep 10]. Available from: <https://www.who.int/news-room/fact-sheets/detail/measles>
- (3) Public Health Agency of Canada. Vaccine Preventable Disease: Surveillance report to December 31, 2019 [Internet]. 2022 [cited 2024 Sep 13]. Available from: <https://www.canada.ca/en/public-health/services/publications/healthy-living/vaccine-preventable-disease-surveillance-report-2019.html>
- (4) King K, Varughese P, De Serres G, Tipples G, Waters J. Measles elimination in Canada. *J Infect Dis*. 2004 May;189(Supplement_1):42.
- (5) World Health Organization. Measles elimination field guide. Manila: WHO Regional Office for the Western Pacific; 2013.
- (6) World Health Organization. Measles reported cases and incidence [Internet]. 2024 [cited 2024 Sep 10]. Available from: https://immunizationdata.who.int/global/wise-detail-page/measles-reported-cases-and-incidence?CODE=Global&GROUP=WHO_REGIONS&YEAR=
- (7) Hübschen JM, Gouandjika-Vasilache I, Dina J. Measles. *Lancet*. 2022 Feb 12;399(10325):678–90.
- (8) World Health Organization. Measles – global situation [Internet]. 2019 [cited 2024 Aug 30]. Available from: <https://www.who.int/emergencies/disease-outbreak-news/item/2019-DON211>
- (9) World Health Organization. Measles: fighting a global resurgence [Internet]. 2019 [cited 2024 Aug 30]. Available from: <https://www.who.int/news-room/feature-stories/detail/measles-fighting-a-global-resurgence>
- (10) Public Health Agency of Canada. National case definition: measles [Internet]. 2019 [cited 2024 Sep 13]. Available from: <https://www.canada.ca/en/public-health/services/diseases/measles/health-professionals-measles/national-case-definition.html>
- (11) Pan American Health Organization. Epidemiological calendar 2016: a basic element for the use of the time variable in health surveillance [Internet]. 2016 [cited 2024 Sep 13]. Available from: <https://www3.paho.org/hq/dmdocuments/2016/2016-cha-epidemiological-calendar.pdf>
- (12) World Health Organization. Expanded Programme on Immunization (EPI): standardization of the nomenclature for describing the genetic characteristics of wild-type measles viruses. *Wkly Epidemiol Rec*. 1998 May;73(35):265–9.
- (13) Shane A, Hiebert J, Sherrard L, Deehan H. Measles surveillance in Canada: trends for 2013. *Can Commun Dis Rep*. 2014 Jun 12;40(12):219–32.
- (14) Brown KE, Rota PA, Goodson JL, Williams D, Abernathy E, Takeda M, et al. Genetic characterization of measles and rubella viruses detected through global measles and rubella elimination surveillance, 2016–2018. *MMWR Morb Mortal Wkly Rep*. 2019 Jul 5;68(26):587–91.
- (15) Kumar S, Stecher G, Li M, Knyaz C, Tamura K. MEGA X: molecular evolutionary genetics analysis across computing platforms. *Mol Biol Evol*. 2018 Jun 1;35(6):1547–9.
- (16) Letunic I, Bork P. Interactive Tree of Life (iTOL) v6: recent updates to the phylogenetic tree display and annotation tool. *Nucleic Acids Res*. 2024 Jul 5;52(W1):82.
- (17) Public Health Agency of Canada. Guidelines for measles outbreak in Canada. *Can Commun Dis Rep*. 2013 Sep 30;39.
- (18) Patton M. Qualitative research & evaluation methods. 4th ed. Thousand Oaks: SAGE Publications; 2015.
- (19) Bankamp B, Kim G, Hart D, Beck A, Ben Mamou M, Penedos A, et al. Global update on measles molecular epidemiology. *Vaccines (Basel)*. 2024 Jul 22;12(7):810.
- (20) Public Health Agency of Canada. Reported cases from 1924 to 2022 in Canada - Notifiable diseases online [Internet]. 2024 [cited 2024 Sep 13]. Available from: <https://diseases.canada.ca/notifiable/charts?c=pl>

- (21) World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020 [Internet]. 2020 [cited 2024 Sep 3]. Available from: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>
- (22) Public Safety Canada. Timeline – CBSA border measures [Internet]. 2021 [cited 2024 Sep 10]. Available from: <https://www.publicsafety.gc.ca/cnt/trnsprnc/brfng-mtrls/prlmntry-bndrs/20210722/041/index-en.aspx>
- (23) Public Health Agency of Canada. Government of Canada's first phase to easing border measures for travellers entering Canada [Internet]. 2021 [cited 2024 Sep 13]. Available from: <https://www.canada.ca/en/public-health/news/2021/06/government-of-canadas-first-phase-to-easing-border-measures-for-travellers-entering-canada3.html>
- (24) Public Health Agency of Canada COVID-19 Surveillance and Epidemiology Team. A retrospective analysis of the start of the COVID-19 epidemic in Canada and worldwide. *Can Commun Dis Rep*. 2020 Jul 2;46(7/8).
- (25) Nicolay N, Mirinaviciute G, Mollet T, Celentano LP, Bacci S. Epidemiology of measles during the COVID-19 pandemic: a description of the surveillance data, 29 EU/EEA countries and the United Kingdom, January to May 2020. *Euro Surveill*. 2020 Aug;25(31):2001390.
- (26) Gianfredi V, Santangelo OE, Provenzano S. The effects of the COVID-19 pandemic on the trend of measles and influenza in Europe. *Acta Biomed*. 2021 Sep 2;92(4).
- (27) Klein A. Covid-19 measures mean zero measles in Australia. *New Sci*. 2021 Nov 6;252(3359):22.
- (28) Khanal S, Kassem AM, Bahl S, Jayantha L, Sangal L, Sharfuzzaman M, et al. Progress toward measles elimination - South-East Asia Region, 2003–2020. *MMWR Morb Mortal Wkly Rep*. 2022 Aug 19;71(33):1042–6.
- (29) Public Health Agency of Canada. Government of Canada to remove COVID-19 border and travel measures effective October 1 [Internet]. 2022 [cited 2024 Sep 26]. Available from: <https://www.canada.ca/en/public-health/news/2022/09/government-of-canada-to-remove-covid-19-border-and-travel-measures-effective-october-1.html>
- (30) Public Health Agency of Canada. Measles vaccines: Canadian immunization guide [Internet]. 2015 [cited 2024 Sep 4]. Available from: <https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-12-measles-vaccine.html>
- (31) World Health Organization. Global progress against measles threatened amidst COVID-19 pandemic [Internet]. 2021 [cited 2024 Sep 3]. Available from: <https://www.who.int/news/item/10-11-2021-global-progress-against-measles-threatened-amidst-covid-19-pandemic>
- (32) World Health Organization. Nearly 40 million children are dangerously susceptible to growing measles threat [Internet]. 2022 [cited 2024 Sep 5]. Available from: <https://www.who.int/news/item/23-11-2022-nearly-40-million-children-are-dangerously-susceptible-to-growing-measles-threat>
- (33) Minta AA, Ferrari MJ, de Swart RL, Metcalf CJE. The long road to measles elimination: a public health history of measles vaccination in the United States, the United Kingdom, and the Netherlands. *Int J Infect Dis*. 2024;132:28–35.
- (34) Public Health Agency of Canada. Highlights from the 2021 Childhood National Immunization Coverage Survey (cNICS) [cited 2024 Sep 5]. Available from: <https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/2021-highlights-childhood-national-immunization-coverage-survey.html>
- (35) Public Health Agency of Canada. Provincial and Territorial Routine and Catch-up Vaccination Schedule for Infants and Children in Canada [cited 2024 Sep 5]. Available from: <https://www.canada.ca/en/public-health/services/provincial-territorial-immunization-information/provincial-territorial-routine-vaccination-programs-infants-children.html>
- (36) Public Health Ontario. Publicly Funded Immunization Schedules for Ontario [cited 2024 Sep 7]. Available from: <https://www.ontario.ca/files/2024-01/moh-publicly-funded-immunization-schedule-en-2024-01-23.pdf>
- (37) Winnipeg Regional Health Authority. Guidance for Planning Public Health School-Based Cohort & Catch-up Immunizations for Children in Grades 6-12 Affected by School Closures During COVID-19 and School COVID-19 Vaccination Clinics [cited 2024 Sep 13]. Available from: <https://professionals.wrha.mb.ca/old/professionals/immunization/files/guidance-cohort-catch-up-immunizations.pdf>

- (38) Nunavut Department of Health. Nunavut Recommended Childhood Immunization Schedule [cited 2024 Sep 13]. Available from: https://www.gov.nu.ca/sites/default/files/documents/2021-10/nunavut_childhood_immunization_schedule_july_2021.pdf.