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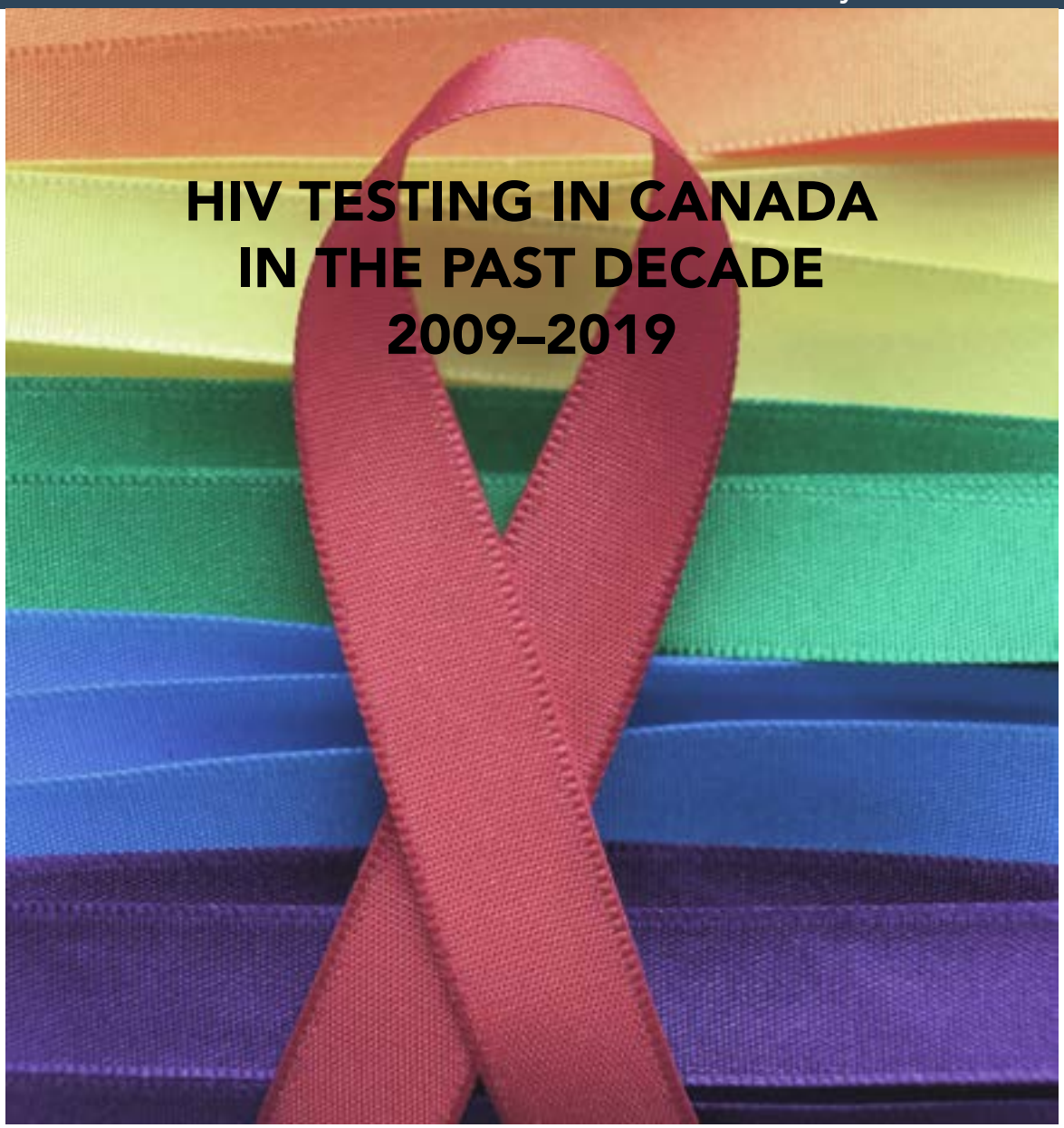

HIV TESTING IN CANADA IN THE PAST DECADE 2009–2019

Public Health Agency of Canada | Agence de la santé publique du Canada

Canada

CCDR
CANADA COMMUNICABLE DISEASE REPORT

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HIV TESTING IN CANADA IN THE PAST DECADE 2090–2019

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RAPID COMMUNICATION

Familial cluster of asymptomatic COVID-19 cases in a First Nation community in Northern Saskatchewan, Canada

Shree Lamichhane[1], Sabyasachi Gupta[1], Grace Akinjobi[1], Nnamdi Ndubuka[1,2]*

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Keywords: COVID-19, asymptomatic, First Nation, Canada, familial cluster, transmission

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Introduction

A novel coronavirus (severe acute respiratory syndrome coronavirus 2, SARS-CoV-2), causing a cluster of respiratory infections, initially appeared in Wuhan, China in December 2019. The outbreak spread rapidly around the world and, as of December 7, 2020, a total of 67,440,864 cases have been confirmed in 191 countries, resulting in 1,541,661 deaths. A wide range of coronavirus disease 2019 (COVID-19) symptoms has been reported, with symptoms ranging from mild to severe that may appear 2–14 days after exposure to the virus. Lately, it has been observed that the asymptomatic or presymptomatic cases make up what may be a large portion of all COVID-19 infections. If these cases cannot be identified and appropriately isolated for medical intervention, this could limit the effectiveness of transmission prevention measures.

We are reporting a familial cluster of COVID-19 cases that started with a paucisymptomatic case and led to two asymptomatic cases. In our familial cluster, five out of nine cases (55%) were found to be presymptomatic at the time of testing, while two cases (22%) remained asymptomatic throughout the course of the infection.

Current situation

Since the pandemic started, the province of Saskatchewan, Canada has reported 11,475 COVID-19 cases. Of these cases, 910 were from Northern Inter-Tribal Health Authority (NITHA) First Nations communities in the Northern Saskatchewan (http://www.nitha.com/). Given that the asymptomatic and presymptomatic persons are potential source of COVID-19 infection (1,2), we are reporting a First Nations familial cluster from the Northern Saskatchewan where the infection started with a paucisymptomatic case and led to two asymptomatic cases. Increasingly, it is recognized that Indigenous determinants of health, such as overcrowding, poverty, impact of Indian residential school history, younger demographics, weak public health infrastructure, limited access to quality health services and higher rate of co-morbidities, can worsen disease outbreaks (3). Specifically, crowded housing conditions may result in ineffective physical distancing and inadequate infection control measures with increased likelihood of COVID-19 transmission. There is also an increased risk of poor mental health, hospitalizations and severe outcomes among those First Nationals individuals with immunocompromised and chronic disease conditions (4). As many First Nation communities are now being affected by COVID-19 outbreaks, this report also provides data necessary for the development and application of public health strategies within other First Nation communities.

Our index patient (20–29 years age group) acquired the infection from a close contact who returned to the community from an area of high transmission out-of-province and subsequently developed a mild symptom (rhinitis), which resolved within a few days. The index patient attended a family dinner two days later where further transmission appears to have occurred. After contact tracing, eight more cases were identified; three from the index's household and five from another household visited by the index patient (**Figure 1**). The exact timing of transmission exposure could not be ascertained because the

persons with whom the index patient was in contact were living in overcrowded settings, and exposure was ongoing. No other possible exposures were identified that could link to these COVID-19 infection. All the COVID-19-positive patients and their close contacts were isolated in accordance with the provincial standards.

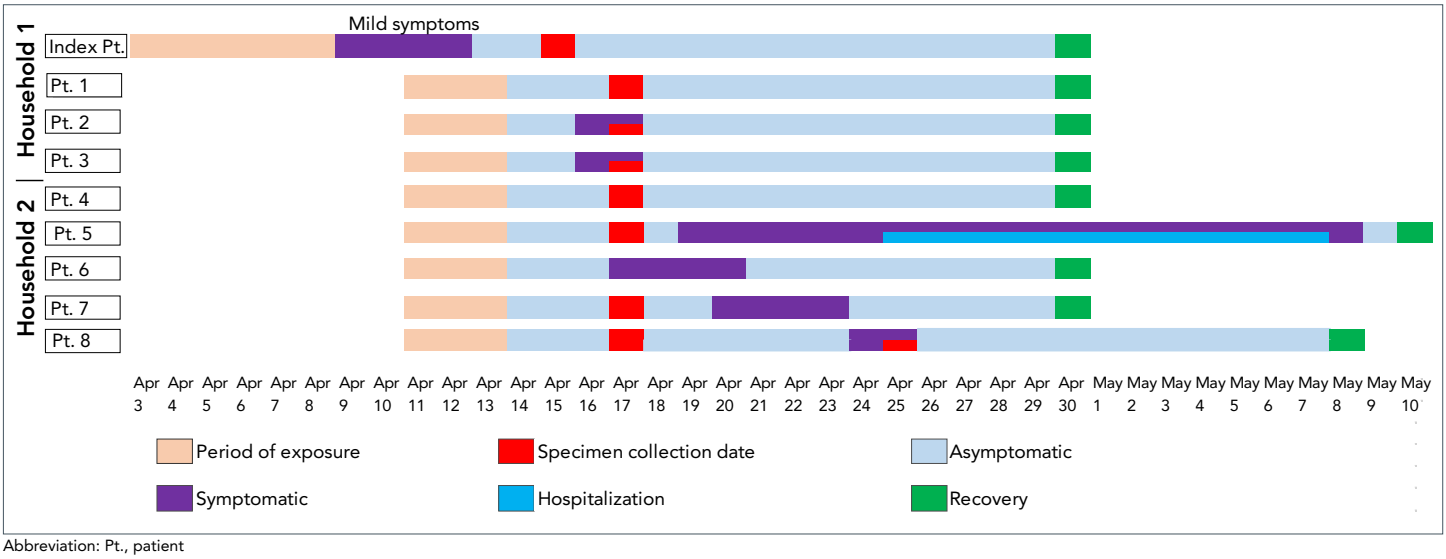
Patient 2 (10–19 years age group) and Patient 3 (30–39 years age group) from Household 1 developed very mild symptoms (loss of taste and smell) for two days; however, Patient 1 (40–49 years age group) did not developed any symptoms. From Household 2, Patient 6 became ill with a sore throat. Patient 5 (30–39 years age group, with a pre-existing chronic medical condition) reported the loss of taste and smell, followed by cough, shortness of breath and diarrhea. As the patient's condition worsened, this patient was hospitalized and recovered within two weeks. Patient 7 (an infant) became ill with a fever and cough; however, the patient's condition improved without medical intervention. Patient 8 (20–29 years age group), who initially tested negative for COVID-19 polymerase chain reaction testing, developed symptoms (wheeze and fever) at 12 days following exposure and was found to be COVID-19-positive on re-testing. Overall, three patients from Household 2 were found to be asymptomatic at time of testing; of them, one (Patient 4, 5–9 years age group) did not develop any symptoms throughout the isolation period.

In our familial cluster, five out of nine cases (55%) were presymptomatic at time of testing while two cases (22%) did not develop any symptoms throughout approximately two weeks of follow-up. Our index patient had only mild symptoms and was unaware of heightened COVID-19 risk status, which added to uncertainty and delayed the early detection and isolation. Despite these concerns, six out of nine cases developed only mild symptoms and recovered with minimal medical attention, highlighting the possibility of containment of COVID-19 cases outside the hospital with appropriate guidance and oversight. As rural communities can face different challenges around COVID-19 depending on where they located, each community and community members should assess their unique susceptibility and social vulnerability to COVID-19 and respond according to the public health measures. Relevant measures to prevent the COVID-19 community spread in these vulnerable communities would include avoiding non-essential travels outside the community and limiting interactions between different households.

Conclusion

Early detection and isolation of symptomatic COVID-19 patients with effective contact tracing investigations are an important disease containment strategy. As asymptomatic and presymptomatic transmission are biologically plausible (1,2), such transmission could limit the effectiveness of control measures (2,5,6). This case summary highlights the importance of early detection, contact tracing, testing of all close contacts—regardless of the presence of symptoms—and preventive 14 days self-isolation of people returning to communities from high transmission areas to prevent asymptomatic spread in remote communities. It also highlights the need for low threshold for testing individuals with very mild symptoms in the 14 days post-return from high transmission areas. Transmissibility by asymptomatic or presymptomatic patients in the setting of crowded living conditions, such as those often seen in remote, northern and Indigenous communities, can contribute to higher transmission rates.

Figure 1: Timeline of exposure to index and household cases in familial cluster



Abbreviation: Pt., patient

Authors' statement

SRL — Literature review, writing–draft
SG — Data analysis, writing–draft
GA — Writing–review and editing
NN — Conception, design, data interpretation, critical review

Competing interests

None.

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The impact of publicly funded rotavirus immunization programs on Canadian children

Pia K Muchaal[1]*, Matt Hurst[1], Shalini Desai[2]

Abstract

Background: In 2008, the National Advisory Committee on Immunization recommended routine rotavirus immunizations in healthy Canadian infants. Over the following seven years, eight provinces and two territories introduced the rotavirus vaccine into their publicly funded immunization programs.

Objective: Assess the burden of rotavirus infections before and after implementation of publicly funded immunization programs.

Methods: We analyzed laboratory-confirmed community cases of rotavirus reported to the National Enteric Surveillance Program and hospitalizations of children younger than three years old from 2007 to 2017 with rotavirus diagnosis-specific ICD-10 codes. Rates of illness were calculated for each province for the two years prior to and after implementation of public funding of the vaccine. The year of implementation was not included to accommodate the uptake period of the vaccine. Age-specific rates were assessed in jurisdictions where five years of data were available the year after the vaccine was publicly funded. The pre–post and difference-in-difference (DID) methodologies were applied to hospital discharge data to evaluate changes between the funding and non-funding jurisdictions.

Results: Community cases of laboratory-confirmed rotavirus infection reported to the National Enteric Surveillance Program declined by 54% between 2010 and 2017. Rates of hospital discharges decreased significantly among children in six provinces after the adoption of the rotavirus vaccine. Hospital discharge rates in Alberta, Manitoba, Ontario and Prince Edward Island dropped between 53% and 71%, and by 75% for British Columbia and Saskatchewan.

Conclusion: Public funding of the rotavirus vaccine appeared to lead to significant reductions in laboratory-confirmed rotavirus cases reported to the National Enteric Surveillance Program and in the rates of rotavirus gastroenteritis-related hospital discharges.

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Keywords: rotavirus, evaluation, vaccination, intervention, burden

Introduction

Rotavirus is a common, infectious disease transmitted from person to person via the fecal–oral route. In the pre-vaccine era, most children experienced an infection by the time they had reached five years old. Based on limited available data, Thomas *et al*. estimated that between 2000 and 2010 an average of 850,233 cases of community rotavirus occurred each year in Canada (1).

Clinical presentations vary widely, from asymptomatic infection to severe disease that can lead to severe dehydration and death. Immunocompromised children are at an increased risk of severe, prolonged and even fatal rotavirus infections (2). In most healthy Canadian children, the illness is self-limiting and rarely results in long-term sequelae or death.

Health Canada has approved two vaccines for use: RotaTeq (Merck Canada Inc.), a three-dose, live, oral pentavalent bovine human rotavirus reassortant, in 2006 (3); and Rotarix (GlaxoSmithKline Inc.), a 2-dose live-attenuated monovalent vaccine derived from a single human strain in 2007 (4).

The National Advisory Committee on Immunization (NACI) recommended the use in healthy infants of RotaTeq (RV5) in 2008 and of Rotarix in 2010 (5).

Public funding of vaccines is under the purview of the provinces and territories in Canada, and immunization schedules can differ between jurisdictions. By the end of the study period covered in this evaluation (2010–2017), eight provinces and two territories had included rotavirus vaccination in their routine infant immunization schedule. Of these ten jurisdictions, seven are considered in this study (**Figure 1**). Introductions were temporally staggered across the country between December 2010 and December 2015. By August 2018, nine provinces and three territories had included rotavirus vaccination in their schedules.

Objectives

Our aim was to study the impact of publicly funded rotavirus vaccination programs by conducting a national analysis of the burden of rotavirus infections in Canada before and after implementation of publicly funded vaccination programs and to compare jurisdictions that adopted the vaccine into their respective routine immunization schedules with those that had not funded the vaccine.

Methods

Data sources

The National Enteric Surveillance Program (NESP) tracks the number of laboratory-confirmed cases of community-acquired rotavirus infections reported weekly by all provincial public health laboratories except those in Québec. However, rotavirus is not a nationally reportable disease in Canada, and laboratory testing and reporting vary by jurisdiction. Only a fraction of cases are reported, which leads to underestimating the magnitude of illness. Furthermore, demographic information is not available for these cases. Despite these limitations, the NESP dataset serves as a proxy for trends in community infection.

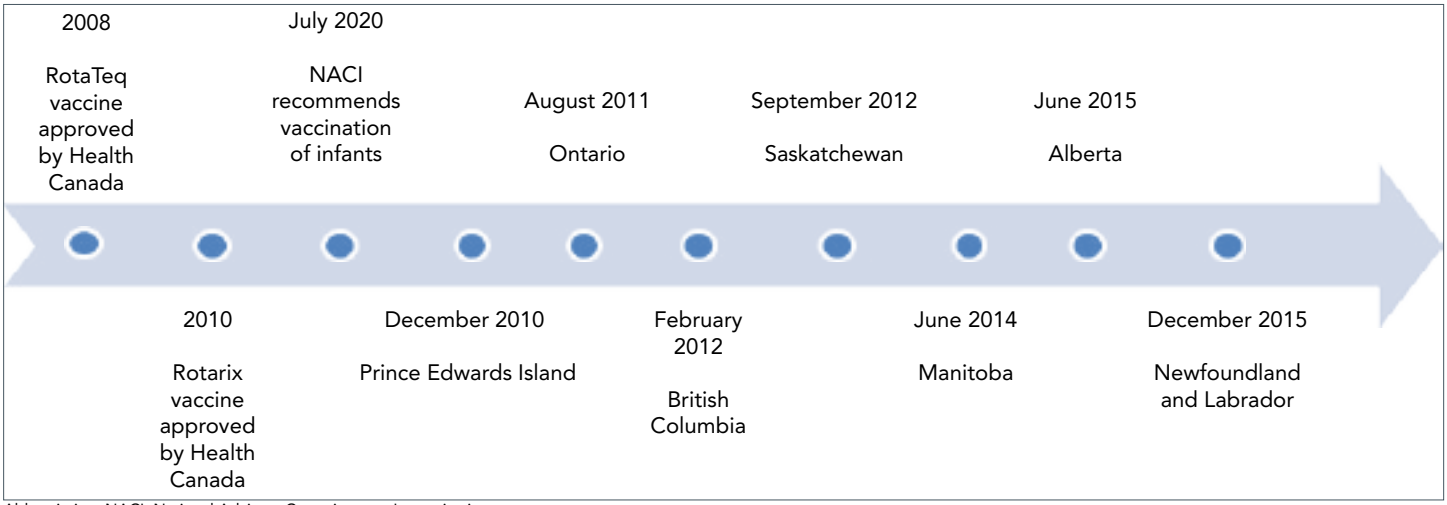
We obtained weekly counts of rotavirus cases reported to the NESP between 2007 and 2017 from the NESP database. A review of the dataset revealed a paucity of reporting in 2007 to 2009. Therefore, only data from 2010 onwards were submitted for analysis.

Using the Canadian Institute for Health Information (CIHI) Discharge Administration Database (DAD), we assessed hospital discharges between January 1, 2007, and December 31, 2017. CIHI-DAD captures administrative, clinical and demographic information on all hospital discharges from acute care hospitals in all Canadian provinces and territories with the exception of Québec. Clinical diagnoses are classified according to the *International Statistical Classification of Diseases and Related Health Problems* tenth revision (ICD-10) coding standards. We assessed individual-level records of hospitalization discharges among children younger than three years old with admission dates in CIHI-DAD between January 2007 and December 2017. We defined the primary outcome measure as an individual with either:

- The most responsible diagnosis code of acute rotavirus enteritis (A080.0)
- At least one of the separately recorded diagnoses, of which there are from 2 to 16, has a code of acute rotavirus enteritis (A080.0)

Nova Scotia publicly funded the rotavirus vaccine in 2019. Although the implementation date is outside of the timeframe considered in this study, one of the province's health authorities participated in a vaccine program in December 2010 with the aim of comparing the efficacy of two delivery systems (6). Therefore, for the purpose of this evaluation, Nova Scotia is assessed as a jurisdiction that also had a vaccine program.

Figure 1: Timeline of adoption of publicly funded rotavirus immunization programs by provinces, 2008–2015



Abbreviation: NACI, National Advisory Committee on Immunization

The Northwest Territories, Yukon and Nunavut were excluded from the analysis due to a lack of provincial/territorial reporting and/or a paucity of data from these jurisdictions. In total, these jurisdictions and Québec account for about 23% of the Canadian population.

We defined the pre and post-funding periods as the two years prior to and the two years after the year the vaccine was adopted into the immunization schedule. The year the vaccine was introduced was excluded from rate calculations to accommodate the vaccine uptake period.

Statistical analysis

National Enteric Surveillance Program data – community rotavirus infections

We summarized national counts of rotavirus laboratory cases reported to NESP by the participating provinces weekly and annually to reflect general reporting trends of community cases. Rotavirus season onset was identified as the first two consecutive weeks when the number of weekly cases was 15% over the annual median value or higher. Similarly, end of season was defined as the last two consecutive weeks where the number of cases was 15%, or less, of the median value. The week with the highest number of reported cases is referred to as the season peak.

Canadian Institute for Health Information-Discharge Administration Database data – hospitalizations

Children younger than three years old were grouped into one of the following age categories: younger than 12 months; 12 to 23 months; and 24 to 35 months. Statistics Canada population estimates were used to calculate age-specific annual rates of rotavirus gastroenteritis (RVGE) hospital discharges and for the reference periods (7). Rates and 95% confidence intervals were calculated to estimate the difference between the pre and post-vaccine inclusion periods using the statistical package SAS version 9.3 (SAS Institute Inc., Cary, North Carolina, United States). Statistical significance was defined as $p<0.05$ from a two-sided Wald test.

Difference-in-difference approach

We used the difference-in-difference (DID) approach, a technique applied to evaluating changes in healthcare policy (8), to assess the impact of vaccinations on RVGE independently of hospitalizations. The key aspect of DID analysis is that, in addition to performing a simple comparison of rates from before and after the intervention (i.e. public funding of the vaccine) to see if rates have changed, there is also an adjustment for the hypothetical situation where there was no intervention and some other event may have been responsible for the observed change. For instance, a mild season of rotavirus after implementation might make the efficacy of the vaccine appear larger than it actually is. The DID approach corrects for this.

Results

Community rotavirus

A total of 5,474 cases were reported to NESP between 2010 and 2017, with 76% of these cases reported over the first four years (2010–2013). Sustained and significant decreases ($p<0.05$) in the annual cases reported nationally to NESP occurred in subsequent years (2014–2017). At the peak of the 2011 rotavirus season, 137 cases were reported (annual median=14 per week) compared to a peak of 15 cases in 2017 (median=6) (**Table 1**; **Figure 2**). Over the seven-year period, the duration of the rotavirus season varied between 25 and 31 weeks. Between 2010 and 2015, 90% to 94% of annual cases were reported within the rotavirus season. Over 2016 to 2017, approximately 4% fewer cases were reported during the season, while more sporadic cases were reported at other times of the year.

Table 1: Cases of rotavirus reported annually to National Enteric Surveillance Program, 2010–2017

Statistics	2010	2011	2012	2013	2014	2015	2016	2017
Total no. of cases reported	828	1,573	803	773	425	433	258	381
Percentage of 10-year total (%)	15.1	28.7	14.7	14.1	7.8	7.9	4.7	7.0
Median no. of cases	8	14	9	6	4	5	3	6
Timing of season								
Onset (NESP week)	1	1	4	3	2	2	4	5
Peak	15	17	19	16	11	15	22	17
End	29	28	31	28	33	28	32	31
Duration (weeks)	29	28	27	25	31	26	28	26
No. of cases at peak	65	137	56	70	27	35	18	27
Percentage of annual cases reported in season (%)	91.4	94.4	90.5	91.6	92.2	90.8	86.0	86.3

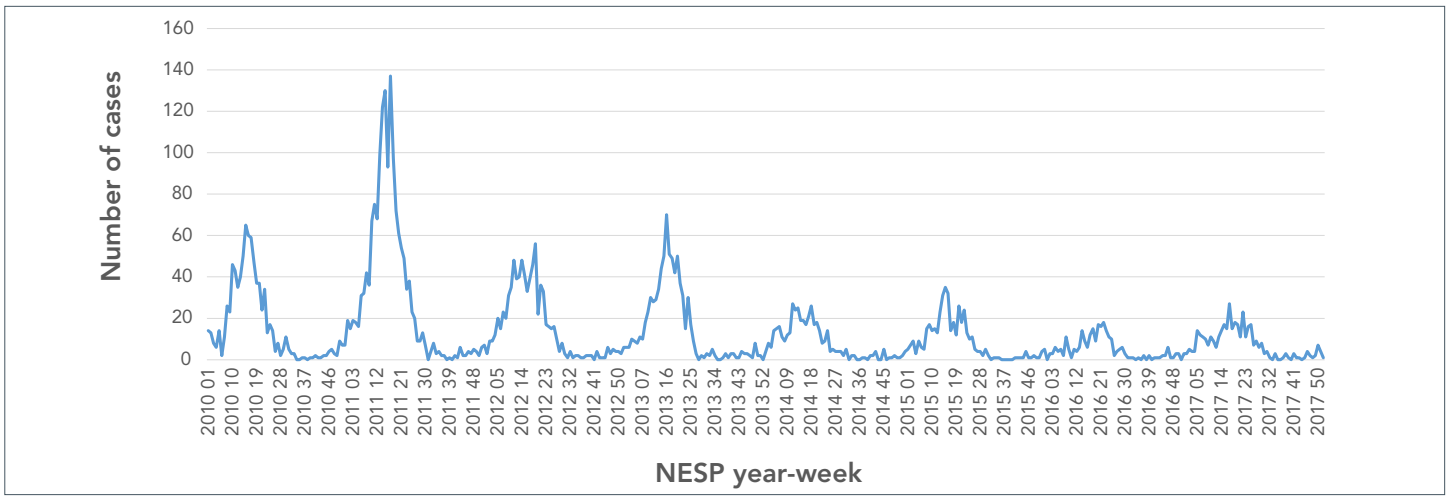
Abbreviation: NESP, National Enteric Surveillance Program

Canadian Institute for Health Information-Discharge Administration Database data – hospital discharges

In the study period (2007–2017), infants and children younger than three years old comprised 70% (N=7,668) of all hospital RVGE discharges. In this group of children, RVGE was the "most responsible diagnosis" for 82% (n=5,379) of hospital discharges. Boys comprised 56% of discharged cases under three years old.

Overall, Canadian rates of rotavirus-related hospital discharges declined after provinces commenced funding rotavirus immunizations subsequent to the 2010 NACI recommendations (**Table 2**). A national comparison of pre and post-vaccine funding periods showed a reduction of 48.2 cases per 100,000 (95% CI, 43.9, 52.6) during the observation period.

Figure 2: Weekly cases of laboratory-confirmed reported to National Enteric Surveillance Program, 2010–2017



Abbreviation: NESP, National Enteric Surveillance Program

Table 2: Annual rates per 100,000 and 95% confidence intervals of rotavirus acute gastroenteritis hospital discharges among children two years or younger

Province	Hospital discharges						Pre-vaccine vs post-vaccine rate difference[a]			
	Pre-vaccine funding			Post-vaccine funding			Rate	LCL	UCL	% change
	Rate	LCL	UCL	Rate	LCL	UCL				
	2009–2010			2012–2013			2009–2010 vs 2012–2013			
Prince Edward Island	241.7	138.3	345.0	70.8	14.1	127.5	−170.8[a]	−288.7	−53.0	↓ 70.7
Ontario	96.9	90.3	103.6	45.3	40.8	49.9	−51.6[a]	−43.5	−59.6	↓ 53.2
New Brunswick	130.7	97.1	164.4	166.6	128.1	205.1	35.8[a]	78.0	188.8	↑ 10.6
	2010–2011			2013–2014			2010–2011 vs 2013–2014			
British Columbia	31.7	24.9	38.4	7.9	4.5	11.3	−23.8[a]	−31.4	−16.3	↓ 75.1
Saskatchewan	288.7	252.5	324.8	71.2	53.6	88.7	−217.5[a]	−257.7	−177.3	↓ 75.3
New Brunswick	169.6	131.2	208.0	169.8	130.6	209.7	0.23	−46.9	47.4	NS
	2012–2013			2015–2016			2012–2013 vs 2015–2016			
Manitoba	14.6	6.9	22.2	4.9	0.6	9.3	−9.6	−18.4	−0.8	NS
New Brunswick	155.1	117.9	192.1	118.8	85.6	152.1	−36.2	−80.9	8.5	NS
	2013–2014			2016–2017			2013–2014 vs 2016–2017			
Alberta	59.0	50.1	67.4	19.5	14.8	24.3	−39.0[a]	−96.6	−29.4	↓ 67.0
New Brunswick	169.8	130.6	209.1	121.8	88.0	155.5	−48.1[a]	−95.1	−1.1	↓ 28.3
	2014–2015			2016–2017			2014–2015 vs 2017			
Newfoundland & Labrador	14.6	0.3	28.9	14.8	−5.7	35.3	0.2	−65.3	−16.6	NS
New Brunswick	143.7	107.0	180.4	122.3	74.4	170.3	−21.3	−68.3	25.5	NS
	2009–2010			2012–2013			2009–2010 vs 2012–2013			
Nova Scotia	94.3	68.4	120.2	34.1	18.3	49.8	−60.3[a]	−119.5	−30.2	↓ 64.0
New Brunswick	130.7	97.1	164.4	166.6	128.1	205.1	35.8[a]	78.0	188.8	↑ 10.6

Abbreviations: LCL, lower confidence limit; NS, not significant; UCL, upper confidence limit
[a] $p<0.05$
Note: The same period was used to assess changes in rates for the non-implementing province, New Brunswick (name bolded)

Mean rates of RVGE hospital discharges of children declined by between 53% and 76% across the provinces after the implementation of publicly funded vaccination programs in six of the seven jurisdictions, Prince Edward Island, Ontario, British Columbia, Saskatchewan, Manitoba and Alberta. RVGE discharge rates also dropped in Nova Scotia. There was a fractional, but not significant, increase in the hospital discharge rates of children in Newfoundland and Labrador (Table 2).

Within five years of the rotavirus vaccine being funded by the earliest adopters—Prince Edward Island, Ontario, British Columbia and Saskatchewan—RVGE discharge rates declined among children under three years of age. In these four provinces, such reductions were most prominent (over 85%) among infants and one-year-old children (**Figure 3**). There was also a statistically significant decrease in hospital discharge rates of two-year old children in Ontario and Saskatchewan.

Publicly funded immunization programs, as measured through a DID approach, reduced RVGE hospital discharge rates in Prince Edward Island, Ontario and Saskatchewan ($p \leq 0.01$) (**Table 3**). The program in Saskatchewan generated a prominent decrease of 201.4 cases per 100,000 (95% CI, −258.1, −144.8). Among children in Prince Edward Island, discharge rates dropped by 182.4 cases per 100,000 (95% CI, −308.6, −56.2). In Ontario, a decline of 63.1 (95% CI, −108.9, −17.4) was noted.

Figure 3: Discharges per 100,000 of rotavirus gastroenteritis hospital discharges in the first five provinces to adopt the vaccine and New Brunswick, children younger than three years, by age group

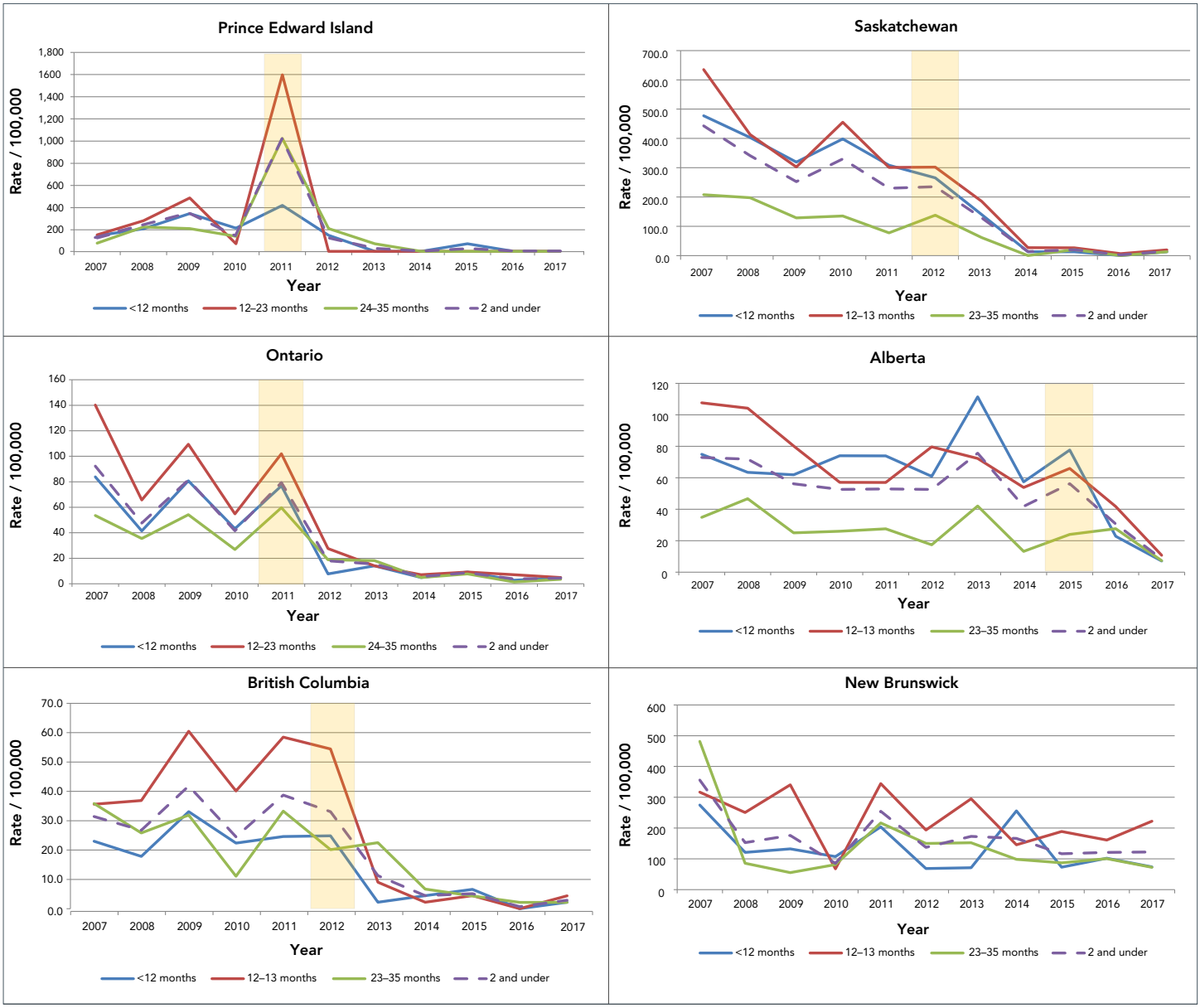


Table 3: Difference-in-difference estimates: impact of publicly funded vaccination programs on the rate of rotavirus gastroenteritis hospital discharges per 100,000, by province

Province	Treatment effect[a] between implementing jurisdiction and control[b]		
	Change in rate per 100,000	Lower confidence limit	Upper confidence limit
Prince Edward Island	−182.4[c]	−308.6	−56.2
Ontario	−63.1[c]	−108.9	−17.4
British Columbia	−24.1	−79.5	31.3
Saskatchewan	−201.4[c]	−258.1	−144.8
Manitoba	3.5	−42.9	50.0
Alberta	−3.2	−51.9	45.5
Newfoundland and Labrador	16.9	−46.1	79.8
Nova Scotia	9.1	−22.4	40.6

[a] Change in rates based on differences-in-differences between pre and post public funding of immunization
[b] Time frame of control (New Brunswick) was matched to the implementing jurisdiction
[c] $p<0.01$

Discussion

The two lines of evidence considered in this study identified decreasing rates of hospital discharges and community cases attributed to rotavirus infections in the regions where the rotavirus vaccine was publicly funded. Temporally, public funding appeared to lead to significant reductions in i) reports of laboratory-confirmed rotavirus cases reported by the provinces to NESP; and ii) RVGE-related hospital discharges.

The rates of RVGE reported to NESP dropped over 50% within the four years after provinces began implementing publicly funded immunization programs. Pre–post estimates of vaccine impact on RVGE hospital discharge rates were significantly lower for infants and one-year-old children in the provinces that funded the vaccine between December 2010 and September 2012. The dramatic rate reductions in young children is not unexpected, as historically these age groups have the highest rates of illness and so would benefit most from the direct effect of the vaccine with good coverage in the population. The Childhood National Immunization Coverage Survey (9) reported coverage of rotavirus vaccine by the early adopting provinces to be 75.4%. Rates of vaccination coverage for rotavirus at the national level were not available prior to 2013.

Among the early-implementing provinces, the proportion of children under two years of age who had received the rotavirus vaccine was similar: British Columbia reported in 2015 that 75% of children aged younger than two years had received the two recommended doses of rotavirus (10). In the same year, 80% of Saskatchewan children under eight months had received the two recommended doses of rotavirus (11). Coverage assessments in Ontario showed rotavirus vaccine uptake had increased to 83% by 2014 (12). In Prince Edward Island, where infant immunizations are delivered exclusively by public health nurses, coverage estimates are greater than 90% (5).

Though not as large, there was a distinct decline in RVGE-associated events in children in Alberta. These data may indicate lower coverage rates compared to the early adopters as the programs were underway only in the later stages of the study period. DID approach estimates for British Columbia and Alberta were not statistically significant, likely because the effects were much smaller and the effect was thus harder to detect. The DID approach found no significant reductions in RVGE hospital discharges for Nova Scotia. Our results parallel the findings from the investigation by Sanford *et al*. (6) that aimed to assess the relative effectiveness of public health nurses and physician offices as immunization delivery systems. The authors noted that there were no reductions in RVGE hospitalizations in study areas with low vaccine coverage. The vaccine coverage was less than 40% in the Nova Scotia setting.

Hospital RVGE discharge rates among children younger than two years old declined by more than 80% between the pre and post periods. By contrast, RVGE rates in New Brunswick, the comparison group, remained unchanged. This supports the claim that the public funding of the vaccine in Canada has been the cause of declining rotavirus infections and not a temporally aligned third factor, such as a milder season of rotavirus.

To date, three Canadian provinces, Ontario, Prince Edward Island and Québec have completed large cohort or population-based vaccination-impact studies for their respective jurisdictions. Each of these studies demonstrated large reductions in RVGE following the implementation of publicly funded programs. The program in Ontario translated to a reduction of up to 79% for RVGE hospitalizations in youth and children younger than 20 years old (12,13). A study in Québec identified an 80.1% reduction in positive tests of RVGE at the Montréal Children's Hospital in 2012 to 2013, a year after the vaccine was introduced, compared to 2006 to 2009 (14). In Prince Edward Island, a universal infant rotavirus vaccine program delivered by public health nurses resulted in the elimination of RVGE hospitalizations among children younger than 24 months old by the second year of the program (5).

The declines noted in the national study presented here and the individual provincial assessments are consistent with findings in multiple high-income countries where RVGE-related hospitalizations fell due to similar vaccination programs. Investigations on the impact of rotavirus vaccinations campaigns conducted in high-income countries reported modest to dramatic reductions in rotavirus hospital admissions, depending on the population assessed (15,16).

Immunization can give rise to changes in disease transmission, reducing illness directly in the vaccinated population and indirectly in unvaccinated individuals (17). Indirect immunity may be generated by community immunity (18). The data available for this study are insufficient to ascertain whether unvaccinated children remained free of illness. However, under a publicly funded immunization program, it is assumed that the majority of the target population will be administered the vaccine.

Limitations

There are several limitations to our study. First, we did not know the vaccine status of cases. In addition, rotavirus infections are not nationally reportable, and so there is no single monitoring system to capture all occurrences of rotavirus in Canadian communities. We therefore leveraged one national surveillance program and hospital discharge data as surrogates. However, doing so was not without challenges. The NESP data are devoid of information on age and sex, and reported cases may be older than the age group considered in this study. Limited diagnostic testing of symptomatic cases results in an under-representation of cases reported to all databases.

Furthermore, clinical presentation of rotavirus disease can be indistinguishable from other forms of acute diarrhea and most cases are treated symptomatically. The symptomatic treatment of acute gastroenteritis cases and the nature of reporting RVGE results in relatively low apparent annual rates of infection. This creates a problem in interpreting the burden of disease, as these rates of infection are, to a large degree, negatively biased. Nonetheless, we were primarily interested in trends, that is, how these rates may have fallen as a result of vaccination interventions. To do this, we assume that any reporting biases that existed in each system remain the same from year to year.

Also of note, hospital data from Québec are not available through the CIHI-DAD system, and hospital discharge data from Northwest Territories, Yukon and Nunavut are scarce. These four jurisdictions, comprising approximately 23% of the Canadian population, were not included in this study.

Though we observed significant decreases in disease burden after introduction of the vaccine, the reductions may not be due to vaccine alone. Years of low RVGE activity have been reported in the absence of vaccination, as was the case in the Netherlands in 2013–2014 (19). Natural fluctuations in disease incidence could have contributed to the observations presented here. The use of the DID estimator moderates this limitation.

Conclusion

In summary, this is a national evaluation of rotavirus vaccine programs in Canada. Our evaluation uses an innovative approach, the DID methodology, to show that depending on when programs were implemented rates of rotavirus-related infections and hospitalizations decreased. Further investigations using innovative methods will be required to detect further changes over time.

Authors' statement

PKM — Conceptualization, investigation, data curation, formal analysis, drafting original manuscript
MH — Methodology, reviewing & editing manuscript
SD — Conceptualization, reviewing & editing manuscript

Competing interests

None.

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Understanding barriers and facilitators to HIV testing in Canada from 2009–2019: A systematic mixed studies review

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Abstract

Background: HIV testing is a core pillar of Canada's approach to sexually transmitted and blood-borne infection (STBBI) prevention and treatment and is critical to achieving the first Joint United Nations Programme on HIV/AIDS (UNAIDS) 90-90-90 target. Despite progress toward this goal, many Canadians remain unaware of their status and testing varies across populations and jurisdictions. An understanding of drivers of HIV testing is essential to improve access to HIV testing and reach the undiagnosed.

Objective: To examine current barriers and facilitators of HIV testing across key populations and jurisdictions in Canada.

Methods: A systematic mixed studies review of peer-reviewed and grey literature was conducted identifying quantitative and qualitative studies of barriers and facilitators to HIV testing in Canada published from 2009 to 2019. Studies were screened for inclusion and identified barriers and facilitators were extracted. The quality of included studies was assessed and results were summarized.

Results: Forty-three relevant studies were identified. Common barriers emerge across key populations and jurisdictions, including difficulties accessing testing services, fear and stigma surrounding HIV, low risk perception, insufficient patient confidentiality and lack of resources for testing. Innovative practices that could facilitate HIV testing were identified, such as new testing settings (dental care, pharmacies, mobile units, emergency departments), new modalities (oral testing, peer counselling) and personalized sex/gender and age-based interventions and approaches. Key populations also face unique sociocultural, structural and legislative barriers to HIV testing. Many studies identified the need to offer a broad range of testing options and integrate testing within routine healthcare practices.

Conclusion: Efforts to improve access to HIV testing should consider barriers and facilitators at the level of the individual, healthcare provider and policy and should focus on the accessibility, inclusivity, convenience and confidentiality of testing services. In addition, testing services must be adapted to the unique needs and contexts of key populations.

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Keywords: HIV, barriers, facilitators, testing, screening, Canada, systematic review, mixed studies, key populations

Introduction

The World Health Organization estimated that approximately 37.9 million people were living with HIV/AIDS worldwide in 2018, including about 1.7 million who were newly infected that year (1). In Canada, more than 63,000 people were living with HIV in 2016, and nearly 23,000 new cases were diagnosed between 2008 and 2017 (2).

HIV testing and diagnosis is a critical first step in the HIV care cascade (HIV diagnosis, linkage to care, antiretroviral therapy initiation and achievement of viral suppression). For people living with HIV who know their status, receiving appropriate treatment reduces the long-term impact of the disease and prevents further transmission (3).

In 2014, the Joint United Nations Programme on HIV/AIDS (UNAIDS) Programme Coordinating Board established the 90-90-90 targets with the goal of ending the AIDS epidemic by 2020. The aim of these targets are for 90% of all people living with HIV to know their HIV status, 90% of all people diagnosed with HIV to receive appropriate antiretroviral therapy (ART) and 90% of all people receiving ART to achieve viral suppression (4,5). Canada has yet to achieve the first of these targets, and an estimated 14% of Canadians living with HIV in 2016 were unaware of their status (2).

Although HIV testing coverage in Canada continues to expand, testing rates vary considerably across Canada (6). Regional testing rates may be influenced by jurisdictional policies and programs determining accessibility of testing and the types of testing available (e.g. point-of-care testing) (7). Certain populations are also known to be disproportionately affected by HIV, including gay, bisexual and other men who have sex with men (gbMSM), transgender individuals, people who inject drugs (PWID) and sex workers (8–12). Owing to the intersection of stigma, discrimination and social determinants of health, these populations are often marginalized and underserved, leading to greater likelihood of HIV acquisition and transmission, and limited access to and uptake of testing (13,14). The differential distribution of these populations across Canada may contribute to regional variation in HIV testing (2).

A comprehensive overview of the barriers and facilitators of HIV testing that exist across key populations and jurisdictional boundaries in the current Canadian context is currently lacking. This knowledge is essential to orient public health policies and action toward the undiagnosed and mitigate the health impact of HIV in Canada. Two reviews describe the barriers and facilitators to HIV testing in the Canadian context (7,15) and identified many barriers and facilitators to testing at the level of the individual (e.g. low risk perception, fear), healthcare provider (e.g. time constraints, insufficient resources) and institution/policy (e.g. cost/accessibility of testing) (7,15–17). However, these reviews were not systematic, do not cover the last decade and did not examine trends in HIV testing in key populations and in specific jurisdictions. Moreover, few studies conducted in Canada were identified in these reviews.

The objective of this systematic mixed studies review is to examine the barriers and facilitators to HIV testing that have been reported across populations and jurisdictions in Canada throughout the last decade and to conduct a narrative synthesis of identified works.

Methods

Search strategy

A systematic mixed studies review was conducted (18) of barriers and facilitators to HIV testing in Canada in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (19) (appendix available upon request). Based on a pre-specified protocol and in collaboration with information specialists, the reviewers developed an electronic search strategy to identify original quantitative, qualitative and mixed-methods studies reporting on barriers and facilitators to HIV testing in Canada and published between January 1, 2009 and December 9, 2019 (appendix available upon request). Medline, Embase, PsycInfo, ProQuest Public Health, ProQuest Sociology Collection and Scopus were searched for peer-reviewed publications, and Google and Google Scholar for grey literature, government and non-governmental organization reports, and dissertations. Government webpages from each province/territory were also searched, and partners of regional offices of the Public Health Agency of Canada were consulted to retrieve other relevant works. In addition, the reference lists of included studies were manually searched for relevant publications.

Eligibility criteria

Studies were eligible for inclusion if they were original quantitative and/or qualitative studies reporting on barriers and/or facilitators to HIV testing in one or more Canadian province or territory; published between January 2009 and November 2019; and written in French or English. There were no restrictions in terms of the study sample size, type of study population or the study context/setting. Studies were excluded if they reported barriers and facilitators to testing for multiple sexually transmitted and blood-borne infections (STBBI) without reporting results for HIV separately, or if study data were collected prior to 2009.

Study selection and data collection

Two reviewers independently screened the titles and abstracts of all identified studies. Potentially relevant records were then retrieved for independent full-text review by both reviewers. Disagreements between reviewers at screening and full-text review stages were resolved by consensus.

The two reviewers independently extracted data from included studies using a piloted data extraction form that was created based on a sample of two quantitative and four qualitative studies selected for their high-quality reporting. For all included publications, the study province/territory, study aim(s), study design, population, sample size, data collection method, years of data collection, inclusion/exclusion criteria and basic demographic data of study participants including the age, sex or gender, sexual orientation and race/ethnicity were extracted. For quantitative studies, the analytical method, study exposure(s), outcome(s), covariates and main effect measures of

identified barriers and facilitators to HIV testing were extracted. For qualitative studies, the analytical method and identified themes pertaining to barriers and facilitators to HIV testing were extracted.

Quality appraisal

Two investigators independently assessed the quality of included works using the Mixed Methods Appraisal Tool (MMAT) (20,21). The MMAT has been validated to critically appraise the methodological quality of studies with diverse designs. The tool includes five questions requiring "yes," "no" or "can't tell" answers. The questions are adapted to each type of study design and assess the appropriateness of the study design for the research question, the likelihood of bias and the appropriateness of measurements and analyses.

Based on the responses to these questions, a five-point quality score was created, assigning one point for each "Yes" response. Studies with four or more "Yes" answers were considered strong in quality, studies with three "Yes" answers were considered moderate in quality and studies with two or fewer "Yes" answers were considered weak in quality. Disagreements in the score assigned by both reviewers were resolved by consensus. No studies were excluded based on their quality, as the objective of this review was to synthesize all available evidence on barriers and facilitators to HIV testing in Canada. (Appendix available upon request).

Data analysis

Barriers were defined as any obstacle or reason given by study participants for declining or being unable to access HIV testing. Conversely, facilitators were defined as any reason that study participants gave for accepting or being able to access an HIV test. Sociodemographic characteristics and behaviours (e.g. age, sex/gender, sexual behaviours) that were associated with decreased or increased HIV testing uptake were considered barriers and facilitators, respectively. To avoid repetition, sociodemographic characteristics that operate both as barriers and facilitators to HIV testing are presented in terms of characteristics associated with increased testing.

Identified barriers and facilitators to HIV testing were analyzed using a convergent qualitative synthesis design in which quantitative data are transformed into qualitative findings (18,22). The results were then integrated using inductive thematic synthesis in which themes are derived from the data without a predefined coding frame. The synthesis was guided by a conceptual framework developed by Deblonde *et al.* (2010) (17) that categorizes determinants of HIV testing according to the level at which they occur: the individual-level; the healthcare provider-level; and the institutional or policy level. To meet research objectives, an overall synthesis of results was conducted followed by a synthesis by key population and by jurisdiction.

Results

Study selection and characteristics

The initial search yielded 1,694 peer-reviewed studies and 49 grey literature records. After the removal of duplicates and publications not meeting eligibility criteria based on their title/abstract, 156 manuscripts were retained for full-text review. Of these, 33 peer-reviewed studies (23–55) and 10 grey literature records (6,56–64) were retained (**Figure 1**).

Figure 1: PRISMA flow diagram

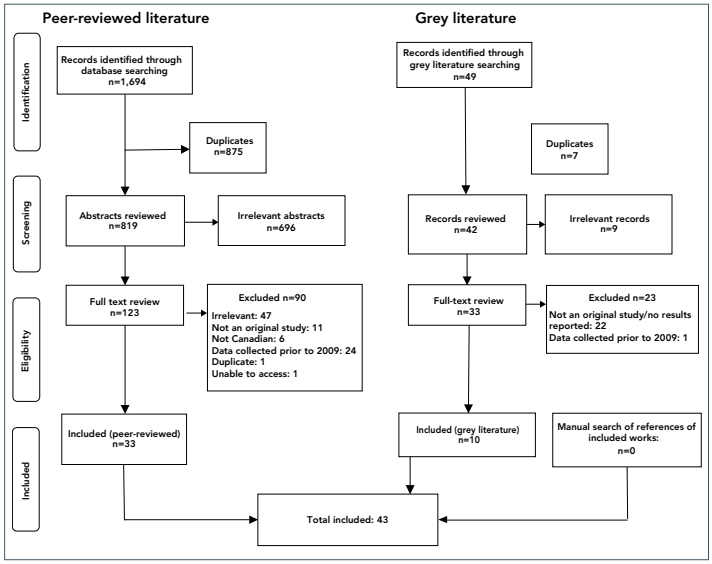

Table 1 shows the characteristics of included studies. Included studies were conducted in British Columbia (n=12) (23,24,26, 27,30,32,34,37,38,43,50,52); Manitoba (n=1) (39); Ontario (n=10) (35,36,40,44–47,51,60,64); Québec (n=5) (29,41,49,58,61); Nova Scotia (n=4) (31,42,56,59); and Newfoundland and Labrador (n=1) (25). Seven studies included multiple provinces/territories (Atlantic provinces (28,62), all of Canada (6,33,48,54,57)) and two did not specify a province/territory (53,55). Of the 43 publications, 42 were cross-sectional studies and one was a cohort study. Of these, 20 were quantitative, 13 were qualitative and 10 were mixed methods studies.

Quality appraisal

Most of the included publications were of strong quality (n=32; 74%), while some were moderate (n=6; 14%) or weak quality (n=5; 12%). (Appendix available upon request). The weakest element in the qualitative studies was a lack of the detail necessary for an evaluation of whether the data substantiated the interpretation of results. The weakest element in the quantitative studies was the risk of non-response bias, which is expected as many of these studies were conducted in hard-to-reach populations. The weakest element in the mixed methods studies was a lack of consideration of divergence between qualitative and quantitative results.

Table 1: Summary of included studies reporting on barriers and facilitators to HIV testing in Canada, 2009–2019

Citation and location	Years of data collection	Study population	Sample size	Age (years)	Male (%)	Study type	Research question	Quality score (/5)
Peer-reviewed literature								
Anderson *et al.*, 2016 (23) Vancouver, British Columbia	2011–2014	Migrant sex workers, managers and business owners of indoor sex work venues	46	Median: 42 (IQR: 24–54)	2	Qualitative: Semi-structured interviews with thematic analysis	Assess the impact of criminalization of sex work on HIV/STI prevention	5
Armstrong *et al.*, 2019 (24) Vancouver, British Columbia	2012–2014	gbMSM	535	Median: 30 (IQR: 24–39)	100	Quantitative: Questionnaire (self-administered)	Determine the reasons for HIV testing and never having tested, and explore correlates of testing	4
Boyd *et al.*, 2019 (25) Newfoundland and Labrador	2006–2016	Patients diagnosed with HIV	Quantitative: 58 Qualitative: 10	Categorical: 20–29 (20.7%), 30–39 (19.0%), 40–49 (41.4%), 50+ (19.0%)	91.4	Mixed methods: Semi-structured interviews with thematic analysis, and retrospective chart review	Determine the timeliness of HIV testing, missed opportunities for testing, and barriers to HIV testing	4
Brondani *et al.*, 2016 (26) Vancouver, British Columbia	2010–2015	General population	519	Categorical: 19–24 (15 %), 25–44 (74%), 45+ (11%)	71.3	Quantitative: Questionnaire (self-administered)	Identify patients' response to, and attitudes toward opt-out HIV rapid screening in a dental setting	3
Deering *et al.*, 2015 (27) Vancouver, British Columbia	2010–2012	Women sex workers	435	Median 35 (IQR: 38–42)	0	Quantitative: Questionnaire (self-administered)	Assess prevalence and correlates of accessing HIV testing	5
Dube *et al.*, 2017 (28) Atlantic provinces	NR	Stakeholders including policy makers, healthcare providers and youth	68	NR	NR	Qualitative: Semi-structured interviews and focus-group discussions with thematic analysis	Explore the scope and accessibility of existing youth-oriented HIV and HCV prevention	5
Engler *et al.*, 2016 (29) Montréal, Québec	2012–2013	Heterosexual clients of an MSM-oriented clinic	202	NR	72.8	Quantitative: Questionnaire (self-administered)	Understand the HIV prevention and sexual health service needs of heterosexual women clients of an MSM-oriented clinic	3
Feng *et al.*, 2018 (30) Vancouver, British Columbia	2015–2016	General population	114	NR	31.2	Mixed methods: Focus groups and individual interviews, and questionnaire (self-administered)	Determine the feasibility and acceptability of point-of-care HIV screening in dental hygiene settings	4
Gahagan *et al.*, 2011 (31) Nova Scotia	2009–2010	General population	Quantitative: 15,518 Qualitative: 50	NR	38	Mixed methods: Semi-structured interviews with thematic analysis, and regional HIV laboratory surveillance data	Explore the individual and structural barriers and facilitators to HIV counselling and testing	4

Table 1: Summary of included studies reporting on barriers and facilitators to HIV testing in Canada, 2009–2019 (*continued*)

Citation and location	Years of data collection	Study population	Sample size	Age (years)	Male (%)	Study type	Research question	Quality score (/5)
Peer-reviewed literature (*continued*)								
Gilbert *et al.*, 2013 (1,32) All provinces	2006–2012	MSM	NR	NR	100	Quantitative: HIV testing laboratory surveillance data	Examine the impact of NAAT HIV testing and social marketing campaign on diagnosis of acute HIV infection among MSM	2
Gilbert *et al.*, 2013 (2,33) All provinces	2011–2012	MSM	8,388	Median: 43 (IQR: 18–84)	100	Quantitative: Questionnaire (self-administered)	Assess the perceived advantages and disadvantages of Internet-based testing among MSM	5
Holtzman *et al.*, 2016 (34) Vancouver, British Columbia	2010–2011	MSM living outside major urban centres	153	Mean: 39.7 (SD: 15.4)	100	Quantitative: Questionnaire (self-administered)	Investigate behaviours and predictors of HIV testing among MSM living outside major urban centres	5
Iqbal *et al.*, 2014 (35) Ontario	2011	Women in labour	92	Mean: 32 (SD: 4.4)	0	Quantitative: Questionnaire (self-administered)	Assess attitudes and opinions surrounding point-of-care HIV testing	2
Kesler *et al.*, 2018 (36) Toronto, Ontario	2010–2012	MSM	150	Median: 44.5 (IQR: 37–50)	100	Quantitative: Questionnaire (self-administered)	Quantify the potential impact of nondisclosure prosecutions on HIV testing and transmission among MSM	4
Knight *et al.*, 2016 (1,37) Vancouver, British Columbia	2013	Young men	50	Mean: 21.7 (SD: NR)	100	Qualitative: Semi-structured interviews with critical discourse analysis	Explore the values that influence decisions and motivations to voluntarily access HIV testing	4
Knight *et al.*, 2016 (2,38) Vancouver, British Columbia	2013	Young men	50	NR Presumed to be the same as Knight *et al.*, 2016 (37)	100	Qualitative: Semi-structured interviews with grounded theory analysis	Determine how HIV-related stigma is experienced differentially across subgroups of young men within voluntary and routine testing practices	5
Lau *et al.*, 2017 (39) Winnipeg, Manitoba	2016	Patients admitted to inpatient care	144	Median: 58 (IQR: 42–68)	48	Quantitative: Questionnaire (interviewer-administered)	Evaluate the attitudes toward routine point-of-care HIV testing in patients admitted to inpatient care	3
Lazarus *et al.*, 2016 (40) Ottawa, Ontario	2013	PWID	550	Median: 43 (IQR 34–50), No: 39 (IQR: 30–48)	78.2	Quantitative: Questionnaire (interviewer-administered)	Determine the factors associated with the uptake of community-based HIV point-of-care testing	4
Lessard *et al.*, 2015 (41) Montréal, Québec	2013–2014	Immigrant MSM	40	Mean: 33 (SD: 10)	100	Mixed methods: Phone interview with thematic analysis	Analyze factors contributing to immigrant MSM's use of a community-based rapid HIV testing	3

Table 1: Summary of included studies reporting on barriers and facilitators to HIV testing in Canada, 2009–2019 (*continued*)

Citation and location	Years of data collection	Study population	Sample size	Age (years)	Male (%)	Study type	Research question	Quality score (/5)
Peer-reviewed literature (*continued*)								
Lewis *et al.*, 2013 (42) Halifax, Nova Scotia	2011	General population	258	78.1% 20–40	53.5	Quantitative: Questionnaire (self-administered)	Gauge community demand for rapid point-of-care HIV testing	4
Markwick *et al.*, 2014 (43) Vancouver, British Columbia	2011–2012	PWID	600	50.8% >48	67.5	Quantitative: Questionnaire (interviewer-administered)	Characterize PWID's willingness to receive peer-delivered voluntary counselling and HIV testing	4
O'Byrne & Bryan, 2013 (44) Ottawa, Ontario	NR	Individuals who identify as gay, bisexual, transsexual, two-spirited, queer or questioning	721	Mean: 37.8 (SD: 12.1)	97.2	Quantitative: Questionnaire (self-administered)	Examine sexual practices and STI/HIV testing and diagnosis histories	5
O'Byrne *et al.*, 2013 (1,45) Ottawa, Ontario	NR	MSM	441	Mean: 38.0 (SD: 13.1)	100	Quantitative: Questionnaire (self-administered)	Investigate impact of nondisclosure prosecutions and HIV prevention	5
O'Byrne & Watts, 2014 (46) Ottawa, Ontario	NR	Gay male youth	8	Mean: 23.3 (SD: NR)	100	Qualitative: Semi-structured interviews with thematic analysis	Explore perceptions of stigma in health care in gay male youth	5
O'Byrne *et al.*, 2013 (2,47) Ottawa, Ontario	NR	MSM	27	Categorical: 19–30 (48%), 31–40 (30%), 41–50 (13%), 51–60 (9%)	100	Mixed methods: Semi-structured interviews with thematic analysis	Examine HIV testing and attitudes of MSM following regional media releases about a local nondisclosure prosecution	4
Pai *et al.*, 2018 (48) All provinces	2015	Stakeholders involved in HIV self-testing initiatives across Canada	183	NR	NR	Mixed methods: Questionnaire (self-administered), open-ended questions and comments	Identify the concerns, opportunities and challenges to implementing HIV self-testing in Canada	4
Pai *et al.*, 2014 (49) Montréal, Québec	2011–2012	Students from a university health clinic	145	Median: 22 (IQR: NR)	39.8	Mixed methods: Questionnaire (self-administered), open-ended questions	Investigated the feasibility of offering an unsupervised self-testing strategy to Canadian students	5
Rich *et al.*, 2017 (50) Vancouver, British Columbia	2012–2014	Gay, bisexual and queer transgender men	11	Median: 26 (IQR: 25–28)	100	Qualitative: Semi-structured interviews with thematic analysis	Explore sexual HIV risk for transgender men in an environment of publicly funded universal access to healthcare including HIV testing and treatment	5

Table 1: Summary of included studies reporting on barriers and facilitators to HIV testing in Canada, 2009–2019 (*continued*)

Citation and location	Years of data collection	Study population	Sample size	Age (years)	Male (%)	Study type	Research question	Quality score (/5)
Peer-reviewed literature (*continued*)								
Scheim & Travers, 2017 (51) Ontario	2013	Transgender MSM	40	Categorical: 18–24 (25%), 25–34 (48%), 35–44 (23%), 45+ (5%)	100	Qualitative: Semi-structured interviews with thematic analysis	Identify trans MSM's perspectives on barriers and facilitators to HIV and STI testing	5
Stenstrom *et al.*, 2016 (52) Vancouver, British Columbia	2009–2011	Tertiary care emergency patients	1,402	Mean: 43.3 (SD: 11.6)	58.4	Quantitative: Questionnaire (self-administered)	Estimate the acceptability of point-of-care HIV testing in an emergency department	4
Stephenson *et al.*, 2014 (53) Not specified	2011–2012	Male Facebook users indicating an interest in men	344	Categorical: 18–24 (42%), 25–34 (26%), 35–44 (13%), 45+ (19%)	100	Quantitative: Questionnaire (self-administered)	Examine the associations between individual characteristics and willingness of MSM couples to use couples' voluntary HIV counselling and testing	5
Worthington *et al.*, 2015 (54) All provinces/ territories	2011	General population	2,139	Categorical: 16–29 (23.3%), 30–59 (50.8%), 60+ (25.9%)	48.2	Quantitative: Questionnaire (self-administered and interviewer-administered)	Describe voluntary HIV testing in the general population and examine individual knowledge, behaviours and sociodemographic factors associated with testing	5
Worthington *et al.*, 2016 (55) Not specified	NR	Nurses	40	NR	NR	Mixed methods: Semi-structured interviews with thematic analysis	Assess the impact of an HIV care mentorship intervention on knowledge, attitudes and practices with nurses and PLWHIV	4
Grey literature								
Barbour, 2017 (56) Halifax, Nova Scotia	NR	Indigenous communities	6	NR	50	Qualitative: Semi-structured interviews with thematic analysis	Obtain community knowledge and understanding of the perceived barriers/facilitators associated with the access/acceptability of HIV testing within Indigenous populations	5
CATIE (Community AIDS Treatment Information Exchange), 2016 (57) All provinces/ territories	2016	Stakeholders working in HIV programming	65	NR	NR	Qualitative: Deliberative group dialogue	Produce key priority directions in HIV testing and linkage programming to improve the ability to reach the undiagnosed and link them to care	2

Table 1: Summary of included studies reporting on barriers and facilitators to HIV testing in Canada, 2009–2019 (*continued*)

Citation and location	Years of data collection	Study population	Sample size	Age (years)	Male (%)	Study type	Research question	Quality score (/5)
Grey literature (*continued*)								
Centre Sida amitié, 2019 (58) Laurentides, Québec	NR	PLWHIV, PWID, expert partners	196	NR	NR	Qualitative: Questionnaire (self-administered and interviewer-administered)	Generate recommendations for communities to attain the 90-90-90 targets	2
Gahagan *et al.*, 2012 (59) Halifax, Nova Scotia	2011	Clients of the Halifax Sexual Health Centre	258	NR	NR	Mixed methods: Questionnaire (self-administered), open-ended questions	Assess performance of Anonymous HIV Testing Program, gauge clients' interest in rapid point-of-care HIV testing and willingness to pay a fee to have this testing option	3
Konkor, 2019 (60) London/Ottawa/ Toronto/Windsor, Ontario	2018–2019	Heterosexual men of ACB communities	156	Categorical: 16–19 (14%), 20–29 (32%), 30–39 (26%), 40–49 (16%), 50+ (12%)	100	Quantitative: Questionnaire (self-administered)	Identify the factors that influence uptake of HIV testing services among heterosexual ACB men	4
Messier-Peet *et al.*, 2018 (61) Montréal, Québec	2017–2018	gbMSM	551	NR	100	Quantitative: Questionnaire (self-administered)	Investigate factors associated with not being tested for HIV among gbMSM at high-risk for HIV	4
Our Youth, Our Response, 2014 (62) Atlantic provinces	2011–2013	Stakeholders from government, community and research sectors, health service providers and clients of community organizations	69	Categorical: 16–25 (16%), 26–35 (20%), 36–45 (19%), 46–55 (20%), 56+ (19%)	45.4	Mixed methods: Interviews and focus groups with thematic analysis	Develop evidence-based recommendations for stakeholders in government, community and research sectors on prevention, policy and programming approaches needed to help mitigate the impact of HIV/HVC	4
PHAC, 2018 (63) All provinces/ territories	2010–2012	PWID	2,687	Mean: 39.4 (SD: NR)	68.2	Quantitative: Questionnaire (interviewer-administered)	To inform HIV prevention and control efforts, public health policy development, and program evaluation	4
Vannice, 2016 (64) Ottawa, Ontario	NR	Women in ACB communities	10	Range: 18–60	0	Qualitative: Semi-structured interviews with thematic analysis	Examine the experiences, perceptions and knowledge regarding HIV testing among ACB women	3
Wertheimer, 2011 (6) All provinces/ territories	2009–2010	Service providers	Quantitative: 75 Qualitative: 15	NR	NR	Mixed methods: Questionnaire (self-administered online), individual interviews	Identify the barriers that affect women's access to HIV testing	2

Abbreviations: ACB, African, Caribbean and Black communities; gbMSM, gay, bisexual and other men who have sex with men; HCV, hepatitis C virus; HIV, human immunodeficiency virus; IQR, interquartile range; MSM, men who have sex with men; NAAT, nucleic acid amplification testing; NR, not reported; PHAC, Public Health Agency of Canada; PLWHIV, people living with HIV; PWID, people who inject drugs; SD, standard deviation; STI, sexually transmitted infection

Synthesis of results

The following narrative synthesis of results summarizes identified barriers and facilitators overall and by key population and jurisdiction. Sociodemographic characteristics and behaviours associated with HIV testing are presented separately because they represent individual-level drivers of testing uptake rather than external barriers/facilitators.

Overview of barriers and facilitators to HIV testing

At the level of the individual, several barriers to HIV testing emerged across multiple contexts: fear of receiving a positive result (6,25,39,56,58,64); stigma surrounding HIV and behaviours or identities perceived to be associated with HIV (23,31,38,41,56,58,60,64); the perception of being at low risk for exposure to HIV (6,24,26,50,51,61,62); insufficient knowledge of HIV and testing options (56,61,64); difficulty accessing testing services, for example, limited clinic opening hours, difficulty getting an appointment (23,28,41,58,60,64); and insufficient confidentiality in testing services (28,41,42,56,58,64). Certain sociodemographic characteristics were identified as being associated with increased testing, including engaging in behaviours associated with HIV (e.g. increased number of sexual partners, injection drug use) (24,27,40,54,60,61,63) and having been previously tested for STBBI (24,25,38).

At the level of the healthcare provider, common barriers were identified as HIV-related stigma from healthcare providers (46,57); perception that a patient is at low risk of HIV exposure (6,64); and reluctance/refusal to offer testing for individuals who were not perceived to be at risk (38,58). Many studies reported healthcare providers suggesting an HIV test (25,26,58) and that non-stigmatizing healthcare practices (23,50,51) facilitated testing.

At the institutional or policy level, the criminalization of certain behaviours (e.g. sex work, drug use, HIV nondisclosure) (23,57) and the lack of resources and adequate healthcare infrastructure in rural and remote regions (28,56,58,62) represent structural barriers to testing. Conversely, policies and institutional practices that increase the accessibility, convenience and confidentiality of testing (e.g. broad range of testing options, reducing wait times, low-cost testing) (6,23,25–27,29,41,49–51,58,62) and integrate testing with routine healthcare services (25,31,38,51,58,63,64), educational/promotional campaigns (6,28,32,62,64) and intersectoral collaboration (6,28,62) were reported as facilitators to testing.

Results by key population

A large number of studies focused on gbMSM (n=15) (24,32–34,36–38,44–47,50,51,53,61), reflecting the historical epidemiology of HIV in Canada. Other key populations include sex workers (n=2) (23,27), PWID (n=3) (43,58,63), immigrant populations (n=3) (23,41,60), Indigenous communities (n=1) (56), and African, Caribbean and Black communities (n=2) (60,64). Results are summarized by key population to highlight the unique needs and context of each population in **Table 2**.

Table 2: Barriers and facilitators to HIV testing by key population in Canada, 2009–2019

Population type	Provinces reporting on population	Barriers	Facilitators
gbMSM (including two-spirited, queer, trans or questioning)	All provinces	• Fear of positive result (51) • Shame associated with requesting HIV testing and responding to the pre-test questionnaire (e.g. disclosure of sexual information) (41) • Lack of anonymous testing (44,47) • Lack of confidentiality in testing services (41) • Lack of knowledge of trans identities and health-related concerns among testing providers (51) • Limited availability and accessibility of HIV testing (31) (e.g. limited clinic opening hours (41)) • Low risk perception of HIV acquisition and/or transmission (24,50,51) • Criminalization of HIV nondisclosure (36,45,47) • Stigma and discrimination with regard to gender, sexuality, sexual identity, sexual relationships and monogamy (31) • Stigmatization by healthcare professionals (46)	• Having a strong network among gbMSM in the community (50) • gbMSM, queer and trans-competent sexual health care (50) • Integrating HIV testing with other routine health services (31) • Internet-based HIV testing (33) • Social media campaigns promoting HIV testing (32)

Table 2: Barriers and facilitators to HIV testing by key population in Canada, 2009–2019 (*continued*)

Population type	Provinces reporting on population	Barriers	Facilitators
Sex workers (including managers and business owners of sex work venues)	British Columbia	• Criminalization of sex work (23) • Criminalization of third parties (managers/owners) creating harmful practices within sex work venues (e.g. restrictions on condom use, rejecting testing in the workplace) (23) • Collaboration between public health outreach and law enforcement (e.g. arriving on site together) resulted in a mistrust of health outreach workers and a reluctance to allow them on site (23) • Occupational stigma resulting in difficulties accessing primary health care and sexual health services (23) • Fear of sex worker status becoming known (e.g. reluctance to request frequent tests from family doctors) (23)	• Mobile HIV prevention programs (27) • Health outreach workers offering STBBI testing in sex work venues (23) • Non-judgmental and non-stigmatizing attitudes of health outreach workers enabling open discussions about sexual health issues (23)
PWID	All provinces	• Low risk perception, lack of interest or perceived urgency (63) • Fear of a positive diagnosis (63) • Feeling healthy (63) • Issues getting tested (e.g. accessibility of testing services) (63) • Feeling that nothing could be done in the case of a positive diagnosis (63)	• Peer-delivered post-test counselling (43) • Regularly seeking HIV/STBBI testing (63) • Testing integrated with routine medical care (63) • Testing suggested by healthcare provider (63) • Potential recent exposure (e.g. through sex, drug use) (63)
Immigrant populations	British Columbia, Ontario, Québec	• Shame associated with requesting HIV testing and responding to the pre-test questionnaire (e.g. disclosure of sexual information) (41) • Concerns about confidentiality (e.g. being seen in the clinic or receiving services from a member of their close-knit community, preference to answer questions on paper/electronic devices) (41) • Difficulties accessing primary health care and sexual health services due to lack of health insurance, linguistic and cultural barriers (23,27,41,60)	• Availability of translators or multilingual health services (23)
Indigenous communities	Nova Scotia	• Geographic barriers to accessing health care in rural and remote communities; absence of primary health care and HIV testing services; inconsistent access to medical transportation (56) • Lack of trust between clients and healthcare providers (56) • Lack of knowledge about HIV (risk factors, risk reduction strategies, modes of transmission, treatment) and HIV testing (feasibility, available types, benefits) (56) • HIV stigma relating to injection drug use (56) • Low risk perception; denial of potential risk linked to certain behaviours (e.g. injection drug use) (56) • Fear of positive result and loss of community acceptance (56) • Stigma and homophobia; perceptions of HIV as a "gay disease," associations with promiscuity, hierarchy of stigmatized behaviours, more social stigma is associated with homosexuality than injection drug use, linked to differential perception of HCV and HIV (56) • Issues with confidentiality within small communities, belief that "people will know" (56)	• Normalization of HIV testing increasing both accessibility and acceptability; shifting away from targeted testing based on behaviour, sexuality and risk toward integration of testing into routine medical care (56) • Increasing availability of testing; offering HIV testing within Indigenous reserves; increasing access to medical transportation (56) • Reducing wait time for results by offering point-of-care testing (56) • Harm reduction service centres integrating HIV testing (56) • Education about HIV (modes of transmission, risk factors) and HIV testing (available types, testing as prevention); sessions delivered by HIV/AIDS service organizations (56) • Collaboration between healthcare providers and HIV/AIDS service organizations to build trust (56) • Practices and protocols that are acceptable to the community (56) • Combined education about other STBBIs (e.g. HCV) (56)

Table 2: Barriers and facilitators to HIV testing by key population in Canada, 2009–2019 (*continued*)

Population type	Provinces reporting on population	Barriers	Facilitators
African, Caribbean and Black communities	Ontario	• Cultural barriers (labelling of women who test as promiscuous) (64) • Difficulty accessing health/testing facilities (not knowing where to get an HIV test) (60,64) • Fear of positive results; preferring not to know (64) • Fear of negative reaction from partner(s) upon disclosure of status (64) • Lack of anonymous testing (64) • Lack of confidentiality in HIV testing services (64) • Insufficient knowledge of HIV (transmission, testing, treatment) (64) • Stigma and discrimination of same-sex sexual behaviour, PWID or alcohol use, misconception that testing implies low masculinity (60,64) • Resistance from family physician to test despite a request (60,64) • Perceiving an offer of testing as a form of stereotyping or profiling (60,64)	• Being offered testing by a family physician in the context of routine care (rather than needing to specifically request it) (64) • Eliminating stigma by normalizing HIV testing (64) • Strategies focused on opening communication and navigating cultural silences (empowering individuals to broach the topic of HIV testing) (64) • Testimonials from PLWHIV/AIDS reducing fear of testing (64) • Community outreach by individuals from similar cultural or linguistic backgrounds (64) • Increasing knowledge of treatment and outcomes, testing recommendations, risk reduction strategies (64) • Public health messaging from government and health agencies, leveraging mainstream media (64)

Abbreviations: AIDS, acquired immunodeficiency syndrome; gbMSM, gay, bisexual and other men who have sex with men; HCV, hepatitis C virus; HIV, human immunodeficiency virus; PLWHIV/AIDS, people living with HIV/AIDS; PWID, people who inject drugs; STBBI, sexually transmitted and blood-borne infection

Several barriers to HIV testing were common across key populations. These included the fear of a positive diagnosis (23,41,51,56,64); experiences of HIV-related stigma (41,56), the perception of being at low risk for exposure to HIV (24,50,51,56,63); limited accessibility of testing services (23,27,41,56,60,64); and insufficient knowledge about HIV (56,64). Other common barriers represent particularly significant obstacles to testing for marginalized populations, including stigma relating to behaviours or identities perceived to be associated with HIV (e.g. sexual behaviours, sexual orientation, sex work, injection drug use) (23,24,31,41,46,50,51,56,60,64) and insufficient confidentiality in testing services, including the lack of anonymous testing and concerns about privacy in small or remote communities (23,41,44,47,56,64).

Other barriers were unique to key populations. Legislation that criminalizes HIV nondisclosure and sex work are barriers to testing among gbMSM (36,45,47) and sex workers (23), respectively. In addition, insufficient knowledge about the health-related concerns and needs of certain populations (e.g. gbMSM/transgender identities, sex workers) by healthcare providers is an obstacle to testing in these populations (23,51,56,60). Many populations also face distinct issues of accessibility, such as limited availability of multilingual health services and lack of health insurance among immigrant populations (23,41,60), and geographic barriers to health care in rural and remote Indigenous communities (56).

Despite the diverse contexts of these populations, several common facilitators emerged. Offering HIV testing in a broad range of modalities (e.g. anonymous testing, unsupervised self-testing) and settings (e.g. mobile clinics, point-of-care testing) (23,27,33,56) as well as the integration of members of key populations with lived experience (e.g. peer-delivered post-test counselling, community-based outreach initiatives) (43,56,64) were frequently identified as means to improve the accessibility and acceptability of HIV testing services to key populations.

Finally, some facilitators were uniquely relevant for certain key populations. Healthcare practices that are inclusive and non-stigmatizing were identified as important facilitators by queer and transgender communities (50,51). The availability of translators or multilingual health services facilitated testing for immigrant populations (23). Among the African, Caribbean and Black community, enabling social connections with people living with HIV and educational initiatives focused on navigating cultural silences around HIV facilitated testing (64).

Results by jurisdiction

Identified sociodemographic characteristics associated with HIV testing, and barriers and facilitators to HIV testing are summarized by jurisdiction in **Table 3**.

Although jurisdictions share many common barriers and facilitators to HIV testing, several trends emerged in particular jurisdictions. Studies conducted in British Colombia highlight the criminalization and stigmatization of sex work and issues related to immigrant status as major barriers to HIV testing (23,24,27). Studies conducted in Ontario feature cultural barriers and issues of stigma and fear of behaviours associated with HIV more prominently than other jurisdictions (38,60,64). Studies conducted in the Atlantic provinces uniquely highlight youth-adapted services as a key facilitator (28,62). Differences in the barriers and facilitators to HIV testing across jurisdictions

Table 3: Sociodemographic characteristics associated with increased HIV testing, barriers and facilitators of HIV testing by jurisdiction in Canada, 2009–2019

Province/territory	Individual level	Healthcare provider level	Policy level
British Columbia			
Sociodemographic characteristics and behaviours associated with increased HIV testing	• Younger age (24,34) • Being more educated (34) • White race/ethnicity (24) • Living in an urban area (24,50) • Engaging in risk behaviours (increased number of anal sex partners, inconsistent condom use, not engaging in serosorting (24,27), PWID (27))	• NA	• NA
Barriers	• Stigmatization of sex work (23) • Immigrant status (lack of health insurance, linguistic and cultural barriers) (23,24,27) • Low risk perception (of HIV acquisition and/or transmission) (24,26,50) • Internalized homophobia (34)	• NA	• Criminalization of sex work (23) • Collaboration between public health agencies and law enforcement creating mistrust of health outreach workers (23)
Facilitators	• Having a strong network in the gbMSM community (50) • Having been previously tested for other STBBIs (24)	• gbMSM, queer and trans-competent sexual health care and HIV testing (50) • HIV testing initiated/offered by healthcare providers (26) • Non-judgmental and non-stigmatizing attitudes of healthcare providers (23)	• Availability of translators or multilingual health services (23) • Mobile HIV prevention programs (27) • Convenient and low-cost testing (e.g. free-of-charge, receiving results on site (26,30)) • Offering various HIV testing modalities: oral swab (26), couples voluntary HIV counselling and testing (53), peer-delivered post-test counselling (43) • Offering HIV testing in different settings: sex work venues (23), dental hygiene clinics (26,30), emergency departments (52) • Social media campaigns promoting HIV testing (32)
Manitoba			
Barriers	• Fear of positive result; preferring not to know (39) • Low risk perception (39)	• NA	• NA
Ontario			
Sociodemographic characteristics and behaviours associated with increased HIV testing	• Older age (40) • Male sex/gender (40) • Having more experience with testing (38) • Being an immigrant (60) • Full-time employment; higher income (60) • Engaging in risk behaviours (use of condoms, having multiple sexual partners, injecting drugs, sex work, having spent time in jail, drug use in jail (40,60))	• NA	• NA

Table 3: Sociodemographic characteristics associated with increased HIV testing, barriers and facilitators of HIV testing by jurisdiction in Canada, 2009–2019 (*continued*)

Province/territory	Individual level	Healthcare provider level	Policy level
Ontario (*continued*)			
Barriers	• Cultural barriers (labelling of women who test as promiscuous) (64) • Difficulty accessing health/ testing facilities (not knowing where to get an HIV test) (60,64) • Fear of the testing process, the length of time to wait for the results, fear of positive results; preferring not to know (35,51,64) • Fear of negative reaction from partner(s) upon disclosure of status (35,64) • Lack of confidentiality in testing services (35,64) • Insufficient knowledge HIV (transmission, testing, treatment) (64) • Low risk perception (37,51) • Misconception that HIV testing is associated with low masculinity (38,60) • Potential nondisclosure prosecution (36,45,47) • Stigma (grounded in taboos surrounding sexuality) and discrimination of same-sex sexual behaviour, PWID or alcohol use (38,60,64) • Needing to convince healthcare providers by revealing stigmatizing identities/ behaviours (38) • Perceiving an offer of testing as a form of stereotyping or profiling) (38,60,64)	• Lack of knowledge of trans identities and health-related concerns among healthcare providers (51) • Stigma from healthcare professionals (46) • Low risk perception among healthcare providers (64)	• NA
Facilitators	• Anonymous testing (44,47,64) • More information on the testing process (35) • More information on mother to child HIV transmission (35) • Individualized prevention approach (35)	• Access to trusted testers (51) • Gender-responsive interventions (51)	• Integrating HIV testing with routine care (de-stigmatize and normalize HIV testing) (38,51,64) • Increasing HIV knowledge and education in the community (e.g. via television and radio), particularly from government health agencies (64) • Providing social connections with PLWHIV (64)
Québec			
Sociodemographic characteristics and behaviours associated with increased HIV testing	• Higher number of sexual partners (61)	• NA	• NA
Barriers	• Fear of positive result, of being judged or rejected, and of disclosing status to partner(s) (58) • Shame associated with requesting HIV test and responding to the pre-test questionnaire (e.g. disclosure of sexual information) (41,58)	• NA	• Lack of health resources in rural regions (58)

Table 3: Sociodemographic characteristics associated with increased HIV testing, barriers and facilitators of HIV testing by jurisdiction in Canada, 2009–2019 (*continued*)

Province/territory	Individual level	Healthcare provider level	Policy level
Québec (*continued*)			
	• Lack of confidentiality in testing services (41,58) • Insufficient knowledge of HIV testing services, locations and recommendations (61) • Limited access to healthcare providers (61) • Limited opening hours of HIV testing clinics (41) • Low risk perception (61) • Testing not covered by public health insurance (58) • HIV stigma (58)		
Facilitators	• NA	• Healthcare providers never refusing a request for HIV testing from a patient (58) • Unsupervised oral self-testing (48)	• Integrating HIV testing with routine healthcare without a pre-test questionnaire (e.g. on sexual behaviours) (58) • Accessible, confidential, convenient (no need for appointment) testing services, including non-nominal testing, rapid testing (29,41,58) • Offering a variety of HIV testing modalities: unsupervised oral self-testing (49) • Offering HIV testing in various settings: in the community, at the pharmacy (58) • Prevention efforts based on harm reduction principles, focusing on the person as well as the virus (58) • Safe HIV testing setting (58)
Nova Scotia			
Sociodemographic characteristics and behaviours associated with increased HIV testing	• Female sex/gender (31)	• NA	• NA
Barriers	• Fear of positive test result, of rejection and of being associated with promiscuity and PWID (56) • Lack of confidentiality in testing services (42,56) • Insufficient knowledge about HIV and testing (56) • Stigma and discrimination with regard to gender, sexuality, sexual identity, sexual relationships and monogamy (31,56)	• NA	• Geographic barriers to accessing health care in rural and remote communities; absence of primary health care and HIV testing services in smaller communities; inconsistent access to medical transportation (56)
Facilitators	• Increasing availability and accessibility of HIV testing services (31,56) • Being able to pay for point-of-care testing (42)	• NA	• Integrating HIV testing with routine health services (e.g. systematic prenatal HIV testing) (31) • Normalizing of HIV testing (56) • Availability of rapid testing (42)
Newfoundland and Labrador			
Sociodemographic characteristics and behaviours associated with increased HIV testing	• MSM (heterosexual men diagnosed later than MSM) (25)	• NA	• NA

Table 3: Sociodemographic characteristics associated with increased HIV testing, barriers and facilitators of HIV testing by jurisdiction in Canada, 2009–2019 (*continued*)

Province/territory	Individual level	Healthcare provider level	Policy level
Newfoundland and Labrador (*continued*)			
Barriers	• Hospital settings (e.g. patients in STBBI clinics diagnosed earlier than those in hospitals) (25) • Fear of diagnosis; denial of risk (25) • Negative interactions with the healthcare system (25) • Stigma surrounding HIV and testing	• NA	• Insufficient knowledge of HIV among the general population (fear of HIV, misconceptions about HIV and drug use) • Lack of adequate support for PLWHIV (25)
Facilitators	• Having been tested for other STBBIs previously (25)	• HIV testing initiated/proposed by healthcare providers (25)	• Integrating HIV testing with routine health services (25) • Offering a broad range of HIV testing options (25)
Atlantic provinces			
Barriers	• Difficulty accessing timely, gender-appropriate and youth-adapted HIV testing services (28) • Lack of accessibility and confidentiality in small community settings (e.g. personal relationships between family and healthcare professionals) (28,62) • Low risk perception; lack of HIV knowledge (62)	• NA	• Lack of personnel and resources for collaboration between Atlantic provinces (62) • Lack of guiding policy for programs, resulting in discordance across sectors (28)
Facilitators	• HIV testing for youth in dedicated sexual health centres • Increasing awareness, education and information about HIV; highlighting the importance of prevention, reducing misconceptions related to HIV to reduce stigma (28,62)	• Continuing education to deliver pre and post-test counselling and referrals to appropriate health services following testing (62) • Increasing awareness, education and information about HIV; highlighting the importance of prevention, reducing misconceptions related to HIV to reduce stigma (28,62)	• Access to nonjudgmental and gender-responsive approaches (services without gender-based stereotypes or inequities) (28) • Education and promotional materials adapted to youth (e.g. age-appropriate content, peer mentoring, social media, phone and Internet-based programs, art-based projects) (62) • Increase awareness, education and information about HIV; highlighting the importance of prevention, reducing misconceptions related to HIV to reduce stigma (28,62) • Increasing the number and types of testing sites, (e.g. clinics in schools, mobile testing sites) and modalities (e.g. point-of-care, anonymous testing) (62) • Inter-organizational and intersectoral collaboration (28,62) • Youth engagement in the development and implementation of HIV/HCV prevention initiatives (28,62)
Canada-wide or unspecified provinces/territories			
Sociodemographic characteristics and behaviours associated with increased HIV testing	• Younger age (54) • Being in a sexual minority group (54) • Female sex/gender (54) • Having casual partners (54,63) • Potential exposure due to drug use (63)	• NA	• High jurisdictional HIV prevalence (54)

Table 3: Sociodemographic characteristics associated with increased HIV testing, barriers and facilitators of HIV testing by jurisdiction in Canada, 2009–2019 (*continued*)

Province/territory	Individual level	Healthcare provider level	Policy level
Barriers	• Anxiety and fear (due to long time between testing and obtaining results, being judged, sickness and death, family or community violence) (6,63) • Difficulty accessing health/ testing services (limited medical facilities) (6,63) • Geographical barriers to accessing health care (6) • Difficulty accessing testing services (63) • Lack of confidentiality in testing services (6) • Lack of pre and post-test counselling (6) • Lack of trust in healthcare providers due to historical context of racism, colonization and homophobia (6,57) • Low risk perception, lack of interest, feeling healthy (6,63) • HIV-related stigma and criminalization of HIV nondisclosure (57)	• HIV-related stigma (57) • Lack of trust in healthcare providers due to historical context of racism, colonization and homophobia (57) • Low risk perception by healthcare providers (6)	• HIV-related stigma and criminalization of HIV nondisclosure (57)
Facilitators	• High self-perceived HIV knowledge (54) • Routine testing for HIV (63)	• Training and sensitizing healthcare providers (6) • Healthcare providers suggesting an HIV test (63) • Unsupervised oral-self testing (48)	• Anonymous testing (6) • Integrating HIV testing into routine medical care (63) • Availability of different testing modalities: rapid testing (6), couples voluntary HIV counselling and testing (53), Internet-based HIV testing (33), unsupervised oral-self testing (48) • Enhancing the capacity of health service providers (e.g. clinics, AIDS service organizations, community organizations) (6) • Gender-responsive interventions and programs (6) • Increasing awareness about HIV (e.g. via educational campaigns and tools) (6)

Abbreviations: AIDS, acquired immunodeficiency syndrome; gbMSM, gay, bisexual and other men who have sex with men; HCV, hepatitis C virus; HIV, human immunodeficiency virus; MSM, men who have sex with men; NA, not applicable; PLWHIV, people living with HIV; PWID, people who inject drugs; STBBI, sexually transmitted and blood-borne infection
Note: Missing provinces/territories indicate that no barriers or facilitators were documented in the available peer-reviewed or grey literature in these jurisdictions in the last decade

were driven primarily by differential presence of key populations across jurisdictions and reflect regional public health priorities.

Discussion

In this systematic mixed studies review, it included results from 43 studies conducted in Canada to document and understand recent and emerging barriers and facilitators to HIV testing in the last decade. The principal motivation was to orient future research and public health action toward reaching the first global HIV target in Canada, taking into consideration key populations and jurisdictional contexts. Another motivation was to identify specific areas for intervention to improve access to HIV testing in a broad range of contexts, including providing accessible, low-cost and convenient testing, ensuring confidentiality, reducing HIV-related stigma, improving education about HIV (e.g. modes of transmission, testing, treatments), normalizing offering HIV testing and integrating testing into routine healthcare practices.

Common barriers emerge across key populations and jurisdictions, including low risk perception, fear and stigma surrounding HIV, lack of knowledge of HIV and testing, insufficient patient confidentiality, limited access to cultural and linguistically appropriate services and lack of resources for testing (7,15). This review identified several emerging innovative practices, including integrating HIV point-of-care testing in a variety of new settings including Internet-based HIV testing (33), sex work venues (27), dental care (26,30), emergency rooms (52), pharmacies (59) and in mobile testing units (26,27). Several innovative testing modalities were also identified: couples voluntary HIV counselling and testing (53), oral swab and oral-self testing (26,49) and peer-delivered post-test counselling (43). Gender-based approaches (28), queer and transgender-competent healthcare providers and adapted interventions and approaches (50), age-adapted education and promotion material, testing sites (e.g. school-based clinics for youth) and youth engagement in the development and implementation of HIV prevention initiatives were also clearly identified as important facilitators (62).

The evidence summarized above highlights the importance of adapting public health policy and programming to the unique contexts of each jurisdiction, including the distribution of key populations and burden of disease. Potential strategies for improving access to HIV testing among key populations include increasing the accessibility of HIV testing by expanding available testing options and promoting health outreach initiatives for hard-to-reach populations. In addition, ensuring inclusive and non-stigmatizing healthcare services and integrating the knowledge of members of these communities are essential to improve the acceptability of HIV testing to key populations. Policy makers and healthcare providers should also consider the intersectionality of identities and experiences in order to better understand the specific drivers of HIV testing in each population (65). These results underscore the importance of adopting a person-centred approach to HIV testing and the need to reach people where they are.

Many of the barriers and facilitators identified in this review operate at the institutional/policy level, potentially indicating an increased focus on up-stream determinants of HIV testing in the last decade. This recent trend underscores the importance of public health action at the systemic level and suggests that HIV testing initiatives could be enhanced by leveraging the expertise of a range of stakeholders including community partners, primary health care, harm reduction services and public health authorities. Expanding intersectoral partnership and collaboration may offer important opportunities to bridge testing gaps and ensure equitable access to HIV testing.

The Pan-Canadian Framework recognizes the importance of testing in achieving global STBBI targets and outlines specific opportunities for action that align with the facilitators identified in this review (66). As outlined in the Government of Canada STBBI action plan (67), improving access to STBBI testing is a core component of a coordinated approach to reducing the impact of STBBI in Canada, with a particular focus on populations that are disproportionately affected by STBBI. This review contributes to existing knowledge of the drivers of HIV testing in Canada and highlights several important gaps and opportunities that can be used to inform public health action toward this goal.

Strengths and limitations

A major strength of this work is the systematic mixed studies review design, which synthesizes quantitative and qualitative data in order to answer complex research questions such as the identification of determinants of HIV testing (18). The inclusion of multiple forms of evidence creates a rich synthesis of extant barriers and facilitators by combining diverse perspectives (i.e. population-level data and individual experiences) and produces results that are directly relevant to decision-makers (22). In addition, the broad scope allows for the identification of emerging and lesser known barriers and facilitators, as well as population and jurisdiction-specific trends in HIV testing in Canada, informing targeted public health action (68).

Nevertheless, this review has limitations. It is possible that some relevant works were not identified by our search strategy and so certain barriers/facilitators may be absent from this synthesis. In addition, the intrinsic nature of the data made it impossible to assess the causal nature of any of the identified barriers or facilitators.

This review may also be limited by publication bias, as published literature reflects historical and regional contexts and priorities, potentially resulting in gaps in the literature to do with non-priority populations and settings. As such, although this review presents results across populations and jurisdictions, some key populations (e.g. PWID, sex workers, immigrants, Indigenous communities and African, Caribbean and Black communities)

and some provinces (e.g. Alberta, Manitoba, Saskatchewan) and the territories are underrepresented, potentially limiting the generalizability of results. In addition, emerging key populations may be missing.

Finally, the scope of this review was limited to barriers and facilitators of HIV testing and may omit other important shared barriers and facilitators to testing for other STBBI.

Conclusion

HIV testing acts as the gateway for HIV treatment and prevention and is a core pillar of Canada's efforts to reduce the health impact of HIV and other STBBI. This work provides a comprehensive and detailed understanding of the barriers and facilitators to HIV testing in Canada and highlights several important factors that can be leveraged to increase HIV testing. The results provide key evidence to influence practice, policy and future research toward achieving global HIV targets.

Authors' statement

CL and CBF contributed equally to this work: conceptualization, development of search strategy, screening of identified works for inclusion, quality appraisal, data extraction, analysis and interpretation of data and manuscript preparation.

Competing interests

The authors have no conflicts of interest to declare.

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Does wearing a mask in public decrease the transmission of COVID-19?

Source: Emerging Science Group of the Public Health Agency of Canada. Rapid Review on the use of Face Masks to Prevent the Spread of COVID-19 in Community Settings: December 2020 Update. Full report available from: phac.emergingsciencesecretariat-secretariatdessciencesemergentes.aspc@canada.ca

Background: Wearing masks in public places is a technically simple, low-cost public health measure to prevent the transmission of coronavirus disease 2019 (COVID-19). But is it effective? The objective of this review was to update the summary of evidence on the use of masks to mitigate COVID-19 transmission in community settings.

Methods: Searches were conducted in PubMed, Scopus, BioRxiv, MedRxiv, ArXiv, SSRN, Research Square and the COVID-19 information centers run by Lancet, BMJ, Elsevier, Nature and Wiley for relevant reviews, peer-reviewed publications and pre-prints up to November 19, 2020. These articles were screened, potentially relevant citations were reviewed, and relevant data were extracted into evidence tables.

Results: Forty-nine studies were identified: one randomized controlled trial (RCT); 15 observational studies; 27 ecological studies; and six reviews.

- The RCT (DANMASK-19) reported insignificant results for mask usage (OR 0.82, 95% CI: 0.54–1.23, p=0.33), likely due to low adherence in the mask group, poor control for household transmission, and low levels of community masking during the study.
- All 15 observational studies showed decreased transmission with mask use, although it was not always statistically significant. One longitudinal study of serial surveys in the United States found an increased odds of transmission control with every 10% increase in mask use. Cluster investigations found a protective effect in those who wore masks. In one study of two hairstylists who had become COVID positive but had consistently worn masks, no secondary cases were found in 139 clients.
- In the ecological studies, n=26/27 studies demonstrated that face mask policies were associated with a decrease in COVID-19 infections and deaths.
    - In nine studies, the decrease in COVID-19 infections attributed to the mask policy ranged from 3.2%–48%.
    - One study from Canada demonstrated that mask policies in Ontario resulted in a 25%–31% weekly reduction in COVID-19 cases starting two weeks after implementation.
    - Three studies assessed the mandated use of masks in all workplaces and found a decrease in COVID-19 infections and deaths, although the results were not consistent.
    - Only one study showed no significant impact with a mask policy when it was implemented under lock down conditions.
- Of the six reviews, the most recent systematic review and meta-analysis with a high AMSTAR (A Measurement Tool to Assess Systematic Reviews) rating found that wearing a mask significantly reduced the risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection (OR 0.38, 95% CI: 0.21–0.69, I^2=54.1%).
- There is currently a paucity of evidence on effectiveness of mask use in school settings.

Conclusion: This body of evidence suggests that mask use does decrease transmission in the community when adherence levels are good and when masks are worn in accordance with public health guidance.

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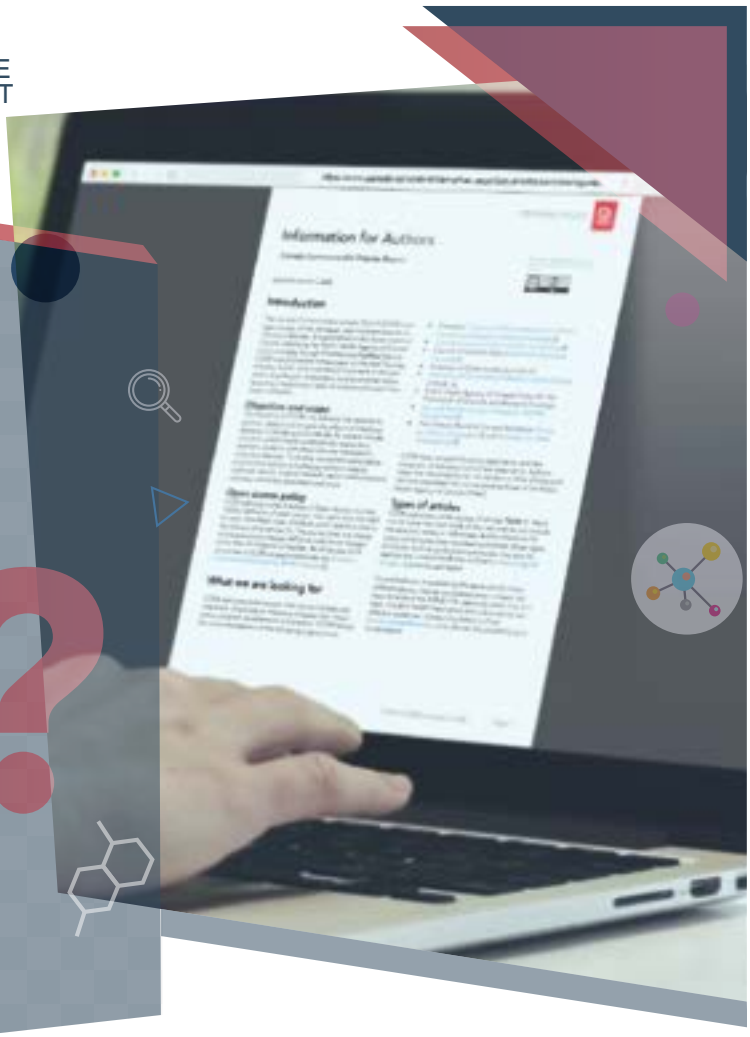

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