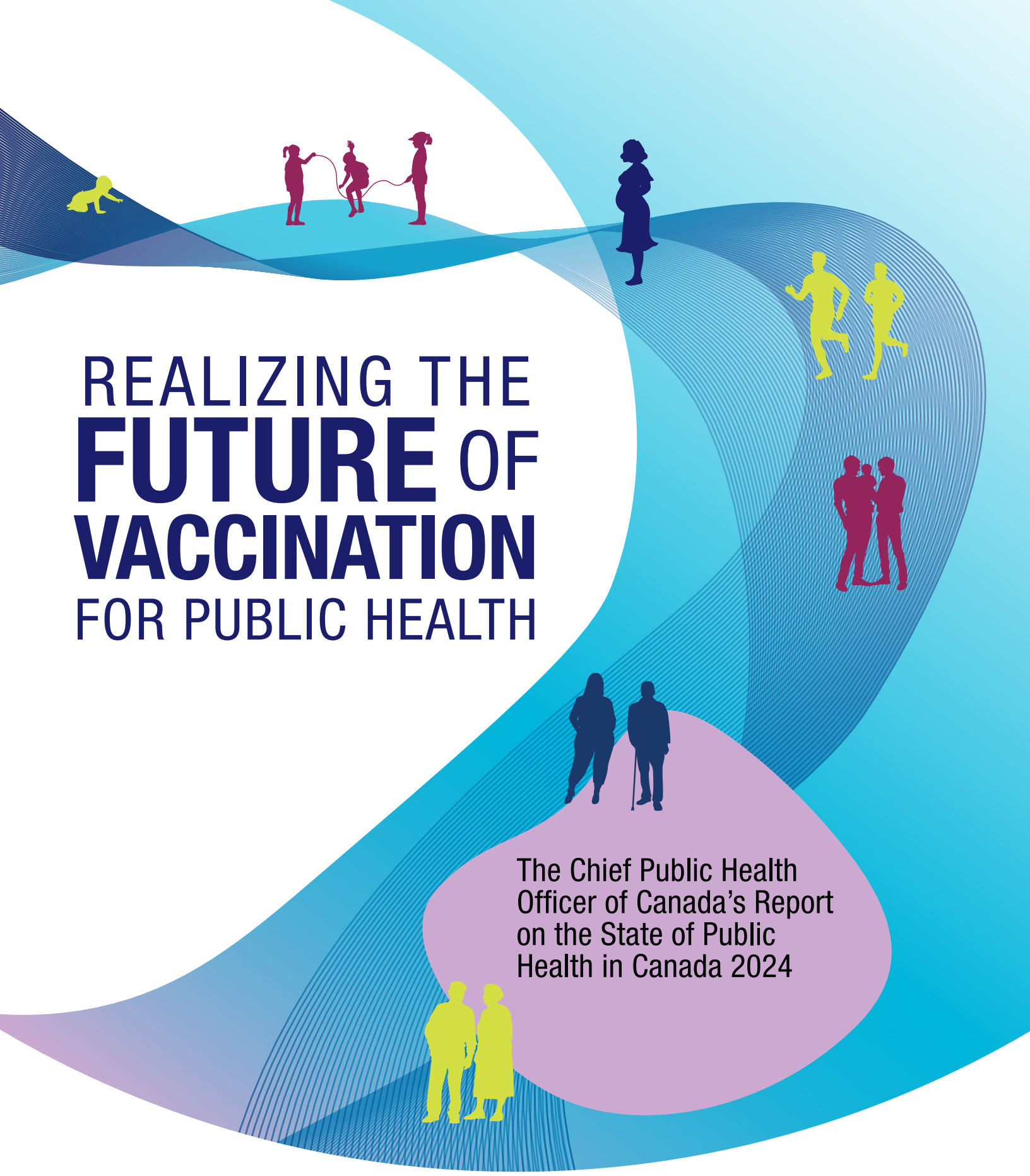

REALIZING THE FUTURE OF VACCINATION FOR PUBLIC HEALTH

The Chief Public Health Officer of Canada's Report on the State of Public Health in Canada 2024

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

Canada

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Table of Contents

Message from the Chief Public Health Officer of Canada

This year, the global community celebrates 50 years of progress since the launch of the Expanded Programme on Immunization (now called the Essential Programme on Immunization). Through this massive collective effort between governments, scientists, health workers, and communities, an estimated 154 million lives have been saved worldwide as a result of vaccines. Similarly, in Canada, we have much to celebrate — the successful implementation of routine human papillomavirus (HPV) vaccination to reduce cervical cancer; the rapid mobilization of resources to support mpox vaccination for those who needed it in 2022; and, the largest vaccination campaign in Canadian history in response to the COVID-19 pandemic. None of these would have been possible without communities leading the way as part of strong and sustained collaboration.

As Canada looks towards renewing the National Immunization Strategy in 2025, vaccines will continue to be integral to disease prevention across the life course. They help people live longer and healthier lives, reduce school interruptions, support safer work and travel, and sustain independence for older adults. Some vaccines also work to protect whole communities through reducing the spread of infectious diseases. By preventing people from getting sick and minimizing serious health outcomes, vaccination decreases healthcare costs and increases economic productivity.

In the coming years, scientific and technological breakthroughs will lead to the introduction of a number of new vaccines that have the potential to address an expanding range of health threats, such as certain cancers and antimicrobial resistance. Novel delivery methods, like nasal vaccines and microneedle patches, hold promise for improving the vaccination experience, enhancing acceptability and accessibility of vaccines. Reducing obstacles in accessing vaccines is particularly important for populations experiencing health inequities, such as people living with low income, individuals residing in rural and remote areas, or those facing other social or structural barriers. Many new technologies and vaccines will continue to broaden the benefits of vaccination beyond childhood and across all stages of life.

The unprecedented spotlight on public health coming out of the COVID-19 pandemic provides an important opportunity to reflect on lessons learned and envision how we can continue to foster a stronger and more resilient vaccination system that adapts to population needs. This includes ongoing work to focus on health equity, and prioritize those most at risk, as well as expand health information systems to assess threats and monitor population health. The COVID-19 pandemic clearly demonstrated the importance of accurate and timely information that people can trust. We must continue efforts that build resilience to mis- and disinformation before crises occur and ensure people can make informed decisions about their health.

We must strive for a vision in which everyone in Canada can experience the benefits of vaccination for health and well-being across their lives.

To achieve this vision, continued work is needed to build a public health system that can better facilitate effective collaboration, reduce health inequities by improving access to vaccines, and adapt to future challenges and opportunities. The public health system also has a responsibility to integrate rights-based approaches to uphold the rights of First Nations, Inuit, and Métis Peoples in Canada. Protecting these rights and supporting self-determination is fundamental to the health and well-being of Indigenous Peoples.

Public health can provide leadership in evidence-informed vaccination planning. We have to consider how to evaluate the often high financial costs of introducing and delivering multiple new vaccines against the health and economic benefits for society. In doing so, we must construct a forward-looking approach that strengthens our current vaccination efforts, plans for future population health needs, and enhances preparedness for pandemics and other public health emergencies.

This year's report builds on my 2021 report, A Vision to Transform Canada's Public Health System, and details how we can strengthen the fundamental components, or building blocks, of the public health system to maximize the value provided by vaccines now and into the future. It proposes tangible actions to guide sustainable investments, strengthen evidence systems, and expand collaboration related to vaccination.

While this report is focused on the vaccination system within Canada, we cannot forget the important role Canada also plays as part of global responses to vaccine-preventable diseases and future pandemics. The world needs Canada to do its part to support a future in which there is sustainable and equitable access to priority vaccines for all.

Dr. Theresa Tam
Canada's Chief Public Health Officer

About this Report

Each year, the Chief Public Health Officer of Canada (CPHO) writes a report on the state of public health in Canada. These reports summarize evidence on high priority public health issues, stimulate dialogue, catalyze action, and provide a way forward to improve the health of people in Canada.

This year's report explores public health system transformation in the context of vaccination. It highlights the past and present role of vaccines in population health and presents a vision for an ideal future of vaccination in Canada. While the report is aimed primarily at decision-makers in all levels of government, the system-level opportunities and actions that are detailed in the report may be relevant to many different players across the vaccination system.

The report builds on themes of equity, intersectoral approaches, and community engagement from previous annual CPHO reports. In particular it leverages the framework presented in the 2021 CPHO annual report by considering how a strengthened and resilient public health system can optimize the impact of vaccination for public health.

Orientation of the Report

The **introduction** highlights the crucial role of vaccination as a cornerstone of public health, emphasizing its health, economic, and societal benefits. It covers the challenges and opportunities facing the vaccination system and envisions an optimal future for vaccination as well as a framework for achievement.

Sections one to three explore the tools that are key building blocks of the public health system from the 2021 CPHO annual report. These are policy and program interventions; evidence, knowledge, and information; and medical and digital health technology.

- **Section one** emphasizes the importance of facilitating equitable access to vaccines by creating supportive resource, healthcare, and information environments. It includes understanding and addressing structural barriers to vaccine access and centring equity and community in vaccination programs and policies.

- **Section two** focuses on enhancing evidence related to vaccination. This involves strengthening public health surveillance, using interdisciplinary research to explore differential vaccine acceptance, better connecting vaccine research and practice, and integrating community knowledge into vaccination evidence systems.
- **Section three** examines leveraging vaccine technology to improve equity. This includes addressing equity gaps through evolving vaccine technology, incentivizing needs-based vaccine innovations, and embedding community engagement throughout the vaccine development process.

Section four discusses the foundations that are fundamental building blocks of the public health system from the 2021 CPHO annual report. These are workforce expertise and human resource capacity; financing; and governance, leadership, and engagement. This section acknowledges the complexities of the vaccination system and the importance of a supported workforce, forward-looking approaches, and strong and agile governance to optimize vaccination in resource constrained contexts.

The **way forward** outlines cross-cutting priority areas with tangible ideas for system-level actions to guide sustainable investments in vaccination, strengthen vaccination data and evidence systems, and expand collaboration mechanisms for the vaccination system.

Appendix A provides an overview of roles and responsibilities in Canada's vaccination system as well as its key players.

Appendix B provides a snapshot of vaccine coverage examples across the life course in Canada.

In addition to research evidence, the report benefits from the leadership and expertise of many contributors. This includes applied public health examples and case studies that were identified by engaging public health and vaccination experts. Further details on the methods and limitations are provided in **Appendix C**.

Evidence and knowledge generation is critical to respond to the challenges and opportunities highlighted in this report. *Generating Knowledge to Realize the Future of Vaccination for Public Health* is a companion resource that calls for coordinated science and research to action report recommendations. The document outlines priority public health knowledge gaps and research needs in the context of ongoing and upcoming domestic and global initiatives. These priorities are aimed at a broad audience, including individual researchers, organizations, funding agencies, and communities, as well as others looking to mobilize vaccine-related research and knowledge. The release of this companion document will follow the publication of the 2024 CPHO annual report.

Health of People in Canada Dashboard

Key indicators on the health of people living in Canada can be found in an interactive online dashboard. The CPHO message that accompanies this resource provides a high-level overview of relevant population trends. All dashboard information is periodically updated.

Land Acknowledgement

The authors of this report respectfully acknowledge that the lands on which we developed this report are the homelands of First Nations, Inuit, and Métis Peoples. Specifically, this report was prepared in the following cities:

- In Halifax, also known as K'jipuktuk, a part of Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People. This territory is covered by the "Treaties of Peace and Friendship" which Mi'kmaq and Wolastoqiyik (Maliseet), and Passamaquoddy Peoples signed between 1725 and 1779. The treaties did not deal with surrender of lands and resources but in fact recognized Mi'kmaq, Wolastoqiyik (Maliseet), and Passamaquoddy title and established the rules for what was to be an ongoing relationship of peace and friendship between nations.
- In Montreal, also known as Tiohti:áke, the traditional and unceded territory of the Kanien'kehá:ka. A place which has long served as a site of meeting and exchange amongst many First Nations, including the Kanien'kehá:ka of the Haudenosaunee Confederacy, Huron/Wendat, Abenaki, and Anishinaabeg.
- In Ottawa, also known as Adawe, on the traditional unceded and unsurrendered territory of the Algonquin People, members of the Anishinabek Nation Governance Agreement.
- In Toronto, also known as Tkaronto, the traditional territory of many nations, including the Mississaugas of the Credit, the Anishinaabeg, the Chippewa, the Haudenosaunee, and the Wendat peoples and is now home to many diverse urban First Nations, Inuit, and Métis Peoples. Toronto is within the lands protected by the Dish with One Spoon Wampum Belt Covenant, an agreement between the Haudenosaunee and Anishinaabeg and allied nations to peaceably share and care for the resources around the Great Lakes.
- In Elora, located in the County of Wellington, which is a part of the Nanfan Treaty #3 and #3.75, the Qu'Appelle Treaty #4, the Toronto Purchase Treaty #13 and #13A, Nottawasaga Purchase/Treaty #18, Ajetance Purchase/Treaty #19, the Huron Tract Purchase Treaty #29, and the Saugeen Tract Purchase/Treaty #45.5, and is the traditional territory of the Anishinabek, Anishinabewaki, Attiwonderonk, Hodenosauneega, Mississauga, Mississaugas of the Credit, Odawa, Petun (Tionontati) and Wendake (Nionwentsïo).
- In Owen Sound, which is a part of Saugeen Treaty #45.5, Half Mile Strip Treaty #67, Saugeen Peninsula Treaty #72, Owen Sound/Nawash Treaty #82, Colpoy's Bay Treaty #93 and the unceded islands of Lake Huron, on the traditional territory of the Anishinabek Nation, specifically the People of the Three Fires known as Ojibway, Odawa, and Pottawatomie Nations. The Chippewas of Saugeen, and the Chippewas of Nawash, known collectively as the Saugeen Ojibway Nation, are the traditional keepers of this land.
- In New Westminster, comprised of spaces also known by names including tsicələs, scɬi'qən', Stautlo, and sχʷəyem, is on the unceded and unsurrendered land of the traditional Halkomelem speaking peoples from the Coast Salish, and in particular the qiqéyt (Qayqayt) and xʷməθkʷəy̓əm (Musqueam) Nations.
- Lastly, in Central Saanich, which is a part of the Douglas Treaties, specifically the South Saanich Treaty, and the North Saanich Treaty, and the traditional territory of the SȾÁUTW̱ and W̱JOŁEŁP First Nations, two of the five communities that constitute the W̱SÁNEĆ Nation.

We recognize that there is much more work ahead to address the harmful impacts of colonialism and racism that continue to generate inequities between Indigenous and non-Indigenous communities. We remain strongly committed to working collaboratively to address health inequities across the country, create a culturally safe public health system, and support the self-determination of Indigenous communities.

Executive Summary

Vaccines provide protection across the life course against a range of infectious diseases. They also can prevent some chronic conditions, like certain types of cancer, and play a role in addressing antimicrobial resistance. Vaccination additionally has wide ranging economic and societal benefits. It can ease strain on healthcare resources, reduce costs to the healthcare system, and increase economic productivity. Successful vaccination efforts help to mitigate the disproportionate impact of infectious diseases on some populations that experience differential exposure, susceptibility, and access to treatment.

Although vaccination is a cornerstone of public health practice, it has not yet been fully leveraged to address existing public health threats. There are gaps in vaccine uptake, access, and evidence, as well as capacity and resource challenges for some people and communities. The public health system must also be prepared to take advantage of future advancements in vaccine technology.

This report offers a vision and framework to realize the full potential of vaccination in Canada, so that everyone, at every stage of life, can experience the benefits of vaccination for health and well-being.

To achieve this vision, public health can continue to take a leadership role to:

- **Harness vaccination to promote health for all people across the life course;**
- **Facilitate collaboration across systems and with communities; and,**
- **Prepare for and adapt to evolving health, technology, and sociocultural contexts.**

Cutting across this framework are principles that can help steer the collective efforts of people, organizations, and institutions that make up the vaccination system. These principles represent the basis of a public health approach to vaccination, one that prioritizes prevention and takes a population-level perspective on health.

- **Population health approach:** Stimulating action across sectors and with a life course perspective to improve population health and reduce vaccination-related inequities.
- **Equity:** A commitment to and recognition that an equity-focused public health system requires multiple voices at decision-making tables. Equity considerations and community engagement inform vaccination programs and policies.
- **Rights-based:** Recognizing colonial injustices and the inherent rights of Indigenous Peoples in Canada, and applying rights-based frameworks to vaccination decision making, programs, and policies.
- **Evidence-informed and effective:** Valuing inclusive, diverse, high-quality, and innovative systems of knowledge and evidence to support optimal vaccination programs and policies.
- **Participatory:** Integrating diverse participation, respect for community knowledge, relationship building, and meaningful collaboration into the core of vaccination activities.

- **Trustworthy:** Earning trust by demonstrating transparency, listening continuously, reflecting on feedback, and taking concrete actions within the vaccination system to be accountable to the people the public health system serves.

To achieve a future in which everyone can benefit equitably from vaccination, efforts need to be strengthened across the public health system. The main content of the report uses the building blocks of Canada's public health system to explore the following four areas in which to focus efforts, with examples of key actions and innovations to work toward them.

Supportive environments that facilitate access to vaccination and reduce barriers to vaccine uptake

- Reducing resource barriers, such as the ability to book and travel to appointments or pay for costs, can improve access to vaccines, particularly for populations facing inequities.
    - **Examples:** Community-based vaccination programs; mobile clinics; flexible service hours; workplace and school-based programs; and integration of vaccination into other forms of social supports.
- Designing supportive healthcare environments can offer positive vaccination experiences.
    - **Examples:** Access to a range of trusted vaccination providers; co-delivery of vaccines with other age-appropriate health interventions; and culturally safe and person-centred approaches to vaccination, especially for groups who experience stigma and discrimination in the health system.
- Creating information environments that can meet people where they are at to facilitate vaccine awareness, literacy, and trust.
    - **Examples:** Tailored communication strategies that are community-informed, culturally relevant, and accurate; trusted relationships with communities; and strategies involving multiple sectors that build resilience to misinformation.

Evidence systems that are interoperable and inclusive to understand population health needs and support vaccination policies and programs

- Broadening health surveillance strategies, enhancing the availability of disaggregated data, and building interoperable data systems can help understand where vaccination efforts are most needed to improve equity.
    - **Examples:** Innovative surveillance methodologies for infectious diseases across the life course; collection and analysis of data by race, ethnicity, sex, gender identity, age, geography, and socioeconomic status; prioritization of First Nations, Inuit, and Métis data sovereignty; and linkage of vaccination and other health data systems.
- Using interdisciplinary research and validated tools can help understand the complex interplay between vaccine access and the knowledge, attitudes, and beliefs that influence vaccine uptake.
    - **Examples:** Focused research with key populations and communities experiencing inequities; survey methods validated by vaccination experts and tested in real-world settings; and interdisciplinary approaches to examine the sociocultural factors influencing vaccination.
- Strengthening the connections between research and vaccination policy and practice can bolster evidence-informed decision making.
    - **Examples:** Networks to generate and mobilize knowledge; and research that evaluates how interventions are applied in real-world settings.
- Incorporating community knowledge into vaccination evidence systems can leverage local context for enhancing vaccination efforts.
    - **Examples:** Community-led data collection and participatory research; consistent and culturally safe methods for First Nations, Inuit, and Métis self-identification and data access; and addressing significant jurisdictional data gaps for urban Indigenous populations.

Purposeful and adaptive vaccine technology that is driven by population health needs and can address equity gaps

- Incentivizing the development of vaccine innovations that reflect epidemiological trends and community needs can improve population health and address health inequities.
    - **Examples:** Collaboration between public health organizations, communities, countries, industry, and academia to incentivize the development of priority vaccines; public-private partnerships; pathogen prioritization reports and preferred product characteristics; and strengthened domestic manufacturing capacity.
- Evolving vaccine technology can be harnessed to address equity gaps.
    - **Examples:** New vaccines for infectious and chronic diseases that disproportionately impact some populations; more effective and durable vaccine formulations; and delivery methods that improve acceptability and accessibility.
- Digital health technologies can be leveraged to support vaccine uptake and efficient vaccine distribution.
    - **Examples:** Reminder systems; electronic consent processes; clinical decision alerts; and digital supply chain platforms.
- Embedding community engagement into the vaccine development process can improve vaccine acceptability, relevance, and access.
    - **Examples:** Formal structures for community engagement; ethical and culturally safe research design; recruitment of diverse clinical trial participants; and co-development of research processes with First Nations, Inuit, and Métis communities.

Strengthened public health system infrastructure for vaccination

- Providing healthcare workers with the right resources and tools, supporting a diverse range of vaccination providers, and building trusted patient relationships can bolster capacity of the public health workforce to deliver vaccines.
    - **Examples:** Scope of practice expansions for allied health professionals and community workers; training to implement culturally safe care; tools to support effective and timely vaccination discussions; and electronic access to patient records and vaccination history.
- Optimizing resource allocation with innovative and comprehensive social and economic analyses will support efficient decision making, by meeting population health needs and balancing equity and investment considerations.
    - **Examples:** Evaluations to assess cost-effectiveness of the prevention of morbidity and mortality; analysis of social and economic benefits associated with vaccination; and indicators measuring the impact of vaccines on health inequities.
- Leveraging existing opportunities for collaboration and coordination on shared priorities can improve vaccination programs across the country, while respecting jurisdictional autonomy and Indigenous self-determination.
    - **Examples:** Cross-jurisdictional vaccination networks to encourage sharing of best practices; coordinated communication efforts that demonstrate transparency; First Nations, Inuit, and Métis representation in vaccination governance structures; and the consideration of equity and rights-based frameworks in all vaccine guidance.

Now is an opportune time to reflect on lessons learned from the COVID-19 pandemic and other recent experiences with emerging and re-emerging infectious diseases in order to better position Canada to meet domestic vaccination needs and support global health security. In the Way Forward, this report proposes tangible actions to help catalyze these efforts across the themes of guiding sustainable investments in vaccination, strengthening vaccination data and evidence systems, and expanding mechanisms for collaboration within the vaccination system. This aspirational vision encourages all those in the vaccination space to work together, so that the full potential of vaccination can be realized.

Vaccination from the Past to the Future

Vaccination as a Key Public Health Tool

Prior to routine vaccination programs, infectious diseases posed significant threats to health and life, particularly among children. In the 1900s, infectious diseases were leading causes of death in Canada.[1–3] The introduction of public vaccination programs in the 20th century, along with improvements in sanitation, notably reduced the burden of vaccine-preventable diseases (see Figure 1).[4, 5] Researchers have estimated that vaccination has saved 154 million lives worldwide since 1974, with an average gain of 66 years of full health per death averted.[4] More recently, COVID-19 vaccination has substantially reduced rates of serious illness and death.[6]

Vaccination remains a global health priority and directly or indirectly contributes to 14 out of the 17 United Nations Sustainable Development Goals.[7] In recognition of this, the World Health Organization (WHO) supported the development of the Immunization Agenda 2030 (IA2030), a global vision and strategy to tackle key issues related to vaccination (see text box "Vaccination and Immunization").[7]

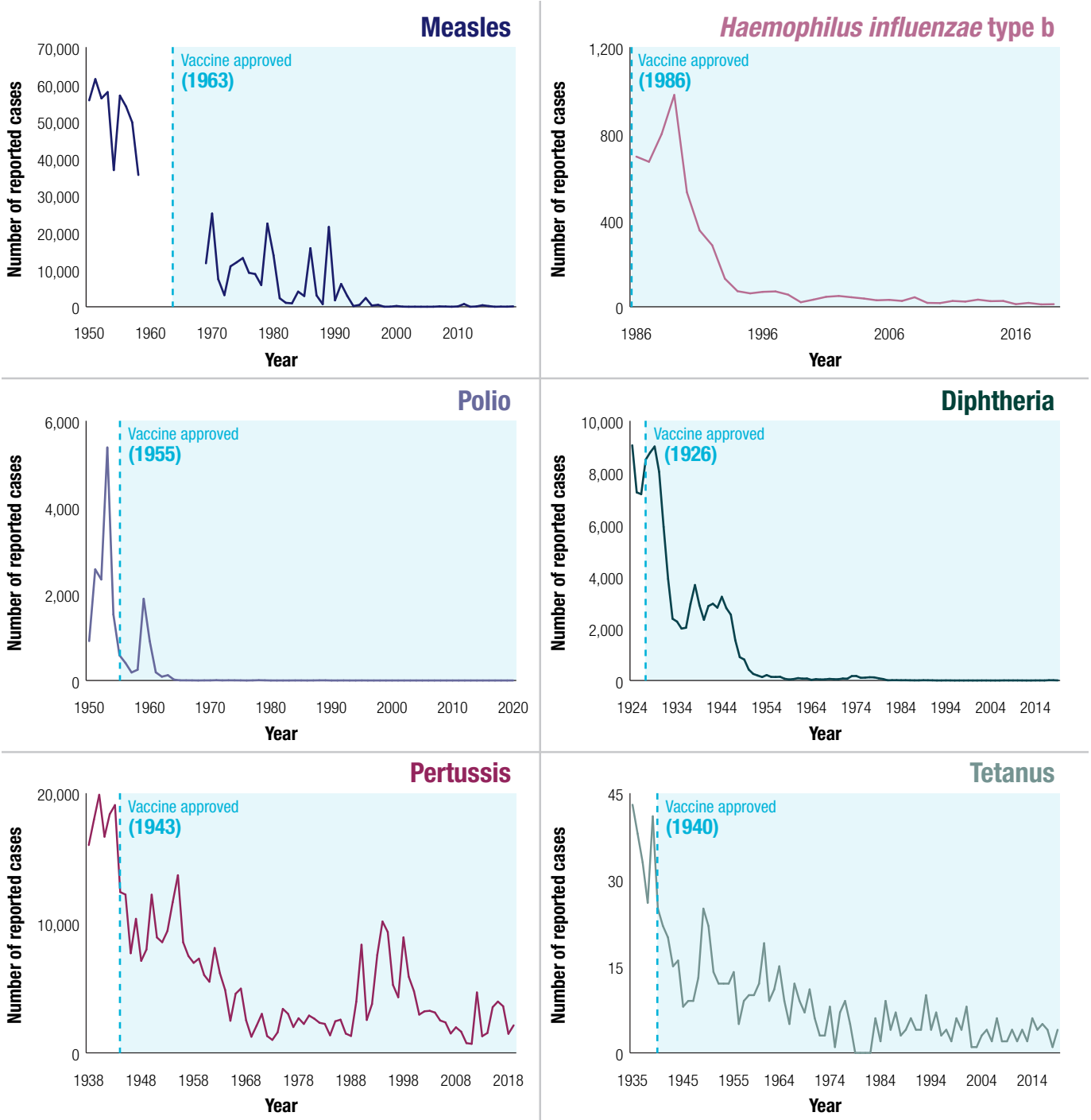
Vaccination and Immunization

Vaccination refers to the act of introducing a vaccine into the body, while immunization is the process of becoming protected against a disease.[8] This protection can result from vaccination or exposure to pathogens, which are microorganisms, such as viruses, bacteria, and parasites that cause disease.

Vaccination and immunization are often used interchangeably. For greater precision and clarity, this report will largely use the word vaccination to refer to immunization via vaccines, except where necessary to reflect original source language.

Historically, public health efforts have focused on establishing routine childhood vaccination programs to protect children early in life, ideally before their first exposure to a pathogen (see text box "How Do Vaccines Work?").[9] However, public health experts are increasingly looking to harness the benefits of vaccination across the entire life course. A life course approach to vaccination aims to maximize the benefits of vaccines for health and well-being throughout the life span and integrate vaccination with other age-related health interventions, from infancy to older adulthood.[10]

Figure 1: Reduction in Vaccine-Preventable Diseases in Canada over the Past Century[1, 2]



Notes: Graphs depict the number of reported cases of each disease per year in Canada for the following timeframes: Measles: 1950–1958, and 1969–2019. Data gap reflects period when measles was not nationally notifiable (1959–1968); *Haemophilus influenzae* type b (Hib): 1986–2019; Polio: 1950–2020; Diphtheria: 1924–2019; Pertussis: 1938–2019; Tetanus: 1935–2019.

The date by which each vaccine was included in provincial/territorial routine vaccination programs may differ from the approval date.

How Do Vaccines Work?

Vaccines work by exposing the immune system to key parts of a pathogen, called antigens. This prompts the body to create an immune response without the risks associated with developing the disease itself. The immune system produces antibodies and develops immune memory for the pathogen.[11] As part of this immune response, some people may experience mild symptoms, such as fever, chills, or fatigue, which usually resolve in a few days.[12]

Many vaccines require multiple doses, given weeks or months apart, to build protection. Then, if exposed to the pathogen in the future, the immune system will be able to respond more quickly to prevent infection or serious illness. Some vaccines offer life-long protection for most people (e.g., two doses of a measles vaccine), while other vaccines need additional doses to maintain protection (e.g., booster doses of the tetanus vaccine) or respond to pathogen mutation (e.g., annual influenza vaccines).[13]

Many vaccinations provide population-level protection through community immunity, also known as herd immunity. When a sufficient proportion of the population is vaccinated against a pathogen, it helps prevent the disease from spreading and protect those who cannot be vaccinated or for whom vaccinations do not work as well, for example due to age or underlying medical conditions.[11]

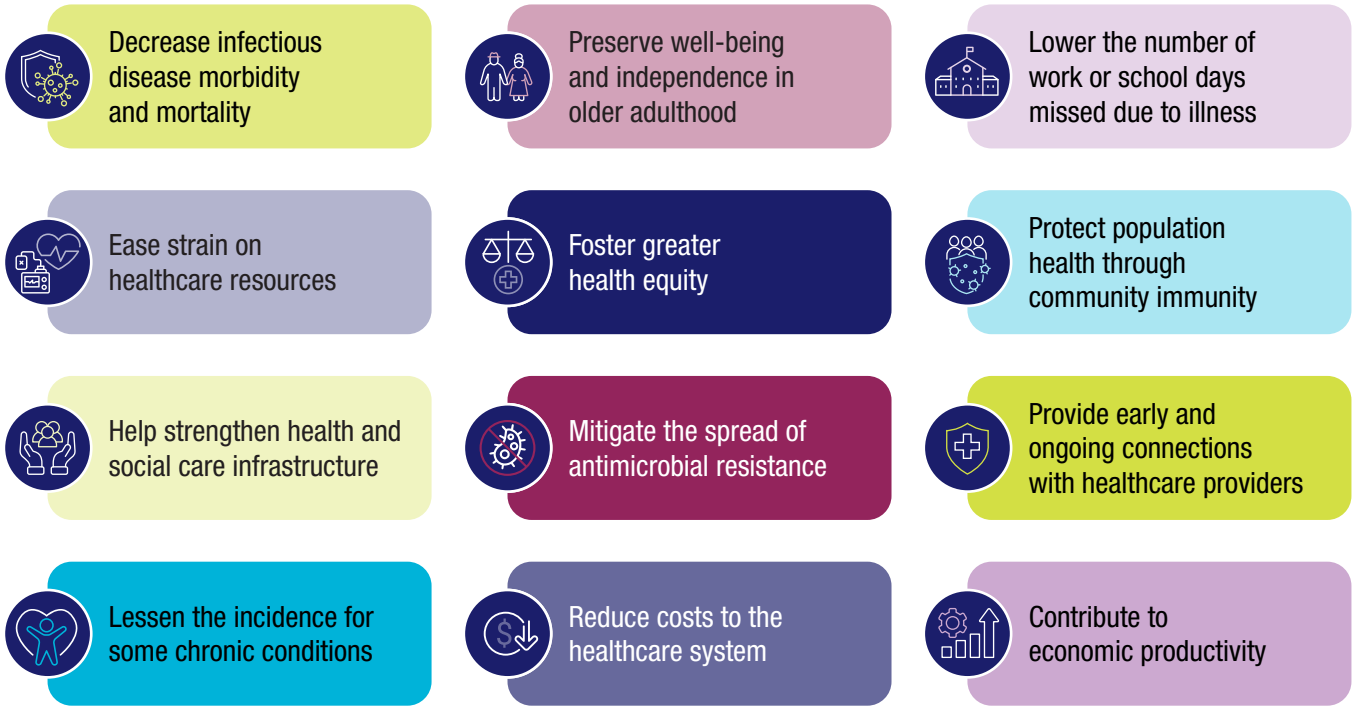
In addition to routine (e.g., measles, chickenpox, polio) and seasonal (e.g., influenza) vaccination programs, vaccination may be recommended for certain international travel (e.g., typhoid).[14] Some vaccines are also used as part of outbreak response (e.g., mpox, meningococcal disease) and others are specifically for emergency preparedness (e.g., anthrax) and often stockpiled in case of a public health threat.[15–19]

The protections offered by vaccines are particularly important for populations who are more likely to experience negative health outcomes associated with infectious diseases; for example, people living with chronic conditions, such as heart disease and autoimmune disorders.[20] Infants may also be at higher risk of complications from an infection while their immune systems are still maturing and before they are old enough to receive vaccinations.[21] For this reason, several vaccines, such as those for pertussis (whooping cough) and influenza, have become a regular part of care during pregnancy.[22, 23] The antibodies pregnant people develop in response to these vaccines can cross the placenta and help protect the baby following birth. The risk of developing serious illness from infectious diseases or their complications is also increased for older adults. This is partly due to aging-related weakening of the immune system, as well as a higher likelihood of having chronic conditions. Receiving vaccines as one ages, like those against influenza, pneumococcal disease, and shingles, helps to preserve well-being and independence in older adulthood.[24]

The Health, Economic, and Societal Value of Vaccination

As summarized in Figure 2, the benefits of vaccines can extend beyond their critical ability to reduce morbidity and mortality from acute infections. For example, human papillomavirus (HPV) vaccination protects against cervical and certain other cancers.[25–28] Researchers' initial findings showed that women who had received the HPV vaccine as part of a school-based vaccination program in British Columbia had a 57% reduction in the incidence of cervical pre-cancer cells.[29] Additionally, vaccination against influenza is associated with a decreased risk of cardiovascular events, and receiving COVID-19 vaccines is associated with a lower risk of developing post-COVID-19 condition.[30–34]

Figure 2: Vaccination has Wide-Ranging Benefits[7, 35, 36]



Note: These are examples and do not represent the full range of vaccination benefits.

Vaccination also plays a role in addressing the growing threat of antimicrobial resistance (AMR). AMR occurs when pathogens no longer respond to antimicrobial products, like antibiotics. Vaccines can prevent the spread of antibiotic-resistant strains of bacteria, such as some types of *Streptococcus pneumoniae* that cause pneumococcal disease.[37–39] Additionally, vaccination lowers the overall use of antibiotics in several ways.[38] For one, certain vaccines provide protection against infectious diseases caused by bacteria, such as whooping cough, thereby minimizing the need for antibiotics. Vaccination also reduces viral illnesses, such as influenza, for which antibiotics may be inappropriately used, since they are ineffective against viruses. Preventing viral infections can also reduce possible secondary or opportunistic bacterial infections that would require antibiotics to treat.[38, 40] Research suggests that half a million AMR-related deaths could be averted each year globally through vaccination.[41]

Reducing the overall burden of infectious diseases through vaccination offers broader health system benefits by decreasing the number of patients who may require treatment, thereby easing strain on healthcare resources. Vaccination is also a core component of well-child visits, which more broadly promote children's health and offer ongoing connections for families to healthcare systems.[42, 43]

Although the positive health impacts of vaccination are most obvious, there are also significant potential economic and societal benefits. The economic outcomes span sectors, offering cost savings to the health system, productivity gains for businesses, and reductions in lost wages for families as a result of work missed due to illness (see text box "The Return on Investment in Vaccination").[35, 44, 45] Additionally, vaccines help protect the health of those who provide care for others, such as healthcare workers, parents, guardians, and caregivers. Vaccination can also lower the number of days parents and caregivers need to miss work to care for sick children. For example, research suggests that influenza vaccination programs were associated with a reduction in school absences.[46–48] School absences may pose a particular challenge for women, as they continue to perform a larger share of parental tasks than men.[49]

The Return on Investment in Vaccination

Many vaccines are cost-saving, meaning that the cost of implementing the vaccination program is lower than the cost of treating the illness that would occur if the program was not implemented.[35] While newer vaccines tend to be costlier and may not be cost-saving, they provide health benefits for a low relative cost, making them one of the most cost-effective public health interventions.[35, 50]

Reducing the incidence of vaccine-preventable diseases generates substantial returns on investment by decreasing healthcare costs, increasing productivity, and averting the economic burden of disease outbreaks.[50–53] Researchers have estimated that Canada's COVID-19 vaccination program resulted in tens to hundreds of billions of dollars in broader economic gains compared to a scenario without vaccination. The largest benefits were due to preventing premature mortality, an estimated $222 billion benefit.[45]

Globally, some evaluations of the economic value of vaccination programs suggest:

- Every $1 USD spent on childhood vaccination programs in the United States saves about $11 USD;[54]
- The average return on investment for every £1 spent on three vaccination programs (HPV, shingles, and pneumococcal disease) in the United Kingdom is £2.18;[55] and,
- Every $1 USD invested in vaccines in 73 low- and middle-income countries saves between $21 and $54 USD.[56]

Vaccination as an Essential Part of the Public Health System

Much of the early development of public health systems was anchored in efforts to control infectious diseases and reduce infant mortality rates, partly through vaccination.[57] Today, vaccination remains a cornerstone of public health practice and is directly implicated in several essential public health functions: health protection, disease and injury prevention, and emergency preparedness and response.[58]

> *Immunizations are one of the most important public health interventions that we've ever instituted. They're a minor miracle. Most of the vaccines that we have, you can administer once or a few times, and then they protect you for a lifetime.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Vaccines and vaccination rely on interconnected systems for research and development, manufacturing, regulatory approval, recommendations for use, program implementation, procurement, delivery, uptake, and surveillance.[7] The network of organizations, processes, and resources involved in these components is referred to as the vaccination system. Key players include research institutions, pharmaceutical and biotechnology companies, international partners, governments (federal, provincial, territorial, Indigenous, and local), non-governmental organizations, healthcare providers, and communities, among many others (see Figure 3). In Canada's federated system, health care, including vaccination, is a shared responsibility among all levels of government. See Appendix A for an overview of roles and responsibilities in Canada's vaccination system.

Figure 3: Overview of Key Players and Their Roles in Canada's Vaccination System[59–65]

Note: These are examples and do not represent the full range of activities or participants in Canada's vaccination system.

Challenges and Opportunities for Canada's Vaccination System

Sustaining and enhancing the positive impacts of vaccination will require addressing challenges and seizing opportunities for improvement within the vaccination system. This includes understanding the drivers of disproportionate infectious disease burden, addressing inequities in vaccine access and uptake, combatting vaccine mis- and disinformation, preparing for new public health threats, and leveraging advancements in vaccine technology. All of these activities are supported by building a resilient public health system that continues to take a leadership role in vaccination.

Enduring Disproportionate Infectious Disease Burden

Structural and social determinants of health influence who is exposed to infectious diseases, how susceptible they are to severe illness, and whether or not they are able to access culturally safe treatment.[66–68] Structural determinants, which include the broader societal and economic context, shape the social determinants, which encompass the conditions of daily life.[69] These determinants of health interact and intersect with each other and broader systems and structures to benefit some people while excluding others, creating barriers to good health and healthy choices. For example, colonization and systemic racism impact income, housing, work, education,

social connections and cohesion, trust, access to health care, and the digital environment.[70]

These conditions can foster or undermine the choices available for people to influence their own health. For instance, an inability to work from home or access paid sick leave may increase the likelihood of being infected during a pandemic, and malnutrition as a result of food insecurity is a risk factor for more severe disease outcomes.[71–73] Stigma and discrimination can undermine access to appropriate, meaningful, and culturally safe health care that meets social, cultural, and linguistic needs.[74] The role of these determinants are recognized in the *Ottawa Charter for Health Promotion*, which emphasized the importance of supportive environments to enable good health and well-being by improving the conditions of daily life.[75]

Inequities in the structural and social determinants of health have led to unequal infectious disease burden for some populations.[76–78] Infectious diseases have disproportionately impacted Indigenous Peoples since the beginning of settler-colonialism. Colonizers introduced pathogens that Indigenous Peoples had not previously been exposed to, like smallpox, diphtheria, and tuberculosis, which caused waves of deadly epidemics. Furthermore, colonial policies, such as residential schools and forced relocations, led to increased exposure and susceptibility to infectious diseases (e.g., from overcrowded living conditions).[79–81] Colonialism endures within policy structures and systems that disrupt Indigenous practices and ways of knowing and being. This creates social and economic conditions that contribute to a high burden of chronic conditions, such as diabetes and heart disease, that increase the risk of experiencing severe outcomes from infections.[82–85]

First Nations, Inuit, and Métis Peoples continue to experience systemic barriers to accessing health services, such as jurisdictional challenges in health policy and funding, anti-Indigenous racism, and a lack of culturally safe and trauma-informed care in many healthcare settings.[86, 87] Additionally, discrimination and colonial practices have led to a lack of trust in the health system and healthcare providers.[79, 80, 88] For Indigenous populations, this includes experiencing unethical research trials, segregated health care, and removal from community for health services, such as Inuit being relocated to southern tuberculosis sanatoria in the mid-1900s.[89–91] Despite these challenges, many First Nations, Inuit, and Métis communities have demonstrated success in integrating health promotion with self-determined infectious disease prevention and mitigation efforts.[85] For example, the Ma Mawi Wi Chi Itata Centre in Winnipeg is a leader in providing culturally relevant programs and services for urban Indigenous populations that address the social determinants of health. They leveraged their expertise and connections to meet community needs during the COVID-19 pandemic, which included access to testing, vaccination, and emergency food kits.[92, 93]

Understanding how systemic racism impacts health requires an intersectional lens, which explores how systems of power and oppression, such as racism, classism, and sexism, are interconnected.[94] For example, researchers and community leaders have emphasized the need to understand the heterogeneous identities, social positions, and histories of Black populations across Canada.[95–97] Black communities have worked to disrupt anti-Black racism and implement Afrocentric approaches to promote Black health in Canada.[98] For example, in 2022, the Black Physicians' Association of Ontario launched the Black Health and Wellness Initiative to improve differential health outcomes and advocate for better care for Black populations in the province through a whole health and well-being approach.[99]

Alongside addressing inequities in the social and structural determinants of health, vaccination can be an important tool to mitigate the unequal impact of infectious diseases by bolstering protection for populations at higher risk of infectious disease exposure and negative health outcomes.[100–102] While there are limited data that include equity measures, one Canadian example of vaccination having an equity impact is routine infant rotavirus vaccination in Ontario. Prior to the vaccination program in 2011, the hospitalization rate for rotavirus-associated gastroenteritis for children from communities facing the most marginalizing conditions was 34% higher than children from the most affluent communities. This difference disappeared following the implementation of routine vaccination, highlighting the program's role in reducing health inequities.[103] Similarly, the national HPV vaccination program in England was associated with reducing inequalities in cervical cancer between socioeconomic groups.[28]

If you're able to work and address some of these structural and societal determinants of health, you will help to improve the equity of vaccines as well.

INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)

Persisting Inequities in Vaccine Access and Uptake

Many of the same structural and systemic factors that drive inequities in infectious disease burden also influence differential access to and uptake of vaccination. For instance, people living with disabilities can face barriers to accessibility for mass vaccination clinics, and newcomers may experience challenges finding accurate information about vaccines and vaccine-preventable diseases that meets cultural and linguistic needs.[104, 105]

Historic and ongoing medical racism has impacted vaccine acceptance among a number of groups, including Indigenous Peoples and Black populations.[79, 80, 106–110] Experiences of stigma, mistreatment, and trauma, such as medical experimentation, reproductive injustice, and abuse, can result in impacts that cross generations.[80, 110] Inequitable access to health care may further exacerbate these challenges. For example, a "patch work" healthcare model has resulted in significant jurisdictional gaps in access to vaccinations for First Nations, Inuit, and Métis Peoples.[108, 111–113] Despite these challenges, many communities have led effective initiatives to facilitate vaccination. For instance, during the rollout of COVID-19 vaccines, Indigenous community groups, governments, and leaders acted quickly to create culturally safe vaccination services.[114–117] For example, Métis Nation Alberta ran a COVID-19 vaccination clinic with Indigenous health professionals, and the Qikiqtani Inuit Association in Nunavut developed COVID-19 vaccine infographics and posters in Inuktitut and English.[117, 118] Similarly, Black communities led research and action to promote vaccine uptake, including the work of the Black Scientists Task Force on Vaccine Equity.[119]

Inequity in access to vaccination is one of many factors that contribute to differential vaccine coverage (the proportion of eligible people who have received a vaccine).[120, 121] For instance, in 2021 in Canada, children at two years of age who lived in remote areas had lower overall vaccine coverage for routine vaccinations than those living in less remote locations.[122] Vaccine coverage varies between vaccines and life stages, with young children having the highest coverage as a result of widespread routine vaccination programs (see Appendix B). However, there is still more progress needed across all age groups to increase vaccine coverage. The Public Health Agency of Canada (PHAC) sets national targets for coverage based on a number of factors, including the proportion of people who need to be vaccinated to provide population-level protection.[123] At the time of writing this report, these targets are being reassessed and updates are expected in 2025. For all routine childhood vaccinations, the current vaccine coverage goal is 95%, while for other vaccines the targets vary between 80% and 90%.[123]

Even if vaccine coverage at the national level is high, there are groups or clusters of individuals (e.g., by geography, community) with much lower vaccine coverage.[124, 125] Sub-optimal and highly varied coverage across sub-populations increases the chance of outbreaks and risks losing some of the gains achieved over the past century.[122, 124] Disaggregated coverage data (e.g., by race, income, disability, sexual orientation, gender identity) and implementation-based research can support the development of tailored and community-led vaccination approaches, particularly for populations facing intersecting social, structural, and economic inequities.[126–128] This requires addressing long-standing challenges with the collection and sharing of disaggregated data in Canada's health data ecosystem.[129]

Changing Information Environments

Most people in Canada believe that vaccines are safe and effective, but ongoing concerted efforts are needed to reinforce social norms that are supportive of vaccination as a collective good.[122, 130] While vaccine coverage remains high overall, vaccination has become a polarized topic, particularly across digital and social media platforms. Mis- and disinformation are not new phenomena, but the speed and reach of their spread online is posing a public health threat (see text box "Vaccine Mis- and Disinformation").[131, 132] Not only are mis- and disinformation growing in scale, they are also becoming more sophisticated, which complicates work to detect and address them.[133] A 2022 systematic review found that exposure to mis- and disinformation can reduce trust, increase polarization, and negatively impact mental health.[131]

Vaccine Mis- and Disinformation

Misinformation is a broad term used to refer to many types of false or misleading information, some of which may exist without malicious intent. Disinformation is incorrect information that is created or spread specifically to deceive or mislead. There are a variety of reasons for the creation and spread of disinformation, including financial motives (e.g., advertising revenue, sale of supplements or natural health products) or the promotion of polarization for personal or political gain.[132] Vaccine mis- or disinformation may be about vaccines or the vaccination system, including vaccine safety or efficacy and conspiracies about vaccine development and promotion.[131, 132]

Both mis- and disinformation can be spread through a variety of channels, such as personal communication, social media, websites, traditional media, and public figures (e.g., celebrities, politicians). This can undermine trust in the systems and institutions that research, develop, manufacture, regulate, promote, and provide vaccination and negatively impact vaccine knowledge, attitudes, beliefs, and uptake.[132]

Mis- and disinformation exploit gaps in digital literacy that make it challenging to discern evidence-informed sources from unreliable ones and to critically evaluate information online.[132, 134] While disinformation is created with the intent to deceive, it may be shared by others who have not verified its claims or validated its accuracy. Boosting digital health literacy can help individuals identify mis- and disinformation and disrupt its spread.[132]

The COVID-19 pandemic was widely described as being accompanied by an infodemic.[135] This refers to a large volume of information, including both accurate and mis- and disinformation, that creates difficulties with finding, prioritizing, or evaluating evidence.[136] In this context, mis- and disinformation, alongside rapidly evolving scientific knowledge and mixed messaging, led to mistrust in health authorities and undermined the public health response.[131, 137–139] The Council of Canadian Academies Expert Panel on the Socioeconomic Impacts of Science and Health Misinformation estimated that misinformation may have resulted in over 2.3 million people delaying vaccination and $300 million in COVID-19-related hospitalization costs in Canada between March and November 2021.[132]

The impacts of vaccination misinformation are seen at different levels:[131, 132]

- **Individual:** Misinformation can distort understanding of vaccines leading to confusion, skepticism, or doubts about their safety and effectiveness. This may contribute to delaying or refusing vaccination.
- **Community:** Misinformation can undermine vaccination efforts, leading to lower vaccine coverage, posing risks to individuals and communities. Additionally, misinformation risks disrupting social cohesion and creating polarization within communities by establishing different realities and conflicting narratives that make it difficult to find common ground.
- **Societal:** Misinformation can erode trust in healthcare institutions, government agencies, and scientific methods and expertise, leading to decreased confidence in vaccine recommendations and public health interventions.

The relationship between trust, mis- and disinformation, and vaccination may be particularly complex for populations who already experience mistrust in health care or government, partly due to social and structural determinants, such as systemic discrimination.[109, 140–142] Ongoing, coordinated, and co-developed action by all players in the vaccination system, including efforts of reconciliation, may help prevent these social and informational dynamics from undermining vaccine acceptance (see text box "Definitions of Key Terms").

Definitions of Key Terms

- **Vaccine acceptance** is the willingness or intent to receive a vaccine.[79]
- **Vaccine confidence** is the belief that vaccines are effective, safe, and part of a trustworthy medical system.[143] Vaccine acceptance and confidence are distinct. Individuals may have high vaccine acceptance and low vaccine confidence and vice versa.[144]
- **Vaccine hesitancy** is the motivational state of being conflicted about or opposed to getting vaccinated, as defined by the WHO in 2022. However, the phrase "vaccine hesitancy" has been used and applied in multiple ways, including being conceptualized as involving beliefs, behaviours, or decision making.[145] Given the varied use of this language, this report will largely rely on the terms vaccine acceptance and uptake, or vaccine knowledge, attitudes, and beliefs to refer to more neutral descriptors of individual or public perceptions towards vaccines, except when referring to original source material.
- **Vaccine literacy** is the degree to which people have the capacity to obtain, process, and understand basic information about vaccines and vaccination services to make informed decisions.[146, 147] It is considered a tool of empowerment and includes the ability to navigate healthcare systems and effectively communicate with healthcare providers. Vaccine literacy is closely linked to digital health literacy, which refers to the ability to seek, identify, understand, and assess health information from digital sources.[148]

Public health decision-makers are also facing an ever more complex information environment. Over the past two decades, there has been an increasing volume of scientific studies on a range of vaccination-related topics.[149] The COVID-19 pandemic further accelerated research with the number of academic publications on vaccine hesitancy alone increasing 40-fold in 2021 and 2022.[150] Therefore, decision-makers grapple with identifying relevant information, synthesizing large amounts of complex and evolving scientific findings, and translating them into actionable public health strategies. Developing and strengthening robust mechanisms for evidence synthesis, knowledge mobilization, and translation of research into policy and practice can support navigation of this growing evidence base.[149]

Evolving Disease and Technology Landscapes

There is an ongoing risk of new outbreaks or pandemics caused by emerging or evolving pathogens. Climate change, for example, is driving ecological changes that exacerbate the spread of climate-sensitive infectious disease (see text box "A One Health Approach to Vaccination in the Context of Climate Change").[151, 152] More than half of known human infectious diseases can be aggravated by the effects of climate change, through affecting people's exposure and susceptibility.[153, 154] Climate change also influences the capacity of public health and healthcare systems to respond to outbreaks, by increasing demand for health services and through threats to infrastructure, workforces, and supply chains.[155] Alongside work on mitigation and adaptation, it is necessary to foster a resilient public health system that can continue to carry out essential functions, including vaccination, in the context of climate change.

A One Health Approach to Vaccination in the Context of Climate Change

The widespread impacts of climate change, including altered ecosystems (e.g., through deforestation, changing temperatures, precipitation patterns), highlight the interconnectedness of human, animal, and environmental health. This necessitates global commitment to action across sectors and interventions at individual, institutional, and structural levels.[156, 157] One Health is "an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals, and ecosystems."[158] A One Health approach recognizes the linkages between these components and can leverage vaccines as part of a broader strategy to reduce the spread of antimicrobial resistance and the transmission of food-, water-, and vector-borne diseases. For instance, some countries have recently introduced vaccines for malaria and dengue fever, and some international travel may require vaccination against yellow fever, all of which are mosquito-borne diseases.[159–163] As climate change can exacerbate the spread of certain infectious diseases and amplifies global migration, vaccines currently recommended for international travel in Canada could become increasingly important.

Additionally, there has been a noticeable increase over the past decade in human cases of Lyme disease in Canada, from 144 cases in 2009 to 2,634 cases in 2019, attributed partly to climate change.[164] This bacterial infection, transmitted through the bite of infected ticks, has surged as increasing average temperatures expand the habitat range of tick populations. A vaccine for Lyme disease was developed in the late 1990s, but was later discontinued by the manufacturer.[165] Since then, efforts have been underway to develop new vaccines for Lyme disease, reflecting its increasing importance in the context of climate change.[166]

Over the next decades, changes to the vaccine landscape are expected, accelerated by advances in vaccine technology spurred by the COVID-19 pandemic, such as the realization of decades of research on mRNA and viral vector vaccines.[167, 168] These advancements could include new vaccines for the treatment of chronic conditions, an expansion of existing therapeutic vaccines, and more effective vaccines for some diseases.[169–175] New platforms are also emerging (technologies that use the same basic components that can be adapted for use against different pathogens) as well as novel delivery methods (e.g., needle-free administration, such as nasal vaccines, inhaled aerosol vaccines, microneedle array patches).[176–178] These innovations may revolutionize the impact of vaccines, especially if they are driven by public health priorities and the needs of communities.[179] However, as the number and costs of approved vaccines increases, the vaccination system could face challenges integrating new vaccines into publicly-funded programs equitably and effectively. A public health system that invests in preparing for the dynamic nature of vaccine technology can maximize the potential to improve population health.

> *The cost of cancer is staggering. So, if we were able find vaccines [for cancer], imagine the benefits of that. The quality of life that we would be able to afford our population would be significant.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Increasing Strain on Healthcare and Public Health Systems

The structures and systems involved in vaccination are facing mounting pressures. Healthcare systems across Canada have long struggled with workforce shortages, limited funding, and under-resourced primary care. The COVID-19 pandemic added even further strain. Public health systems across the country have been balancing responses to concurrent challenges, such as the COVID-19 pandemic, the toxic drug poisoning crisis, tuberculosis outbreaks, and extreme weather events.[151, 152]

Alongside the rising costs and number of vaccines, resource constraints pose obstacles to the sustainability and stability of vaccination programs.[58, 152, 180–182] However, this context also presents an opportunity to strengthen the connections between public health and healthcare systems. By reducing the spread of vaccine-preventable diseases, vaccination can help mitigate the strain on medical resources and personnel, contributing to greater resilience of the healthcare system.

An Optimal Future of Vaccination for Public Health

Moving forward, a strong and resilient public health system is needed to support existing vaccination programs as well as prepare for the future. Vaccination has been and continues to be a vital public health tool, with the COVID-19 pandemic catalyzing a surge in research and advances across scientific, social, and programmatic domains. Consequently, synthesizing lessons learned while also harnessing emerging innovations can support all communities to benefit from vaccination. This section proposes a vision to guide and inspire an optimal future of vaccination for public health, including core goals and a framework for achievement.

Vision: A public health system in Canada that enables everyone to experience the benefits of vaccination for health and well-being across their lives.

In order to achieve this, the system can:

Harness vaccination to promote health equity across the life course

Goal: Everyone has equitable access to the appropriate resources, trusted information, and relevant health care that they need to support vaccination. Equity is integrated into vaccine research, development, evidence systems, delivery, reporting, and decision making. Opportunities to receive vaccinations are fairly distributed, readily available, appropriate, acceptable, and timely at all stages of life. This includes addressing the different social, structural, and ecological drivers that shape the living conditions and environments in which people are born, grow, live, work, and age.

Facilitate collaboration across systems and with communities to support vaccination

Goal: All parts of the public health system along with healthcare providers, community leaders, advocacy groups, local organizations, and other sectors collaborate to foster physical, social, and information environments for equitable vaccination. This involves optimal coordination and alignment of resources, policies, and transparent communication strategies that position vaccination as a fundamental tool to improve population health.

Prepare for and adapt to evolving health, technology, and social landscapes

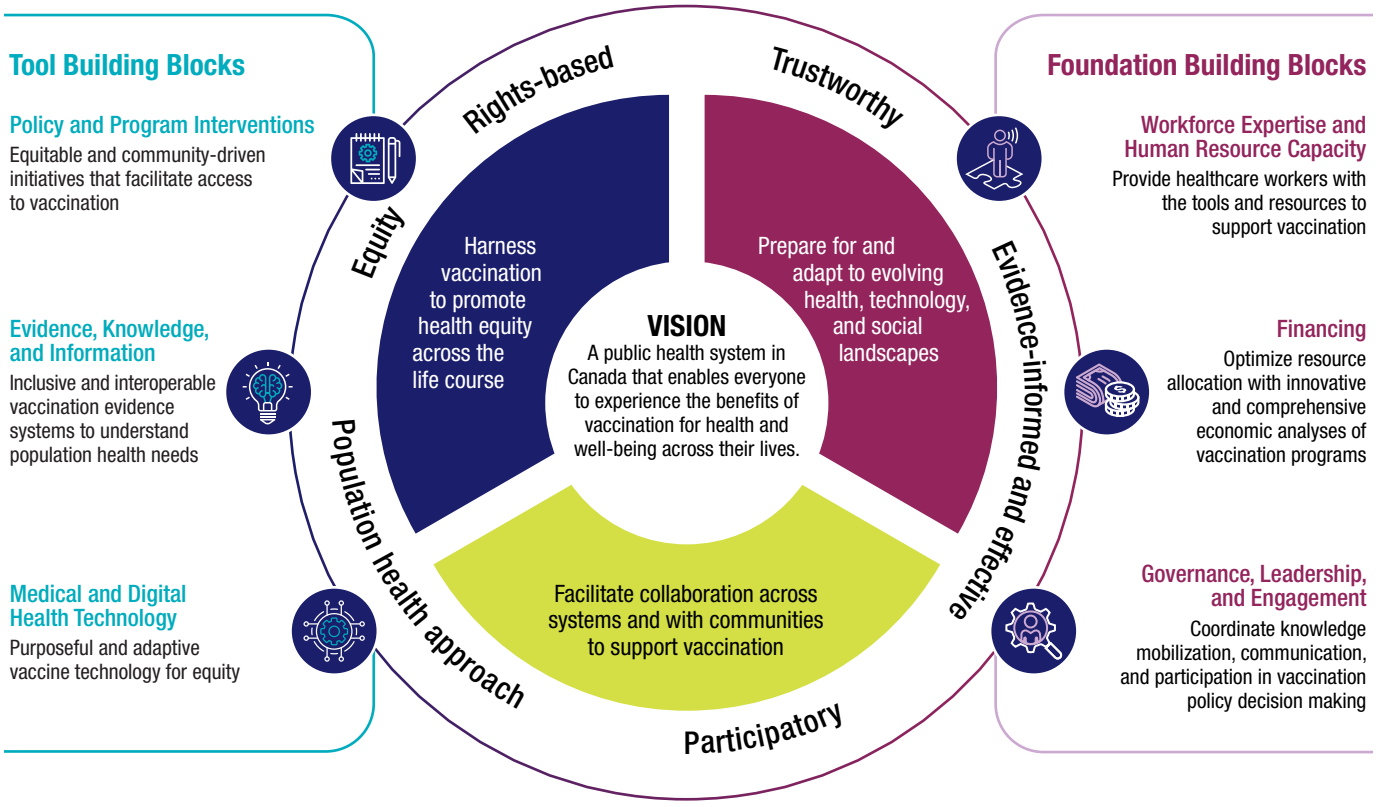
Goal: Communities, researchers, healthcare providers, and decision-makers have the resources, evidence, and capacity to respond to changes in social, cultural, and economic contexts that affect vaccination. In addition to sustaining routine vaccination programs, they have the agility to better address emerging health threats and anticipate new vaccine and digital health technologies by identifying gaps in knowledge, developing novel approaches, mobilizing information, and implementing evidence-informed best practices. This requires listening to and understanding community needs and continuously incentivizing better data, research, and innovations to address them. These actions contribute to public health emergency preparedness, which involves taking steps before an emergency to be ready to respond to it and manage its consequences.

Realizing the Vision

To achieve a future in which everyone can benefit equitably from vaccination, it is important to consider how to strengthen vaccination initiatives at the level of public health systems. The 2021 CPHO report offered a system-level vision and framework towards a transformed public health system that is equipped to accomplish the aim of optimal health and well-being for all people in Canada.

This 2021 framework can be adapted to help guide system-level action to realize the future of vaccination in Canada. It includes the fundamental building blocks of the public health system that support public health functions and practice. They are interrelated but broadly categorized into tools and foundational elements. Figure 4 illustrates a core objective for each building block. Sections 1 to 3 of this report explore the tool building blocks and Section 4 explores the foundation building blocks, as applied to vaccination.

Figure 4: Framework to Achieve an Optimal Future of Vaccination for Public Health



The framework also included overarching principles that steer the collective efforts of people, organizations, and institutions in public health towards an equitable, world-class system. In the context of this report, they have been updated to include rights-based approaches and adapted for the vaccination system.

- **Trustworthy:** Earning trust by demonstrating transparency, listening continuously, reflecting on feedback, and taking concrete actions within the vaccination system to be accountable to the people the public health system serves.
- **Evidence-informed and effective:** Valuing inclusive, diverse, high-quality, and innovative systems of knowledge and evidence in order to make the best decisions to support optimal vaccination for the health of populations.
- **Population health approach:** Stimulating action across sectors and with a life course approach to improve the health of all populations and reduce vaccination-related inequities among communities.
- **Participatory:** Integrating diverse participation, respect for community knowledge, relationship building, and meaningful collaboration into the core of public health practice and action on vaccination.
- **Equity:** A commitment to and recognition that an equity-focused public health system requires multiple voices at decision-making tables. Equity considerations and engagement with communities inform the design and delivery of programs and policies, so they are responsive to unique community needs and address inequities.

- **Rights-based:** Recognizing colonial injustices and the inherent rights of Indigenous Peoples in Canada, and applying rights-based frameworks to vaccination decision making, programs, and policies (see text box "Implementing Indigenous Rights-Based Frameworks in Vaccination for Public Health").

Together, the building blocks offer tangible entry points for accomplishing the above three goals and operationalizing the core public health principles. In the following sections, actions and innovations for vaccination are explored for each building block of the public health system.

Implementing Indigenous Rights-Based Frameworks in Vaccination for Public Health

The public health system has a responsibility to advance reconciliation and implement rights-based frameworks in the design, implementation, and evaluation of programs and policies. Reconciliation involves recognition of the colonial systems and practices that have led to and continue to impact health and social inequities for First Nations, Inuit, and Métis Peoples as well as taking action to reduce these inequities.

Rights-based approaches centre on respecting, protecting, and fulfilling rights.[183] The inherent rights of Indigenous Peoples in Canada include self-determination and self-government, rights relating to lands, territories, resources, culture, language, and health and well-being. Achieving equitable health outcomes and working towards reconciliation requires upholding these rights.

This means that strategies, interventions, and policies directed at Indigenous Peoples are led by or co-developed with First Nations, Inuit, and Métis leaders, governments, and/or communities. In alignment with a distinctions-based approach, it is important to recognize the distinctive cultural and regional diversity amongst First Nations, Inuit, and Métis Peoples to best meet context-specific needs. Indigenous-led and strength-based approaches are grounded in the interconnectedness of physical, mental, emotional, environmental, and spiritual health and well-being. These approaches recognize the historical and ongoing impacts of colonization, engage multiple viewpoints, and value First Nations, Inuit, and Métis Knowledges, culture, and expertise.

Key examples of rights-based frameworks for Indigenous Peoples in Canada relevant to health are the Truth and Reconciliation Commission of Canada's (TRC) Calls to Action and the *United Nations Declaration on the Rights of Indigenous Peoples*.[183, 184] The TRC Calls to Action numbers 18 to 24 outline actions to address discrimination and health inequities experienced by Indigenous Peoples.[184] The UN Declaration affirms the minimum standards for the survival, dignity, and well-being of Indigenous Peoples throughout the world.[183] Canada has committed to implementing the TRC Calls to Action as well as the *United Nations Declaration on the Rights of Indigenous People Act* and its associated Action Plan.[184–186] There are also tools for those working in the public health system to support advancing rights-based frameworks in organizations, for example the Indigenous Gender Based Analysis Plus Toolkit.

Within the UN Declaration, the following four overarching themes outline the essential standards required for the prosperity, dignity, and well-being of Indigenous Peoples: the rights to self-determination, to cultural identity, to participate in decision making, and to live free from discrimination. This report builds on the application of these themes to advocate a rights-based approach to vaccination.

1. The right to self-determination

Respecting the autonomy and authority of First Nations, Inuit, and Métis Peoples in decision-making processes related to health can facilitate the development and implementation of self-governance in health care.[187] The UN Declaration reaffirms that Indigenous Peoples have the right to decide what is best for their communities, the right to control their own government structures, and the right to determine their own political, cultural, social, and economic development, including in the health domain.[183] This may include First Nations, Inuit, and Métis communities having control over the design, implementation, and delivery of health services, including vaccination programs. Resource gaps and jurisdictional challenges can prevent Indigenous communities from realizing full self-determination. Additionally, there is an ongoing need to support culturally safe and accessible vaccination services for urban Indigenous populations.

2. The right to cultural identity

Connection to cultural identity, including access to traditional medicines and health practices, is a core component of the health and well-being of Indigenous Peoples.[188–190] The UN Declaration states that Indigenous Peoples have the right to their own practices, culture, traditions, and traditional knowledges.[183] This includes the right to Indigenous cultural healing and medicine approaches within mainstream health systems. Two-Eyed Seeing, described by Elder Albert Marshall, is an approach to seeing the differences and similarities in Indigenous and Western perspectives, and to valuing and integrating aspects of both. Drawing on the strengths of both Indigenous and non-Indigenous approaches to health, Two-Eyed Seeing supports the connection to cultural identity and continuity, within the context of mainstream systems.[191]

Indigenous-led and accessible vaccination programs that respect cultural identity, provide culturally relevant services, incorporate traditional healing practices, and recognize diverse cultural perspectives on health can be woven into frameworks that guide the provision of care. Altruism and community care are core Indigenous values that align with the goals of vaccination to protect both individual and population health. These values facilitate successful First Nations, Inuit, and Métis vaccination efforts, as demonstrated by the leadership, innovation, and compassion present in the COVID-19 vaccine rollout in Indigenous communities and organizations.[88, 192]

3. The right to participate in decision making

The UN Declaration reaffirms that Indigenous Peoples have the right to be consulted and involved in the decision-making process on all issues that impact their rights.[183] In the context of vaccination and vaccine development, this includes respecting the free, prior, and informed consent process in the research and development of new vaccine technologies through to delivering vaccinations in communities.[79] This involves ensuring meaningful engagement and co-development of vaccine strategies, decision making, and communications to facilitate accessibility, cultural safety, and transparency. Indigenous-led vaccine communication initiatives have been successful by using materials with tailored language for vaccine education and providing access to cultural supports, such as Elders and Knowledge Keepers, prior to, during, and after vaccination.[80, 116]

4. The right to live free from discrimination

Indigenous Peoples have the right to be free from systemic and structural barriers and have equitable access to relevant and high-quality health care.[183] Yet Indigenous populations in Canada are disproportionately impacted by infectious diseases. Overcrowded housing, financial insecurity, food insecurity, water crises, limited access to quality health care, and systemic racism are some of the systemic and structural barriers that contribute to higher disease burden.[187] Indigenous Peoples who experience intersecting forms of oppression, such as based on their gender identity or sexual orientation, may face additional challenges leading to worse health outcomes.[193–195]

Indigenous-led initiatives, such as community-based organizations, health clinics, and dedicated Indigenous health teams, can provide culturally safe health services to Indigenous Peoples, including vaccination programs. For instance, Indigenous-led culturally appropriate clinics in meaningful locations, such as community and Friendship Centres, promoted vaccine acceptance and uptake during the COVID-19 pandemic.[192] More cultural humility and anti-racism training is needed for healthcare workers who provide services, including vaccinations, to Indigenous Peoples. This training would emphasize awareness of historical injustices and foster an environment that is free from anti-Indigenous racism and discriminatory practices.[187, 196]

Taking action to prevent and address discrimination also requires disaggregated data, including distinctions-based Indigenous identity data.[183, 187, 197] This requires First Nations, Inuit, and Métis communities to have full participation in all aspects of relevant data collection, control, and management.[198]

SECTION 1

Policy and Program Interventions: Equitable and Community-Driven Initiatives that Facilitate Access to Vaccination

Access to vaccination may be most directly understood as having the ability to travel to a vaccination provider and to pay the costs (in money and/or time) associated with vaccination.[121] However, the scope of vaccine access can also be extended to all conditions that contribute to informed vaccination decision making, including whether one has access to trusted and culturally safe healthcare services as well as understandable, accurate, and tailored information about vaccination and vaccine-preventable diseases.

> *Access to vaccination should be defined broadly. It's not just literal access to the vaccine, but how awareness about the vaccine is raised, how it's delivered, how vaccine hesitancy is addressed. In the First Nations communities I work with, it's also about culturally safe, trauma-informed and person-centred care, whether a person has transport to go get the vaccine…*
>
> **– INTERVIEW PARTICIPANT (PUBLIC HEALTH PHYSICIAN)**

Many initiatives to support vaccination focus on individual-level factors affecting vaccine uptake, rather than vaccine access. However, if access is not considered, or is viewed too narrowly, differential vaccine uptake may be incorrectly solely attributed to low vaccine acceptance, rather than structural issues.[109, 199] This places undue responsibility on individuals rather than recognizing the broader systems and social determinants that influence vaccination.[109, 199, 200] Understanding the structural barriers to vaccine access enables public health systems, communities, and sectoral partners to tailor approaches to populations facing intersecting inequities.[126, 201–203] These structural barriers have been detailed in a number of articles and reviews, particularly highlighting barriers faced by groups, such as Indigenous Peoples, some other racialized populations, people living with low income, people experiencing homelessness, newcomers, people who are incarcerated, older adults, and people living with disabilities.[79, 109, 121, 204, 205]

Communities are essential in creating equitable opportunities to access vaccinations by informing and leading initiatives that mitigate barriers and fostering supportive resource, healthcare, and information environments. Communities come in many forms and individuals often belong to multiple communities.[152] In public health, communities can refer to groups sharing common locations, interests, lived experiences and histories, or identities. The 2021 and 2023 CPHO reports detailed the essential role of community for

uptake of COVID-19 vaccines (2021) and the mpox vaccine (2023). These lessons can be applied more broadly to better understand barriers to access and improve differential vaccine uptake.[58, 152]

Design Supportive Resource Environments for Low-Barrier Vaccination

People need the resources to book vaccine appointments, travel to vaccination sites, and pay for any associated direct (e.g., transportation, childcare, non-publicly-funded vaccines) or indirect (e.g., lost wages for missed hours of work) costs. Research suggests these challenges are greater for certain populations, such as people living with low income, facing technological or digital literacy barriers, residing in rural or remote communities, relying on public transit, living with disabilities, having precarious employment, and newcomers.[104, 109, 126, 127, 199, 206–215] Populations facing significant competing pressures on resources, such as people experiencing homelessness, may have to prioritize food and shelter over vaccination.[121] Therefore, improving access to vaccines requires collaboration with social services and the integration of vaccination with other types of support. For example, the University of Prince Edward Island worked with community-based organizations and family resource centres across the province to reduce barriers to participating in vaccination programs for families experiencing additional life challenges by providing accurate information about vaccines along with emotional and structural support.[216]

> *I think bringing [vaccines] to where people are is really important. Life is difficult. It's hard to get a vaccine. So, putting additional effort into making sure that it's as easy as possible, particularly for the people who face the most barriers, is going to have a much bigger impact.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Some childhood and adolescent vaccination programs have long relied on school-based vaccination to support access by removing the need to book appointments and travel to vaccination sites. School-based vaccination programs vary by province and territory, but often include vaccines recommended in adolescence, such as hepatitis B; tetanus, diphtheria, and pertussis (Tdap); HPV; and meningococcal vaccines.[217] Some jurisdictions also offer catch-up programs in schools for students who may have missed earlier childhood vaccinations.[218, 219]

School-based vaccination can improve vaccine coverage and reduce inequities in vaccine uptake for children and adolescents.[217, 220, 221] For COVID-19 in Quebec and HPV in Calgary, school-based vaccination clinics were associated with mitigating differences in vaccine coverage that were rooted in socioeconomic inequities.[220, 222] Opportunities to strengthen school-based vaccination programs include bolstering the public health workforce for vaccination activities, implementing culturally appropriate education initiatives concurrently with parents, students, and teaching staff, introducing approaches that address needle-related fears and anxiety, and utilizing electronic informed consent processes.[217, 223–228] Universities can also play a role in supporting vaccination among young adults.[229, 230] For example, the University of Moncton in New Brunswick organized a social media contest and webinar series to encourage COVID-19 vaccination.[231, 232]

Intersectoral approaches, which refers to the ways different groups and sectors may work together, can bolster vaccination. This includes workplace vaccination campaigns, which have been used to increase vaccine access and uptake, particularly related to influenza vaccination.[233] Immunize Canada has created an influenza immunization toolkit to support employers with onsite vaccine campaigns and clinics, including informational posters, email templates, and guidance on messaging and implementation.[234] Workplace-related vaccination initiatives can also help address specific needs, such as the intersecting risks faced by migrant agricultural workers during the COVID-19 pandemic. As essential workers and newcomers to Canada, this population faced greater risks of exposure to COVID-19 while also experiencing numerous barriers to vaccination.[235–237] Mobile or targeted vaccination clinics were used to promote vaccination and help address these barriers.[203, 236, 238] During the rollout of COVID-19 vaccinations, a number of approaches were used to promote low-barrier access to vaccination (see text box "Improving Access to Low-Barrier Vaccination for Underserved Populations Through Microgrants"). These included transportation assistance to vaccination sites,

community-based pop-up clinics, in-home vaccination, mobile vaccine clinics, support with vaccine appointment booking, flexible service hours, childcare, walk-in appointments, and providing vaccination without requiring a health insurance number.[126, 127, 203, 239–241]

Improving Access to Low-Barrier Vaccination for Underserved Populations Through Microgrants

The Dr. Peter Centre in Vancouver is a national leader in harm reduction and provides integrated health care with a stigma-free, wrap-around approach for underserved populations.[242] Between 2021 and 2024, the Centre awarded 37 microgrants to grassroot organizations across Canada to adapt existing program models for vaccination. Many recipients recognized the microgrant model as a "game changer" for hyper-local groups experiencing capacity constraints.

With these microgrants, recipient organizations focused on maintaining relationships with key populations, such as people experiencing homelessness, people living with HIV, and those who use substances. This included hosting vaccination clinics at community barbeques, promoting vaccine services through community theatre, staffing pop-up events with peer ambassadors, and integrating vaccine education into existing complex care programs, like supervised injection sites.[243, 244]

The organizations also identified best practices for community-driven approaches to support vaccination programming, such as engaging communities during design and implementation phases, addressing the social determinants of health and structural barriers, establishing relationships within and outside the healthcare system, creating accessible and non-stigmatizing spaces, and broadening beyond COVID-19 vaccines. The Dr. Peter Centre led a national community of practice and in-person workshops for groups who received funding to share knowledge, explore best practices, and generate solutions to challenges in providing low-barrier care.[243, 244]

Alongside initiatives that work to mitigate resource-related barriers to vaccine access, upstream action is necessary to address the structural and social determinants of health that create them.[199] For example, efforts to address inequities associated with precarious work would extend beyond clinics with extended hours to include intersectoral action to foster secure work with benefits and a fair income.

> *Nine-to-five doesn't always work for individuals that might have multiple jobs, that are working shift work, those kinds of things. [We need to] make things more accessible, which we've demonstrated through the pandemic by working together and going outside the nine-to-five.*
>
> **INTERVIEW PARTICIPANT (COMMUNITY ORGANIZATION)**

Create Supportive Healthcare Environments that Offer Positive Vaccination Experiences

Vaccination is also enabled by a supportive healthcare environment, which encompasses the wide range of spaces in which health services are provided. Some key features of such an environment include access to a trusted healthcare provider, the availability of culturally safe and person-centred care, and the integration of vaccination into other healthcare services.[245]

Inadequate and inequitable access to health care can be a significant barrier to vaccination and is compounded for populations who may face stigma and discrimination when interacting with the healthcare system.[199] Approximately one in seven people living in Canada reported not having a regular healthcare provider in 2021.[246] Access to vaccination providers is key for adult vaccination, which does not have the same vaccine delivery infrastructure as childhood vaccinations (e.g., defined schedule, regular checkups, school-based programs). Research suggests that alongside reminders and financial support, recommendation by a healthcare professional is a key facilitator of adult vaccination, including during pregnancy.[130, 209, 247–251] Therefore, the role of other types of providers, such as pharmacists or nurses, could be particularly relevant for some populations, such as older adults, and those living in rural communities, where access to primary care may be more constrained.[252] However, equity concerns remain since not all people living in Canada have equal access to nearby pharmacies, and they may or may not offer vaccination services.[253–255]

Historical and ongoing systemic mistreatment and racism against Indigenous Peoples and Black, African, and Caribbean communities in North America have been identified as primary drivers of vaccine hesitancy in these populations.[120, 121] Therefore, strengthening access to culturally safe health care is critical to vaccination. This includes multi-level interventions to acknowledge systemic racism, understand lived experiences, prioritize cultural humility, offer vaccine delivery in trusted locations, and support community-led initiatives.[109, 120, 121] Organizations like the Indigenous Primary Health Care Council have developed toolkits and hosted webinars in collaboration with health system partners about cultural safety, power dynamics, and best practices for vaccination in First Nations, Inuit, and Métis communities.[256–258]

There are other populations who may also be less likely to seek vaccination services due to experiences of stigma and discrimination in health care, such as people who are 2SLGBTQI+, people living with disabilities, people experiencing homelessness, people who use drugs, and people who are justice-involved.[109, 259–262] For example, providing safe care for individuals who are 2SLGBTQI+ includes soliciting and using correct pronouns and names, and avoiding assumptions about family structures. For people living with disabilities, it is important to consider the accessibility of vaccination sites and services.[104, 215] This goes beyond ensuring the physical design of buildings to include communication, social, and sensory accessibility.[104, 263]

Creating a supportive healthcare environment also means taking person-centred approaches to vaccination and creating positive vaccination experiences that reduce vaccine-related pain and fear. This could include the implementation of strategies like the CARD (Comfort, Ask, Relax, Distract) tool developed in 2019 by researchers at the University of Toronto and the Hospital for Sick Children. The CARD system provides strategies that can be used to help cope with stress, anxiety, and pain, before and during vaccination.[264, 265] Implementation of CARD has been shown to positively impact vaccination experiences for vaccine recipients and providers across multiple settings, such as pharmacies, schools, long-term care facilities, and mass vaccination clinics.[264, 266, 267]

Lastly, co-delivery of vaccines with other health services can improve access, facilitate comprehensive care, and maximize health system resources. Reducing missed opportunities for vaccination is part of the IA2030, which emphasizes the importance of integrating vaccination into other primary health care and using any interactions with the health system as an opportunity to verify vaccine status and provide any missed vaccines.[7] Integrating vaccination services with other age-appropriate health interventions supports optimizing health outcomes across the life course.[24]

Most behavior is far more influenced by environmental factors than anybody wants to believe. If we can create systems that make the healthiest choice the easiest choice, whether that's a vaccine or anything else, people tend to do the easiest thing.

INTERVIEW PARTICIPANT
(MEDICAL OFFICER OF HEALTH)

Foster Supportive Information Environments for Vaccine Awareness, Education, and Trust

Access to timely and accurate information about the safety and effectiveness of vaccines and the frequency and severity of vaccine-preventable diseases from a trusted source is key for shaping knowledge, attitudes, and beliefs about vaccines.[121, 199] Tailored messages that are appropriate, accessible, easy to understand, and culturally relevant can increase vaccine acceptance and uptake. Creating such a supportive information environment requires understanding the dynamics of how individuals and communities produce, consume, and interact with information.[132, 268] The way that messages are framed can shape how information is perceived and responded to, and this may differ between population groups. Tailoring communications requires considering both broader insights from behavioural and social sciences, alongside proactive community engagement and multidisciplinary research to understand these potential differences and shifting trends.[269–272]

Not all people living in Canada have equitable access to supportive information environments. In particular, there are gaps for newcomers, people without consistent access to media or the internet, those with lower health and/or digital literacy, and people facing language barriers.[199, 210] There are a number of different approaches to improve access to vaccine information in a native language. For instance, during the initial COVID-19 vaccine rollout, the Single Room Occupancy Collaborative launched a multi-dialect vaccination education campaign for Chinese older adults in Vancouver's Chinatown single room occupancy hotels and the Société Réso Santé provided French peer supports at mobile vaccine clinics for the minority francophone population in British Columbia.[273, 274]

Facilitating supportive information environments for vaccination is most effectively achieved through community knowledge, engagement, and representation.[275] This central role of community requires investing in collaborative and trustworthy partnerships to inform and lead tailored education and communications (see text box "Collaborative Co-Development for the Gay Men's Sexual Health Alliance Mpox Awareness Campaign in Ontario"). This has included engaging peer educators or community ambassadors for vaccine education and outreach as well as developing multilingual and culturally appropriate communication materials, social media campaigns, and hotlines to answer questions.[203, 239, 240, 276]

Collaborative Co-Development for the Gay Men's Sexual Health Alliance Mpox Awareness Campaign in Ontario

In the spring and summer of 2022, several cities in Canada experienced an outbreak of mpox, with the virus spreading through intimate or sexual contact with a person infected with mpox. Gay, bisexual, and other men who have sex with men were disproportionately impacted. However, by the fall of 2022, cases had declined significantly, largely due to behaviour change and supported by vaccination efforts with a stockpiled vaccine. Community engagement and partnerships with gay men's sexual health groups were significant factors contributing to this success.[17, 277, 278]

For example, the Gay Men's Sexual Health Alliance (GMSH) co-created a collaborative and community-informed campaign to prevent the spread of mpox. The partnership included the Ontario Ministry of Health, infectious disease experts, and front-line community agencies across the province. GMSH launched a public health campaign on various social media platforms about reducing risk and accessing vaccination as well as created education materials for clinical care environments.

Senior public health officials noted GMSH's existing relationships and credibility with the community were invaluable in implementing a timely, tailored, and sensitive outreach effort. Front-line community agencies and local public health units reflected that the knowledge mobilization and communication support provided by GMSH allowed them to concentrate on other critical components of their work, such as vaccine distribution.[279]

Systemic barriers, current and historical experiences of medical racism, and inequities in resources may result in distrust of the government or health institutions and catalyze the spread of misinformation.[140, 141, 259] Information from trusted sources, such as local or religious leaders and healthcare professionals from the same culture or community, can be more impactful in creating supportive information environments, particularly among racialized groups.[121] For example, during the rollout of COVID-19 vaccines, members of the Alberta International Medical Graduates Association (AIMGA) used their diverse linguistic and cultural knowledge to engage with ethnocultural and newcomer communities at community, mobile, and workplace vaccination clinics.[241] They implemented a vaccine navigation tool where interpreters were matched to clients for support with vaccine appointments as well as partnered with Alberta Health Services and other community immigrant-serving organizations to establish on-site COVID-19 vaccination clinics at a meat processing facility.[280–283]

For First Nations, Inuit, and Métis Peoples, vaccine messaging can be more effective when it directly involves Indigenous Elders, Knowledge Keepers, leaders, and health practitioners who are trusted and credible within their communities. Engaging these figures as vaccine champions as well as listening to and incorporating their feedback contributes to more meaningful and culturally relevant communication strategies.[80, 116] For instance, the Métis National Council developed COVID-19 vaccination resources that included video messages from Elders and information on how vaccination would protect community well-being.[116]

> *What people trust is their friends, their family, their community leaders, the people in their lives. I think it's really critical that we get the local experts involved, whether they're experts in the vaccine or experts in their community or both. Those are the people who need to design how we do things at the community level.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Research in Canada suggests that trust in institutions declined during the COVID-19 pandemic, with a key driver being belief in misinformation.[284, 285] Social media algorithms curate content to user preferences, which may shield them from opposing viewpoints and accelerate the spread of

misinformation. This can create different perceptions of reality and disrupt social cohesion.[132] Monitoring the spread and content of mis- and disinformation (e.g., through social media listening) and trust (e.g., through public opinion research), enables public health organizations to understand trends and develop materials that respond to public concerns and pre-empt or counter misinformation.[284, 286–288]

Best practices to counter vaccine-related mis- and disinformation are an active area of research and can be context specific. Strategies include correcting misinformation and moderating social media content, and more upstream interventions that build resilience to misinformation.[132, 268, 289, 290] For example, prebunking strategies aim to counter misinformation before it has the chance to spread widely. This involves pre-emptively providing correct information, debunking potential myths or misconceptions, explaining common deceptive tactics, and equipping individuals with the critical thinking skills to recognize and resist misinformation when exposed to it.[291–294]

Public health organizations can also demonstrate transparency in decision making, including by openly communicating uncertainties in evidence and emerging science as well as by actively soliciting feedback, reflecting on lessons learned, and making necessary adjustments following a public health emergency.[138, 275, 295] Evidence- and behaviourally-informed communication with clear, consistent, and engaging messaging and co-developed with community partners and aligned across institutions, may mitigate information overload and mixed messaging in public health emergencies. It is also important that communications are timely and updated to reflect evolving information.[275, 296]

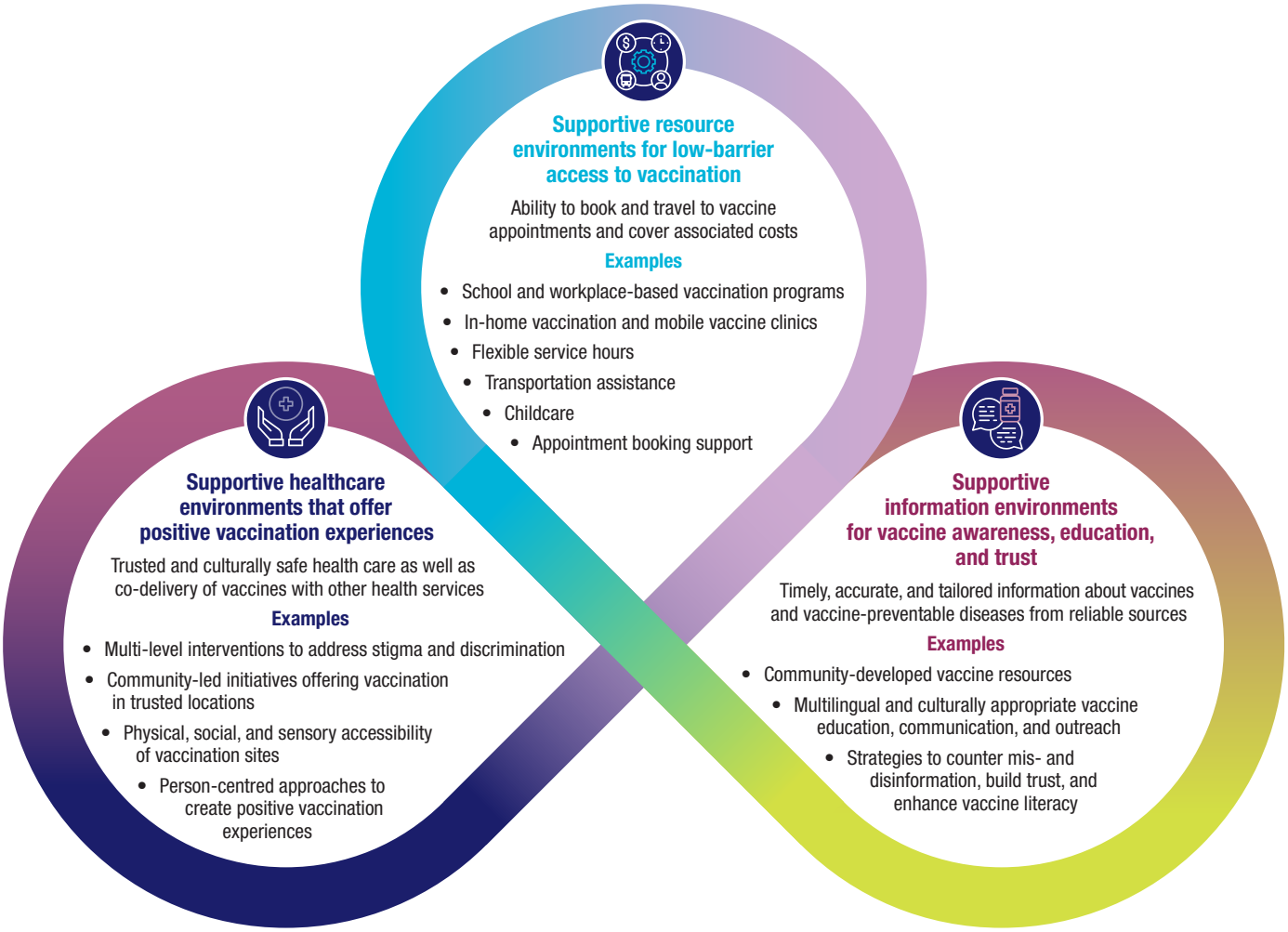
Since mis- and disinformation are not limited to vaccination, collaboration across sectors to build digital health literacy can enhance resilience to misinformation across domains. Public health organizations can collaborate with education departments to foster critical thinking skills and science literacy from a young age, integrate vaccine education into school curricula, and support parental learning.[132, 225, 289, 297, 298] For example, Kids Boost Immunity is an online school-based resource in Canada that aims to combat vaccine misinformation by strengthening critical thinking skills. Lessons cover a broad range of topics, including the immune system, disease spread, and vaccines; as well as how government works, global inequality, climate change, and Indigenous history and governance.[299] Completing quizzes earns vaccine donations to UNICEF, which students rated as their favourite aspect of the site. Of the over 6,000 school teachers that they have reached, 83% agreed students had a positive experience learning about vaccines.[300]

Institutions (e.g., government, legislative, educational, media, health care, other service delivery institutions) can help to mitigate the spread and impact of mis- and disinformation by taking concrete actions to enhance their trustworthiness and serve as reliable sources of information.[132, 284, 291] Ultimately, rebuilding trust requires a multifaceted approach that addresses historical grievances, improves public interactions, ensures transparency, and builds upon existing trusted relationships within communities. This includes specific and ongoing action to advance truth and reconciliation, identifying and eliminating policies and practices that perpetuate racism, prioritizing lifelong cultural humility, and improving interactions with institutional programs and services.[184, 301, 302] Such initiatives should be informed by and accountable to communities. By doing so, institutions can acknowledge and address systemic practices and policies that are inequitable and erode trust. Where institutions are not trusted sources for some communities, working with local messengers for those populations can facilitate supportive information environments.[120, 121]

> *So when the next crisis comes along, [what happens] where we really need to do something like COVID-19 vaccinations? We'll have lost everything we learned and built, and you won't be starting at zero again. That's not the way it works. You start sub-zero. When you lose the trust, you double down.*
>
> **INTERVIEW PARTICIPANT (COMMUNITY ORGANIZATION)**

Improving vaccine access and acceptance requires working to create supportive resource, healthcare, and information environments, as summarized in Figure 5. Multi-component interventions that use a combination of strategies are likely to be most effective.[303, 304] See text box "Community Initiatives to Build Supportive Vaccination Environments through the Immunization Partnership Fund" for several successful case studies that highlight efforts to foster these supportive environments.

Figure 5: Facilitating Access to Vaccination Through Supportive Environments



Community Initiatives to Build Supportive Vaccination Environments through the Immunization Partnership Fund

Established in 2016, the Immunization Partnership Fund (IPF) funds community-driven initiatives that are equity-driven, evidence-informed, and culturally safe. From 2021–2022, the IPF funded 101 initiatives. Projects bridged information gaps and helped to build supportive information environments. Many initiatives leveraged community, cultural, or peer ambassadors to share health information, developed trusted relationships with community members and healthcare providers, hosted community-led clinics, and reduced barriers to vaccine access.[281] While other IPF projects are highlighted throughout this report, the following organizations employed a combination of strategies to improve vaccine acceptance and access.

The Regroupement des centres d'amitié autochtones du Québec (RCAAQ) is a collective of centres that provides culturally safe services to urban Indigenous populations in Quebec. From 2021 to 2023, RCAAQ led Miro Matisiwin ("Well-being" project), which used fixed-site and mobile clinics to increase COVID-19 vaccine uptake amongst individuals who were not well-served by traditional vaccination services. From 2023 to 2024, Mamu ("Together" project) expanded on the learnings of Miro Matisiwin to improve awareness and uptake of routine and seasonal vaccinations through culturally relevant promotional materials, successfully reaching 120,000 online users. Providing culturally relevant care, using a trauma-informed lens, and working to decrease access barriers were all central to RCAAQ's program model.[280, 305, 306]

Children's Healthcare Canada is a national association that supports and advocates on behalf of healthcare delivery organizations caring for children, youth, and their families in Canada. Since 2021, Children's Healthcare Canada has led various initiatives aimed at enhancing the capacity of frontline healthcare professionals to confidently vaccinate children and youth, especially those at increased risk of severe outcomes from vaccine-preventable diseases. They have co-developed tailored resources and facilitated knowledge sharing and educational resources. They also sought opportunities to build an emotional connection between parents/guardians and healthcare professionals, a best practice for encouraging behaviour change and dispelling vaccine-related misinformation.[307] In 2022 and 2023, Children's Healthcare Canada teamed up with ScienceUpFirst, an initiative countering misinformation online, to co-host National Kids and Vaccines Day to promote vaccine confidence and uptake for children in Canada.[308]

SECTION

2

Evidence, Knowledge, and Information: Inclusive and Interoperable Vaccination Evidence Systems to Understand Population Health Needs

As with other public health priorities, vaccination policies and programs rely on the ability to collect, analyze, and make decisions based on evidence. To support understanding and decision making, it is critical that vaccine evidence systems strengthen traditional public health surveillance and also explore Indigenous Knowledges, multidisciplinary research, practitioner expertise, and community knowledge.

Enhance Public Health Surveillance Systems for Vaccination

One of the primary ways that public health systems contribute to the vaccination evidence base is through surveillance data. Public health surveillance involves the ongoing and systematic collection, analysis, and application of data to understand and work to improve the health of populations.[309] This includes various surveillance data sources, such as traditional public health, healthcare, and laboratory information systems, cross-sectional surveys, media and internet monitoring, and other methods, such as wastewater surveillance.[309] Comprehensive vaccination surveillance systems incorporate data and analysis of vaccine-preventable diseases, vaccine coverage, and vaccine safety (see text box "A Summary of Vaccine-Related Public Health Surveillance Data in Canada"). Improving the impact of vaccination using public health data requires expanding surveillance methods, ensuring the availability of stratified data, prioritizing data sovereignty, and facilitating linkages between systems.

A Summary of Vaccine-Related Public Health Surveillance Data in Canada

Tracking Vaccine-Preventable Diseases

Disease surveillance involves understanding the burden and epidemiology of disease, monitoring trends, and identifying outbreaks and emerging pathogens. Surveillance occurs at local, regional, provincial, territorial, national, or international levels, and can include data from various sources, including laboratories, healthcare providers, administrative records, communities, and media and internet monitoring. These data may be used to assess the impact of vaccination programs on reducing disease incidence, implement targeted interventions to manage outbreaks, and inform public health policies and decision making.[310, 311]

Monitoring Vaccine Coverage

Assessing vaccine uptake across locations and populations is critical for understanding vaccine coverage, identifying inequities and developing approaches to address them, and improving coverage overall. Most provinces and territories have developed and implemented vaccination registries, also called immunization registries, to record vaccination information for individuals and the population more broadly.[312] These centralized electronic information systems hold data on vaccine doses administered and may be used to report vaccine coverage, identify under-vaccinated populations, and monitor the impact of vaccination programs.[313] They can also include mechanisms to help mitigate barriers to vaccine uptake for individuals through features like vaccination reminders, appointment scheduling, electronic informed consent management, and targeted promotion campaigns.[313–315]

Maintaining High Standards of Vaccine Safety

Before a vaccine is approved in Canada, Health Canada conducts a rigorous scientific review of its safety, efficacy, and quality.[62, 316] Following authorization, Canada has a robust and well-established vaccine safety surveillance system involving Health Canada, PHAC, provinces and territories, healthcare providers, vaccine manufacturers, and international regulators to ensure that the benefits of vaccines continue to outweigh the risks. This includes systems to monitor and investigate adverse events following immunization (AEFIs). An AEFI is any health event that occurs after administration of a vaccine. These may be a direct result of a vaccination or may be unrelated, occurring coincidentally in the hours, days, or weeks after vaccination. Provinces and territories submit AEFI reports to PHAC, most of which are generated by healthcare providers.[317, 318] Health Canada's post-market surveillance program also collects reports of suspected adverse reactions from consumers, vaccine manufacturers, and safety information from international regulators. Health Canada and PHAC continuously review and analyze safety data to confirm and respond to potential issues, which may include communicating new risks or changing the recommended use of the product. Serious adverse events can occur but are rare.[60, 316, 319]

Broaden Surveillance Strategies

Since vaccines provide benefits across the life course, surveillance systems for vaccine-preventable diseases need to cover both child and adult populations where appropriate to support vaccination. For example, respiratory syncytial virus (RSV) is a respiratory virus that is a common cause of bronchiolitis and pneumonia in young children.[320] RSV-related hospitalizations are also high among older adults, however the burden in this population has historically not been well understood, with varying testing, case definitions, and reporting practices over time and across jurisdictions.[320–323] Without a strong baseline of typical seasonal disease epidemiology, assessing the impact of future RSV vaccination programs for adults is challenging, highlighting the need for a life course approach to disease surveillance.[323] Diagnostic tools that test for several pathogens at once (e.g., multiplex assays) can support more comprehensive surveillance efforts. This may be especially relevant for respiratory illness, such as influenza, COVID-19, and RSV, that have overlapping symptoms and often have peaks in transmission simultaneously.[324–327]

Some disease surveillance methodologies rely on capturing cases through people seeking treatment or from diagnostic testing and therefore may underreport cases, particularly for populations not well-served by healthcare systems.[328–331] Several surveillance approaches were rapidly developed or adapted in response to the COVID-19 pandemic to fill this gap and meet the data needs of public health decision-makers.[332] For example, many Indigenous communities implemented community-based rapid point-of-care testing for COVID-19 with support from the National Microbiology Laboratory and Indigenous Services Canada.[333, 334] Wastewater testing had been used for decades around the world to monitor polio and pathogens causing gastrointestinal disease, but its application greatly expanded during the COVID-19 pandemic.[335, 336] Smaller-scale community-led wastewater testing also enabled northern, remote, and isolated communities to obtain early warning signals and take action quickly.[333] For instance, Yukon First Nations developed a COVID-19 wastewater monitoring system for select communities in 2022 and made the data publicly available.[337] At the time of writing this report, several infectious diseases are monitored in communities across Canada through wastewater testing.[338] Scientists are also exploring the utility of this surveillance methodology for other public health priorities, like antimicrobial resistance, tuberculosis, and substance use.[339–344]

The use of innovative methodologies, such as big data approaches, machine learning, and artificial intelligence (AI) more generally, is also being explored in the context of vaccine and vaccine-preventable disease surveillance. This could include applications like epidemic tracking and forecasting, streamlining AEFI and vaccination record data entry, and analyzing social media, news sources, and scientific literature to generate and understand vaccination coverage and safety data.[345–347] However, there are limitations to the use of this technology, and it is crucial that AI complement rather than replace traditional surveillance systems.[345, 346] It is also important to prioritize data sovereignty with Indigenous communities, and to consider potential inequities caused by algorithmic bias, a lack of data diversity, and differential access to technology.[346, 348] Application of these methods requires evaluation and consideration of legal, ethical, privacy, and data sovereignty concerns and collaboration between public health, communities, and AI experts to build solutions based on public health needs.[346, 348]

Collect and Share Disaggregated Data

Vaccine-preventable disease and vaccine coverage data stratified by sociodemographic factors are necessary to understand health inequities and identify appropriate and tailored vaccination programs and communications to address them. In Canada, vaccine coverage may vary significantly between communities or districts for some vaccines.[122, 130, 349–355] Regional or community-based pockets of low vaccine uptake create risks for vaccine-preventable disease outbreaks and can contribute to disproportionate disease burden. Identifying under-vaccinated groups so that local public health organizations can work with communities to mobilize vaccination efforts requires disaggregated data, including by race, ethnicity, sex, gender identity, age, geography, and socioeconomic status.[356, 357]

Demand for better data disaggregation and race-based data collection, as well as calls for community engagement and data governance in research exploring health inequities amplified during the COVID-19 pandemic. For example, in 2021, the Black Health Equity Working Group published the

Engagement, Governance, Access, and Protection Framework, part of which sets forward a data sovereignty approach for the engagement of Black communities.[358]

During the COVID-19 vaccine rollout, PHAC worked in partnership with provinces and territories to develop the Canadian COVID-19 Vaccination Coverage Surveillance System, which provided aggregated weekly numbers of vaccine doses administered and the proportion of the population vaccinated, by age group and sex.[359] While useful for understanding overall coverage, this system lacked disaggregated data on additional population characteristics, such as ethnicity or Indigeneity, since provinces and territories do not always collect or report this type of data in the same way. This reflects one of many long-standing health information challenges with data infrastructure, limited workforce capacity, and data-sharing agreements.[360]

Lack of adequate and disaggregated vaccine-preventable disease and vaccine coverage data is an obstacle for vaccination planning, particularly for First Nations, Inuit, and Métis communities. Without access to and ownership of vaccination data, it can be difficult for Indigenous organizations to effectively plan and implement vaccinations programs tailored to the specific needs of their communities. These data gaps may limit the ability to monitor vaccine coverage, track outbreaks of vaccine-preventable diseases, and ensure equitable distribution of vaccines.[361, 362]

Many current data collection approaches do not allow for distinctions- or nations-based analyses for First Nations, Inuit, and Métis populations, or recognize heterogeneity within communities (e.g., First Nations communities living on-reserve, urban Indigenous populations).[128, 361, 363] Vaccination records that are stored in multiple places and difficult to access, known as record scattering, has been identified as a particular challenge for First Nations communities and urban Indigenous populations, since records may be kept on- or off-reserve and held by provincial or federal governments.[364] Therefore, co-developed, respectful, and inclusive practices driven by data and research principles established by First Nations, Inuit, and Métis communities are needed.[187, 198, 365, 366] This includes incorporating consistent Indigenous identifiers, ensuring proper anonymization techniques, and conducting analyses that are informed by Indigenous knowledge and contexts.[361, 362, 367–369]

Build Interoperable Data Systems

Alignment of vaccine coverage reporting requirements across the country during the initial rollout of COVID-19 vaccines facilitated considerable progress in collaboration, data standardization, and interoperability that allowed for an expanded use of vaccination registries.[370–372] However, for other vaccinations, variations between provincial and territorial registry systems, such as differences in data collected, vaccine schedules, vaccination providers, timeliness, and mechanisms for data entry, have consistently posed obstacles to interoperability.[314, 373] For example, requirements for reporting vaccinations to registries vary between healthcare providers and vaccination settings across jurisdictions.[314]

> *The main gap or opportunity would be an interface with other electronic data systems with other jurisdictions.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

There is an opportunity to expand upon pandemic achievements using a federated data approach.[370] PHAC is collaborating with provinces and territories on a proof-of-concept for connecting vaccination registries by drawing from existing work on standards, interoperability, and health data stewardship. Improvements could facilitate the transfer of vaccination records between jurisdictions to reduce duplicative or missed vaccinations. Comprehensive vaccine coverage data may help people living in Canada and their healthcare providers to access vaccination records through childhood to adulthood, even as people move between locations.[313–315] Such systems could be further enhanced to enable people to track and consent to vaccinations, as well as receive digital proof of vaccination.[315]

Comprehensive vaccine uptake data also support vaccine safety monitoring. Records that provide reliable information about the specific vaccines received by individuals, including lot numbers and administration dates, can help to promptly investigate adverse events following vaccination. Accurate vaccine administration data contributes to establishing how frequently adverse events occur compared to the number

of doses administered, which helps to determine how often those events would normally be expected to happen. This is important for detecting potential safety signals requiring further investigation. Additionally, in the rare event that recipients need to be contacted by a healthcare provider for follow-up, such as in the case of an emerging safety concern, having accurate and up-to-date vaccination records facilitates efficient communication and ensures timely interventions can be taken.[314]

Linked surveillance systems on vaccine-preventable diseases, vaccine coverage, and vaccine safety can maximize the impact of vaccination. For example, combining vaccine coverage and vaccine-preventable disease data allows for assessment of how effective a vaccine is at providing protection against certain outcomes.[314, 374–376] Furthermore, enabling connections between vaccination surveillance systems with broader administrative data can allow for comprehensive monitoring and evaluation of the impact of vaccination programs. Internationally, Denmark and Norway are two examples of countries with national registries that feature linkages across a number of health record systems to identify specific health outcomes, assess programs, and monitor vaccine safety and effectiveness.[377–380] The interconnected nature of the vaccination system also means that surveillance of other indicators relevant to public health can be valuable to supporting vaccination. Examples include indicators relating to health equity, healthcare capacity, supply chain and logistics, and human and financial resources.[381, 382]

Use Interdisciplinary Research to Understand Differential Vaccine Coverage, Uptake, and Acceptance

In addition to data from provincial and territorial registries, the federal government uses surveys to estimate national vaccine coverage, inform promotion and education initiatives, and satisfy WHO reporting requirements. Some examples of national vaccination surveys in Canada are the childhood National Immunization Coverage Survey, the adulthood National Immunization Coverage Survey, the Seasonal Influenza Vaccination Coverage in Canada Survey, and the Survey on Vaccination during Pregnancy.[383] These surveys, done at regular intervals, provide an important opportunity to obtain national estimates of vaccine coverage and gain insights into knowledge, attitudes, and beliefs about vaccines or vaccine-preventable diseases.

Methods used in these surveys often do not allow for in-depth examination of intersecting sociodemographic factors (e.g., income, immigration status) and their relationship with vaccine uptake, access, knowledge, attitudes, or beliefs.[384] In addition, some national surveys may not recruit a sufficient number of respondents to accurately represent some populations, such as people whose first language is not English or French, people living in the Territories, and people living in institutions (e.g., correctional or long-term care facilities).[122, 130, 312, 385] Therefore, more focused research is important to monitor vaccine coverage and to assess specific and interacting regional or population factors that contribute to vaccine acceptance (see text box "Community-Led Development of a Comprehensive African Nova Scotian and Black Vaccine Coverage and Attitudes Database in Nova Scotia").[386–389]

Academic researchers, non-profit and community organizations, and public health authorities are key players that may conduct these more focused studies. For instance, the Enhancing HPV Vaccination in First Nations in Alberta project (a joint effort involving University of Calgary researchers, First Nations from six partnered communities, and the Alberta First Nations Information Governance Centre) used community-centred data collection to understand barriers and facilitators of HPV vaccine uptake in First Nations communities.[390–392]

Community-Led Development of a Comprehensive African Nova Scotian and Black Vaccine Coverage and Attitudes Database in Nova Scotia

In 2022, the Department of Health and Wellness (DHW) for Nova Scotia collected the largest-to-date vaccine coverage dataset for African Nova Scotian and Black populations in Nova Scotia using IPF funding from PHAC. Partnering with diverse community organizations, the provincial government, research institutions (Dalhousie University and the Canadian Centre for Vaccinology [CCfV]), and local leadership was central to the project's operations and structure.

The community-led survey received over 1,100 responses in 10 languages. It informed COVID-19 vaccine coverage estimates and assessed vaccine knowledge, attitudes, and beliefs in historic African Nova Scotian and Black, immigrant, and refugee communities. While overall intention to receive a vaccine was high, the data suggested that anti-Black racism, as well as mistrust and fears from the historic mistreatment of Black populations, were driving factors for those with low intention to receive a vaccine.

An evaluation found that much of the project's success could be attributed to Black experts and communities leading development, coordination, and delivery. Further, the work was grounded in Africentric practices and aligned with the "For Us By Us" approach in which community facilitators lead engagements, community voices are valued, and results are shared back with communities. The project further facilitated collaboration between the DHW and the CCfV to explore broader opportunities to improve African Nova Scotian and Black health and well-being in Nova Scotia.[281, 393]

One of the challenges with comparing, synthesizing, and analyzing surveys on vaccine knowledge, attitudes, and beliefs is the inconsistent use of indicators between studies. A more systematic approach, using frameworks and tools validated by vaccination experts and tested in real-world settings, is required to gain a robust understanding of the determinants of vaccine uptake and acceptance, and to monitor changes over time. For example, the WHO's Strategic Advisory Group of Experts on Immunization has developed the Behavioral and Social Drivers of Vaccine Uptake Framework, which summarizes validated tools and indicators that may be used to assess the factors affecting vaccine uptake in a given population and to design, implement, and evaluate tailored interventions.[394] However, effective strategies to address disparities in vaccine acceptance and uptake must consider attitudinal and behavioural drivers concurrently with access barriers. More research and tools are needed to assess the prevalence and interplay of these factors.[200, 395–397]

> *Understanding where people are at in terms of their intent to vaccinate, their behavior, their understanding of the diseases, their understanding of the vaccine — I think we need to have a broad understanding of all these pieces, otherwise we're a bit flying in the dark.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Vaccination records and surveys may be limited in their ability to identify critical differences across populations or to explain how individual, community, and structural factors interact to influence vaccine uptake. Answering these questions requires interdisciplinary studies examining a range of factors that support vaccination.[122, 251, 398, 399] Research in this field has evolved over time to capture more complex systemic, community-level, interpersonal, and individual factors, and to integrate insights from a variety of different disciplines.[400] However, concerns remain that vaccine acceptance models may not fully account for the interconnected influence of culture, politics, and history, including structural determinants, such as systemic racism, institutional practices, public policies, and dominant social norms.[400]

Many disciplines across the humanities and social sciences provide insight on factors influencing vaccine attitudes and behaviour. For example, behavioural science could help inform how people may interpret and respond to certain types of information or messaging and can enhance the design and evaluation of communications. Interdisciplinary approaches and methods are able to more closely explore societal factors that influence the context surrounding vaccination. These include anti-intellectualism, public trust, mis- and disinformation, systemic discrimination, and the social and cultural history of infectious diseases.[80, 132, 140, 401–404]

Bolster Connections between Research and Vaccination Policy and Practice

In addition to conducting robust vaccine surveillance and research, it is essential that the evidence generated is able to inform policy and practice decision making. Promoting evidence-informed decision making is one of the core principles of IA2030.[7] Various mechanisms can be used to connect decision-makers with the best available evidence, including through technical advisory groups.[7, 405]

Research networks also have an important role to play in knowledge generation and mobilization. This may be particularly true during pandemics, when urgency drives the process of developing and applying evidence.[19, 406] For example, the Canadian Immunization Research Network (CIRN) is a network of over 100 investigators across 40 institutions that receives funding from PHAC. The network facilitates collaborative research for decision-making by working at the interface between clinical, surveillance, and epidemiological research, and public health program evaluation.[407] Their networks include the Special Immunization Clinic Network that assesses and provides recommendations to individuals who have experienced AEFIs and the Canadian National Vaccine Safety Network that conducts active safety surveillance.[407]

One way to support evidence-informed decisions is through actionable research intended to help develop, track, and improve vaccination policies and programs. This includes implementation research and evaluation to understand the effectiveness of vaccine policies and programs.[408] Implementation research can help assess interventions and apply policies and programs in diverse settings, considering local factors influencing acceptability, feasibility, and scalability.[7] Human-centred design principles offer a complementary approach by facilitating co-design of vaccine interventions that meet the needs of people being vaccinated, healthcare providers, healthcare organizations, and broader public health systems.[409–411] These forms of applied research can help public health systems increase the reach and impact of vaccination programs, as well as enable scaling up or sustainability, especially when they are co-developed with communities.[411]

> *We have an obligation to figure out where we can have the biggest impact with vaccines because we still don't have unlimited resources. So, I think there's great opportunity, but it also comes with a lot of obligation to understand these vaccines better.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Incorporate Community Knowledge into Vaccination Evidence Systems

Communities can leverage local knowledge, including insights from lived experience, culture, and tradition, to identify opportunities to foster vaccine acceptance and increase vaccine access. The 2023 CPHO report also emphasized the importance of community knowledge for emergency preparedness and response and the need for systems that facilitate ongoing and meaningful partnerships. Community knowledge provides context for data and can avoid further

stigmatization arising from its interpretation by those outside of the community.[412] Explicit efforts need to be made to integrate community knowledge into evidence systems.[413] This can be supported through inclusion of and investment in community-based data collection as well as participatory and community-led research methods. For instance, in 2022, Hotìì ts'eeda, a support centre for patient-oriented research in the Northwest Territories, hosted a three-day gathering to explore Indigenous youth perspectives and develop community-based resources and outreach strategies for vaccination. Discussions were situated within the framework of Indigenous health and wellness, social determinants of health, value systems, and Indigenous knowledge.[414]

Indigenous data sovereignty means that First Nations, Inuit, and Métis communities lead and have ownership of the vaccination data collection and analysis process. Communities have the right to hold ownership over their knowledge, including traditions, cultures, and histories and traditional Western evidence sources, like quantitative and qualitative research data.[415] Acknowledging and respecting Indigenous data sovereignty involves planning for consistent and culturally safe methods for Indigenous self-identification and data access, as well as addressing significant data gaps for First Nations living off-reserve and Inuit and Métis Peoples living outside of their home community.[152, 192]

Some examples of community-determined principles for data sovereignty are the First Nations principles of ownership, control, access, and possession [OCAP® is a registered trademark of the First Nations Information Governance Centre (FNIGC)]; the Inuit Tapiriit Kanatami's National Inuit Strategy on Research; and the Manitoba Métis ownership, control, access, and stewardship (OCAS) principles.[187, 198, 416] Existing data agreements between some Indigenous organizations and provinces and territories facilitated the collection of COVID-19 vaccination data and public health response. However, such agreements do not exist across many jurisdictions and for many communities, and even where they do there remain large gaps, such as the availability of distinction-based data that reflect the unique characteristics, identities, and cultural contexts of First Nations, Inuit, and Métis Peoples across communities, including in urban settings.[128, 361, 363]

SECTION

3

Medical and Digital Health Technology: Purposeful and Adaptive Vaccine Technology for Equity

Progress in vaccinology is ongoing, including research and development of new vaccine targets, formulations, delivery methods, and platforms.[417–419] This includes innovations for routine and seasonal vaccinations as well as those for emergency use during outbreaks or pandemics. The COVID-19 pandemic accelerated advancements in digital health and vaccine technology, most notably the culmination of years of research on mRNA and viral-vector based vaccines as well as therapeutics.[167, 168, 420–422] To ensure these advances contribute to population health and health equity, it is important to engage key players, including public health organizations and communities, and integrate a focus on equity throughout the vaccine development process.

Address Equity Gaps with Evolving Vaccine Technology

New vaccines can help address health inequities by targeting diseases experienced disproportionately among some populations. For example, sexually transmitted and blood-borne infections, including gonorrhea, disproportionately impact certain groups, such as gay, bisexual, and other men who have sex with men, who additionally experience higher rates of antimicrobial resistant gonorrhea.[423] Research is being conducted to determine whether existing meningococcal vaccines could be leveraged to develop a vaccine against gonorrhea.[424] There is also an unmet need for vaccines to prevent many common hospital-acquired infections (e.g., *Clostridioides difficile*), which often more greatly impact older adults.[425–427] More broadly, researchers are exploring the potential for vaccines to address other population health challenges, including conditions like dementia, diabetes, substance use disorder, and cancer, which also disproportionately affect populations facing inequities.[171–173, 428–431]

Improvements to existing vaccines could also lead to products that improve duration of immunity, reduce the number of doses required, provide alternative vaccine formulations for those with allergies, or generate better immune responses, especially in older adults or immunocompromised individuals.[432–434] For example, a more effective vaccine against tuberculosis is a global public health priority.[435] While the national prevalence of tuberculosis in Canada is low, it disproportionately impacts certain populations, such as Indigenous communities. This is a result of historic and ongoing colonial policies, including forced relocation, loss of traditional lands, and the residential school system, which have led to persistent structural, social, and economic inequities.[436, 437] While an existing vaccine, first introduced in 1921, has been used to prevent life-threatening tuberculosis disease in infants and children, its effectiveness has been limited and variable, particularly in adolescents and adults who have the largest disease burden.[438, 439] Additionally, the initial development and trials for this vaccine were, in 1933, unethically conducted on First Nations children from the Qu'Appelle reserves in southern Saskatchewan, contributing to a history of medical mistreatment and discrimination.[440]

The development of combination vaccines that protect against multiple pathogens can reduce the number of required doses and appointments, contributing to a supportive resource environment (see Section 1).[441, 442] This is particularly relevant for populations for whom this may be a barrier to uptake, such as those with many children, living in rural or remote areas, living with low income, or experiencing homelessness.[215, 443] Novel vaccine delivery strategies, such as oral vaccines, nasal sprays, and microneedle array patches could reduce reliance on healthcare professionals for administration, which may be important during pandemics requiring rapid large-scale access.[433, 444, 445] They also can improve vaccine acceptability, for instance for people with a fear of needles or communities that have experienced medical discrimination. In addition to facilitating patient comfort, needle-free administrations may offer additional benefits by helping to reduce clinical waste or challenges associated with maintaining cold temperature logistics.[177, 446] Other innovations (e.g., vaccines with longer shelf-lives or less restrictive temperature requirements, super-insulated storage containers) can also facilitate vaccine distribution, particularly in rural and remote areas.[447] The durability of vaccine products may be particularly important in the context of climate change, as rising temperatures and an increase in the frequency and severity of extreme weather events could make maintaining proper storage and transport conditions more difficult.[151, 304, 448]

> *New forms of vaccines, oral and nasal, [have] removed some of the barriers in terms of injectable vaccines. More people in our organization or even in the community can offer these vaccines.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Establishing a diverse array of vaccine types (e.g., live-attenuated, inactivated, mRNA) is fundamental for facilitating innovation in both new and existing vaccines and delivery methods. This diversity becomes especially crucial during outbreaks of emerging vaccine-preventable diseases, where there may be an urgent requirement for large-scale production of new vaccines within tight timeframes.[449] As part of public health emergency preparedness, the federal government is responsible for negotiating contracts with manufacturers to ensure rapid, secure, and priority access to a sufficient supply of pandemic influenza vaccines produced in Canada.[450] A broader range of available vaccine products not only accelerates response times, but also mitigates dependence on single manufacturing sites and supply chains (see text box "100 Days Mission").[418]

100 Days Mission

The 100 Days Mission, a project from the Coalition for Epidemic Preparedness Innovations, refers to the goal of being able to produce safe and effective vaccines, diagnostics, and therapeutics at scale for global deployment within the first 100 days of a pandemic. One of the key objectives of this initiative is to use prototype pathogens as guides to expand knowledge for entire pathogen families. This supports preparedness for unknown threats, referred to as pathogen X. Based on an analysis of priority pathogens with elevated potential to cause pandemics, multiple vaccine options will be tested in early clinical trials. This proactive approach ensures that when a new viral threat is identified, prototype vaccines, based on existing, closely related viruses, are available to be adapted using rapid response platforms.[451–453]

Leverage Digital Health Technologies for Efficient Vaccine Uptake and Distribution

Digital health technologies have been used to aid with vaccine awareness and decision making, including reminder/recall systems, electronic consent for school-based vaccinations, clinical decision support alerts to healthcare providers, as well as interventions to share educational materials about vaccines or combat mis- and disinformation.[454–456] Recent systematic reviews suggest that initiatives such as text messages and social media interventions have shown some promise in supporting HPV vaccination among adolescents and influenza vaccination among pregnant people.[457, 458] More research is needed to understand the effectiveness of these interventions, including how to adapt them for relevance among diverse cultural groups.[304, 456, 459, 460] Additionally, many of these digital health technologies need sufficient human resource capacity to be effective. For instance, the Done by 2 Program, led by the Saskatchewan Health Authority, comprises an electronic vaccination database and reminder system along with community program builders who use the database to engage parents or guardians of children under two years of age overdue for vaccinations.[461] It is also necessary to ensure that the application of these technologies does not widen the digital divide between those who can and cannot access them.[462]

> *For COVID-19 it was a new system for us that complemented what our system had… [it could send] reminders and people could even book themselves into time slots. I think that made a huge difference. It was more client-oriented. If we had a system across the board for all vaccines, that would be quite helpful.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Technological innovations may also contribute to robust and resilient vaccine supply chains and distribution. Digitally enabled supply chain infrastructure allows for an accurate and proactive distribution of vaccines to where they are most needed. For example, during the COVID-19 pandemic, PHAC developed an digital platform for supply chain management, VaccineConnect, to manage vaccine allocation, ordering, distribution, and inventory.[463] Predictive algorithms, data modelling, and analytics further automate and inform strategies for demand forecasting. This ensures that vaccinations can be completed efficiently, with minimal wastage, which may occur if cold chain requirements are not met.[464–466] Digital inventory and information management systems are also needed at the provincial and territorial level to reduce administrative burden of manual tracking on healthcare staff.[360]

Incentivize the Development of Needs-Based Vaccine Innovations

New technologies offer opportunities to improve population health and address health inequities. In order to realize these goals, it is necessary for the appropriate vaccine innovations to be supported, and for resulting vaccine products to be accessible to those who need them most. Without this, innovations in vaccines can present challenges that have the potential to exacerbate inequities.

The IA2030 highlights needs-based innovation as a key area of focus.[7] Such an approach requires strong mechanisms to prioritize vaccine research and innovation according to both global epidemiological trends and community needs, with a particular focus on communities who have been under-resourced. However, this can be a challenge because commercial incentives and national priorities may favor investment in some areas over others, with implications both globally and domestically.[467–469] Alongside scientific obstacles, systemic inequities in health funding and research prioritization may impede progress in developing vaccines for certain infectious diseases that disproportionately impact some populations.[470–473]

This issue is compounded by a global pharmaceutical context where preventative products, like vaccines, have historically made up a relatively small share of the market compared to more profitable therapeutic treatments.[474] Given the importance of vaccination for public health, governments and other funders have employed various strategies to promote vaccine development for global, regional, and domestic priorities.[472] These may include "push" mechanisms, which subsidize costs (e.g., regulatory vouchers, research funding), and "pull" mechanisms, which increase demand (e.g., advance purchase agreements, tax credits for sales).[475, 476]

Collaboration among countries, funders, industry, and academia is paramount to incentivize the development of priority vaccines.[477] Canada alone represents only a small share of the global market, so pooling resources and collaborating with other nations and non-governmental organizations that have shared priorities can amplify impact and tackle challenges more effectively.[472, 478] Moreover, such cooperation fosters the exchange of expertise and accelerates research endeavours. One approach is public-private partnerships, which involve collaborations between the private sector, government, and/or non-governmental organizations. There are various models of public-private partnership for vaccine development, but it is common for academic partners to undertake initial research and innovation and then transfer this knowledge to a private sector partner to test the vaccine and bring it to market.[479] The Canadian vaccine against Ebola is a prime example of the success of collaboration between government departments, private industry, and international partnerships (see text box "Partnerships in the Development of VSV-EBOV – Canada's Vaccine for Ebola").

Partnerships in the Development of VSV-EBOV — Canada's Vaccine for Ebola

Ebola is a viral disease that spreads through contact with blood and bodily fluids from an infected person and has a high case fatality rate.[480] The breakthrough Canadian discovery and development of the VSV-EBOV vaccine against Ebola was a collaborative effort involving PHAC, the International Development Research Centre, the Canadian Institutes of Health Research, Global Affairs Canada, the Department of National Defence, Public Safety Canada, private industry, and international partners.[481] Initially developed by the National Microbiology Laboratory with funding from the Canadian Safety and Security Program in 2006, it was licensed to biotechnology companies for clinical trials and production in 2010.[482–484] The success of the VSV-EBOV vaccine not only bolstered Canadian and global preparedness against Ebola, but also showcased the importance of international cooperation in the face of global health challenges.

Between 2018 and 2020, the vaccine was given to over 300,000 people in response to outbreaks in the Democratic Republic of the Congo and other parts of Central Africa. Researchers estimated that during these outbreaks the vaccine had been 97.5% effective at stopping Ebola transmission. This was accomplished by implementing a large-scale ring vaccination scheme, a strategy involving vaccinating close contacts of an infected person and contacts of those contacts.[485] By 2021, VSV-EBOV was pre-qualified by the WHO and, following a recommendation by the Strategic Advisory Group of Experts on Immunization, a global stockpile was established to respond to outbreaks.[486]

Public health organizations can leverage their knowledge of population health to support needs-based prioritization.[469, 472] For instance, in 2015, the Government of Canada published a set of priorities for research and development of new vaccines based on the pathogens and diseases of greatest concern to public health. This also included areas of focus for Canada's research community and vaccine industry to consider when creating their strategies and work plans.[487] In the United States, the Biomedical Advanced Research and Development Authority hosts an annual industry day conference to increase awareness of government medical countermeasure priorities and encourages connections between the public and private sector.[488] At the international level, the WHO publishes pathogen prioritization reports as well as preferred product characteristics and target product profiles, which offer detailed descriptions of desirable attributes for vaccines, to promote the development of novel applications most relevant to unmet public health needs.[489–491]

Canada has a history of making significant contributions to vaccine research. However, throughout the COVID-19 pandemic, Canada has been dependent on other countries for vaccine supply, as domestically there were few facilities available to do end-to-end vaccine production, and none were equipped to work with emerging technologies at population scale or to scale-up rapidly.[492] In response, the Government of Canada established the Biomanufacturing and Life Sciences Strategy, which committed an initial $2.2 billion over seven years through Budget 2021 to begin rebuilding the life sciences sector, with an early focus on strengthening domestic vaccine and therapeutic production capacity, in addition to funding life sciences skills development, research infrastructure, and robust clinical trials system.[493] This strategy has launched several key funding programs and has made a number of investments, including the Canada Biomedical Research Fund, the Biosciences Research Infrastructure Fund, the Clinical Trials Fund, and the Strategic Innovation Fund.[494–496]

Embed Community Engagement into the Vaccine Development Process

In addition to developing mechanisms to integrate community priorities into vaccine development, it is also necessary to ensure that vaccine research includes and reflects diverse communities. This is particularly important in the design and conduct of clinical vaccine trials. Historically, vaccine development has lacked appropriate community engagement structures.[497–499] However, some recent examples, including HIV vaccine research and drug development for tuberculosis and HIV, can inform better community inclusion in vaccine research.[500–502] For example, both the Good Participatory Practice: Guidelines for Biomedical HIV Prevention Trials and the Good Participatory Practice Guidelines for Tuberculosis Drug Trials offer a roadmap for inclusive community engagement in research.[503, 504]

Community leaders and representatives serve many important roles, including enhancing research tools and frameworks so that they are relevant, acceptable, and culturally appropriate, resulting in improved participant recruitment and retention.[505–507] This can enable clinical trials that are fair and accessible.[508] Enrolling participants from diverse social contexts and geographies, particularly those who experience differential exposure, susceptibility, or access to treatment for disease, may increase the applicability of findings to real-world settings and produce higher quality findings.[508–511] Certain populations historically excluded from clinical trials (e.g., pregnant people) also require special consideration.[512–515] Community members engaged in vaccine development research can additionally act as trusted messengers for disseminating results and raising awareness.[506, 510]

> *When there is distrust, rebuilding trust in an institution is next to impossible or will take a long time. And that's where peers come in.*
>
> **INTERVIEW PARTICIPANT (COMMUNITY ORGANIZATION)**

For First Nations, Inuit, and Métis Peoples, vaccine research requires attention to unique cultural, ethical, and sovereignty considerations.[505, 516] This is necessary to address unethical research practices perpetuated against Indigenous Peoples, such as harmful medical experimentation and unethical vaccine trials.[89, 440] Furthermore, the over-research of Indigenous communities by non-Indigenous researchers, without ownership or reciprocity for community, undermines trust and perpetuates harm.[89, 517, 518] Actively co-developing the research process with Indigenous communities involves seeking input and approval from appropriate governance structures and recognizing the diversity and distinctions of Indigenous populations and the importance of community-specific factors.[519]

In addition to being a necessary component of truth and reconciliation efforts, community engagement promotes the sharing of power to address the root causes of health inequities and acknowledges unique values and interests. This approach prioritizes community voices in determining who benefits from and is affected by research, including the potential positive and negative outcomes. Achieving these goals requires that community engagement is prioritized as a long-term investment in trust and facilitating lasting partnerships.[509]

SECTION

4

Strengthened Foundations of the Public Health System to Support Vaccination

The full potential of innovations in vaccination program and policies, evidence systems, and technologies to improve population health and well-being can only be accomplished by a public health system with strong and nimble foundations. This is particularly important in the context of shifting disease, social, and economic contexts. A supported public health workforce that can effectively deliver vaccinations, a forward-thinking approach to resource allocation, and agile governance structures provide the solid groundwork for optimizing vaccination.

Workforce Expertise and Human Resource Capacity: Provide Healthcare Workers with the Tools and Resources to Support Vaccination

The primary provider of vaccinations varies across age groups and jurisdictions and includes family doctors and pediatricians, public health nurses (especially in school-based programs or community health clinics), and pharmacists. Healthcare workers more broadly play critical roles in facilitating vaccination and are generally considered to be highly trusted sources of information.[520, 521] It is important to support the accessibility, capacity, cultural competence, knowledge, and vaccine uptake of vaccination providers and other healthcare workers to ensure they are well positioned to do this essential work.

> *We know that one of the most important factors related to immunization uptake is trust of the person who's providing care. If people don't have a primary healthcare provider, then there's less opportunities for a trusted person to talk to them about immunization and provide that immunization if they are behind.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Millions of people in Canada do not have access to a regular healthcare provider, such as a family doctor, general practitioner, or nurse practitioner, which may negatively impact patient outcomes, health equity, and access to vaccination.[522–524] Challenges were exacerbated by the disruptions of the emergency phase of the COVID-19 pandemic and contributing factors include a growing and aging population, burnout among healthcare providers, and a decline in the proportion of physicians choosing to practice family medicine.[523, 525–527] Solving the primary care crisis will take time, and as such, optimizing vaccination requires the mobilization of a variety of trusted healthcare workers for all aspects of vaccination delivery (see text box "Trusted Nurses and Community Health Aides Work to Reduce Complacency towards Vaccination in Northern Canada"). For example, to support individuals experiencing homelessness, Inner

City Health Associates in Toronto, employed community health workers with lived experience, who supported the development of vaccine resources and assisted clients in navigating the healthcare system.[281, 528] Additionally, in recent years, there has been an expanded scope of practice for certain providers, such as pharmacists, in some jurisdictions to include vaccination.[529, 530]

Trusted Nurses and Community Health Aides Work to Reduce Complacency towards Vaccination in Northern Canada [531, 532]

Nunatsiavut ("Our Beautiful Land" in Inuktitut) is an Inuit self-governing nation along Labrador's coast composed of five remote communities. The Nunatsiavut health team prioritizes an approach to vaccination that aligns with the Inuit value of collective well-being, ensuring the protection of all community members, including those who cannot be vaccinated. Community health aides, who are local members and often know or speak Inuktitut, receive training as employees of the nursing program. They assist with daily tasks like appointment and records management, obtaining informed consent, and outreach.

To reduce vaccine complacency and misinformation, local government, health professionals, and community members collaborate on regular events and campaigns. Intersectoral partnerships between public health and education departments have resulted in a sustained, local workforce, which supports continuity of vaccine promotion over time.

Nunatsiavut attributes much of their high childhood vaccine coverage to trust in public health nurses and community health aides, with 100% coverage for routine vaccines for children under two years of age, and over 95% coverage for hepatitis B and HPV for school-aged children.

Even when healthcare workers are not directly involved in administering vaccines, their role in providing care at various points in the life course creates opportunities for meaningful discussions and education on vaccines. For example, the Canadian Association of Midwives and the National Council of Indigenous Midwives have made considerable efforts to increase midwives' knowledge of and skills in discussing vaccines with clients.[281, 533, 534] This also included developing tailored resources that adapt vaccine education materials to reflect the values and approaches of the midwifery model of care.[535, 536] To support healthcare providers in delivering vaccinations or effectively discussing vaccines with their patients, training related to vaccines and vaccination could be made more accessible to a broader range of healthcare workers in school and on the job.[537–541] The *Immunization Competencies for Healthcare Professionals* developed by PHAC provides a framework for vaccination training, such as the Canadian Paediatric Society's Education Program for Immunization Competencies.[61, 542]

Addressing the systemic challenges that healthcare workers encounter is paramount for enhancing their capacity and ability to provide quality care, including vaccination-related efforts. High rates of staff turnover, particularly in remote and northern communities, disrupt continuity of care and impact the development of trusted relationships with community members.[543] Additionally, administrative burdens and time constraints further hinder efforts to optimize care and communication about vaccination.[210, 544, 545] Opportunities to decrease system-level and administrative barriers include electronic access to comprehensive patient records and vaccination history, streamlining consent processes, appropriate compensation for additional responsibilities, and clear and concise vaccination schedule information, particularly for adults.[226, 546, 547]

As described in Section 1, access to culturally safe health care is a key component of creating supportive vaccination environments. Interventions to address bias and discrimination in the health system were detailed in the 2019 CPHO report, with emphasis on actions to build

inclusive public health and healthcare systems at individual, interpersonal, institutional, and population levels.[74] Similar approaches can be used to better equip vaccination sites and healthcare workers to provide culturally safe and trauma-informed care. This includes workforce diversity initiatives, implementing cultural humility models, institutional collaboration with communities, and ongoing and continued conscious and implicit bias training.[74, 117, 126, 199, 241] Continuing education and formal resources are required to support healthcare workers in building cultural competency to meet the needs of the communities they serve.

Vaccination providers have also reported a need for better training and education on engaging in conversations about vaccines with their patients, particularly in the context of rapidly evolving technology and new vaccine recommendations.[209, 548, 549] Healthcare provider transparency about potential side effects and vaccine safety surveillance systems can increase trust and vaccine acceptance.[209] Therefore, providing timely and concise information about recent vaccine evidence as well as resources on effective counselling strategies are important for preparing busy healthcare providers to discuss vaccination with their patients.[209, 548, 550] For example, motivational interviewing or the use of decision aids, can enhance the role of healthcare providers as trusted messengers of information and improve vaccine uptake (see text box "Motivational Interviewing to Support Conversations about Vaccination as Exemplified by Quebec's EMMIE Program").[551–554]

Motivational Interviewing to Support Conversations about Vaccination as Exemplified by Quebec's EMMIE Program

Motivational interviewing (MI) is a person-centered communication strategy designed to enhance an individual's internal motivation to change their behavior. In the context of vaccination, MI aims to educate patients about vaccination in a way that is tailored to their unique needs and level of understanding, while respecting their beliefs and remaining empathetic. The technique is composed of three core elements: fostering a collaborative and empathetic atmosphere, engaging individuals about perceived motivations, and directing conversations toward the desired behavioral changes. A four-step MI-based framework to support healthcare providers in leading vaccine conversations includes engage, understand their views, offer information, and clarify and accept their decision.[551]

The Entretien motivationnel en maternité pour l'immunisation des enfants (EMMIE) is a provincial initiative to promote childhood vaccination in Quebec.[555] Launched at the end of 2017, this program implements the PromoVac strategy to offer parents a personalized session discussing vaccination by counsellors trained in MI during their hospital stay following the birth of their child. The EMMIE program's evaluation revealed that children whose parents received the intervention were 10% more likely to have complete vaccination coverage by two years of age. In addition, evaluation results showed an 11% increase in vaccination intent and a 30% decrease in reluctance to be vaccinated.[551] The program also demonstrates high levels of parent satisfaction, with 96% of parents recommending it to others.[556]

Since healthcare workers may act as role models for vaccine acceptance, it is important to understand and support their own knowledge, acceptance, and uptake of vaccines.[557, 558] Moreover, vaccination of healthcare workers is important for infection control in care settings and preserving overall system capacity. For instance, during the initial rollout of COVID-19 vaccines, vaccine acceptance and uptake among staff at long-term care facilities emerged as a significant protective factor for residents.[559, 560] Interventions that combine multiple methods, such as education, incentives, and organizational policies are most effective to facilitate healthcare worker vaccination, with particular attention to those experiencing inequities.[561–564]

Financing: Optimize Resource Allocation with Innovative and Comprehensive Economic Analyses of Vaccination Programs

Investments in public health and prevention broadly are understood to be cost-effective and are often cost-saving.[50, 565] However, funding constraints and "boom and bust" cycles of public health spending pose challenges to implementing and sustaining long-term programming, including vaccination.[58] Public health decision-makers must balance emerging or urgent public health issues with optimizing ongoing vaccination programs to protect population health, all while managing the often limited resources available.[566]

> *The speed at which the changes are happening, and new products are coming out probably requires a more deliberate process around how we assess and implement these [vaccines] in a very planned and predictable way.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

As technology advances and new, potentially more expensive, vaccines are authorized for use, jurisdictions will need to decide if and how to include these in publicly-funded vaccination programs. In making these decisions, policymakers must be equipped with evidence regarding the cost-effectiveness of these vaccines and the circumstances under which their deployment is most suitable — whether for broad implementation or more targeted use.[567] To facilitate timely decision making for provincial and territorial vaccination programs, PHAC expanded the mandate of the National Advisory Committee on Immunization (NACI) in 2019 to include programmatic factors, such as economic considerations, into its recommendations. In 2023, NACI published guidelines for the economic evaluation of vaccination programs in Canada.[51]

Economic evaluations are typically conducted for individual vaccines upon their authorization. However, as the number of available vaccines increases, jurisdictions will need to assess publicly-funded vaccination programs as a whole to effectively determine how best to integrate new vaccines. More holistic analyses would entail comprehensively evaluating the cost-effectiveness of the multiple vaccinations and delivery approaches that together make up the recommended schedule. Such analyses may help navigate the complexities of vaccination program planning and resource allocation amidst an expanding array of vaccine products.[182, 566]

> *We need health economists who can look at the financial impacts, because really even the expensive vaccines are usually pretty cost-effective compared to almost everything else we do in health care.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Additionally, while economic evaluations typically consider the direct prevention of morbidity and mortality associated with vaccination, the inclusion of broader social and economic benefits of vaccination can provide a more fulsome perspective. There is increasing recognition of the need to include population health and other multisectoral impacts, such as on antimicrobial resistance, economic productivity, educational achievement, and ecological footprint in economic evaluations.[38, 51, 568] Additionally, region-specific cost-effectiveness models may be useful in considering differences in disease epidemiology as well as costs of implementation and delivery between jurisdictions.[567]

An increasing number of economic models are taking into consideration the disproportionate burden of infectious diseases on certain populations to facilitate pursuing an equity approach. Equity-informative economic evaluation is a growing field to identify the differential health impacts of vaccination programming and find strategies for narrowing health equity gaps in cost-effective ways.[569] Decision-makers may decide to invest in a particular approach to respond to an important inequity, even if it means choosing a different threshold for cost-effectiveness.[570] Researchers and decision-makers can work together to establish the goals and values most relevant to their context and to reflect those criteria in their analyses.[51] More research and work is needed in this area to facilitate the use of equity-informed economic evaluations.

Despite the importance of economic evaluations as a tool to guide vaccination decision making, there are significant barriers to their widespread use. This includes limited capacity and expertise in health economics in the public health workforce, particularly for emerging methods, like equity-informative and holistic program-level analyses. Additionally, to support local or region-specific evaluation, expertise in economic evaluation at these levels is needed. However, this expertise is often not available, particularly for smaller, less resourced jurisdictions.[571, 572] Finally, the utility of economic models is dependent on the availability and quality of the data that they are built on. In particular, data disaggregated by sociodemographic variables are required to support equity-informative analyses (as discussed in Section 2).[571]

Governance, Leadership, and Engagement: Coordinate Knowledge Mobilization, Communication, and Participation in Vaccination Policy Decision Making

Vaccination programs are a result of a complex decision-making process that occurs in specific scientific, sociopolitical, and economic contexts. They also reflect the interests and priorities of many different key players and institutions.[566] These factors may complement or compete with each other, requiring thoughtful governance within and across jurisdictions in Canada. A core challenge for governance in Canada is the shared nature of the funding, decision making, and delivery processes relating to vaccines. Vaccination governance is further complicated by the dual role of vaccines as both a public health tool and, increasingly, an individual healthcare intervention, particularly as more vaccines are developed for individuals with specific risk factors versus the entire population.[573]

> *[Vaccination decision making] gets complicated in terms of how you do it, who does what, how is it shared, but also who funds it, or who has the capacity.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Despite some challenges, the involvement of multiple jurisdictions in vaccination decision making also creates opportunities for knowledge exchange and mobilization to derive maximum benefit from lessons learned, best practices, and program evaluations. Canada relies on a series of networks, working groups, and committees to align activities, share feedback, and reduce duplicative work about vaccination across jurisdictions. Some examples include NACI, the Communicable and Infectious Disease Steering Committee and the Canadian Immunization Committee (CIC), as part of the Pan-Canadian Public Health Network.[59] Such groups can be leveraged to support the exchange of best practices and evidence to ensure everyone benefits from knowledge gained across the vaccination system.

The National Immunization Strategy (NIS), established in 2003 and last updated in 2016, provides an overarching framework to guide and align interjurisdictional vaccination efforts across the country. The strategy's priority areas and objectives aim to increase vaccination rates, reduce vaccine-preventable diseases, and enhance overall public health.[574] A renewed NIS is expected to be published in 2025. The CIC, a federal, provincial, and territorial committee, serves as a national forum to implement the NIS and foster cooperation, collaboration, and engagement on vaccination issues between all levels of government.[575]

Throughout the COVID-19 pandemic, the CIC served as a regular platform for sharing information and best practices, ensuring that members were kept abreast of emerging issues. It also provided tools, resources, research, and data

to support jurisdictional vaccine planning and rollout efforts. This type of knowledge mobilization can also happen at local and regional levels and through more informal structures, such as communities of practice, where experts exchange knowledge, offer expertise, bridge communication gaps, and identify strategies to overcome challenges.[576–578] Research suggests that communities of practice may support organizational change, systems thinking, and team learning.[576]

> *Shared learning is important. What was useful about community of practice sessions was that the challenges we were facing were often similar [to the] challenges that others were facing as well.*
>
> **INTERVIEW PARTICIPANT (COMMUNITY ORGANIZATION)**

Vaccination practices and programs vary across jurisdictions as a result of provinces and territories tailoring programs to their own needs, capacities, and budgetary contexts.[59] These differences may include vaccination schedules and vaccine eligibility, approaches for delivering vaccines, promotion strategies, and data collection practices in vaccine registries.[579, 580] This can sometimes create challenges for the vaccination system as a whole.[581] For example, when vaccine promotion emphasizes the importance of not delaying routine childhood vaccines and adhering to published schedules, parents may question why programs differ between provinces and territories if they are based on providing the best possible protection. This may further pose obstacles for those moving within or between regions.[582] In addition to differences in schedules for existing vaccines, newly approved vaccines may be added to publicly-funded programs on different timelines in some jurisdictions.[583, 584]

Variation in COVID-19 vaccine eligibility across provinces and territories contributed to frustration and confusion for the public and for vaccine providers alike.[19] As scientific understanding and vaccine recommendations shifted rapidly, changes and differences in messaging had a similar effect.[137] When the rationale behind these differences is not adequately and transparently communicated, it may undermine trust in the public health system.[19, 275] Governance structures that facilitate close collaboration between jurisdictions along with consistent, transparent, and accessible communication of the scientific and programmatic reasons for decisions support alignment across Canada while respecting jurisdictional autonomy.[275]

The public health system has a responsibility to reflect Indigenous Peoples' right to self-determination in public health governance structures, including those related to vaccination.[585, 586] This means supporting First Nations, Inuit, and Métis leadership and communities in designing, delivering, and managing their own vaccination programs and services through self-governance and sufficient resources and funding. It also requires inclusion for Indigenous Peoples in vaccination policy development and decision making to ensure that self-determination is not undermined by the policies of non-Indigenous organizations and governments.[587, 588] Article 71 of the *United Nations Declaration on the Rights of Indigenous Peoples Action Plan* calls for strengthening Indigenous engagement across public health and healthcare systems by improving bilateral mechanisms and linkages between federal, provincial, and territorial officials and Indigenous representatives.[186] There is not a universal governance model that will be applicable or appropriate for all First Nations, Inuit, and Métis communities, and governments at all levels have a responsibility work with communities to support self-determination.[585] One example of prioritizing self-determination in vaccination decision-making was the COVID-19 vaccine rollout for First Nations in Manitoba (see text box "Self-Determination through the First Nations-led Integrated Vaccine Operation Centre").

> *We just resourced the community and the Indigenous health experts to make decisions about how the rollout was going to work for those communities and didn't do it necessarily the same way as we did for non-Indigenous communities. And that was incredibly effective.*
>
> **INTERVIEW PARTICIPANT (MEDICAL OFFICER OF HEALTH)**

Self-Determination through the First Nations-led Integrated Vaccine Operation Centre

Manitoba's Integrated Vaccine Operation Centre coordinated COVID-19 vaccinations for all First Nations in Manitoba during the COVID-19 pandemic. The Centre was led by Ongomiizwin Health Services in partnership with the Assembly of Manitoba Chiefs, Southern Chiefs Organization, and Manitoba Keewatinowi Okimakanak/ Keewatinohk Inniniw Minoayawin.

First Nations-specific data on vaccine coverage for urban and on-reserve populations was made available daily to inform rapid programming decisions. In alignment with Indigenous data sovereignty principles, communities had ownership and control of these data. On-reserve, Indigenous-led clinics were established in areas of greatest need and used traditional practices to align with community values.

Additional factors that contributed to high uptake included building trust through quick mobilization and response, having consistent cultural and science-based messaging, expanding the definition of healthcare workers to include traditional healers, and leveraging existing partnerships with community leaders. This First Nations-led approach contributed to over 90% vaccine coverage for the primary series of COVID-19 vaccines in First Nations communities in Manitoba by December 2022.[589–591]

Beyond engaging communities in vaccine rollout, evidence and data collection, and development (as described in Sections 1–3), an equity lens can be applied across vaccination policy decision making. This can be facilitated through exploring equity-focused vaccine delivery models in partnership with communities and explicitly integrating equity into decision making for the introduction of new vaccines.

Early and ongoing engagement of groups experiencing inequities is needed to better integrate equity into vaccine delivery systems.[126] One example of a tool to support this is the COVID-19 Immunization Primary and Community Care Mapping tool developed by the University of British Columbia, which uses rapid engagement and consensus building techniques with public health officials, primary care providers, community organizations, and municipal and cultural leaders in Western Canada to co-design solutions for improving vaccine uptake.[592] Meaningful community engagement requires a robust social infrastructure that is supported by long-term funding.[152] Such resources are increasingly important given the central role of community members and organizations in responding across public health priorities.[58]

An illustration of the application of equity considerations to vaccination guidance is NACI's development of the Ethics, Equity, Feasibility, and Acceptability (EEFA) Framework. This framework provides a basis for systematically considering and assessing issues that impact health equity in the development of vaccine recommendations. As part of the framework, the evidence-informed Equity Matrix Tool can be used to identify potential inequities, reasons for their existence, and possible interventions to reduce them.[593]

The complexities of the vaccination system, from its shared responsibilities to its intersectoral nature, can create logistical and governance challenges. However, these circumstances also offer valuable opportunities for innovation by featuring diverse perspectives, strong networks and relationships, and a shared dedication to optimize vaccination for public health. When all components of the system are mobilized around common goals with the evidence systems and resources in place to facilitate successful and inclusive collaboration, the full potential of vaccination for all people in Canada can be realized.

Way Forward

This report offers a vision in which everyone can experience the benefits of vaccination at all stages of life. Investing in our vaccination infrastructure and leveraging vaccines as a preventive tool will pay dividends across public health and healthcare systems by improving the health of individuals and communities, optimizing the use of health system resources, and contributing to global health security.

We are at a pivotal moment in time to realize the full potential of vaccines, with key lessons learned from the COVID-19 pandemic and other infectious disease outbreaks (e.g., mpox, measles), as well as promising new technologies on the horizon that could address a wider range of illnesses. However, there are important challenges that must be addressed. These encompass structural barriers that impact access to vaccines, digital environments that enable the spread of mis- and disinformation, and competing priorities for funding at a time of increasing population needs and stretched resources.

As part of the health system focused on preventing disease, promoting health, and advancing equity, public health has a crucial role to play to strengthen the network of organizations, processes, and resources that make up our vaccination system. Maximizing the impact of vaccination requires strong public health leadership to set priorities, make future oriented decisions, and foster efficiency, inclusivity, and transparency. The public health system will need to be ready to take advantage of emerging vaccine technologies and ensure it has the capacity to implement them equitably. Public health also has a responsibility to show leadership in integrating rights-based approaches to protect the rights of Indigenous Peoples in Canada and fulfil commitments to truth and reconciliation.

This report and Canada's upcoming renewed National Immunization Strategy provide opportunities to further this public health leadership role and come together to collaborate across jurisdictions, sectors, and with communities to better prepare our vaccination system for future demands. The following proposed actions can be taken across the vaccination system to help catalyze these efforts and move toward realizing the vision set forward in this report.

Guide Sustainable Investments in Vaccination

Resource constraints and competing priorities can make it difficult to prioritize prevention over response. In particular, given limited public health budgets, it may be challenging for decision-makers to add costly new vaccines to publicly-funded vaccination programs. Without a plan to adapt funding models for these innovations, we may miss key opportunities to improve population health and address inequities. Being able to concretely describe and forecast the economic, social, and health impacts of vaccination will help to demonstrate the value of vaccines and plan for the future. Additionally, it is important to assess public health system performance to identify opportunities for improvement.

Performance indicators and annual reporting practices specific to vaccination can support adapting programs and policies to an evolving vaccination landscape and guide resource allocation.

Investment in improving public health infrastructure to deliver vaccines is an ongoing priority. This includes information technology, program evaluation, and workforce capacity and expertise. The public health workforce has been under considerable pressure due to under resourcing and the need to respond to increasingly frequent public health emergencies. Vaccination may be one of many responsibilities of public health workers, such as public health nurses in rural and remote areas who provide a diverse range of services to support community health. It is important to provide workers with sufficient resources and infrastructure to do their jobs. At the same time, opportunities to leverage a diverse range of health and non-health professions, such as community health workers, need to be explored.

Additionally, sufficient and consistent funding is necessary to tailor and adapt approaches for populations not well served by traditional vaccine delivery methods. Meeting the vaccination needs of these groups is critical for achieving the coverage required for community immunity for some vaccines.

Actions

- Conduct evaluations of entire publicly-funded vaccination programs to plan for the future and ensure they contribute to achieving public health objectives (e.g., proactive economic evaluations that consider current and potential future child and adult vaccine schedules and integrate equity considerations, effectiveness analyses of vaccination schedules).
- Invest in information technology infrastructure to modernize the vaccination system, including supporting comprehensive data and evidence systems, digital consent processes, and supply chain management.
- Bolster capacity of the public health workforce for vaccination, including by leveraging a range of professionals and by training and recruiting trusted community health workers.
- Equip the public health workforce with the tools they need to effectively facilitate and deliver vaccination (e.g., on-the-job and academic training, digital infrastructure).
- Allocate funding for evaluating and improving vaccination programs delivered across the life course. This includes setting equity targets for vaccine coverage as well as sustaining and scaling up programs that work to close equity gaps (e.g., community- and school-based vaccination and programming, integration with other health services).
- Provide resources to uphold First Nations, Inuit, and Métis Peoples' right to self-determination, and support Indigenous communities to develop vaccination approaches and interventions tailored to their needs.

Strengthen Vaccination Data and Evidence Systems to be Responsive, Inclusive, and Connected

Effective vaccination programs and policies require data and evidence that is timely, comprehensive, relevant, and accessible to decision-makers and communities. As the vaccination and population health landscapes evolve, so too must evidence systems. This means adapting to new research, technological innovations, and advanced data collection and analysis tools. It also requires strengthening the research-to-practice continuum by improving linkages between research and surveillance, programs, decision-makers, and the communities they serve.

The vaccination system needs to work for everyone. Comprehensive evidence and disaggregated data are required to respond to community priorities and to evaluate the impact of vaccination programs and policies. An inclusive evidence base involves integrating community knowledge while honouring principles of data sovereignty.

The COVID-19 pandemic and other recent health emergencies have highlighted the importance and challenges of collecting, sharing, accessing, and using health data. Calls for improved data interoperability across the public health system have been ongoing, including for vaccine registries. Despite historic efforts on this key priority, there are still barriers to interoperability of registries and other data systems.

Respecting commitments made following the COVID-19 pandemic, including via the Working Together to Improve Health Care for Canadians Plan and the joint federal, provincial, and territorial Action Plan on Health Data and Digital Health, it is time to mobilize expertise, innovation, and collaboration to modernize Canada's data systems.

Actions

- Accelerate the advancement of interoperable vaccination data systems, including vaccination registries, through the development of common standards for data collection, sharing, and use.
- Strengthen public health surveillance and facilitate linkages with health administrative data to monitor the impact of vaccination at the population level.
- Incentivize research that fills critical evidence gaps, particularly those that support vaccination programs and policies across the life course, as well as those that explore the sociocultural contexts that influence trust in institutions and vaccination.
- Develop, validate, and apply equity-informed methods and indicators to measure and understand the intersections between vaccine access, acceptance, knowledge, attitudes, and beliefs across the life course.
- Prioritize Indigenous data sovereignty in surveillance and research systems, including facilitating the availability of appropriate data for decision making.
- Establish mechanisms to support community-driven research and data collection and integrate community engagement, knowledge, and methods into interdisciplinary vaccination evidence systems.

Embed and Expand Collaboration Mechanisms for the Vaccination System

Collaboration is a core strategy for maximizing expertise across the vaccination system. Canada's federated system allows jurisdictions to tailor vaccination programs according to their needs. However, the resources and capacity to evaluate vaccination programs or forecast future demands may not always be available, especially for smaller jurisdictions, including First Nations, Inuit, and Métis communities and governments. Exchanging knowledge and skills across jurisdictions and sectors facilitates opportunities to better optimize vaccination and support self-determination.

Public health expertise can be used to help advance vaccine innovation. This includes understanding who is most impacted by infectious diseases and how best to meet population needs for vaccination. Clear and effective mechanisms are required to prioritize the integration of public health perspectives into vaccine research and development. Public health can collaborate to find upstream solutions to challenges that crosscut sectors, such as digital health literacy, mis- and disinformation, and public trust in science.

Communities play essential roles in tailoring programs and communications, identifying research priorities, and collecting and contextualizing disaggregated data, among other activities. Developing robust collaboration mechanisms supported by long-term funding to maintain relationships with community leaders and organizations can help embed community engagement as a key component within the vaccination system.

Canada can also demonstrate ongoing leadership on global health security and other shared priorities through international partnerships. Both global and domestic collaboration showed many strengths during the COVID-19 pandemic, and the strengthened relationships and governance mechanisms from this period continue to evolve, fostering a more responsive system.

Actions

- Develop and enhance processes for exchanging knowledge, skills, and expertise relevant to vaccination across federal, provincial, territorial, local, and Indigenous jurisdictions (e.g., economic and program evaluation, communication strategies).
- Work across jurisdictions and sectors (e.g., education, technology) to conduct and coordinate evidence-informed vaccination communications, build science and digital literacy, and counter mis- and disinformation.
- Strengthen intersectoral mechanisms to integrate public health considerations into domestic and international vaccine innovation and investments.
- Demonstrate a commitment to self-determination in vaccination governance systems and include strong Indigenous representation where there is potential impact on Indigenous Peoples.
- Implement approaches that facilitate ongoing community engagement and incorporate community perspectives into vaccination program and policy decision making.
- Support international governance structures and relevant agreements involving vaccines that contribute to global health security and address shared challenges, including One Health, health inequities, and pandemic preparedness.

APPENDIX A

An Overview of Roles and Responsibilities in Canada's Vaccination System

The Public Health Agency of Canada (PHAC) is responsible for coordinating bulk procurement of publicly-funded vaccines, ensuring security of the vaccine supply, monitoring post-market vaccine safety and effectiveness, assessing vaccine coverage, developing vaccine recommendations, promoting vaccines through public communications and engagement, and producing educational and clinical guidance for healthcare providers (e.g., the development of Immunization Competencies for Health Professionals).[59, 61, 62] PHAC manages the National Emergency Strategic Stockpile, which contains select vaccines as well as other medical countermeasures.[15] In addition, PHAC monitors and provides policy guidance on the delivery of the Pan-Canadian Vaccine Injury Support Program.[594] Many of these activities are done in collaboration with provinces and territories or other federal departments.

PHAC is also the secretariat for two vaccine-related external advisory bodies. The National Advisory Committee on Immunization (NACI) is Canada's National Immunization Technical Advisory Group, which is a group of experts responsible for providing independent, evidence-informed advice on issues related to vaccination and vaccines.[595] NACI consists of independent experts who provide ongoing medical, scientific, and public health recommendations related to vaccines approved for use in humans in Canada.[59, 596] NACI's advice is considered by provincial and territorial decision-makers to inform vaccination programs as well as by healthcare providers who recommend or administer vaccines to patients. The Committee to Advise on Tropical Medicine and Travel (CATMAT) provides evidence-informed guidance for healthcare professionals on matters related to tropical medicine and travel health, including vaccinations for international travellers.[59] Typically, vaccines recommended for travel that are not part of routine programs are not publicly funded in Canada, but are available for purchase. As new evidence becomes available, PHAC synthesizes the recommendations of NACI and CATMAT and updates the Canadian Immunization Guide, to provide comprehensive vaccine information for healthcare providers.[59]

In addition to NACI and CATMAT, PHAC provides secretariat support for several governance groups to support collaboration at federal, provincial, and territorial levels on vaccination. This includes the Communicable and Infectious Disease Steering Committee, responsible for supporting a more integrated national approach to communicable disease prevention and control.[597]

Health Canada is the sole authority responsible for the approval, licensing, and regulation of vaccines for human use under the *Food and Drugs Act* and *Food and Drugs Regulations*.[59] Before a vaccine is approved in Canada, Health Canada conducts a rigorous scientific review of its safety, efficacy and quality. An authorization is only issued when benefits of the vaccine outweigh the risks of its use. Following authorization, Canada has a robust and well-established vaccine safety surveillance system involving Health Canada, PHAC, provinces and territories, and vaccine manufacturers.[59]

Although vaccine recommendations are made at the federal level, provinces and territories hold the primary responsibility for matters related to the administration and delivery of healthcare services, including vaccination programs. Once a vaccine is approved, provinces and territories are responsible for decisions regarding if and how vaccines are included in publicly-funded vaccination programs in their jurisdictions.[59, 62] The majority of these vaccines are paid for by provinces and territories and acquired through a bulk purchasing program coordinated by PHAC, but some may be purchased directly from manufacturers by individual jurisdictions. Provinces and

territories consider NACI's advice (some provinces also have their own advisory bodies), but determine their vaccination programs and policies based on their unique circumstances, including epidemiology, demographics, barriers to access, vaccine delivery mechanisms, and budgets, among other considerations.[59, 598] As a result of these diverse factors, recommendations and schedules vary across the country. Programs may be designed for the general population or geared more to those at higher risk of infection or severe outcomes. Provincial and territorial governments are additionally accountable for maintaining vaccination records, tracking vaccine coverage and safety within their jurisdiction, conducting public education and engagement (e.g., campaigns, information, professional training, guidance on vaccines), providing direction to healthcare providers for reporting adverse events following vaccination, and monitoring and evaluating vaccination programs.[59]

Vaccines are administered by trained healthcare workers. Locations where vaccines can be given may vary between communities and include public health clinics, physician and nurse practitioner practices, schools, pharmacies, community health centres, and nursing stations. Local public health authorities may implement vaccination programs, distribute vaccines, and work with healthcare providers and community organizations to facilitate awareness and outreach initiatives. Further, local public health authorities assess reports of adverse events following immunization and monitor vaccine coverage in their jurisdiction.[62]

Community-based organizations bolster the work of governments, public health, and healthcare providers through meaningful community engagement, building trust, and enhancing the reach of vaccination efforts. They support community-driven and tailored initiatives to promote equitable access to vaccines by leveraging their networks and knowledge of community needs.[281] Professional health associations, such as the Canadian Nurses Association, the Canadian Paediatric Society, and the Society of Obstetricians and Gynaecologists of Canada, develop clinical practice guidelines, ongoing training and education, and tools and resources tailored to the needs and roles of their members.[599–601] National organizations, such as the Canadian Red Cross, also provided clinical and non-clinical support to vaccine operations during the early rollout of COVID-19 vaccines.[64]

First Nations, Inuit, and Métis authorities are in different stages of developing health governance agreements with provincial, territorial, and federal governments, to take on the leadership of design, delivery, and management of healthcare services for their communities. This also encompasses community-led vaccination programs, including by urban Indigenous populations.[63, 65] However, there are jurisdictional challenges and gaps in vaccination for First Nations, Inuit, and Métis populations due to the division of responsibilities between the different levels of government. For instance, Indigenous Services Canada provides funding and health services for First Nations people living on-reserve and Inuit communities. These health services supplement those that are provided by provincial and territorial governments. There are not equivalent dedicated federal programs for First Nations living off-reserve, Métis communities, or urban Indigenous populations.[63, 87]

There are other actors crucial to various aspects of Canada's vaccination system. Federal government departments with vaccination-related research, policy, and operational considerations include National Defence and the Canadian Armed Forces; Immigration, Refugees and Citizenship Canada; Public Services and Procurement Canada; Global Affairs Canada; Correctional Services Canada; and Innovation, Science and Economic Development Canada.[59] Pharmaceutical companies and biotechnology firms develop, manufacture, run clinical trials for, distribute, and monitor vaccine products. Academic institutions are pivotal in conducting research, supporting the Canadian evidence base on vaccination, and educating and training future scientists, healthcare professionals, and policy makers. Additionally, logistics and transportation providers contribute to the distribution and storage of vaccines across the country. Canada also works with international partners, like the WHO and the Pan American Health Organization, on vaccine effectiveness and safety monitoring as well as surveillance of vaccine-preventable diseases.[60, 602, 603] At the global level, there are several relevant international health agreements that guide vaccination goals (see text box "The International Policy Landscape for Vaccination and Infectious Diseases").

The International Policy Landscape for Vaccination and Infectious Diseases

Several global health governance tables and agencies have strategic goals to collectively improve and protect worldwide population health. Commitments within these agreements include reducing the global spread of infectious disease through surveillance and vaccination.

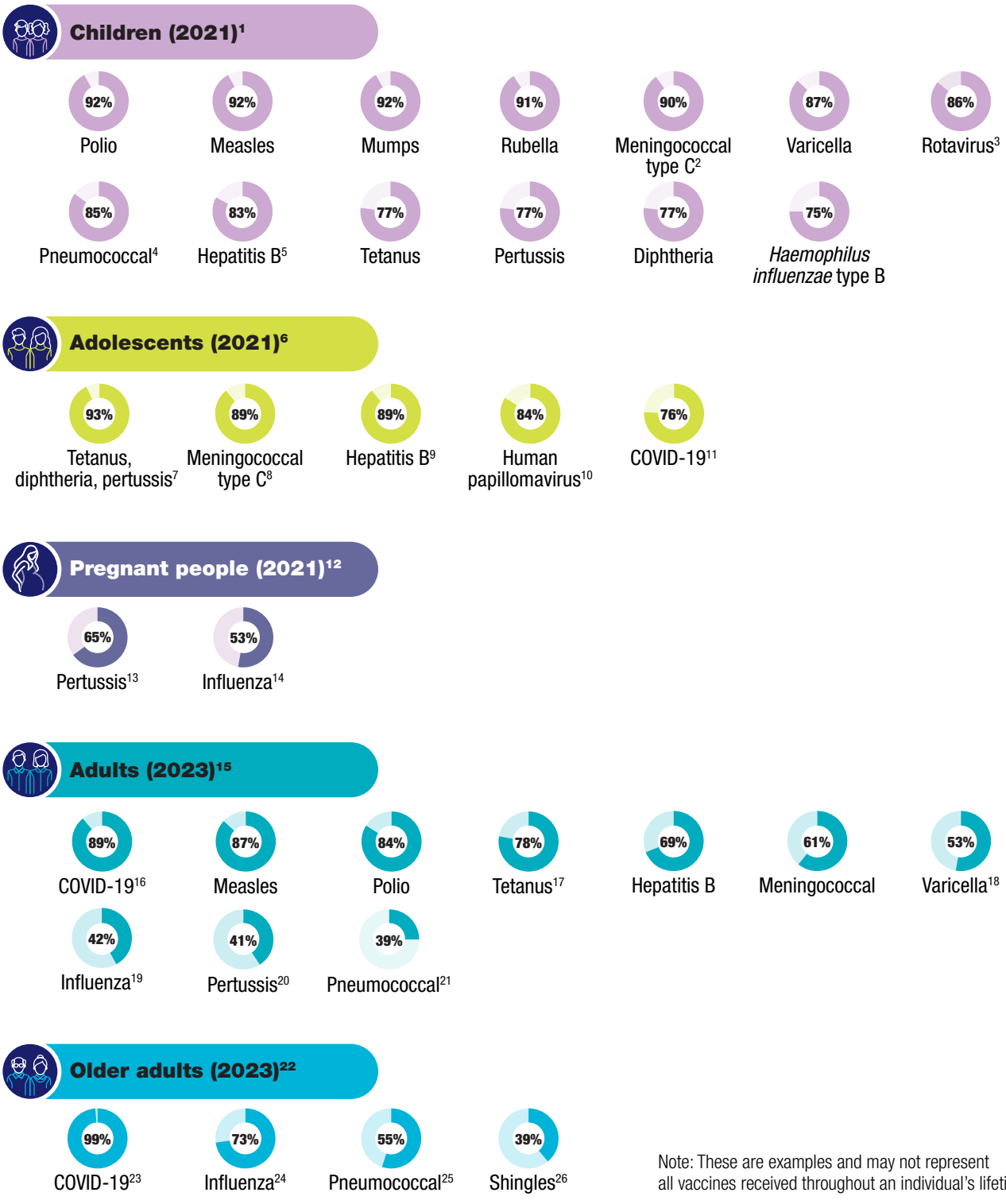
Immunization Agenda 2030 (IA2030): IA2030 is a global vision for vaccines and vaccination co-created by countries and development partners and endorsed by the WHO. This strategy provides the framework to tackle key issues related to vaccination in all countries. The main goal is a world where everyone, everywhere, at every age, fully benefits from vaccines to improve health and well-being. It is guided by being people-centred, country-owned, partnership-based, and data-driven.[7]

The International Health Regulations (IHR): The IHR is a key international health instrument rooted in the WHO Constitution. The IHR was established to prevent and manage the international spread of disease. Additional recent amendments to build in key lessons from global health emergencies require that all countries have the ability to detect, assess, report, and respond to public health threats and strengthen global preparedness.[604, 605]

The Pandemic Agreement: In December 2021, the 194 WHO member states, including Canada, agreed to create a new international pandemic instrument to enhance global health security against disease outbreaks. The proposed agreement will set principles, priorities, and objectives for pandemic preparedness, focusing on building resilience; supporting prevention, detection, and responses to outbreaks; better ensuring equitable access to countermeasures; and enhancing global coordination. The agreement seeks to foster high-level political commitment, an all-of-government and whole-of-society approach, and sustained political and financial investment both domestically and globally.[606, 607]

A Snapshot of Vaccine Coverage in Canada

Figure 6: A Snapshot of Vaccine Coverage in Canada[22, 122, 130]



Note: These are examples and may not represent all vaccines received throughout an individual's lifetime.

Figure 6 Notes

- Percentages have been rounded up/down to nearest whole number.

[1] Children, by 2 years of age:

- **Source:** Public Health Agency of Canada. Highlights from the 2021 Childhood National Immunization Coverage Survey (cNICS). Government of Canada; 2023.
- Weighted coverage estimates based on parental records and/or healthcare provider records and/or provincial immunization registry data (registry data for Prince Edward Island and Manitoba only).
- Coverage estimates indicate the proportion of children who were vaccinated by their second birthday.
- **Number of doses by second birthday:** Polio ≥ 3; Measles ≥ 1; Mumps ≥ 1; Rubella ≥ 1; Meningococcal type C ≥ 1-2; Varicella ≥ 1; Rotavirus ≥ 2; Pneumococcal ≥ 3-4; Hepatitis B ≥ 3; Tetanus ≥ 4; Pertussis ≥ 4; Diphtheria ≥ 4; *Haemophilus influenzae* type B ≥ 4.
- **[2] Meningococcal type C:** Coverage estimated for meningococcal C by a 2-dose program in British Columbia, Alberta, Yukon, and Northwest Territories; 1-dose program in all other provinces/territories.
- **[3] Rotavirus:** Coverage estimated by a 2-dose program of rotavirus vaccine in British Columbia, Alberta, Manitoba, Saskatchewan, Quebec, Ontario, Prince Edward Island, Newfoundland and Labrador, Yukon, and Northwest Territories. Coverage estimated by a 3-dose program New Brunswick. Rotavirus uptake will be assessed for Nova Scotia and Nunavut in the next cycle of the cNICS.
- **[4] Pneumococcal:** Coverage estimated by a 4-dose program in Northwest Territories and Nunavut; 3-dose program in all other provinces/territories.
- **[5] Hepatitis B:** Coverage estimates were limited to jurisdictions where a 3-dose program for infants was in place as of March 1, 2021 (British Columbia, Quebec, New Brunswick, Prince Edward Island, Yukon, Northwest Territories, and Nunavut). Children were considered vaccinated if they received the number of doses recommended by the child's province/territory of residence.

[6] Adolescents, aged 12-17 years:

- **Sources:** Public Health Agency of Canada. Highlights from the 2021 Childhood National Immunization Coverage Survey (cNICS). Government of Canada; 2023; Public Health Agency of Canada. Canadian COVID-19 vaccination coverage surveillance system (CCVCSS) report. Ottawa: Government of Canada; July 12, 2024. https://health-infobase.canada.ca/covid-19/vaccination-coverage/
- Weighted coverage estimates based on parental records and/or health care provider records and/or parental recall and/or provincial immunization registry data for Prince Edward Island and Manitoba. Coverage was determined for at least 1 dose of human papillomavirus (HPV) and hepatitis B vaccines because parental knowledge was used. As some provinces and territories request parental consent only once for the entire vaccine series, parents may be unable to specify the number of doses received.
- **[7] Tetanus, diphtheria and acellular pertussis (Tdap) booster** (1 dose): Coverage estimates indicate the percentage of adolescents who were vaccinated by their 17th birthday. In Quebec one dose Td is recommended in the third year of high school.
- **[8] Meningococcal type C** (1 dose): Coverage estimates indicate the percentage of adolescents who were vaccinated by their 17th birthday. Booster dose since eleventh birthday for all provinces and territories except Northwest Territories. In this territory, the meningococcal vaccine is administered in grade 12 only to those attending post-secondary school out-of-territory.
- **[9] Hepatitis B** (≥ 1 dose) **and [10] Human papillomavirus** (≥ 1 dose): Coverage estimates indicate the percentage of adolescents who were vaccinated by their 14th birthday.
- **[11] COVID-19:** Among adolescents aged 12-17 who received at least one dose of an approved COVID-19 vaccine.

[12] Pregnant people:

- **Source:** Public Health Agency of Canada. Results of the Survey on Vaccination during Pregnancy 2021. Government of Canada; 2022.
- **[13] Pertussis:** Implementation of a publicly funded vaccination program against pertussis began in jurisdictions starting in April 2018 with complete implementation as of April 2022. The pertussis vaccine was not yet publicly funded for pregnant women in Ontario at the time of data collection for the 2021 Survey on Vaccination during Pregnancy.
- **[14] Influenza:** Women who gave birth between December 1st, 2020 and March 1st, 2021 for influenza. Only mothers who knew if they had been vaccinated (n= 1,577 in 2021) are counted in these calculations.

[15] Adults, aged 18 years and older:

- **Sources:** Public Health Agency of Canada. Adult National Immunization Coverage Survey (aNICS): 2023 Results. Government of Canada; 2024; Public Health Agency of Canada. Canadian COVID-19 vaccination coverage surveillance system (CCVCSS) report. Ottawa: Government of Canada; July 12, 2024. https://health-infobase.canada.ca/covid-19/vaccination-coverage/; Public Health Agency of Canada. Seasonal Influenza Vaccination Coverage Survey (SIVCS): Highlights from the 2023–2024 Seasonal Influenza (Flu) Vaccination Coverage Survey. Government of Canada; 2024.
- The 2023 adult National Immunization Coverage Survey (aNICS) asked respondents if they have ever been vaccinated for 11 routine vaccines given to adults, vaccines given during childhood, COVID-19, seasonal influenza, and MpoX vaccines, though number of doses received was not available.
- **[16] COVID-19:** Among adults 18 years and older who received at least one dose of an approved COVID-19 vaccine.
- **[17] Tetanus:** Tetanus vaccine received in the last ten years among adults 18 years and older.
- **[18] Varicella:** Among adults younger than 50 years of age.
- **[19] Influenza:** Among adults 18 years and older who received the influenza vaccine during the 2023–2024 influenza season.
- **[20] Pertussis:** For adults, 18 years and older, the pertussis booster is given in combination with tetanus and diphtheria (Tdap) in Canada. Pertussis vaccination refers to a pertussis-containing vaccine received in adulthood.
- **[21] Pneumococcal:** Among adults aged 18 to 64 years with at least 1 chronic health condition and all adults aged 65 and older (50 and older in Nunavut), or all respondents who were current smokers at the time of the survey.

[22] Older adults:

- **Sources:** Public Health Agency of Canada. Adult National Immunization Coverage Survey (aNICS): 2023 Results. Government of Canada; 2024; Public Health Agency of Canada. Canadian COVID-19 vaccination coverage surveillance system (CCVCSS) report. Ottawa: Government of Canada; July 12, 2024. https://health-infobase.canada.ca/covid-19/vaccination-coverage/; Public Health Agency of Canada. Provincial and Territorial Routine Vaccination Programs For Healthy, Previously Immunized Adults. Government of Canada; 2024. Public Health Agency of Canada. Seasonal Influenza Vaccination Coverage Survey (SIVCS): Highlights from the 2023–2024 Seasonal Influenza (Flu) Vaccination Coverage Survey. Government of Canada; 2024.
- **[23] COVID-19:** Among adults 65 years and older who received at least one dose of an approved COVID-19 vaccine.
- **[24] Influenza:** Among adults aged 65 years and older, who received the influenza vaccine during the 2023–2024 influenza season.
- **[25] Pneumococcal:** Among adults 65 and older (one dose).
- **[26] Shingles (Herpes zoster):** Among adults aged 50+ who received at least one dose of the vaccine; The herpes zoster (shingles) vaccine is publicly funded in Ontario for individuals 65–70 years of age; in Quebec for individuals aged 80 years and over; in Prince Edward Island for individuals aged 60 years and over; in Yukon for individuals 65–79 years of age.

Methodology

Process

The 2024 Chief Public Health Officer of Canada (CPHO) Annual Report was drafted based on a review of the best available evidence, including academic research, guidance from expert advisors, and engagement with public health, First Nations, Inuit, Métis, and community experts. Where possible, Canadian research and representative data were prioritized.

The evidence was identified through the approaches summarized below.

Review of Scientific Evidence

- The Public Health Agency of Canada (PHAC) commissioned the McMaster Health Forum to complete a rapid evidence profile to answer the question: "What do we know from the best-available evidence about the impacts of different vaccine delivery approaches or programs on vaccine access, uptake, program costs and efficiency and patient and provider experiences?". Four electronic databases: (COVID-END Inventory, Health Systems Evidence, HealthEvidence, and PubMed) were searched for existing evidence syntheses published within the last ten years (up to March 18, 2024) and included literature published in English or French.
- At the request of the Office of the CPHO (OCPHO), PHAC also commissioned updates to the following reviews:
  - COVID-19 vaccine mandates and their relationship with vaccination intention, psychological reactance, and trust: a rapid behavioural evidence synthesis (updated March 27, 2024 by the Ottawa Hospital Research Institute)
  - Rapid Review Update 1: What is known about parents' considerations for vaccine uptake for children and adolescents? (updated February 14, 2024 by the National Collaborating Centre for Methods and Tools)
  - Rapid Review Update 1: What is known about reasons for vaccine confidence and uptake in populations experiencing inequities? (updated February 14, 2024 by the National Collaborating Centre for Methods and Tools)
  - Evidence brief on attitudes and acceptance of COVID-19 booster doses in Canada (updated February 9, 2024 by PHAC)
- Several evidence reviews were conducted by the Vaccination Behaviour and Confidence Team at PHAC, including "Immunization strategies to increase vaccine uptake among people experiencing homelessness, people who use drugs, and people with severe and persistent mental illness"; "Communicating effectively about vaccination"; and "Vaccination among Black Populations in Canada". Reviews were scoping in nature, with supplementary grey literature and used PubMed, Embase, SCOPUS, and PsycINFO databases.
- Ongoing literature searches by OCPHO, completed by report sub-topics as needed in English and French, using online databases, such as Medline and Scopus.

Public Health Reports and Other Grey Literature

- Ongoing and frequent literature searches completed by OCPHO to find grey literature and public health reports on vaccination from trusted sources, such as public health organizations (e.g., World Health Organization, Pan American Health Organization) and government publications (e.g., federal, provincial/territorial, municipal, and Indigenous governments).
- Identification of applied public health examples and case studies through engagement with external public health and vaccination experts.
- Policy, grey literature, and applied examples scan conducted by a PHAC internal reference group consisting of analysts and individuals with vaccination expertise from regional offices.

Engagements and Key Informant Interviews

- A targeted engagement process, completed by OCPHO, focused on:
  - Innovative perspectives and opportunities relating to the optimal future of vaccines and vaccination, and the role of public health, in Canada;
  - Challenges to implementing successful vaccination programs and intersectoral challenges in the vaccine space;
  - First Nations, Inuit, and Métis experiences and perspectives on a rights-based approach to vaccination; and,
  - Community organizations' needs and perspectives on how to facilitate action on equity, community mobilization, and vaccination.

The engagement process included 16 interviews with public health leaders, including medical officers of health, public health physicians, and community partners, in June and July 2024, in French and English. Potential interviewees were identified through reviewing scientific and grey literature, and engaging with internal and external experts and partners. The OCPHO also sent a request for volunteers to the Regional Medical Officer and Liaison Network at Indigenous Services Canada. Targeted interview requests were made to ensure representation from a diversity of settings across Canada.

The engagement process also comprised targeted engagements with the Assembly of First Nations, Inuit Tapiriit Kanatami, the Métis National Council, the Manitoba Métis Federation, the Native Women's Association of Canada, the Canadian Indigenous Nurses Association, and the Ontario Federation of Indigenous Friendship Centres.

Limitations

Scope and literature search

The 2024 CPHO Annual Report explores a vision for the optimal future of vaccination for public health in Canada. Vaccines and vaccination are large fields, with research and practice that cross a number of academic and professional disciplines. Since the purpose of the report is to provide an overview of presented topics and concepts, there are necessary restrictions on the level of detail provided in each section. Accordingly, the report does not represent an exhaustive evidence review, but rather a summary of select key literature. Only literature published in English and French was reviewed. A detailed assessment of study quality and risk of bias was not conducted in this review.

Language

To the extent possible, the report writers attempted to use standardized, inclusive, and culturally appropriate language when drawing on evidence related to different communities and their experiences of health. However, in some instances they relied on the terminology included in the source documents (e.g., pregnant women), if this language had particular meaning or relevance in those materials.

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