The Chief Public Health Officer's

Report on the State of Public Health in Canada

2013

Infectious Disease—
The Never-ending Threat

Canada

Également disponible en français sous le titre :
Le rapport de l'administrateur en chef de la santé publique sur l'état de la santé publique au Canada, 2013 : Les maladies infectieuses — Une menace perpétuelle

The Chief Public Health Officer's Report on the State of Public Health in Canada, 2013: Infectious Disease—The Never-ending Threat is available on the Internet at the following address: http://publichealth.gc.ca/CPHOReport

This publication can be made available in alternative formats upon request.

Publication date: September 2013

PRINT Cat.: HP2-10/2013E ISSN: 1917-2656 **PDF** Cat.: HP2-10/2013E-PDF ISSN: 1924-7087 Pub.: 130329

Dr. David Butler-Jones
Chief Public Health Officer of Canada

A MESSAGE FROM CANADA'S CHIEF PUBLIC HEALTH OFFICER

When I was a child in the late 1950s, hospitals in Canada were filled with kids suffering from the complications of vaccine-preventable infections, including polio. Parents greatly feared the threat of this crippling illness which affected thousands of Canadians. To everyone's great relief, a vaccine was developed by Jonas Salk, and the disease was eventually eradicated in our country and most of the world.

When I think back to my childhood, the idea of eliminating a disease was a somewhat foreign concept. Then, through advances in medicine, a little shot in the arm—or better yet a few drops in the mouth or on a sugar cube—and we were suddenly immune to a range of diseases. It was a miracle. It is also one of the greatest success stories in public health. However, this success runs the risk of making us complacent. I am concerned that the gains we have made in battling infectious diseases may be lost if we do not redouble our efforts and ensure we stay focused on infectious diseases and the health of Canadians.

We are in a constant struggle to protect ourselves from the potentially harmful, complex and unseen world of microbes. But not all microbes are harmful. We are surrounded by billions of microbes and we interact with them in important ways: they live on our skin, in our digestive tract, in our mouth and nose and on every imaginable surface. Microbes are often associated with disease, but most are harmless or even beneficial to our health. Nevertheless, some do pose serious risks to health.

Canada has made advancements in combating the more harmful micro-organisms. There have been improvements in the conditions necessary to build resilience to infectious diseases, such as adequate income, food security, acceptable housing, access to education and early childhood care. In addition, the introduction of vaccines to prevent illness, the discovery and therapeutic use of antibiotics to treat deadly diseases, and advances in surveillance and epidemiology have also contributed to how well and long we live. But despite all our progress, our ability to overcome infectious diseases remains, at best, limited.

In March 2003, Canada was part of a global SARS outbreak that claimed 44 Canadian lives. Since then, the Government of Canada has taken great strides—including the creation of the Public Health Agency in 2004—to improve how it protects Canadians from infectious disease outbreaks and public health emergencies. Over the past nine years, the Agency has taken a leadership role in working with its public health partners to strengthen Canada's capacity to prepare for and respond to infectious disease outbreaks and public health emergencies. We have put new structures in place to improve how governments work together, developed comprehensive plans to prepare for public health emergencies, and enhanced our alert systems and disease prevention and management capabilities. The Agency's approach is to plan for all types of threats by using tools that can be shared with its partners and adapted to the nature and magnitude of the event. In our fight against infectious diseases, we must recognize that our preconceptions about them may need to be challenged or reassessed.

Oh! Let us never, never doubt / What nobody is sure about!—Hilaire Belloc, *The Microbe*

We must also be prepared for new and emerging infectious threats that can come from various sources such as nature, or even from the intentionally harmful acts of others. Although we do our best to prevent and control the spread of infection in our environment, outbreaks continue to occur. In response, the Agency has developed protocols and networks to identify outbreaks and to ensure that we are able to respond effectively. The Agency has both scientific experts who are available to guide our response and medical supplies that can be deployed to aid Canadians during an outbreak.

Within this report, I describe how infectious diseases influence public health and the health status of Canadians. I also discuss the role that all Canadians can play in preventing and controlling infectious diseases in their homes and communities. Since not all infectious diseases could possibly be covered in one report, I have chosen a limited number of topics that I feel warrant greater discussion and awareness.

As you read this report, I hope you ask yourself the same questions I ask myself every day in my role as Canada's Chief Public Health Officer:

- Are we taking the necessary steps to protect ourselves and our communities?
- Are there additional ways we can participate in reducing infectious diseases?
- What more can be done?
- Who else can we work with to better address the challenges that still remain?

While we have made great progress, challenges remain and work is ongoing. It is clear to me that continuous improvement in public health—by everyone—will be required throughout the 21st century to sustain our impressive record of battling infectious diseases.

Dr. David Butler-Jones

Dr. David Butler-Jones is the Government of Canada's first and current Chief Public Health Officer. He heads the Public Health Agency of Canada, which provides leadership on the government's efforts to protect and promote the health and safety of Canadians. He has worked in many parts of Canada in both Public Health and Clinical Medicine and has consulted in a number of other countries. Dr. Butler-Jones has taught at both the undergraduate and graduate levels and has been involved as a researcher in a broad range of public health issues. He is a Professor in the Faculty of Medicine at the University of Manitoba as well as a Clinical Professor with the Department of Community Health and Epidemiology at the University of Saskatchewan's College of Medicine. From 1995 to 2002, Dr. Butler-Jones was Chief Medical Health Officer and Executive Director of the Population Health and Primary Health Services Branches for the Province of Saskatchewan. Dr. Butler-Jones has served with a number of organizations in the following roles: President of the Canadian Public Health Association; Vice President of the American Public Health Association; Chair of the Canadian Roundtable on Health and Climate Change; International Regent on the board of the American College of Preventive Medicine; Member of the Governing Council for the Canadian Population Health Initiative; Chair of the National Coalition on Enhancing Preventive Practices of Health Professionals; and Co-Chair of the Canadian Coalition for Public Health in the 21st Century. In recognition of his service in the field of public health, York University's Faculty of Health bestowed an honorary Doctor of Laws degree on Dr. Butler-Jones in 2007. In 2010, Dr. Butler-Jones was the recipient of the R. D. Defries award, the highest honour presented by the Canadian Public Health Association, recognizing outstanding contributions in the field of public health.

ACKNOWLEDGEMENTS

Many individuals and organizations have contributed to the development of *The Chief Public Health Officer's Report on the State of Public Health in Canada, 2013: Infectious Disease—The Never-ending Threat*.

I would like to express my appreciation to the consultants who provided invaluable advice, strategic guidance and expertise:

- The Honourable Gary Filmon, PC, OC, OM, LLD, Chairman, Exchange Income Corporation;
- John Frank, MD, Director, Scottish Collaboration for Public Health Research and Policy; Chair, Public Health Research and Policy, University of Edinburgh; Professor Emeritus, Dalla Lana School of Public Health, University of Toronto;
- Peter Glynn, PhD, Health Systems Consultant;
- David Mowat, MBChB, MPH, FRCPC, FFPH, Medical Officer of Health, Region of Peel, Ontario;
- Daryl Pullman, PhD, Professor of Medical Ethics, Division of Community Health and Humanities, Memorial University;
- Jeff Reading, MSc, PhD, FCAHS, Professor and Director, School of Public Health and Social Policy, Faculty of Human and Social Development and Centre for Aboriginal Health Research, University of Victoria;
- Cornelia Wieman, MSc, MD, FRCPC, Psychiatrist, Centre for Addiction and Mental Health; and
- Brenda Zimmerman, MBA, PhD, Director, Health Industry Management Program; Associate Professor of Strategy/Policy, Schulich School of Business, York University.

I would also like to thank the many individuals and groups within the Public Health Agency of Canada for their contribution. Specifically, I would like to recognize the dedicated efforts of the CPHO Reports Unit: Sarah Bernier, Jane Boswell-Purdy, Suzanne A. Boucher, Paula Carty, Maureen Hartigan, Deborah Jordan, Russell Mawby, Chrystal Reaney, Erin L. Schock, Jennifer Lynn Scott, Melannie Smith, Andrea Sonkodi, Crystal Stroud, Gregory Taylor and Michelle Tracy for all their effort throughout the process of delivering this report.

As well, I would like to recognize the contributions made by the 2012/13 Core Advisory Group: Emily Adkins-Taylor, Rana Bader, Gillian Badger, Janet Blakely-Stephens, Cheryl Hammond, Cate Harrington, Amanda Hayne-Farrell, Mana Herel, Nina I. Jetha, Mariola Mascarenhas, Julie McGihon, Emma Moore, Carole Nesbeth, Allison Ringrose, Patricia Salsbury, Shelly Sarwal, Jo-Anne Stead, Rob Stirling, Jocelyn Stoate, Tracy Townsend, Jan Trumble Waddell, Manon Turcotte, Emily Weir, Lindsay Wild and Lindsey Williams.

My thanks to Ben Wilson for his contribution to the tone and style of the report, and to Joanna Odrowaz and Line Nadeau for their exacting English and French edits.

I would also like to acknowledge the contributions of the following external reviewers:

- James Blanchard, MD, MPH, PhD, Professor of Community Health Sciences & Medical Microbiology, University of Manitoba, Faculty of Medicine;
- David Buckeridge, MD, PhD, FRCPC, Associate Professor of Epidemiology and Biostatistics, McGill University;
- Richard Massé, MD, FRCPC, MSc, Assistant Professor, School of Public Health, University of Montréal;
- Allison McGeer, MD, PhD, MSc, Microbiologist, Infectious Disease Consultant, Mount Sinai Hospital; and
- Kumanan Wilson, MD, FRCPC, MSc, Scientist, Clinical Epidemiology, Ottawa Hospital Research Institute.

In addition I would also like to recognize the following organizations for their contributions to this report:

- Assembly of First Nations;
- Indigenous Physicians Association of Canada;
- Inuit Tapiriit Kanatami;
- National Association of Friendship Centres; and
- National Collaborating Centre for Aboriginal Health.

Special thanks to those from the following federal government departments, agencies and programs who collaborated with us on this publication:

- Aboriginal Affairs and Northern Development Canada;
- Agriculture and Agri-Food Canada;
- Canada Mortgage and Housing Corporation;
- Canadian Food Inspection Agency;
- Canadian Institutes of Health Research;
- Citizenship and Immigration Canada;
- Employment and Social Development Canada;
- Environment Canada;
- Health Canada;
- Justice Canada;
- Privy Council Office; and
- Public Safety Canada.

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INTRODUCTION

The Public Health Agency of Canada was established in September 2004 to strengthen Canada's capacity to protect and promote the health of Canadians.[1–3] In 2006, the *Public Health Agency of Canada Act* confirmed the Agency as a legal entity and the appointment of a Chief Public Health Officer (CPHO) (see the textbox "The role of Canada's Chief Public Health Officer").[1] The legislation requires that the CPHO report on the state of public health in Canada annually.[1]

Goals of the report

The CPHO's reports are intended to highlight specific public health issues that the CPHO has determined warrant further discussion and action in Canada.

This report presents the various factors that contribute to good health and what Canadians can do, both individually and collectively, to advance public health in Canada. As much as this report is a mechanism to increase awareness, it is also meant to inspire action, build upon existing health programs and initiatives and develop new solutions to promote, improve and maintain optimal health and well-being for all Canadians.

What the report covers

This report, the CPHO's sixth on the state of public health in Canada, focuses on how infectious diseases influence public health and the health status of Canadians. The aim is to shed light on Canada's successes and ongoing challenges in the prevention, control and management of infectious diseases.

This report cannot comprehensively cover all areas of infectious disease in Canada. Instead, its goal is to explore a few related topics, all relevant to infectious disease and public health, that the CPHO has determined warrant further attention and that have a clear call to action. Each topic is independent in its own right, and the issues have been presented in such way that they can be read on their own. Ideally, coverage of these topics will generate greater awareness and foster discussion, engagement and continued commitment among all levels of government, healthcare professionals, educators, researchers and individual Canadians.

The following is a brief summary of the topics covered.

Immunization and Vaccine-preventable Diseases—Staying Protected examines:

- The important role of immunization in preventing infectious diseases in Canada
- How to increase and maintain immunization coverage
- How to continue to educate Canadians about the benefits of vaccines and increase public confidence
- Strategies to improve immunization programs across Canada

Healthcare-associated Infections—Due Diligence discusses:

- How infections are transmitted in healthcare settings
- Some of the more common infections and their effects
- How to reduce the risk of infection and transmission

Antimicrobial Resistance—A Shared Responsibility examines:

- A brief history of antimicrobials and antimicrobial resistance
- What factors have helped increase the rate at which antimicrobial resistance is spreading
- Common ways to transmit antimicrobial-resistant organisms as well as treatment options
- How to manage and minimize the impact of antimicrobial resistance on the population

Tuberculosis—Past and Present discusses:

- Tuberculosis in Canada and internationally, and more specifically, in vulnerable populations
- Common prevention and treatment practices as well as considerations of drug resistance and co-infection

Food-borne and Water-borne Infections—Invisible Threats examines:

- Common causes of food-borne and water-borne infections in Canada
- How food-borne and water-borne infections are transmitted
- Strategies to manage and minimize food and water contamination

The role of Canada's Chief Public Health Officer[3]

The Chief Public Health Officer:

- is the deputy head responsible for the Public Health Agency of Canada, reporting to the Minister of Health;
- is the federal government's lead public health professional, providing advice to the Minister of Health and the Government of Canada on health issues;
- manages the Public Health Agency's day-to-day activities;
- works with other governments, jurisdictions, agencies, organizations and countries on public health matters;
- speaks to Canadians, health professionals, stakeholders, and the public about issues affecting the population's health;
- is required by law to report annually to the Government of Canada on the state of public health in Canada; and
- can report on any public health issue as needed.

In a public health emergency, such as an infectious disease outbreak or natural disaster, the Chief Public Health Officer:

- briefs and advises Canada's Minister of Health and others as appropriate;
- works with counterparts in other departments, jurisdictions and countries, as well as with experts and elected officials, to communicate with Canadians about how to protect themselves and their families;
- delivers public health information to Canadians via media appearances, public statements, updates to the Public Health Agency website, and columns and public advertisements in daily and community newspapers;
- provides direction to Public Health Agency staff, including medical professionals, scientists and epidemiologists, as they plan and respond to the emergency;
- leads daily national teleconferences, as appropriate, with federal government scientists and experts to share information and plan outbreak responses; and
- coordinates with jurisdictions through regular teleconferences with Canada's provincial and territorial Chief Medical Officers of Health and others.

Sexually Transmitted Infections—A Continued Public Health Concern explores:

- Common sexually transmitted infections (STIs) in Canada
- The short- and long-term health outcomes of STIs including those with associated chronic conditions
- Strategies and approaches to reduce the transmission of infection and manage disease over the lifecourse

Conclusion—Continuing Efforts underlines:

- The need to remain vigilant in the face of new and existing infectious disease threats
- The common themes among the six sections in the report
- That prevention and control of infectious diseases is a shared responsibility among industry, government, healthcare and individuals
- That a long-term infectious disease strategy must address the social determinants of health

Appendices A–C examine:

- The demographics of the Canadian population, including life expectancy and patterns of ill health, disability and mortality
- Determinants that influence health—income, employment, education and health behaviours
- Definitions and data sources

Infectious diseases in Canada

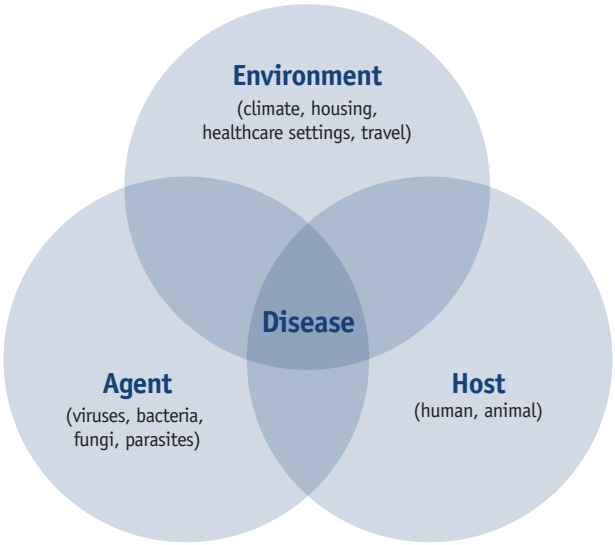
Canada has made great advances in preventing and controlling infectious diseases as a result of widespread improvements in hygiene and sanitation measures, implementing water treatment systems, enhancing food safety, researching and developing new drugs and immunizing against vaccine-preventable diseases.[4–6] Despite the progress made, infectious diseases are still a major health issue and public health concern. Many Canadians will become ill with at least one infection each year. Most of these infections are minor and go unreported, but some can be serious. Most are preventable.[7–11] Continued commitment to reduce the incidence and prevalence of infectious disease is necessary to keep Canadians healthy and prevent illness and premature death.

About infectious diseases

Infectious diseases arise from the complex interactions between the agent, the environment, and the host (see Figure 1). Agent refers to an infectious micro-organism: a virus, bacterium, fungus or parasite. When infectious micro-organisms break through natural defences and make their way into the host (human or animal), they can multiply and cause illness. In some cases, only one system or organ is affected in the body; in others, the infection affects the entire host.[14, 15]

Infectious micro-organisms can spread through air or water or food; by direct physical contact or indirect contact with a contaminated object or surface; and via insect or animal or another person.[12, 16, 17] The length of time that a micro-organism stays infectious and the distance it can travel depends on the type of organism and the environment in which it exists.[17]

FIGURE 1 Epidemiologic triad of disease causation[12, 13]



Many factors in the environment can contribute to the growth and spread of infectious diseases including: global travel, urbanization and immigration; housing; healthcare practices and public health infrastructure; food production and preparation; the use and misuse of antibiotics and microbial adaptation; and human behaviour. The range of diversity plus the ability of micro-organisms to evolve and adapt to changing populations, environments, practices and technologies create ongoing threats to health and continually challenge our efforts to prevent and control infectious diseases.[14, 18]

Why infectious diseases are important

Infectious diseases are a public health issue. There are areas for concern (e.g. antibiotic-resistant bacteria, healthcare-associated infections, food- and water-borne illnesses and potential disease outbreaks and pandemics) that require attention and action.[18] Addressing them now, before the risks and impacts advance any further, is essential. Improving Canada's ability to prevent known infectious diseases and to recognize and control rare or newly emerging threats is necessary to reduce the burden of disease and improve and maintain the health of Canadians.[19, 20]

This issue extends beyond the borders of Canada; infectious diseases are a global concern. A fast-changing, globalized world has provided increased opportunities for emergence and re-emergence of infectious diseases. That being said, it has also brought about significant developments in the prevention and control of infectious diseases.[18, 19] Canada has a better understanding of how infections emerge, persist, develop resistance and cause disease. It is important to continually reconsider prevention and control strategies and take advantage of new ways to tackle infectious diseases and improve and maintain the health of Canadians.[19–21]

Addressing infectious diseases also involves managing diseases and their impacts after the point of infection. There are particular challenges associated with certain infectious diseases over the long term, when they take on chronic characteristics as an individual ages.[22] For example, some diseases start as infectious but can become a chronic disease later in life (e.g. human papillomavirus [HPV] and hepatitis B and C). These diseases can have long term health impacts that make individuals more vulnerable to other diseases and conditions such as influenza, cancer and mental health conditions.[22] Our evolving understanding of the links between infectious and chronic diseases will inform future prevention and treatment efforts.

Infectious disease and determinants of health

Addressing the prevention, control and management of disease also requires broadening our approach to health interventions to consider what influences health both inside and outside the healthcare system. It involves identifying factors that can put Canadians at increased risk of health complications and infections. Social and economic factors, the physical environment and individual behaviour all play a role. These factors interact to influence collective and individual health and well-being (see the textbox "Determinants of health").[23, 24]

Determinants of health[23]

- income and social status
- social support networks (e.g. family, peers)
- education and literacy
- employment and working conditions
- social environments (e.g. community, workplace)
- physical environments (e.g. housing, community infrastructure)
- personal health practices and coping skills
- healthy child development (including/during pregnancy)
- biology and genetic endowment (e.g. sex)
- health services
- gender
- culture

Determinants of health contribute to an individual's overall state of health, which in turn, can influence an individual's risk of infection and disease. Determinants of health also play a role in an individual's resistance to infection, the progression of disease and the treatment and management of illness after the point of diagnosis.[25–28] Tuberculosis (TB) is a good example of the relationship between infectious disease and the determinants of health.[29–31] Living in a low income household, living in crowded inadequately ventilated housing or being homeless, being malnourished or affected by other socio-economic conditions are some, but not all, of the known risk factors for developing a TB infection.[31–33] Thus, preventing and managing infectious diseases such as TB firstly, involves addressing what puts Canadians at risk, and secondly, requires building upon and improving economic and social supports.[25–27, 29–31]

By strengthening and investing in the determinants of health, there is more opportunity to positively influence the overall health status of Canadians. Individuals with access to adequate health and social services have better health outcomes and a reduced likelihood of developing illness and/or disease.[24–28] Making progress will require identifying and reducing risks and vulnerabilities, as well as expanding efforts to ensure adequate supports and resources are available to meet basic needs.[23–28] Simply put, addressing the determinants of health should be part of any long-term infectious disease strategy.[24, 25, 27, 28]

Infectious disease and preparedness

Diseases can spread globally and affect populations worldwide. Taking steps to make sure Canadians are less vulnerable to the impact of infectious diseases is an ongoing challenge. Canada has made great strides in safeguarding the population and responding to emerging and ongoing health threats.[19, 34] Recent experiences with SARS and H1N1 have provided valuable guidance; these events have also emphasized the vulnerability that remains.[19–21] The best approach is to plan and be prepared to respond. Canada cannot become complacent. Planning for all types of threats, combined with other fundamental measures such as surveillance, infrastructure, and capacity, will put Canada in the best position to respond to any emergency.[20, 34]

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IMMUNIZATION AND VACCINE-PREVENTABLE DISEASES—STAYING PROTECTED

HIGHLIGHTS

- Vaccine-preventable diseases continue to be a global public health challenge.
- Until vaccine-preventable diseases are eradicated worldwide, Canadians remain at risk.
- Immunization is an effective protective measure against vaccine-preventable diseases.

Prevention of disease is a core function of public health. Immunization is a good protective measure against many infectious diseases and has shown remarkable success. Common infectious diseases that were once a major cause of morbidity and mortality in Canada, particularly among children, are now preventable with vaccines. Nevertheless, vaccine-preventable diseases are still a public health concern and prevention efforts must continue. Immunization is important for all Canadians to stay protected against vaccine-preventable diseases.

Immunization—a collective protection

Vaccines provide protection against specific infectious diseases for which they are directly targeted. Protection is provided not only for individuals immunized, but may also benefit others in the population.[1–4] Immunization is defined as "the process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine."[3]

VACCINES work by creating an immune response, which provides protection from infection.[5, 6] The body's immune system is stimulated to make antibodies in two ways: by getting an infection or by getting a vaccine.[5, 7] Getting vaccinated is a safer way to make antibodies, as a person does not have to suffer through the disease itself and risk disability or even death.[5, 7] After getting a vaccine, the body sets up its own defence system by producing antibodies that remember how to fight off the bacterium or virus.[5, 7] If the real bacteria or virus that causes this disease enters the body, the defence system knows how to fight it off.[5, 7]

The immune system will often remember how to fight a bacterium or virus for the rest of a person's life.[5, 7] Sometimes, however, the immune system needs a reminder in the form of a booster shot (e.g. diphtheria and tetanus every 10 years).[6, 7] Some vaccines, such as those used to prevent influenza, require an annual dose for adults and children as the viruses that cause the disease keep changing and new vaccines against new strains are needed every year.[7]

As the number of people who get immunized increases, the probability of infectious disease transmission decreases. As a result, the community resistance to the disease becomes stronger in a way that provides a protective barrier for those individuals who cannot be immunized for health reasons such as illness, age or allergy. This collective protection is called *herd immunity*.[2, 7–9] However, the proportion of the population that must be immune to achieve a herd immunity

threshold varies with each infectious disease and its transmission characteristics. Ideally, the highest possible coverage for a vaccine-preventable disease is preferable.[7, 8] Indeed, high immunization coverage in one region or country can benefit other jurisdictions, particularly since infectious diseases are able to easily cross borders as a result of global trade, migration and travel.[2]

Vaccine effectiveness and programs

Immunization has been proven to cost-effectively improve longevity and quality of life—and save lives.[2, 4, 10, 11] Immunization can also help ease pressures on the healthcare system (e.g. less antibiotic use and fewer hospitalizations and long-term disabilities).[4, 10–12] Beyond averted illnesses and deaths and direct healthcare cost savings, immunization can contribute to broader economic benefits in other areas, such as education (e.g. healthy children tend to perform better in school) and labour (e.g. by averting loss of income and productivity due to illness).[2, 4, 11, 12]

In general, vaccination programs compare favourably with other public health interventions in terms of cost per life year saved. As a result, deciding to include inexpensive vaccines against common diseases (e.g. measles, mumps and rubella) in publicly funded immunization programs is fairly straightforward.[1, 4, 11, 13] That being said, some newer and relatively expensive vaccines (e.g. the meningococcal vaccine) result in health benefits but not always savings in terms of net cost per case prevented.[1, 13, 14] The decision to include these vaccines in publicly funded immunization programs, therefore, depends on public acceptance and general willingness to pay for the health benefits.[1]

Vaccine expert and review committees, such as the National Advisory Committee on Immunization (NACI), have to consider many different aspects when making recommendations. They must deliberate on which new vaccines to recommend, the type of coverage (an entire population or high-risk groups only), combinations of vaccines, the dosing schedules and the vaccine delivery methods. New vaccines and programs must be evaluated carefully, and it is important that researchers and policy makers work together to identify programs that deliver the greatest benefit for the least cost.[1, 13]

NATIONAL ADVISORY COMMITTEE ON IMMUNIZATION (NACI) is a scientific technical body made of experts in the fields of pediatrics, infectious diseases, immunology and public health. NACI provides ongoing medical, scientific and public health advice about the vaccines approved for use in Canada, including vaccine schedules for individuals at different risk due to occupation, travel, underlying illness, lifestyle and age.[15, 16]

An ideal vaccine would protect, for life, against a disease after a single dose. It would have no adverse effects and would be effective for all immunized individuals, including infants and the elderly. It would be inexpensive, stable during shipping and storage and easy to administer. Researchers and vaccine manufacturers continue to work to improve on the effectiveness of vaccines; in the meantime, our existing vaccines save lives. The safety of vaccines and the effectiveness of immunization programs must be continually evaluated to attain the most benefit.[1, 17]

Immunization in public health—past and present

Public health is the organized efforts of society to keep people healthy and prevent injury, illness and premature death. It is a combination of programs, services and policies that protect and promote health.[18, 19] Better hygiene and sanitation, access to safer and more nutritious foods, improved living standards, the development of antibiotics and other medical advancements have all helped make Canadians healthier.[20] So too have vaccines, which have improved the health of Canadians by decreasing and, in many cases, halting the spread of infectious diseases.[21]

Reduction in incidence of vaccine-preventable diseases

The incidence of various infectious diseases began to drop dramatically after vaccines came into widespread use in Canada (see Table 1).[1, 21–28] Through innovative tools, education and training, as well as effective immunization delivery strategies, common infectious diseases that were once a major cause of illness and death, particularly among children, have been significantly reduced through immunization.[1, 29]

TABLE 1 Incidence of selected vaccine-preventable disease in Canada, pre-vaccine era compared with 2007 to 2011[1, 22–28, 30, 31]

Disease	Pre-vaccine era* Peak annual number of cases	2007–2011 Peak annual number of cases
Congenital rubella syndrome (CRS)	29 (1979–1983)	0
Diphtheria	9,010 (1925–1929)	4
Haemophilus influenzae type b (Hib) (children <5 years)	526 (1986–1990)	12
Measles	61,370 (1950–1954)	750
Mumps	43,671 (1950–1954)	1,110
Pertussis (whooping cough)	19,878 (1938–1942)	1,967
Poliomyelitis	1,584 (1950–1954)	0
Rubella	37,917 (1950–1954)	12
Tetanus	19 (1957–1961)	6

* Five years preceding vaccine introduction.

However, as the incidence of a vaccine-preventable disease decreases following successful immunization programs, there is a potential for Canadians to become complacent and question the role of vaccines in preventive healthcare. This could lead to lower immunization coverage and resurgence of the disease.[1, 7, 10, 32–34] The viruses and bacteria that cause such diseases are still common and circulate within Canada and around the world, meaning that people who are not protected by immunization can become infected with the disease.[7, 35]

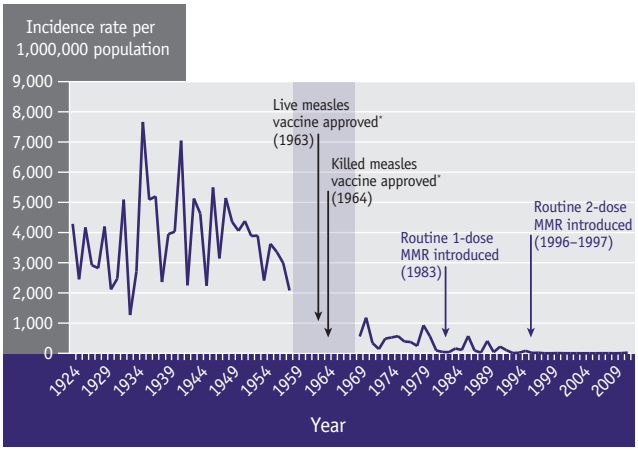
The recent measles outbreaks in Canada illustrate the need to remain vigilant.[24] Measles is a highly contagious virus, and health complications from the disease can be very serious, requiring hospitalization and even causing death.[24, 36] Before the vaccine was implemented in Canada in 1963, measles was widespread and large epidemics occurred every two to three years.[24, 31, 36] Immunization resulted in a dramatic decrease in the incidence rate of measles (see Figure 1).[24, 36–38] However, there have been several measles outbreaks since 2005, including nine notable outbreaks (see the textbox "Measles: The need to remain vigilant").[24] Until measles and other vaccine-preventable diseases are eradicated worldwide, Canadians remain at risk. A safe protection against emergence and re-emergence of infectious diseases is immunization.[24]

Measles: The need to remain vigilant

Canada has made great progress in preventing and controlling measles. This is due in large part to the interruption of measles transmission, as a result of high vaccine coverage as part of routine infant and childhood immunization programs.[1, 24] Nevertheless, measles outbreaks still occur periodically in Canada.[24] For example, in recent years, Quebec, British Columbia and Ontario experienced measles outbreaks in 2011, 2010 and 2008, respectively.[24] Overall, between 2005 and 2011, a total of 1,046 confirmed cases of measles were reported in Canada.[24] As of March 2012, more than 776 cases had been recorded in Quebec.[39] This has been the biggest measles outbreak in the Americas since 2002.[40]

Worldwide, measles is still a leading cause of death in children.[10, 24] The World Health Organization (WHO) global goal was to reduce measles mortality by 90% by 2010 (compared with levels in 2000).[10, 24] While the goal was not achieved, global mortality due to measles was reduced by 74% from 535,300 deaths in 2000 to 139,300 deaths in 2010.[24] As long as people travel and the disease is still circulating, measles can continue to be imported into Canada. Thus, the best protection against measles is to be immunized.[1, 24]

FIGURE 1 Incidence rate (per 1,000,000 population) of measles, by year, 1924 to 2011, and year of vaccine introduction in Canada[24, 31, 37, 38]



* In 1963, live vaccine was approved for use in Canada, followed by the approval of killed vaccine in 1964. The killed vaccine had limited availability, and use was discontinued by the end of 1970. A single dose schedule with the live vaccine was introduced into all provincial/territorial routine immunization programs by the early 1970s. The routine one-dose measles-mumps-rubella vaccine was introduced in 1983.

Note: Measles was not nationally notifiable between 1959 and 1968.

Increase and maintain immunization coverage

Routine childhood immunization is, for the most part, accepted as standard practice in Canada.[1, 15] Adequate and well-timed immunization of infants and children is necessary to protect against vaccine-preventable diseases.[1, 41–43] While newborns are protected against many diseases because they still have maternal antibodies, this immunity disappears within the first year of life.[1, 42] It is important for parents and caregivers to keep track of and maintain their child's immunization record to ensure it is up-to-date. This is also a good opportunity for parents to check that their own immunizations are current.[1, 41]

Preventing disease by immunization is a lifelong process.[1] The proportion of the population aged 65 years and older is increasing more rapidly than that of any other age group, and if population projections remain consistent, there will be more seniors than children in Canada by 2015.[44] To prevent infections and control the spread of disease, Canadians should be made aware of, and encouraged to take part in, immunization programs beyond the childhood years.[1, 45] Specific immunization efforts should also target high-risk groups in Canada, such as healthcare providers, newcomers to Canada, international travellers and specific populations with low immunization coverage who may be vulnerable to vaccine-preventable diseases.[1, 46–48]

A number of vaccines—booster or annual doses—are recommended for those aged 15 years and over. Without them, Canadians remain vulnerable to infectious diseases such as pneumococcal infections, pertussis and influenza. For example, adults require a tetanus booster every 10 years to remain protected.[1, 49] Between 2000 and 2011, 97% of reported cases of tetanus in Canada were among Canadians aged 20 years and older.[30] Improved coordination of and delivery strategies for adult immunization as well as identification of barriers to vaccine uptake are needed to achieve and maintain adequate immunization coverage.[1, 29, 45]

Seasonal influenza immunization rates are relatively low in Canada, even among those at highest risk.[50] In 2011, an estimated 30% of Canadians aged 12 years and older received the influenza vaccine in the past year.[51] Annual influenza vaccination is encouraged for all Canadians, particularly those at high risk of influenza-related complications, those capable of spreading influenza to individuals at risk and those who provide essential community services.[52] Among infants, the elderly and those with underlying medical conditions, influenza can cause severe illness and even death.[52–55] Even healthy, young individuals are at risk.[52, 54] Some Canadians may perceive the influenza vaccine as "optional," or not as crucial, as other vaccines.[56] However, an annual influenza vaccine offers the best protection, and the more Canadians are immunized, the greater the collective protection.[52, 54] To increase and maintain high immunization coverage, greater attention to education and public outreach is needed.[56, 57]

Identifying the reasons Canadians accept or refuse vaccines is essential to learning how to develop, evaluate and promote effective strategies for immunization.[56] Hesitancy towards immunization can be due to a number of factors including personal beliefs, values, opinions, lifestyle choices and alternative personal health perspectives. Other factors include concerns about vaccine safety, perceptions of low disease risk and fear of vaccine "overload" in children.[33, 34, 56, 58–61] Strategies to identify and overcome factors associated with less than optimal vaccine uptake are needed.[1, 33, 57] A combination of approaches may be beneficial; these include recommendations from healthcare professionals (e.g. physicians, nurses and pharmacists); education on the risks and benefits of vaccination; targeted messaging for specific groups; expanded opportunities for being immunized; coordinated immunization programs across Canada; and the availability of up-to-date immunization records, databases and information systems.[1, 60]

Immunization—a shared responsibility

By and large, immunization in Canada is a public health success story. However, the future presents new challenges and opportunities for improvement. The continued success of immunization depends on the concerted efforts of all levels of government and of researchers, healthcare professionals and the public.

Canada's National Immunization Strategy

In 2003, Canada launched the National Immunization Strategy (NIS), a collaboration between federal and provincial and territorial governments to initiate consistent and comprehensive approaches to immunization planning, purchasing, delivery and education.[62–64] In the past 10 years, the NIS has helped build stronger partnerships between federal and provincial/territorial governments and key stakeholders, thus improving access to vaccines across Canada and the effectiveness and efficiency of immunization programs.[63–65]

Maintaining vaccine effectiveness and safety

Vaccine effectiveness and safety are of the highest importance and concern for all vaccine stakeholders.[66] As the incidence of vaccine-preventable diseases declines, public and mass media concern has shifted to vaccine safety.[60] Perceived vaccine safety risks can get as much attention—if not more—than *actual* vaccine safety risks and can be difficult to dispel despite credible scientific evidence.[1] This can bring about hesitancy towards vaccines and a loss of confidence in immunization altogether.[1] This, in turn, threatens the continued success of immunization programs.[1, 32, 67]

Many vaccines have been used in Canada for decades with no evidence of long-term adverse effects.[1, 66, 68, 69] While it is recognized that no vaccine is 100% effective or perfectly safe, vaccines are much safer than the diseases they prevent. For the majority of Canadians, vaccines offer an effective and safe protection against vaccine-preventable diseases.[1, 9, 66, 70, 71] Common short-term adverse events include redness, swelling and pain at the injection site. Serious adverse events following immunization are, however, rare.[1, 72]

Debunked vaccine myths

Recent research using comprehensive scientific methods and reviews of studies worldwide have debunked the myths and confirmed that:[1, 68, 69, 73, 74]

- the measles-mumps-rubella (MMR) vaccine does NOT cause autism;
- the hepatitis B vaccine does NOT cause multiple sclerosis (MS) or relapses of pre-existing MS;
- the pertussis vaccine (DTaP, Tdap) does NOT cause brain damage;
- the influenza vaccine does NOT give a person the seasonal flu;
- childhood vaccines do NOT increase the risk of asthma; and
- vaccines do NOT cause sudden infant death syndrome (SIDS).

Vaccines are developed in accordance with the highest standards and are continually monitored for safety in Canada and around the world.[1, 66] On average, it can take 10 years for the necessary data and evidence to be gathered before a vaccine is authorized for use in Canada.[71] Following Health Canada's regulatory approval, several surveillance systems are in place to monitor the safety of vaccines. These include the Canadian Adverse Events Following Immunization Surveillance System (CAEFISS) and a pediatric hospital-based surveillance network known as IMPACT (Immunization Monitoring Program ACTive).[1, 66, 71, 75–77]

Although the vaccines used in Canada today are effective, efforts must continue to develop even better vaccines. Continuously exploring new ways to optimize vaccine surveillance systems so as to respond to vaccine-associated adverse events more efficiently is also essential. In addition, communicating effectively about vaccine safety and monitoring activities will help improve and maintain professional and public confidence.

Public confidence, education and promotion

Social media can be a constant, but not always reliable, source of information-sharing for Canadians. Some media outlets can shift the focus away from recognizing the effectiveness of immunization towards other issues such as increased hesitancy and/or suspicion of adverse effects resulting from vaccination. This can have an impact on public perception and confidence in vaccine use in Canada.[1, 34, 57]

False controversies about the measles-mumps-rubella (MMR) vaccine

In 1998, the British medical journal, *The Lancet* published a study by Dr. Andrew Wakefield that claimed to link the MMR vaccine to autism. The study was later discredited, and *The Lancet* retracted Dr. Wakefield's paper in 2010. Following release of the original article, vaccination levels plummeted in Britain and incidence rates of the diseases surged. The effect on immunization rates was felt worldwide.[1, 32, 67]

Medical researchers and scientists worldwide have concluded there is no evidence of a link between autism and the MMR vaccine. Vaccines used to protect children from measles, mumps and rubella are effective and safe.[1, 66, 67, 69, 73]

Education and effective communication is paramount. Identifying alternative ways to inform Canadians about vaccine-preventable diseases, immunization programs and vaccine effectiveness is vital to overcoming any potential effects of misinformation or loss of trust.[1, 57] Information must be easy to understand, visible, current and evidence-based to spread key messages effectively.[57]

A healthcare encounter in which an individual is eligible to be immunized, but is not, is considered a missed opportunity. Missed opportunities present challenges to achieving optimal immunization coverage.[59] High quality, standardized educational resources to help healthcare professionals effectively communicate about immunization are necessary. Transparency on risks and benefits of immunization, as well as clear and targeted messaging to specific audiences are essential to inform Canadians and maintain trust.[1, 57] Such resources can help healthcare professionals explain evidence-based information on the effectiveness and safety of vaccines.[1] As well, healthcare providers can help patients understand that there is no substitute for immunization, and that while there may be alternative therapies available, they are not as effective as immunization programs.

Improved coordination of immunization programs

Immunization recommendations for vaccines used in Canada are made by the National Advisory Committee on Immunization.[16] Provinces and territories remain responsible for immunization programming decisions following reviews and recommendations by their own scientific advisory committees or immunization leads. They implement immunization programs that meet their goals, policies and strategies as well as epidemiological and financial circumstances.[61, 65]

Provincial or territorial immunization programs determine which recommended vaccines are provided at no direct cost to Canadians.[61, 63, 78] Though immunization schedules are more or less consistent among jurisdictions, there is some variation (e.g. in vaccine products used, combined vaccines, administration at different ages, number of booster doses required, etc.).[1, 79] Additional vaccines may be recommended to Canadians, depending on their state of health, occupation, activities or travel plans but not all are publicly funded.[1] This makes it a challenge for complete immunization coverage across Canada, given that some routine vaccines and vaccines for special circumstances are publicly funded in some jurisdictions, but not in others.[61, 62]

Recent years have seen an increase in the number of new vaccines on the Canadian market and a rise in costs.[11, 13] As a result, provincial and territorial immunization schedules do diverge, as jurisdictions must choose between available health interventions to meet the needs of their population.[1, 79] However, such divergence

can impose avoidable burdens on healthcare systems and families and make access to vaccines inequitable across jurisdictions and in different population groups, resulting in public confusion over the necessity, utility and safety of certain vaccines.[1, 57, 63]

Improved coordination of immunization schedules and programs across Canada would support the demand for equitable access to needed vaccines for all Canadians. In addition, equitable access would offer the best coverage and protection for those Canadians who move between provinces and territories or conversely, risk infection due to differing provincial/territorial immunization schedules and programs.[57, 61–63, 78, 79]

Complete and compatible immunization registries

Accurate and timely information on those who have been immunized as well as information on the immunization coverage levels in specific population groups and regions are important to indicate the level of protection against specific vaccine-preventable diseases in a population. Such information helps target priority regions and populations for immunization during disease outbreaks and helps avoid unnecessary and costly re-immunization. It also helps identify any adverse events following immunization.[57, 61, 62, 78, 80, 81]

Currently, six provinces and territories have some form of an immunization registry in place.[81, 82] An interconnected network of complete, compatible and accessible immunization registries across provinces and territories would make it easier to track immunization records when people move from one jurisdiction to another. Healthcare professionals and patients could easily find out which vaccines are missing, which booster doses are needed and which new vaccines are available.[57, 81, 82]

Being able to effectively monitor uptake of vaccines and produce better surveillance information through compatible and accessible immunization registries would put Canada in the best position to evaluate and assess vaccines and immunization programs. Enhanced information would allow for better program evaluation and opportunities to be more strategic in identifying immunization needs.[57, 81]

ACTIONS FOR SUCCESS

Infectious diseases can have an impact on an individual's quality of health and longevity. It is important that Canadians stay protected as outbreaks of vaccine-preventable diseases can, and do, occur in Canada. Immunization is a good prevention measure against vaccine-preventable diseases. Therefore, continued commitment to immunization programs in Canada is essential. Everyone has a role to play.

- Accurate and accessible information about vaccine-preventable diseases helps Canadians stay protected.
- Healthcare professionals and those who care for people at high risk need to promote and embrace immunization to reduce the transmission of disease.
- Healthcare professionals need to be more engaged in promoting vaccine uptake, in identifying barriers to immunization and developing solutions.
- Canada can continue to improve strategies to strengthen and maintain public confidence in immunization.
- Coordination of routine immunization schedules and programs across Canada is a shared responsibility.
- Compatible immunization registries would facilitate the sharing of surveillance data across Canada.

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HEALTHCARE-ASSOCIATED INFECTIONS—DUE DILIGENCE

HIGHLIGHTS

- More than 200,000 patients get infections every year while receiving healthcare in Canada; more than 8,000 of these patients die as a result.
- Mortality rates attributable to *Clostridium difficile* infection have more than tripled in Canada since 1997.
- The healthcare-associated methicillin-resistant *Staphylococcus aureus* infection rate increased more than 1,000% from 1995 to 2009.
- About 80% of common infections are spread by healthcare workers, patients and visitors.
- Proper hand hygiene can significantly reduce the spread of infection.
- Best practices in preventing infection can reduce the risk of some infections to close to zero.

Contracting an infection while in a healthcare setting challenges the basic idea that healthcare is meant to make people well. Hospitals, long-term care facilities, clinics and home care services are meant to help people get better. Yet it is estimated that more than 200,000 Canadians acquire a healthcare-associated infection (HAI) each year and that 8,000 of them die as a result.[1] Although definitive numbers are not available, it appears that these numbers are rising.[2]

The World Health Organization (WHO) suggests that HAIs (also known as nosocomial infections) are universal, affecting healthcare systems in every country.[3] However, noting that Canada is not alone does not make it less of a problem or any more acceptable. More must be done to keep Canadians safe while they seek treatment and care.

Preventing HAIs involves the right engineering and the right equipment; attention to hygiene; training of healthcare providers and staff; and the cooperation and help of patients and their families and friends. Washing hands, cleaning environments and sterilizing instruments are the best ways to prevent HAIs.[7–9] However, following best practices is not always simple. It involves many people and increasing awareness in a complex environment. Educating and encouraging healthcare workers, patients and visitors to wash their hands at the right time and consistently perform other hygiene practices is one challenge. Others include the ever-changing characteristics of infectious agents and the increasing risk of infection associated with advances in medical care and increasingly vulnerable patients.

A HEALTHCARE-ASSOCIATED INFECTION (HAI) is an infection that a patient contracts (or acquires) in a setting where healthcare is delivered (e.g. a hospital) or in an institution (e.g. a long-term care facility) or in a home care arrangement. The infection was neither present nor developing at the time the individual was admitted (or started treatment).[4, 5]

Some of the HAIs monitored by the Canadian Nosocomial Infection Surveillance Program (CNISP) include:

- Methicillin-resistant *Staphylococcus aureus* (MRSA) infections;
- Vancomycin-resistant enterococci (VRE) infections;
- *Clostridium difficile* (*C. difficile*);
- Surgical site infections (SSI); and
- Central venous catheter-associated bloodstream infections (CVC-BSI).[6]

Becoming infected

People become infected with bacteria, viruses, fungi and parasites when these micro-organisms spread through the air, through direct or indirect contact or when infected blood or body fluids enter the body (e.g. the bloodstream).[10–12] The risk of infection is higher in places where people gather, and the impact is magnified in hospitals and long-term care facilities because patients are already ill and at particular risk of infection due to medical interventions and "hands-on" care.[5]

About 8% of children and 10% of adults in Canadian hospitals have an HAI at any given time.[13, 14] The severity is greatest among those who are elderly, very young, have weakened immune systems or have one or more chronic conditions.[15] Of greatest concern are the bacteria that are resistant to multiple types of antibiotics (see "Antimicrobial Resistance—A Shared Responsibility").[8] More than 50% of HAIs are caused by bacteria that are resistant to at least one type of antibiotic.[16]

Some infectious agents can spread easily from people who are infected to those who are not. They can also spread from healthy individuals who may carry the agent but do not develop clinical infections or know they are sick (see the textbox "Infected, colonized and the iceberg effect"). Infection can easily spread from patient to patient through the hands of healthcare workers during treatment or personal care or by touching contaminated shared surfaces, such as bathrooms, toilets or equipment. Even the simple act of holding a loved one's hand can risk spreading infection if hands haven't been correctly washed.[17]

While direct person-to-person touch is the primary pathway, the healthcare environment itself can be a route of transmission. Bacteria can exist on many objects in the patient environment (e.g. bedrails, telephones, call buttons, taps, door handles, mattresses, chairs).[17] Some of those bacteria can survive for a long time—in some cases for many weeks and even months.[17]

Methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile* (*C. difficile*) are two of the most well-known bacteria that are able to adapt and survive in the healthcare environment long enough to cause infection.[17]

Infected, colonized and the iceberg effect

An INFECTED individual is one in whom infectious agents have developed to the point where the person gets ill and shows symptoms such as fever and high white blood cell count.[18, 19] An infected person may transmit infectious agents to another person through touch (direct to another person or indirect touching of the same object). However, not all individuals exposed to the infectious agent become infected and sick. Instead, they may become COLONIZED.[18] Since most colonized individuals have no symptoms, they are unaware they are carrying the infectious agents. As a result, everyone—not just those who are sick—must be vigilant about hygiene and handwashing to protect others.[18]

For some bacteria and viruses the number of colonized people is much higher than the number of infected people (i.e. who are sick). The relationship between the number colonized and the number infected is often referred to as the ICEBERG EFFECT. The smallest part of the iceberg—the tip visible above the water—represents those who are infected and have symptoms. The largest portion of the iceberg—underwater and mostly invisible—represents the number of colonized people with no symptoms.[18] The key message here is, that which is visible is not representative of all that is present and we need to be concerned with what is not always visible.

Clostridium difficile

C. difficile is not a new bacterium. First identified in the 1930s, it was recognized as a cause of human illness in 1978.[20] Within the last five years, *C. difficile* has earned much public attention as a difficult-to-control superbug that attacks vulnerable patients, particularly the elderly, and undermines the safety of healthcare institutions.[20, 21]

The bacteria are found in feces and causes mild to severe diarrhea as well as other serious intestinal conditions, including life-threatening pseudomembranous colitis, bowel perforation and sepsis.[22, 23] *C. difficile* infection (CDI) is the most frequent cause of infectious diarrhea in hospitals and long-term care facilities in Canada.[20]

In hospitals reporting to the Canadian Nosocomial Infection Surveillance Program (CNISP), the incidence of CDI in the first nine months of 2011 was 4.5 cases per 1,000 patient hospital admissions.[24] Although the incidence of CDI has remained fairly steady in recent years, the severity seems to be increasing. The mortality rate attributable to CDI in Canadian hospitals more than tripled over the last decade and a half, from 1.5% of deaths among CDI patients in 1997 to 5.4% in 2010.[24, 25]

The bacteria can be spread by touching contaminated feces and then a surface object and/or an individual. Eventually, the bacteria can reach the mouth or nose as a result of touching one's face or eating.[21] Some populations, particularly seniors and those who are immune-compromised, are more vulnerable to infection.[21] *C. difficile* is not a significant risk for healthy people; however, they can still be colonized, potentially passing on the bacteria to others who may become infected.[26]

Research on object contamination shows that as levels of environmental contamination increase, so does the prevalence of *C. difficile* transmitted between healthcare workers and from them to patients.[26] This specialized bacterium is very difficult to remove.[26] It creates spores that are resistant to many of the usual cleaning and disinfection practices.[26] The spores can survive for up to 5 months on surfaces such as tables, medical equipment and other objects, making hygiene critically important in hospitals and healthcare institutions.[20, 26] *C. difficile* is a particular problem for people already on antibiotics. Antibiotics kill many of the normal 'good' bowel bacteria, allowing *C. difficile* to multiply and produce the toxins that damage the bowel and cause diarrhea.[20]

Simple acts can help reduce the risks of CDI. For example, proper hand hygiene can make a big difference (see "Preventing infection in healthcare settings"). Since the spores are resistant to alcohol, washing hands with soap and water is recommended over alcohol hand rubs in a healthcare facilities experiencing outbreaks of *C. difficile*.[26]

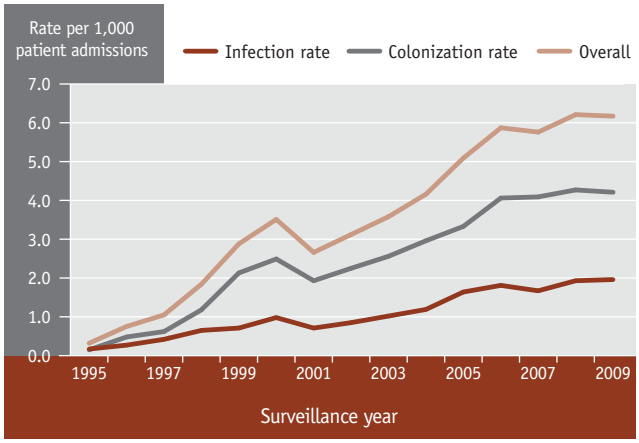
Addressing CDI requires understanding many aspects of the bacteria: who is at risk and why; how it spreads; and how to most effectively clean the environment in healthcare settings.[9] As noted in "Antimicrobial Resistance—A Shared Responsibility", it also requires making sure that antibiotics are used as wisely as possible. Surveillance to monitor cases of CDI and to evaluate hospital programs to protect patients is critical to reducing infection.[26]

Staphylococcus aureus and methicillin-resistant *Staphylococcus aureus*

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a drug-resistant form of *Staphylococcus aureus* (*S. aureus*)—the most common cause of serious hospital-acquired infections.[27] *S. aureus* spreads primarily through direct skin-to-skin contact as well as indirectly, as when people share personal items such as towels, razors and needles. If this bacterium enters the body it can cause infections in many areas including the skin, bones, blood and vital organs such as the lungs and the heart.[28] Many people have *S. aureus* on their skin at any given time and approximately 30% of people are colonized with *S. aureus* in their nose.[29, 30] For healthy individuals, this does not pose a threat; however, they could spread the bacteria by touch to other people. This is particularly difficult to control in healthcare settings where healthcare workers need to touch patients to assess, treat and help them. In addition, visitors often touch a patient to greet or comfort them.[17]

Of particular concern in healthcare situations are MRSA infections as these are generally multidrug-resistant.[31] In the early 1940s, penicillin was completely effective in treating *S. aureus*. However, after this antibiotic became widely used, the micro-organism quickly adapted and became penicillin-resistant.[31] In the early 1960s, the antibiotic methicillin was introduced and shortly after that MRSA emerged.[31]

FIGURE 1 Healthcare-associated MRSA rates per 1,000 patient admissions from 1995 to 2009, Canada[32]



Rates of healthcare-associated MRSA infection and colonization have been steadily increasing for more than a decade (see Figure 1).[32] The combined, overall rate went from less than 1 case per 1,000 patient admissions in 1995 to more than 6 cases in 2009. The infection rate increased by more than 1,000%, from 0.17 cases per 1,000 patient admissions in 1995 to 1.96 cases in 2009. The increase in the colonization rate was even larger, with the number of colonized cases per 1,000 patient admissions climbing from 0.15 in 1995 to 4.21 in 2009.[32] While more common in healthcare settings, MRSA infections have been found among patients who had never been in a healthcare facility, indicating that MRSA was spreading in the community.[31] These strains of MRSA are called community-associated as opposed to healthcare-associated.

Preventing infection in healthcare settings

Everyone—patients, visitors and healthcare workers—is responsible for preventing infection in healthcare settings. While prolonged hospitalization and being immune-compromised can increase a person's risk of infection, research shows that applying infection control practices can reduce those risks by significantly decreasing overall rates of infection, thereby reducing exposure.[33] Those practices range from individual behaviours to institution-wide policies.[33, 34]

Addressing infection prevention in healthcare settings involves multiple tactics. Some of those are:

- educating everyone about how infections occur and how to prevent them;[34]
- reminding everyone, including visitors, to carefully clean their hands with soap and water or alcohol-based hand rubs before and after interacting with patients;[34]
- making hand hygiene options easily available (e.g. by having alcohol-based hand rubs and handwashing stations/washrooms accessible in key locations);[35]
- limiting touching of patients by visitors, especially areas that may be more prone to transmitting infection such as open wounds or sores;[36]
- working with infection control specialists, and following advice for additional precautions where necessary (e.g. wearing gowns, gloves, limiting number of visitors, need for isolation rooms);[34]
- monitoring rates of infection, and evaluating and improving preventive programs;[37]
- using checklists to ensure best practices in infection prevention are followed;[38] and
- detecting and identifying outbreaks of infection with careful and continuous monitoring and surveillance.[34, 37]

During infectious disease outbreaks such as SARS and H1N1 healthcare facilities became much more diligent in enforcing infection prevention and control practices for staff, patients and visitors. A study of the effect of those stepped-up efforts in an Ontario hospital showed that intensive care patients were more than twice as likely to develop an HAI in the pre-SARS period as in the SARS period.[39]

Recognizing the global need for infection control, WHO launched the first Global Patient Safety Challenge in 2005—an international campaign to encourage member states to reduce the risk of infection in healthcare settings. The "Clean Care is Safer Care" campaign includes several components: clean products, clean practices, clean equipment and clean environment, all within the overall goal of implementing WHO hand hygiene recommendations.[40, 41] Canada joined the Global Patient Safety Challenge in 2006 and later launched the Canadian Patient Safety Institute's (CPSI) Stop! Clean Your Hands program.[42, 43] This program is part of Canada's Hand Hygiene Challenge, which is meant to improve hand hygiene practices and compliance in healthcare settings.[44]

Hand hygiene

It's clear: clean, healthy hands equals better health. Proper hand hygiene—washing hands with soap and water or using alcohol-based hand rubs—is the single best way of preventing HAIs.[40, 45] Even small improvements in hand hygiene result in large benefits: an increase in adherence to hand hygiene by only 20% has been shown to reduce the rate of HAIs by 40%.[46, 47] Even though infection control today has new challenges, such as antibiotic resistance, the principles of hand hygiene remain key to preventing infection.[40] For example, the use of regular soap and water, rather than antimicrobial soaps, is sufficient. In fact, antimicrobial soaps may contribute to the development of antimicrobial resistance (see "Antimicrobial Resistance—A Shared Responsibility").[48, 49] When hands are not visibly soiled or soap and water are not readily available, alcohol-based hand rubs should be used.[50]

Despite public health messages about the importance of washing hands to reduce the spread of infection, handwashing is not always done effectively. This could be because people establish hand hygiene patterns in childhood. Old habits are hard to break—changes in practice can be difficult and slow even among some healthcare professionals.[47, 51] Everyone needs to learn and practice the correct technique (see the textbox "Proper hand hygiene tips").

Proper hand hygiene tips

The Public Health Agency of Canada recommends that Canadians wash their hands often, with soap and warm water, for about 20 seconds or, if handwashing is not possible, use an alcohol-based hand rub. The proper handwashing practice is to:

- Remove all jewellery and rinse hands with warm running water.
- Use a small amount of liquid soap in the palm of your hands and rub your hands together for about 20 seconds to form a lather that covers your entire hands including the palms, the backs, the backs of the thumbs, the fingertips and between the fingers.
- Rinse hands well for about 10 seconds and then dry completely. Try not to touch faucets and other items with clean hands.[50]

It is never too early to learn the basics of washing hands. Parents, teachers and childcare workers can teach children the importance of handwashing as well as how to do it correctly. The amount of time it takes children to soap their hands thoroughly is the same as the amount of time it takes to sing a nursery rhyme such as "Twinkle, Twinkle Little Star."[50]

A vital part of ensuring effective hand hygiene is making sure that healthcare professionals know about the risks and prevalence of HAIs and about the benefits of having proper hand hygiene. For healthcare providers, following specific handwashing practices is critical to controlling infections and reducing transmission.[45, 46, 52]

Patients can also make a difference and improve hand hygiene practices among healthcare workers and visitors by simply asking if they have cleaned their hands or requesting that they do so.[47] However, while most patients want to be involved in improving hygiene, many say that they are reluctant to ask questions in case they become a nuisance to their healthcare team.[47] Better efforts are needed to make patients and their advocates feel comfortable in speaking up for their own safety and to encourage them to be vigilant in healthcare settings.

Cleaning environments

While hand hygiene is a critically important way to fight HAIs, one strategy alone cannot win the battle; many other practices need to be in place.[53] Cleaning equipment and environments is also very important—and connected to hand hygiene since hands touch equipment and the environment in healthcare settings.[9]

There are policies and guidelines which specify the way in which healthcare environments should be cleaned and disinfected, such as how often, with what types of products and in what way. These guidelines are best practices based on factors such as how often a surface is touched, the risk of infection with the type of activity in the area, the vulnerability of the patients and the probability of contamination from body fluids.[9] For the most part, items should be cleaned and disinfected shortly after use. Finishes on furniture and surfaces on equipment should be made of materials that can be cleaned, and items that have been damaged should be properly discarded.[9] Many healthcare settings now use external cleaning services. In these situations, it is also essential that proper policies and procedures are followed.[9]

After cleaning and disinfection of the environments in healthcare settings is carried out, there are no national standards in Canada to measure how clean things are. Instead, the level of cleanliness is assessed by how clean things look.[9] But visual assessments are not enough. Researchers in the United Kingdom found that 90% of the wards that looked clean still contained unacceptable numbers of micro-organisms.[54] The researchers proposed bacteriological standards for assessing surface hygiene in healthcare facilities modified from the standards used for food preparation surfaces.[53]

Monitoring infection

Most HAIs are preventable. As many as 70% of some types of HAIs could reasonably be prevented if infection-prevention and control strategies are followed.[55] But this is just one estimate—not enough is known about infections and how many patients could have been affected had programs not been in place.

Monitoring, tracking and prevention activities together work towards reducing the number of HAIs.[37] Nearly all hospitals in Canada routinely monitor the incidence of HAIs through surveillance activities. Surveillance is either broad (assessing all care areas) or targeted to specific units (e.g. the intensive care unit) or for specific infections that are a priority for a particular hospital.[37]

However, just because some type of monitoring occurs does not mean that it is effective in preventing and controlling HAIs. The Centers for Disease Control and Prevention in the United States carried out the Study on the Efficacy of Nosocomial Infection Control (SENIC) project to identify the most effective approaches to infection surveillance, prevention and control.[56] A survey of Canadian hospitals with more than 80 beds reported in 2008 that hospitals carried out, on average, only two-thirds (68%) of the recommended surveillance activities based on SENIC project findings and only 64% of the recommended infection control activities. In addition, only 23% had the recommended number of infection control professionals on staff.[2] Mandatory standards, monitoring and public reporting are necessary to understand and tackle HAIs. Some current practices are inconsistent and uncoordinated, and more could be done to improve monitoring, addressing and reporting of HAIs in Canada.

Standards and best practices

Daily prevention and control of infectious agents is important everywhere. However, it is particularly important in healthcare environments. Hospitals started to establish infection prevention and control programs in the late 1950s. Initial concerns were with staphylococcal bacteria, and addressing them focused on identifying the infection and isolating patients. During the 1980s, infection prevention and control programs expanded to long-term care facilities and the community.[57, 58] There are now aggressive efforts across various types of healthcare services in Canada to create networks and to uphold standards in infection prevention and control.

The Canadian Patient Safety Institute (CPSI) works with governments, health organizations, leaders, and healthcare providers to raise awareness and facilitate best practices to make healthcare safer.[59] Through their primary program, Safer Healthcare Now!, CPSI provides services, tools and resources for all levels of healthcare, including frontline workers, middle managers, senior leaders and boards.[60]

Through a peer review process, Accreditation Canada's standards assess governance, risk management, leadership and infection prevention and control in healthcare organizations. Accreditation Canada's more than 600 peer reviewers (or surveyors) are healthcare professionals across many fields from different types of healthcare services (including physicians, nurses, scientists, therapists and social workers). Accreditation Canada currently has over 1,000 client organizations including regional health authorities, hospitals and community programs and services in Canada and internationally.[61]

Patient safety is a priority for accreditation, which is implemented and monitored as part of Required Organizational Practices (ROPs) developed by Accreditation Canada. ROPs are put in place to mitigate risk, reduce the potential for adverse events and foster high-quality care.[62] The ROPs fall into six patient safety areas: safety culture; communication; medication use; worklife/workforce; infection control; and risk assessment.[63]

Similarly, the Community and Hospital Infection Control Association-Canada (CHICA-Canada) is a national association that promotes best practices in infection prevention and control. Generally, the focus is to improve patient care and staff health in healthcare facilities and the community by developing united control efforts (involving multidisciplinary teams), standardizing practices, promoting research and facilitating educational programs for all those working in healthcare settings.[64]

In terms of surveillance, the CNISP was established in 1994. It is a collaboration between the Canadian Hospital Epidemiology Committee, a subcommittee of the Association of Medical Microbiology and Infectious Disease Canada, and the Public Health Agency of Canada. The CNISP gathers data from participating locations across the country to provide rates and trends on HAIs at Canadian health care facilities. These evidence-based data can be used in the development of national guidelines on clinical issues related to HAIs.[65]

ACTIONS FOR SUCCESS

HAIs complicate the lives of Canadians when they are at their most vulnerable, resulting in longer illnesses and greater risk of death. They can impact people even after they are discharged from healthcare facilities.[57, 66, 67] What's more, the longer patients remain infectious, the longer they can spread infectious agents to others.[66] Continued vigilance is necessary to reduce the numbers of those affected by HAIs. The nature of healthcare continues to evolve. To be current and ahead of emerging and re-emerging threats, infection prevention and control must also evolve as the nature of infection evolves. Canada can do more to reduce and try to eliminate risk of infection within healthcare settings. All Canadians can be involved in minimizing the spread of infection by taking actions within their control.

- Clean and safe healthcare environments are everyone's responsibility.
- Public awareness and education for healthcare providers are necessary to prevent HAIs.
- Proper handwashing and hygiene practices in healthcare environments are essential in preventing HAIs.
- National and targeted surveillance beyond the current range of coverage is needed to develop guidelines and responses to emerging HAI issues and trends.

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ANTIMICROBIAL RESISTANCE—A SHARED RESPONSIBILITY

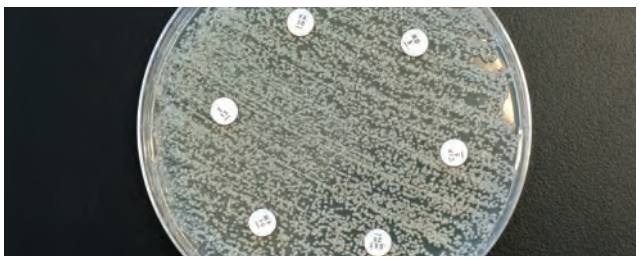
HIGHLIGHTS

- Antimicrobial resistance is inevitable, but can be delayed.
- Antimicrobial-resistant micro-organisms are not restricted to healthcare facilities.
- Inappropriate use of antimicrobial agents and limited research into and development of new agents have helped accelerate antimicrobial resistance.
- Treatment of diseases caused by antimicrobial-resistant organisms takes more time, uses more resources and is more costly.
- Managing antimicrobial use is everyone's responsibility.
- The World Health Organization has recognized antimicrobial resistance as one of the most serious public health threats to the treatment of infectious diseases worldwide.

The discovery of penicillin by Alexander Fleming in the 1920s and its development as therapy by Howard Florey in the 1940s are generally accepted as the start of the modern antimicrobial revolution.[1] With the advent of antimicrobial agents (antimicrobials), the chances of recovering from an infection have increased considerably.[2–5] However, the overuse and misuse of antimicrobials among people, in animals and for crops, as well as the innate adaptability of micro-organisms have made these drugs less effective.[3, 4, 6–8]

Development and transmission

That micro-organisms develop resistance to antimicrobials is inevitable.[7, 8] They multiply quickly and mutate and adapt to hostile environments.[7, 9, 10] Micro-organisms have existed on earth for more than 3 billion years, and have developed over time a natural ability to become resistant to antimicrobials in order to survive, which is one of the main reasons the most resilient micro-organisms thrive.[7, 9]



ANTIMICROBIALS are natural, semisynthetic or synthetic substances that destroy or inhibit the growth of micro-organisms.[11, 12]

ANTIBIOTICS are either produced by micro-organisms or are semisynthetic substances derived from micro-organisms. They are used to treat infections caused by bacteria.[7]

A MUTATION is a permanent and heritable change in an organism's DNA that may lead to the creation of new traits or characteristics.[13]

HORIZONTAL GENE TRANSFER is "the process of swapping genetic material between neighbouring bacteria".[13]

MULTIDRUG-RESISTANT (MDR) micro-organisms have "acquired non-susceptibility to at least one agent in three or more antimicrobial categories."[14]

EXTENSIVELY DRUG-RESISTANT (XDR) micro-organisms are not susceptible to at least one agent in all but two or fewer antimicrobial categories.[14]

PANDRUG-RESISTANT (PDR) micro-organisms are not susceptible to all agents in all antimicrobial categories.[14]

Antimicrobials, such as antivirals, antibiotics, antifungals and antiparasitics, kill or slow the growth of most micro-organisms (i.e. viruses, bacteria, fungi and parasites, respectively).[7, 11, 12, 15] However, those micro-organisms with greater resistance survive and continue to infect their host, illustrating Darwin's principle of "survival of the fittest."[8, 16]

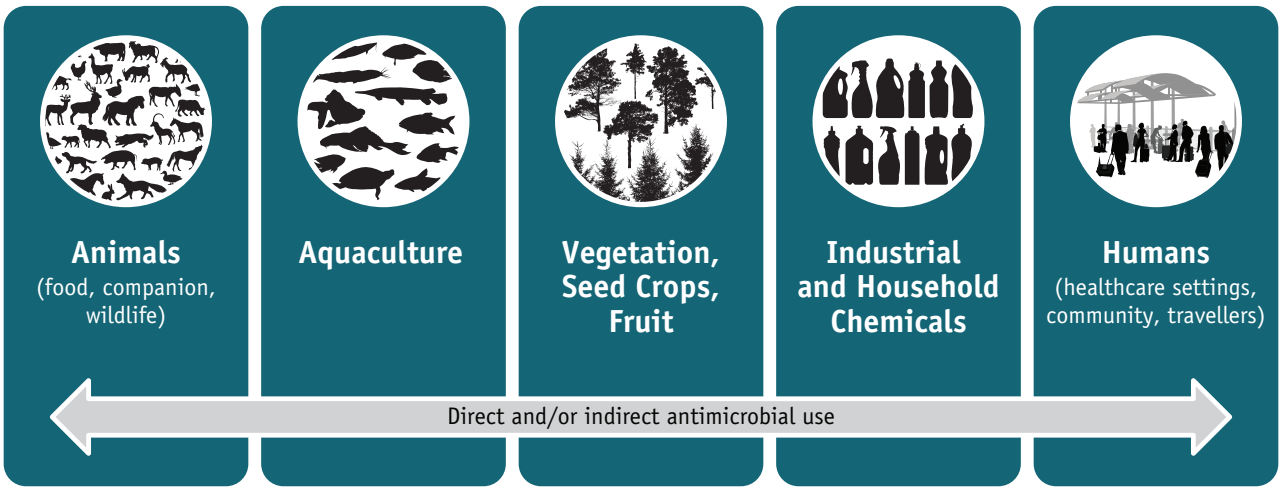
Antimicrobial resistance is the ability of micro-organisms to resist the effects of antimicrobials.[7, 13, 17] The micro-organisms change in a way that reduces or eliminates the effectiveness of drugs, chemicals or other agents designed to cure or prevent infections and/or disease caused by the micro-organism.[7, 13, 17] Bacteria may be naturally resistant or insensitive to antimicrobial agents (intrinsic resistance) or may become resistant after being exposed to antimicrobial agents (acquired resistance); alternatively, a combination of both intrinsic and acquired resistance may counter the effects of antimicrobial agents.[12, 13] The majority of strains of bacterial species can show intrinsic resistance; acquired resistance can occur through mutation, horizontal gene transfer or a combination of each.[13, 18] Unlike intrinsic resistance, acquired resistance is less common, existing only in some bacterial strains and species sub-populations.[13] A bacterium can make antimicrobials ineffective by modifying or degrading parts of the antimicrobial, expelling the antimicrobial, or changing its own structure so as to reduce the antimicrobial's ability to bind or attach to the bacterium.[13, 19]

While antimicrobials do not themselves create resistance, they can create the environments in which resistant bacteria flourish.[12, 20] This happens because they kill only susceptible bacteria, leaving resistant strains to survive and multiply.[12, 13, 20] Over time, this can lead to strains that are resistant to multiple drugs, and in extreme cases, resistant to all drugs.[13, 14, 21] Common diseases with strains that are resistant to at least one antimicrobial agent include salmonellosis, gonorrhea, tuberculosis and influenza.[22, 23] For example, gonorrhea, once easily treated using first-line antibiotics, currently has 32 different antibiotic-resistant strains.[24–26] Multidrug-resistant strains may account for as many as 60% of gonorrhea cases worldwide each year.[23]

Antibiotic use and research

Antimicrobials are widely used in many sectors of society (see Figure 1), and their effects on people, animals and the environment can be far-reaching, contributing both directly and indirectly to the development of antimicrobial resistance.[18, 27, 28] As such, the decision to use antimicrobials needs to take the potential antimicrobial risks into consideration.[7, 12, 17, 29, 30]

FIGURE 1 Sectors impacted by antimicrobial use[7, 27, 31]



Note: Modified after Linton, A.H. (1977) and Irwin, R. (2007).

Animals

In Canada, more than three-quarters of antimicrobials are used in animals.[32] Of the antimicrobials used in animals, approximately 90% are used to promote growth or to guard against disease and infection (prophylaxis).[7, 33] The development of antimicrobial-resistant pathogens in animals can pose risks to public health when they are transmitted as food-borne or water-borne contaminants.[32] Between 2003 and 2011, the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) tested 26,428 human *Salmonella* samples caused from exposure to contaminated food products.[34] Of these, 28% of the *Salmonella* strains were resistant to one or more antimicrobials.[34] In 2011, CIPARS observed consistently high levels of resistance to a specific antimicrobial, ceftiofur, in *Salmonella* isolates found in retail chicken products, as well as in *Salmonella* causing human infections.[35] This antimicrobial resistance was attributed to the use of antibiotics in chicken hatcheries.[36] Once the use of antimicrobials ceased, a significant decrease in antibiotic resistant *Salmonella* was seen in both retail chicken and humans.[36]

Antimicrobials are also often used in companion animals, for example, dogs, cats, horses and other pets.[37–39] Unfortunately, available information regarding antimicrobial resistance and antimicrobial use is generally lacking for companion animals.[37, 38] Given that more than one-half of Canadian households share their homes with at least one dog or cat, better information about antimicrobial use and resistance in this group of animals is important.[40]

Aquaculture

In Canada, antimicrobial agents are also used in the farming of aquatic organisms, or aquaculture.[12] Although publicly available information about antimicrobial resistance and use in aquaculture is limited, the use of antimicrobials has steadily decreased in British Columbia since 1995.[12, 41–43] Increased use of vaccination in aquaculture has decreased the need to use antimicrobials to guard against disease.[12] The majority of antimicrobials (97%) that are administered for aquaculture are given to young, non-market fish.[12]

Plants

Antibiotics have been used since the 1950s to control certain bacterial diseases (e.g. fire blight and bacterial spot) that affect fruits, vegetables and ornamental plants.[44] In the United States, antibiotics applied to plants account for less than 0.5% of total antibiotic use.[12, 44]

Industrial and household chemicals

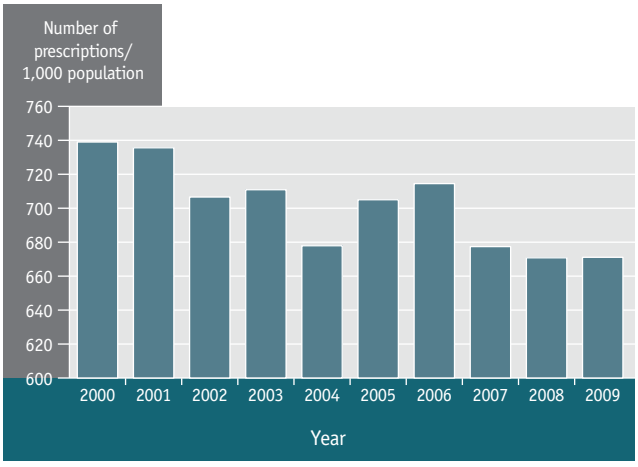
Antibiotic-like substances and antibacterial agents are now common in various household products such as clothing, cosmetics, toothpaste, cleansers and detergents.[7, 12, 21, 45–47] Despite the fact that they do not significantly reduce infections or microbial contamination—and may contribute to the development of antibiotic resistance—the number of products containing antibacterial agents continues to increase.[47–50] In 1993, there were 23 common household products containing antibacterial agents in the United States; less than a decade later, there were more than 700.[21, 51]

Humans

Antibiotics have revolutionized medicine: healthcare providers can prescribe a wide range of treatments for their patients who are, as a result, less likely to die or to suffer serious outcomes.[7, 23] However, bacteria may become resistant if prescribed antibiotics are used inappropriately or are not completed.[7, 12, 30, 52] Healthcare providers frequently have to depend on partial or imperfect information to diagnose an infection and decide on treatment.[30] Antimicrobials may be given "just in case," or broad-spectrum antimicrobials may be prescribed when narrow spectrum antibiotics might be sufficient.[7, 30] In addition, some patients demand a prescription for antibiotics when they are not needed, to the point of seeking out healthcare providers who will prescribe the antibiotics they want.[20, 53, 54]

The number of oral antimicrobial prescriptions for humans has decreased since 2000. Despite this, for every 1,000 Canadians, more than 670 prescriptions for oral antimicrobials were filled by retail pharmacies in 2009 (see Figure 2).[55] In addition, estimates suggest that one-half of all patients do not complete their prescribed courses of medication, including antibiotics, making a person more vulnerable to resistant bacteria.[56] Not completing the prescribed antibiotic therapy can create an environment in which resistant bacteria can flourish.[7, 17]

FIGURE 2 Total number of prescriptions per 1,000 population for oral antimicrobials dispensed by retail pharmacies in Canada, 2000 to 2009[55]



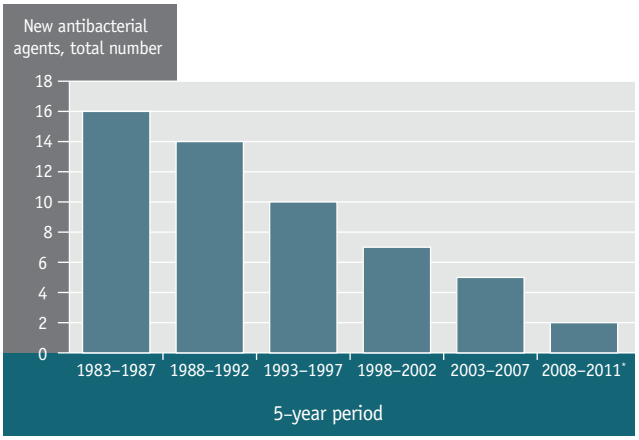
Healthcare settings often have to deal with antimicrobial resistance since antibiotics are frequently used.[28, 30, 57] Resistant micro-organisms can spread quickly and easily through institutions when prevention and control procedures are inadequate or nonexistent (see "Healthcare-Associated Infections—Due Diligence").[57, 58] Methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE) and carbapenemase-producing *Enterobacteriaceae* (CPE) are examples of increasingly common pathogens that can cause multidrug-resistant healthcare-associated infections (HAIs).[59–62] In 2009, more than 2,000 confirmed infections and more than 4,500 confirmed colonizations of healthcare-associated MRSA were reported to the Canadian Nosocomial Infection Surveillance Program (CNISP); between 1998 and 2005, more than 3,000 new cases of VRE were identified.[60, 61]

Antimicrobial-resistant infections, such as tuberculosis and community-acquired MRSA (CA-MRSA), can also be transmitted from person to person outside of healthcare settings.[17, 59, 63–65] In 2011, of the 139 tuberculosis isolates that were drug-resistant, 18 were classified as MDR and one as XDR in Canada (see "Tuberculosis—Past and Present").[66] Between 1995 to 1999 and 2004 to 2007, the percentage of Canadian patients with CA-MRSA increased from 6% to 23%.[67] Poor hygiene practices, such as inadequate handwashing, may spread the bacteria more easily.[65]

Research

Fewer new antimicrobials are being developed for a number of reasons.[9, 10, 68–70] The overall success rate of antimicrobials and low return on investment makes them less profitable for drug companies.[9, 68, 69] Since antibiotics are generally used as short-course therapies (1 to 2 weeks) for a targeted disease, therapies for chronic diseases tend to be more profitable.[9, 68] Between 1983 to 1987 and 2008 to 2011, approval of new systemic antibacterial agents by the United States Food and Drug Administration decreased by 87% compared to the period from 1983 to 1987 (see Figure 3).[9, 71] In 2004, only five new antibiotics were listed as under development by the largest pharmaceutical companies; in the same year, four new drugs to treat erectile dysfunction were listed as under development.[9]

FIGURE 3 Number of new systemic antibacterial agents approved by the United States Food and Drug Administration per 5-year period, 1983–1987 to 2008–2011[71]



* Data are accurate through February 2011.

Note: New molecular entities are considered.

Impacts of antimicrobial resistance

Antimicrobial resistance has a great impact on human health.[7, 19, 72] Antimicrobial-resistant infections are associated with a greater risk of death, more complex illnesses, longer hospital stays and higher treatment costs.[7, 17, 72, 73] The people most likely to be affected are the most vulnerable—the elderly, the very young, critical care patients, those who are immune-compromised, those being treated with immune-suppressing drugs and those who have had antimicrobial-resistant infections before.[7] Also at risk are those who are frequently exposed to antimicrobial-resistant pathogens (via healthcare institutions, consumption of contaminated food/water or through direct contact with infected animals).[7, 17]

Antimicrobial resistance is also an issue in hospitals, where patients are given antibiotics to fight off many types of infections.[20] When treatment is unsuccessful, patients are able to spread the resistant strain for longer periods of time.[7, 17, 74] Heavy antibiotic use can lead to the development of drug-resistant strains that may be untreatable, even by the strongest available antibiotics.[17, 20, 74] In hospitals patterns of resistance can vary, underlining the need for accurate records of antibiotic use and outcomes in order to define the scope of the problem and identify populations and areas at greatest risk.[20]

In addition to being more difficult to treat, antimicrobial-resistant infections are more costly to treat. If first-line medicines are ineffective, more expensive therapies may be needed, probably for longer, with more adverse effects.[7, 17, 20, 74] A Canadian study estimated the annual hospital costs of MRSA to be between $42 million and $59 million, while an American study found the treatment costs associated with antimicrobial-resistant infections to be about $6,000 to $30,000 more per patient compared with the treatment costs of antimicrobial-susceptible infections.[75–77]

Mitigation strategies

Antimicrobial resistance is increasing around the world.[9, 57] Managing the effects of using antimicrobials is not a problem that can be solved by any one city, country or continent.[28, 57] The following discussion outlines strategies to manage antimicrobial use.

Surveillance

Surveillance of both antimicrobial use and antimicrobial resistance would help monitor trends and patterns, and measure the effectiveness of policies and interventions.[7, 57, 78, 79] Such surveillance needs to take place in different environments (in the community and in institutions, on the farm and along the food supply chain) locally, nationally and internationally.[7, 57, 78]

Many countries, including Canada, have developed systems to measure the extent and distribution of both antimicrobial use and the associated resistance. CIPARS was established in 2002 to monitor antimicrobial use and antimicrobial resistance of specific bacteria across the food supply chain.[80] The program is based on several integrated surveillance components that are linked to examine the relationship between antimicrobials used both in food animals and in people and the associated health impacts.[81] This information is used to support the development of evidence-based policies to control antimicrobial use in hospitals, the community and agricultural settings so as to make these drugs more effective, and to identify appropriate measures to slow the emergence and spread of resistant bacteria between animals, food and people.[32, 81] CIPARS is coordinated by the Public Health Agency of Canada's Centre for Food-borne, Environmental and Zoonotic Infectious Diseases, Laboratory for Foodborne Zoonoses and National Microbiology Laboratory, in partnership with the Canadian Food Inspection Agency, the Veterinary Drugs Directorate of Health Canada and provincial health and agriculture ministries.[32]

CNISP was established in 1994 to gather information on HAIs in Canadian healthcare facilities.[82] These data allow clinicians and policy makers to compare rates (benchmarks) and trends and gather information for the development of national guidelines on clinical issues.[82] CNISP is a collaboration between the Canadian Hospital Epidemiology Committee, a subcommittee of the Association of Medical Microbiology and Infectious Disease Canada and the Centre for Communicable Diseases and Infection Control of the Public Health Agency of Canada.[82] At present, 54 sentinel hospitals from 10 provinces participate in the CNISP network.[82] CNISP conducts surveillance for MRSA, *Clostridium difficile* infection (CDI), VRE and CPE, among others.[83, 84]

Internationally, the Danish Integrated Antimicrobial Resistance Monitoring and Research Programme (DANMAP) was established in 1995 by the Danish Ministry of Food, Agriculture and Fisheries and the Danish Ministry of Health.[85] The program monitors the amount of antimicrobials consumed by people and food animals, as well as the number of antimicrobial-resistant organisms in food animals, food of animal origin and people.[85] DANMAP also studies associations between consumption of antimicrobials and resistance and identifies the pathways by which antimicrobial resistance spreads.[85] Antimicrobial resistance is monitored in human and animal pathogens, zoonotic bacteria and indicator bacteria.[85]

The National Antimicrobial Resistance Monitoring System (NARMS) is a collaboration between three United States agencies: the Centers for Disease Control and Prevention (CDC), the Food and Drug Administration (Center for Veterinary Medicine) and the Department of Agriculture (Agricultural Research Service).[86] NARMS data have been collected continually since the system was established in 1996, making it possible to analyze trends as well as provide useful information about patterns of emerging resistance that arise from animal and food sources and their impact on public health.[87] The data may also be used to investigate outbreaks.[87]

Stewardship

The development of new drugs will not be enough to address the growing resistance problem as micro-organisms will change in ways to reduce their effectiveness.[7, 88] For this reason it is important to use existing drugs judiciously.[52, 88] Antimicrobial stewardship has been defined as "the optimal selection, dose, and duration of an antimicrobial that results in the best clinical outcome for the treatment or prevention of infection, with minimal toxicity to the patient and minimal impact on subsequent resistance."[89, 90] To achieve this, everyone must adopt attitudes and practices that mitigate the spread of antibiotic resistance—by using antibiotics appropriately, through targeted education and awareness programs and by re-establishing common preventive hygiene measures.[20]

Regulations and practical measures could help to lessen the external pressures on bacteria to become resistant.[57] Antibiotics should be given only to those who stand to benefit and avoided for viral illnesses such as colds or many sore throats.[20] Well-targeted antibiotic therapy (which depends on an accurate diagnosis) reduces the need for sequential, hit-and-miss courses of antibiotics and the consequent risk of developing antibiotic resistance.[20] In some instances, combining multiple antibiotics may improve the chances of curing a bacterial infection more quickly, and thereby reduce the possibility of resistance.[20] Programs such as Alberta's Do Bugs Need Drugs? aim to educate healthcare professionals and the general public on their roles in managing antimicrobial use and mitigating antimicrobial resistance (see the textbox "Antimicrobial stewardship: Do Bugs Need Drugs?").[91]

Antimicrobial stewardship: Do Bugs Need Drugs?

Do Bugs Need Drugs? (DBND) is a community education program about washing hands and the responsible use of antibiotics.[91] DBND materials, available for healthcare professionals and the general public, explain why antibiotic resistance is an issue and how to prevent antibiotic resistance from developing.[91] Teaching correct handwashing is a key component of DBND materials because handwashing prevents many infections and the need for treatment.[91]

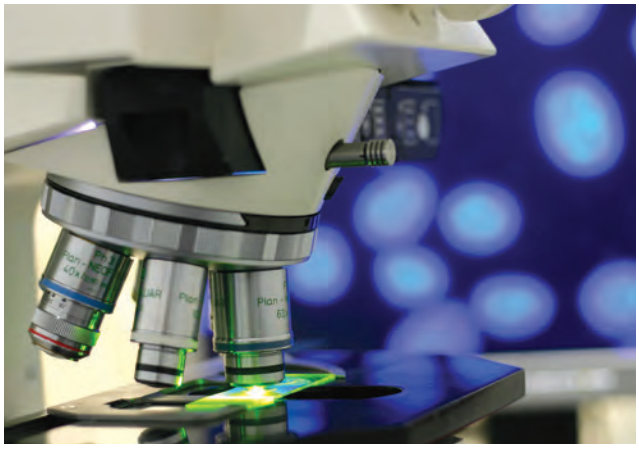
The DBND program started as a small six-month pilot in Grande Prairie, Alberta, Canada, in 1998–1999.[91] It is now a provincial program in Alberta and in British Columbia, and elements of the program are used in other parts of Canada, the United States and elsewhere.[91] Programs are available for physicians, pharmacists, nurses, teachers, schools, daycare centres, preschools, early childhood educators, occupational health nurses, human resources personnel, older adults, parents, children and the general public.[91] Annual evaluations of the program have shown decreases in prescription rates for ear infections and sore throats as well as a decrease in overall antibiotic consumption.[92, 93]

Similarly, using antibiotics in animals should be limited to treating infection and not for long-term mass medication for growth promotion or guarding against disease.[94] Limiting antibiotics could help reduce the development of resistance in animals and the transmission to other animals and to people.[33] In addition to having no official guidelines or policies to manage antimicrobial use in animals, Canada is one of the few industrialized countries that allows over-the-counter sale of antimicrobials for use in food animals.[95, 96] To help veterinarians assist their clients in creating and implementing sound antimicrobial programs, the Canadian Veterinary Medical Association has created a set of guidelines for beef cattle, dairy cattle, poultry and swine.[97] They recommend using targeted drug therapies only when needed and only within the confines of a valid veterinary-client-patient relationship.[97]

Increasing public awareness of the issues associated with antimicrobial resistance is vital.[20, 98] Studies have shown that when people are told the reasons why appropriate antimicrobial use is important and given related guidance, behaviours can be modified to reflect more positive use.[20, 98] Good handwashing and hand hygiene techniques remain the best protection against the spread of infections and antibiotic-resistant micro-organisms.[99–101]

Commitment and cooperation

Health risks due to antimicrobial resistance are a global concern.[28, 57] Mobilizing the necessary expertise and resources to prevent and control antimicrobial resistance depends on the commitment and cooperation of policy makers and decision makers and the global medical and veterinary community.[57]



The World Health Organization (WHO) has been advocating for better coordination to promote infection control and appropriate antimicrobial use, to help fill knowledge gaps and to develop new drugs and vaccines more effectively.[28, 57] At the 51st World Health Assembly in 1998 and in the subsequent report, *Overcoming Antimicrobial Resistance*, WHO stated its concern "about the rapid emergence and spread of human pathogens resistant to available antibiotics" and urged member states to implement policies to address the problem of antimicrobial resistance.[102] In 2001, the WHO Global Strategy for Containment of Antimicrobial Resistance emphasized the need for member states to address a number of principles and actions for reducing and containing the problem of antimicrobial resistance.[28] Further, in 2008 the WHO Advisory Group on Integrated Surveillance of Antimicrobial Resistance (WHO-AGISAR) was established to help minimize the public health impact of antimicrobial resistance associated with animal, food and human sectors.[103, 104] As part of the 2011 World Health Day, which focused on antimicrobial resistance, policy packages were developed to help countries and governments reduce inappropriate use of antimicrobials in people and animals and stop the spread of antimicrobial resistance.[105, 106]

Within Canada, the Public Health Agency of Canada coordinates national efforts to prevent and control infectious diseases, including those due to antimicrobial-resistant organisms; Health Canada regulates antimicrobials for sale for people and animals; the Canadian Institutes of Health Research promotes research in all aspects of infectious disease including antimicrobial resistance and strategies to combat it; and the Canadian Food Inspection Agency, in addition to working with the Public Health Agency of Canada and Health Canada to monitor antimicrobial resistance through CIPARS, also verifies that medicated livestock feeds meet federal standards.[6, 107–109] Provincial and territorial ministries of health and agriculture and various professional organizations (the Canadian Veterinary Medical Association, the Association of Medical Microbiology and Infectious Disease Canada, Ontario Medical Association) and non-governmental organizations (the Canadian Bacterial Surveillance Network, the Canadian Antimicrobial Resistance Alliance and the Northern Antibiotic Resistance Partnership) are all involved in the control of antimicrobial resistance, through education and the setting of standards and guidelines.[110–114]

ACTIONS FOR SUCCESS

Antimicrobial resistance will continue to occur. The challenge is to limit unnecessary pressures that promote the development of antimicrobial resistance and to continue to develop solutions to manage current and future problems.

- The appropriate use of antimicrobial agents in both human and veterinary medicine only as needed is key to reducing the development of antimicrobial resistance.
- Robust monitoring of antimicrobial use in hospitals and the community, as well as agriculture and aquaculture, can enrich resistance and disease surveillance data.
- The search for new, effective antimicrobials is essential to keep infectious diseases from becoming a major cause of morbidity and mortality.

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TUBERCULOSIS—PAST AND PRESENT

HIGHLIGHTS

- Tuberculosis is preventable and curable.
- Tuberculosis is a contagious disease that is primarily spread through the air and usually infects the lungs.
- In 2011, approximately 8.7 million new cases of tuberculosis were identified and 1.4 million tuberculosis-related deaths occurred worldwide.
- Although tuberculosis in Canada has steadily decreased over the last 30 years, it continues to disproportionately affect some populations in Canada.
- Antimicrobial-resistant strains are evolving and becoming increasingly difficult to treat.

Tuberculosis (TB) is a preventable and curable infectious disease, and yet it remains a significant global public health challenge.[1, 2] Each year, tuberculosis infects millions of people and is the second leading cause of death due to infectious diseases worldwide.[1] While the majority of TB cases and deaths occur in low- and middle-income countries, TB does exist in Canada.[1, 3, 4] During the first half of the twentieth century, TB was one of the leading causes of death and hospitalization; today, however, TB disease and death rates in Canada are low.[4–6] Still, certain populations are disproportionately affected by TB, including the foreign-born and Canadian-born Aboriginal populations.[3, 4] As well, new treatment-resistant strains of TB are emerging.[7, 8] Efforts to reduce impact of this infection are ongoing.

Tuberculosis infection and disease

TB is an infectious bacterium that is spread from person to person primarily through the air.[8, 9, 13] TB bacteria of the lungs or airways enter the air when a person with active TB disease exhales by coughing, sneezing, and even just talking.[8, 13] Once in the air, the bacteria can stay there for hours.[8, 13] Once an individual inhales them, the human body can react in one of three ways:

- a healthy immune system can fight off the TB bacteria;
- the immune system is not able to fight the TB bacteria completely and inactive bacteria stay in the body (latent TB infection);
- the immune system does not respond sufficiently, allowing the TB infection to take hold and symptoms to start showing (active TB disease).[11, 14]

Many factors influence the development and spread of TB. Known risk factors for developing either latent TB infection or active TB disease include:

- having a weakened immune system or underlying illness such as human immunodeficiency virus (HIV) or diabetes;
- coming into close contact with individuals with known or suspected TB, for example, by sharing living space or living in communities with high rates of infection or disease;

- having a personal history of active TB;
- having received inappropriate or inadequate treatment for TB disease in the past;
- living in a low income household, in crowded and inadequately ventilated housing or experiencing homelessness;
- being malnourished or affected by other socio-economic conditions;
- having a history of smoking or substance abuse;
- being a resident in an institutional setting such as a long-term care or correctional facility; and
- working with people at risk of developing TB (e.g. healthcare professionals, correctional staff).[13, 15, 16]

TUBERCULOSIS is an infectious disease caused by a group of bacteria, *Mycobacterium tuberculosis* complex.[9] There are two tuberculosis-related conditions: LATENT tuberculosis infection and ACTIVE TB disease.[10–12]

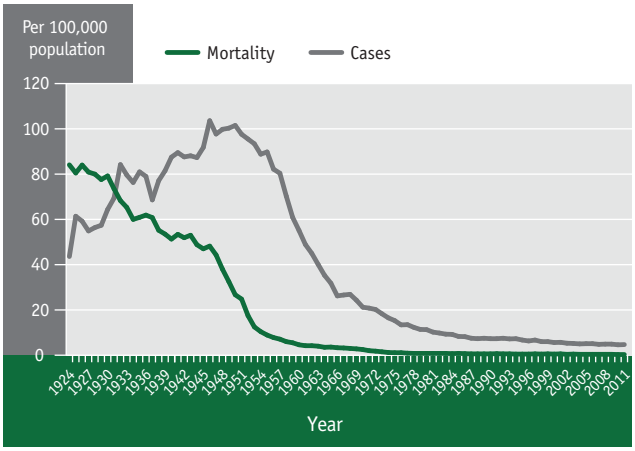
Individuals with latent TB infection have been infected with the bacterium, but it is dormant and does not cause symptoms nor make the person infectious. In these cases, infection can be identified through a skin test or a blood test. Without treatment, a small proportion of these infected individuals will develop active TB disease in their lifetime.[8, 11, 13]

Generally, latent TB infection develops into active disease as a result of weakened immune system, the existence of other health conditions or exposure to others with active TB. Active TB disease of the lungs is contagious, and individuals with active TB disease often feel sick and have a cough, pain in the chest area, experience weight loss or have a fever. TB can also affect the kidneys, spine, brain and lymph nodes. Persons with active TB require treatment.[8, 10, 12]

TB is a classic example of the relationship between an infectious disease and the social determinants of health.[16] A landmark study illustrated TB's decline in the U.K. from 1838 to 1970, and attributed this decline primarily to improving social and economic conditions rather than clinical advances.[17] The research claims that, while effective medical interventions (e.g. antibiotics, chemotherapy) helped to reduce TB rates, those interventions were introduced only after TB rates were already in decline, and thus could not have been the main driving factor.[17] Rather, it was improvements to nutrition, hygiene, housing and working conditions in the post-industrial era that contributed most to the health progress achieved during this era.[17, 18]

In Canada, the combination of the development and use of antibiotics coupled with social and infrastructure improvements have contributed to the dramatic drop in TB deaths and hospitalizations (Figure 1).[6, 19–21] At the time of Canada's Confederation, TB was considered the leading cause of death and the most important health problem facing Canadians.[5, 19, 22, 23] In 1944, streptomycin, the first anti-TB-specific antibiotic, was developed. By 1953, streptomycin was widely used in Canada.[24] Ten years after the wide use of antibiotics (streptomycin as well as others), the number of hospitalizations for TB was halved in Canada.[18–21, 23, 24] However, Figure 1 shows that TB has not disappeared entirely in Canada and efforts to address TB are focused on a range of factors influencing transmission.

FIGURE 1 Reported tuberculosis incidence and mortality rates, Canada, 1924 to 2011[6]



Reducing the impact of disease is dependent on addressing the underlying social and economic factors that drive the disease and influence its activation or re-activation.[16, 18] The WHO Commission on Social Determinants of Health suggests that interventions that are external to health-oriented interventions but that address social and economic conditions will have significant potential to strengthen future efforts against TB.[16, 25]

The global burden of TB

In 2011, there were approximately 8.7 million new cases and 1.4 million deaths associated with TB worldwide.[1] The estimated global incidence of TB is highest in Asia and Africa, with India and China together accounting for almost 40% of the world's TB cases.[1]

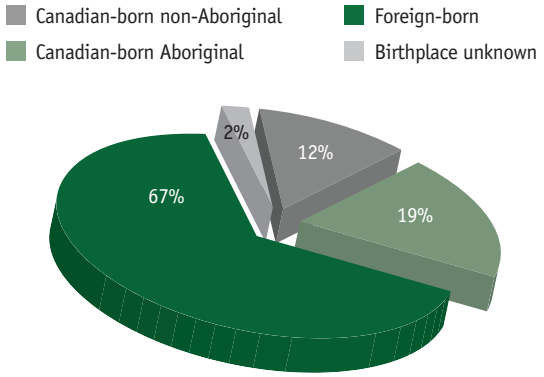
March 24th is WORLD TUBERCULOSIS DAY marking the discovery of the cause of the disease. By commemorating this day, the aim is to make the public aware that tuberculosis continues to be an epidemic in much of the world, causing the death of over a million people each year.[26]

Part of the United Nation's sixth Millennium Development Goal to combat HIV/AIDS, malaria and other diseases is to halt and begin to reverse the global TB epidemic by 2015.[27] The number of new TB cases fell by 2.2% between 2010 and 2011, and since 1990, the TB mortality rate has decreased by 41%, indicating that progress is being made towards reaching the global target goal of a 50% reduction in TB deaths by 2015.[1] Nevertheless, the global burden of TB remains high. Canada has a role to play in reducing the global burden as a participant in international health efforts and in addressing TB among Canada's foreign-born population.

TB in Canada—A snapshot

With 1,607 new active and re-treatment (latent) TB cases reported to the Canadian Tuberculosis Reporting System in 2011, TB is no longer common in the overall Canadian population.[3] However, although the overall rate is low (4.7 per 100,000), TB is disproportionately distributed among specific sub-populations.[3] Of all the reported TB cases in 2011, 67% were among foreign-born individuals, 19% were among Canadian-born Aboriginal individuals, 12% were among Canadian-born non-Aboriginal individuals, and 2% were of unknown origin (see Figure 2).[3]

FIGURE 2 Reported new active and re-treatment tuberculosis cases by place of birth, Canada, 2011[3]



Geographic distribution

Canada's provinces with the largest population—British Columbia, Ontario and Quebec—have the largest total number of TB cases representing 70% of TB cases, in 2011.[3] The majority of the cases were among foreign-born individuals as a result of a larger influx in these regions.[3] Although the population is smaller, rates of TB are much higher in northern regions (generally including regions in the territories and northern portions of some provinces).[3] In 2011, Yukon reported 11.5 cases per 100,000 population, Northwest Territories reported 29.8 cases per 100,000 population and Nunavut reported 222.1 cases per 100,000 population.[3] The majority of cases in Manitoba and Saskatchewan were also primarily located in their northern regions and were among Canadian-born Aboriginal people.[3] For example, 76% of Saskatchewan's active and re-activated TB cases were in northern Saskatchewan, an area that represents only 3.5% of that province's population.[28] In the Atlantic region in 2011, the majority of reported TB cases are among foreign-born or Canadian-born non-Aboriginal populations.[3]

TB and the foreign-born population

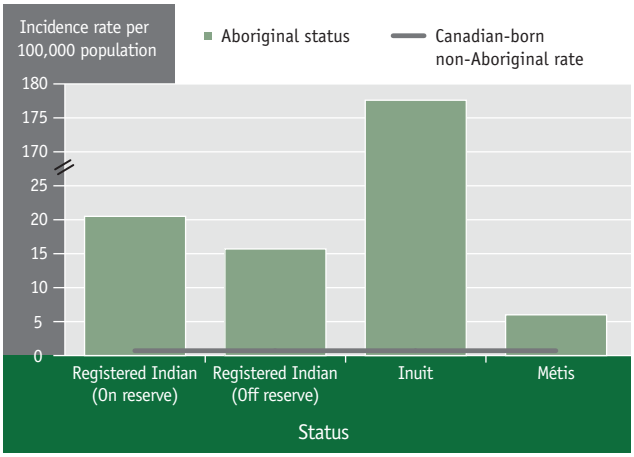
In 2011, people who were foreign-born accounted for the majority of new active and re-treatment TB cases in Canada.[3] Although the overall number of reported cases has not increased significantly since 1970, the proportion of the foreign-born population with TB infection or disease has increased.[4] About 80% of Canada's foreign-born population with TB originated from high TB-incidence regions such as Africa; the western Pacific and southeast Asia (defined WHO regions).[3] Those with latent TB infection are more likely to develop active TB disease within 5 years after arrival.[4, 29, 30] Not enough is known about the foreign-born population and the influence of their social and economic determinants of health. Limited data continue to be a public health challenge in addressing TB in this population.

TB and Canada's Aboriginal population

Despite the overall low incidence of TB in Canada, the burden of TB in the Aboriginal population is much greater than in the overall population.[14, 31] The Aboriginal population is about 4.3% of the total Canadian population but accounts for about 19% of estimated TB disease burden.[3, 32] In 2011, the incidence rate of active TB disease reported for the Canadian-born Aboriginal population was 34 times higher than for the Canadian-born non-Aboriginal population.[3, 32]

In 2011, the overall rate of TB infection and disease among Canadian-born Aboriginal people was nearly six times the overall Canadian rate (23.8 per 100,000 population compared with 4.7 per 100,000 population) and higher than the rate among foreign-born people (13.5 per 100,000 population).[3] Figure 3 shows that the highest TB rate was found among Inuit at 177.6 per 100,000 population, followed by First Nations living on a reserve (20.5 per 100,000 population); First Nations not living on a reserve (15.7 per 100,000 population); and Métis (6.0 per 100,000 population).[3] The numbers do reflect the burden of TB in some of these remote communities. For example, the overall Inuit population is small and therefore minimal changes in the number of cases can substantially alter rates. The incidence rates of TB disease vary across four Inuit regions (Inuvialuit [northern section of the Northwest Territories], Nunavut, Nunavik [across northern Quebec] and Nunatsiavut [northern Labrador]).[33] In 2011, the incidence of TB disease was much higher in Nunavik and Nunavut compared to Inuvialuit and Nunatsiavut which had low numbers.[33]

FIGURE 3 Reported new active and re-treatment tuberculosis cases by Aboriginal status, Canada, 2011[3]



Several factors are believed to affect TB rates in Aboriginal communities. These include historical context, other health conditions, environmental conditions and challenges related to the health system.[4, 14, 31, 33–36] The historical context is particularly relevant. Before contact with Europeans, TB infection did not exist in Aboriginal communities. The creation of trade and work relationships (such as development of the western railway in the late 19th century) and the establishment of the reserve system changed the structure of Aboriginal societies and increased risk factors for the development and spread of TB.[36–38] Living on reserves, in villages and residential schools, with crowded living conditions and malnutrition, fostered the progression of TB infection to active disease.[4, 19, 36] Children in residential schools were particularly at risk due to the living conditions associated with dormitories and malnutrition.[4, 36]

There is evidence of TB infection within Aboriginal populations that has existed over generations.[4, 36, 38] Previous TB infection or disease becomes activated or re-activated (often as a result of social and economic conditions such as limited access to medical practices, inadequate housing and other underlying illnesses) and exposes a new generation to TB infection. Molecular evidence shows that most TB in Canada stems from reactivation of disease.[4, 36]

There is also a history of community loss and displacement related to TB prevention and control practices. Aboriginal family members with active TB disease, particularly Inuit, were often transferred for treatment in sanitoria in the south. Many did not return to the communities and often the bodies of the deceased were often not returned to their families or communities. The legacy of these practices has adversely influenced communities and affected the social acceptance of prevention and treatment.[33, 35]

Other conditions that are risk factors for progression of latent TB infection to active TB disease are also prevalent in some Aboriginal communities. These include diabetes, malnutrition, HIV infection and substance use.[4, 35, 36] For example, diabetes, a recognized risk factor for TB development, is about three to five times more prevalent in the First Nations population than the overall Canadian population.[4] HIV is also a strong risk factor for TB (see "TB and HIV co-infection"), and new reported cases of HIV are increasing the risk for TB comorbidity.[4]

Social and environmental factors can increase the risks of transmission, infection and the progression from latent infection to active disease. For example, living in inadequate, poorly ventilated and overcrowded housing can cause increased risk of exposure to TB infection and progression to TB disease.[39] Poor housing conditions are disproportionately high in Aboriginal communities.[31, 35, 39] Compared to non-Aboriginal Canadians, First Nations people living on a reserve have higher household occupancy density and poorer housing conditions (e.g. air quality, ventilation).[39] As well, living in remote communities limits access to services and nutritious foods.[35, 40]

The healthcare system for TB prevention and control in Aboriginal communities can be complex.[35, 36] The system is multijurisdictional as provinces/territories, federal departments and agencies, First Nations and Inuit organizations and local communities are involved in delivering TB prevention and control programs to communities. Complex systems are often associated with challenges in coordinating and efficiently delivering services.[35] Remoteness in terms of access to expertise, testing facilities and medications further challenges the delivery of service. Periods of infectiousness and illness can be prolonged by delays in diagnosis and interruptions in treatments as well as increasing resistance to typical treatments.[4, 35] Distance to services, diagnostics, laboratories and medication suppliers can influence how local social services and healthcare providers collaborate and communicate.[4]

To significantly reduce the incidence and burden of TB among First Nations living on a reserve, Health Canada worked in collaboration with First Nation and Inuit organizations and communities, federal and provincial partners and TB experts to develop the *Strategy Against Tuberculosis for First Nations On-Reserve* in 2012.[35] There are three themes to this strategy:

- "Preventing, Diagnosing and Managing TB," which includes aligning with other efforts such as the Canadian Tuberculosis Standards; decreasing transmission of TB; recognizing the role of cultural competency; consistently managing information and addressing shortages of healthcare providers.
- "Targeting Populations at Greatest Risk for TB" and working with those communities to provide targeted TB programming.
- "Developing and Maintaining Partnerships" by involving members of the community in prevention and control practices; clarifying roles and responsibilities; and increasing awareness and addressing the social determinants of health.[35]

In 2013, the *Inuit-Specific Tuberculosis (TB) Strategy* was released by Inuit Tapiriit Kanatami (in collaboration with the National Inuit Committee on Health and the Inuit Public Health Task Group) to focus on the need for effective approaches for TB prevention, control and care in order to address the disproportionate burden of TB disease among Inuit compared to the overall Canadian population.[33] The disparity is believed to be rooted in a number of influencing factors including the social and economic determinants of health. The strategy aims to increase awareness about TB rates among Inuit populations, the factors influencing those rates, and to guide stakeholders and partners in developing a holistic TB action plan that is culturally appropriate and sustainable.[33]

The Canadian Institutes of Health Research (CIHR) funds research that bridges scientific knowledge and traditional knowledge of First Nations, Inuit and Métis peoples to help identify health interventions that work. The CIHR Pathways to Health Equity for Aboriginal Peoples is a forward-looking funding program developed to increase the understanding of Aboriginal health inequalities and how to address them.[41] This initiative aims to address four timely and important health inequities affecting First Nations, Inuit and Métis peoples: TB, obesity, suicide and oral health.[41]

Prevention and treatment

Without receiving appropriate and timely treatment, two-thirds of the world's population with TB disease will die.[1, 2] Overall, the global goal of TB treatment is to reverse incidence of TB in the period of a lifetime.[1] In this context, there has been much success as 85% of all newly diagnosed cases were successfully treated in 2010.[1] However, more can be done.

Public health programs rely on combined and collaborative practices that include implementing standards and guidelines, enlisting cross-sectoral collaboration and engaging public commitment to manage disease. In Canada, the public health role has two parts: the infrastructural and the operational aspects.[4] Addressing TB in Canada is a shared responsibility between the federal government and the provinces and territories. Each jurisdiction has legislation that requires reporting data, diagnostics and test results of all TB cases. In areas with high rates of TB, trained teams offer primary medical and social support and address specific risks of HIV co-infection. A high priority for TB control programs is to identify cases and trace the spread of disease.[4] Commitment to address TB also relies on public understanding of the severity of the issue and the need for action. Raising awareness and educating Canadians on TB, its origins, causes, symptoms and need for treatment is important to reducing the number of future cases.[4] Practices such as the Inuit Strategy are working to increase awareness and knowledge of the burden of TB in Inuit communities.[33]

Immunization was used as a TB prevention and control mechanism in Canada.[42] The Bacille Calmette-Guérin (BCG) vaccine was developed in the 1920s and was given to babies and young children to protect them against the most severe strains of active TB disease.[42, 43] In Canada, BCG was widely used from the 1920s until anti-TB medications were more widely used and TB incidence decreased.[4, 44] BCG as a prevention tool has had mixed results. In Canada, its widespread use has been mostly discontinued except in certain circumstances.[4, 33–35, 44] For example, in order to reduce risks to children, Nunavut administers BCG to all newborns, and in the Northwest Territories, BCG is available to infants in TB-endemic regions or communities.[33]

Today, several antibiotics are used to treat latent and active TB disease.[4, 45] Treatment of active TB disease takes months.[4, 45, 46] During the initial intensive phase, a combination of (usually) four doses are administered to destroy rapidly replicating *Mycobacterium tuberculosis* bacteria and to prevent the development of antimicrobial resistance.[4] During the continuation phase, the number of treatments used are reduced and the focus is on killing the remaining, slowly replicating, bacteria.[4] The antibiotics used to kill these TB bacteria only work when the TB bacteria are growing.[4, 46] Treatment of latent TB infection is also recommended for those with an increased risk of TB to reduce the chances of it developing into active TB disease.[4, 47] Effective treatment is only possible with the maintenance of treatment plans.

Further challenges

Antimicrobial resistance

Antimicrobial resistance occurs when the micro-organism that causes disease is no longer susceptible to the medications available to treat it (see "Antimicrobial Resistance—A Shared Responsibility").[48, 49] If a person receiving TB treatment stops taking the prescribed medication before the end of treatment or does not take it as directed, the TB may become resistant, and, as a result, difficult to treat.[8, 46, 50] There is also the risk of spreading the antimicrobial-resistant strains of TB to others.[8, 46]

Strains of *Mycobacterium tuberculosis* are becoming increasingly resistant to anti-TB treatments—especially in areas where TB control programs have been less effective.[1] Multidrug-resistant *Mycobacterium tuberculosis* (MDR-TB) strains are resistant to at least two of the most effective first-line treatments, isoniazid and rifampin.[1, 7] In these cases, alternate treatments that are more costly, usually have more reported side effects, and may be less effective as the first-line treatment that needs to be taken.[1, 50] The number of cases of MDR-TB reported in the countries with the highest burden of TB has almost doubled between 2009 and 2011.[1] In 2011, nearly 60,000 cases of MDR-TB were reported globally to the World Health Organization (WHO)—one in five (19%) of the confirmed TB cases.[1] About one-third of MDR-TB patients may die each year.[51] In 2011, 18 cases of MDR-TB were reported in Canada.[7]

Extensively drug-resistant *Mycobacterium tuberculosis* (XDR-TB) strains are resistant not just to isoniazid and rifampin but also to most of the alternatives used to treat MDR-TB.[7] In 2011, XDR-TB had been confirmed in 77 countries.[51] Since the Canadian Tuberculosis Laboratory Surveillance System began testing for XDR-TB in 1998, 234 isolates have been classified as MDR-TB and 6 as XDR-TB.[7] While XDR-TB is not yet a major problem in Canada, it is a growing international concern.[7]

TB and HIV co-infection

Globally, TB is among the most common cause of infection and death for those living with HIV.[2, 52, 53] About one-third of those living with HIV worldwide are also co-infected with TB, while in 2011, an estimated 13% of all new TB cases were co-infected with HIV.[1, 2, 53] However, this estimate varies by region and is much higher in HIV-endemic regions such as sub-Saharan Africa where about 70% of those with TB are also infected with HIV.[53] Co-infection with TB can also accelerate the progression of HIV infection to AIDS.[2, 53]

The risk of developing TB increases when the immune system is weakened. Since HIV weakens and destroys immune systems, being HIV-positive increases a person's vulnerability to TB and HIV can accelerate the progression of latent TB to active disease.[53] While co-infection can occur at any stage, the risk of TB co-infection increases as immune suppression advances. The use of anti-retroviral and/or preventive TB therapy is believed to be a cost-effective alternative to treatment after TB infection causes disease.[53] As TB and HIV share common social and economic risk factors, addressing these determinants of health would also be effective.[25]

Early identification, diagnosis and treatment of TB is important for all but particularly for those who are HIV positive.[4, 54] Newly diagnosed HIV infections should be assessed for likelihood of exposure to TB (e.g. living in close contact with individuals with known or suspected TB).[4, 15] Globally, only about 2.4% of people living with HIV and AIDS are actually tested for TB.[53] Even with screening, identifying the disease can be difficult as much of TB testing focuses on lungs when TB infection of other sites of the body is also possible.[1, 53] Regardless, healthcare professionals should be watchful of suspicious cases.[4, 54] As well, the *Canadian Tuberculosis Standards* recommended that people diagnosed with TB should also be assessed for HIV infection.[4]

Treating the TB infection and disease is critically important to those living with HIV, but can be complicated due to interactions between medications. Medications used to treat HIV can affect TB treatment; and medications used to treat TB can decrease the effectiveness of HIV treatment. Antimicrobial-resistant TB further complicates treatment for those living with a range of co-infections.[1, 4]

Public health programs and health services for TB control must be coordinated within HIV and AIDS programs because of the frequency of dual infection. In areas with high TB infection rates, people with HIV infection should be monitored for TB. Since those living with HIV are likely to experience symptoms or realize they have been exposed before seeing a healthcare provider, ongoing prevention and health promotion programs that raise awareness about the risks of co-infection are necessary in HIV support programs.[1, 54]

Given the rates of TB among foreign-born Canadians and the number of Canadians travelling abroad, Canada also has a role to play in the global reduction of TB and, in particular, the reduction of TB and HIV co-infection. Canada must continue to collaborate with partners in organizations such as the Global Fund to Fight AIDS, Tuberculosis, and Malaria, the Stop TB Partnership (e.g. Global Drug Facility, TB Reach) and WHO.[1, 55–58] As a result of these programs, progress has been made towards achieving the aforementioned 2015 Millennium Development Goals.[27, 59] Canada supports international efforts in the fight against tuberculosis. The Economic Action Plan 2013 reaffirms Canada's commitment to expanding prevention, care and treatment for those most vulnerable.[59–61]

ACTIONS FOR SUCCESS

Tuberculosis continues to be a global health problem. TB is preventable and treatable but still kills many people each year. While Canada's overall rates are low and continue to decline, challenges remain. High rates among the foreign-born population show that Canada is not isolated from the global burden. As well, unacceptably high rates of TB persist among Aboriginal populations persist and, in some cases, have increased. In addition, those who are immune-compromised or who are HIV positive are at increased risk of TB co-infection. Antimicrobial resistance has challenged traditional treatment options. Canada needs to be ever more vigilant in its prevention and control efforts to mitigate the spread of TB in the future.

- Healthcare providers, policymakers and affected communities have a key role to play in raising awareness and education about TB and its early detection and treatment.
- Timely diagnosis and management of TB requires close collaboration between individuals, communities and healthcare providers to reduce and control the impact of TB on Canadians.
- Healthcare professionals and policymakers need to further collaborate with Aboriginal communities to:
  - » Foster community involvement;
  - » Address social and economic factors influencing health; and
  - » Provide targeted and enhanced programming.
- Continue to participate in international activities to reduce the global burden of disease and work towards addressing the underlying determinants of health globally and domestically.

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FOOD-BORNE AND WATER-BORNE INFECTIONS—INVISIBLE THREATS

HIGHLIGHTS

- Food- and water-borne illnesses are common and preventable public health issues.
- Serious outbreaks of food- and water-borne diseases in Canada are rare.
- Food and water safety are a responsibility shared among governments, industry and consumers.
- Large-scale farming and food processing combined with a global food supply makes it more challenging to keep food safe.
- Water-borne pathogens contaminating drinking water supplies, recreational water and water used in food production can pose significant threats to human health.
- Small and private water systems are more vulnerable to water-borne disease outbreaks.

Safe food and water are critical for good health and are a core public health issue.[1, 2] However, supplies of safe food and water cannot be taken for granted.[3, 4] Many sectors work together in Canada—through innovation, technology and policy—to keep food and water safe.[2, 5–11]

Cause and effect

A food-borne illness, often called "food poisoning," occurs when a person consumes contaminated food, while a water-borne illness is caused by contaminated water.[7, 12–15] In both cases, contaminants are usually micro-organisms—bacteria (e.g. *Salmonella* or *Campylobacter*), parasites (e.g. *Cryptosporidium*) or viruses (e.g. noroviruses)—but may also be chemical or physical.[7, 12–14, 16–18] Chemical contamination of food occurs when a foreign substance, such as bleach, comes into contact with food.[12, 19] Examples of physical contamination include shards of glass or metal.[12] Surface and ground water generally becomes contaminated by pets, livestock or wild animals defecating in or near a water source.[16, 18, 20, 21] Run-off from landfills, septic fields, sewers and agricultural lands can also contaminate water.[16, 18, 20, 21]

Regardless of the type of contamination, it can be very difficult for individuals to determine if food or water is contaminated, as it may appear and taste fine but still make people sick.[4]

Food- and water-borne events in Canada

Between 1995 and 2011, about 1,000 reported cases of food-borne illnesses involved sprouts—no fewer than eight outbreaks in five different provinces.[22, 23] During the largest of these outbreaks, in 2005, there were more than 648 reported cases of salmonellosis in Ontario.[22, 23]

The presence of pathogenic *Escherichia coli* and *Campylobacter* in the community water supply of Walkerton (Ontario) in 2000 claimed seven lives and left almost one-half the town's population ill.[24]

In 2001, the community water supply in North Battleford (Saskatchewan) was contaminated with *Cryptosporidium*, causing between 5,800 and 7,100 people to become ill.[25]

While there were no reported illnesses, residents of the Kashechewan reserve in Northern Ontario were evacuated when *Escherichia coli* contaminated all of the water supply in 2005.[26, 27]

In the summer of 2008, a listeriosis outbreak linked to deli meat caused the death of 23 Canadians.[5]

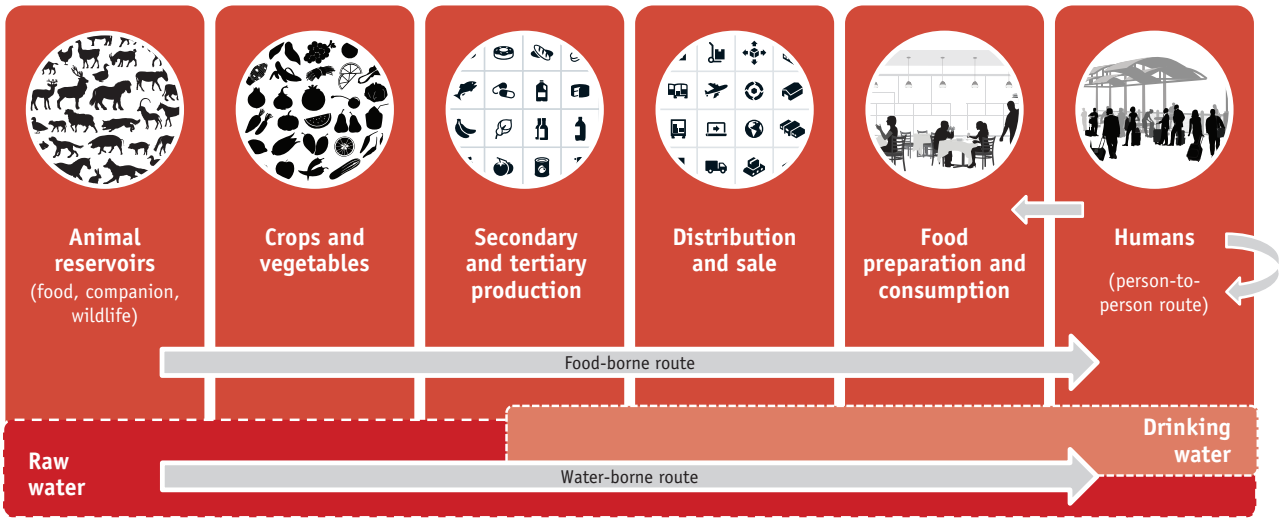
Food-borne illnesses are estimated to affect 4 million Canadians each year.[28] While a number of cases of food- and water-borne illnesses are reported each year (see Table 1), many more go unreported.[29, 30] In fact, not everyone exposed to a food- or water-borne pathogen will become sick. Many will have no symptoms and no consequences to their overall health.[4, 16, 29, 31–35] Of those who do become sick, symptoms are often mild and can include stomach cramps, nausea, vomiting, diarrhea and low-grade fever.[15, 16, 29–34, 36] As a result, most people do not seek medical treatment and the number of reported cases are under-represented.[4, 16, 29, 31–33, 37] However, the most vulnerable—the very young, the elderly, pregnant women and those with chronic diseases or weakened immune systems—may have more severe symptoms and even die.[4, 16, 29, 31, 32, 34, 38, 39] For example, about 2% to 3% of people who become sick with a food-borne illness may develop chronic health problems such as chronic arthritis or kidney failure.[32, 34, 35, 40, 41]

Water-borne pathogens pose a threat to human health and are also a threat to animal health, as well as to the health and biodiversity of aquatic ecosystems.[18] Disease outbreaks related to inadequate drinking water and sewage treatment practices were commonplace among early settlers.[42, 43] Only in the beginning of the last century did public officials embrace the water-waste-health connection and begin to actively pursue adequate sanitation and clean water systems with an eye to improving and maintaining public health.[42–44] Advances in sanitation, water treatment and distribution have directly contributed to reduced mortality rates in Canada and the elimination of water-borne diseases such as cholera and typhoid.[3, 44, 45]

From farm to fork

The route from food production to consumption is very complex, with many points where it can be contaminated (see Figure 1).[4] For example, meat can become contaminated during slaughter if it comes into contact with intestinal contents; raw fruits and vegetables can be contaminated if washed or irrigated with contaminated water; food handlers may neglect to wash their hands and introduce micro-organisms into food; and micro-organisms can be transferred through shared contaminated surfaces.[41, 46–53] Large-scale farming and the global nature of the food supply further complicate food safety.[5, 54] Longer shelf lives, wider and more rapid distribution of foods, and increased trade and travel all make tracing the source of food-borne contamination more difficult.[54]

FIGURE 1 Potential routes of gastrointestinal illness[17]



Despite the many opportunities for contamination in the food supply chain, most food-borne illnesses can be prevented during the final preparation and handling of food.[4, 55–57] Making sure that food is properly prepared, cooked and stored can reduce or eliminate the risk of illness (see the textbox "Food handling tips").[31, 56–59]

For example, even if a batch of meat was contaminated with *E. coli* during slaughter, the risk of illness can be significantly reduced if the meat is handled and cooked properly.[46, 48]

TABLE 1 Reported cases of common food- and water-borne pathogens in Canada*, 2011

Pathogen	Description	Sources	Reported cases in Canada[60]
Campylobacter	A bacterium that attacks the digestive system. Symptoms usually occur 2 to 5 days after initial exposure, but can occur up to a month later. Symptoms are characterized by diarrhea, abdominal pain, malaise, fever, nausea and vomiting.[61]	• raw or undercooked meat like poultry, beef, pork and lamb; • raw milk and other raw dairy products; • raw vegetables; • shellfish; and • untreated drinking water.[40]	9,478
Cryptosporidium	A very contagious parasite that causes stomach pain, nausea, diarrhea and vomiting. Most people will recover but some infections, especially in those who have weakened immune systems, can cause death.[62]	• untreated drinking water; • direct contact with infected people; • raw or undercooked foods; • raw fruits and vegetables; • not washing hands carefully after using the washroom or changing a diaper; and • direct contact with animals at petting zoos or farms.[63]	590
Giardia	A microscopic parasite that causes diarrhea. Complications such as arthritis can arise from prolonged infection.[64]	• untreated drinking water; • direct contact with infected people; and • direct contact with infected animals.[65]	3,816
Salmonella	A bacterium that attacks the digestive system. Symptoms generally occur 6 to 72 hours after ingesting contaminated food or water. Symptoms can include sudden onset of diarrhea, fever, abdominal cramps, nausea and vomiting lasting 4 to 7 days.[66]	• raw or undercooked poultry, meat, fish and eggs; • raw vegetables and fruit; • raw milk and dairy products; • pets and pet food products such as treats; and • not washing hands carefully after using the washroom or handling pets or raw meats.[41]	6,596
Shigella	A group of bacteria that typically causes diarrhea, fever and stomach cramps. Severe cases can cause death.[50, 67]	• untreated wading pools or play fountains; • food in contact with contaminated water; and • not washing hands carefully after using the washroom or changing a diaper.[50]	1,062
Verotoxigenic *Escherichia coli* (*E. coli*)	A bacterium that affects the digestive system. Symptoms often include severe stomach cramps, diarrhea, vomiting and fever.[48]	• improperly cooked beef; • raw fruits and vegetables; • untreated drinking water; • raw milk and dairy products; • unpasteurized apple juice/cider; and • direct contact with animals at petting zoos or farms.[48]	639

* Infected people do not always seek medical care and therefore not all cases are captured by existing surveillance systems.

Food handling tips[31, 56–59]

- Cook food thoroughly and use a food thermometer to verify that the recommended internal temperature has been reached.
- Avoid cross-contamination by separating raw and cooked foods.
- Wash hands, utensils and cutting boards before touching other foods.
- Wash raw fruits and vegetables well.
- Refrigerate leftovers promptly.
- Follow safe home canning practices.

Internal cooking temperatures:

FOOD	TEMPERATURE
Beef, veal and lamb (pieces and whole cuts)—medium-rare	63°C (145°F)
Beef, veal and lamb (pieces and whole cuts)—medium	71°C (160°F)
Beef, veal and lamb (pieces and whole cuts)—well done	77°C (170°F)
Pork (pieces and whole cuts)	71°C (160°F)
Poultry (pieces)—chicken, turkey, duck	74°C (165°F)
Poultry (whole)—chicken, turkey, duck	85°C (185°F)
Ground meat and meat mixtures (burgers, sausages, meatballs, meatloaf, casseroles)—beef, veal, lamb and pork	71°C (160°F)
Ground meat and meat mixtures—poultry	74°C (165°F)
Egg dishes	74°C (165°F)
Others (hot dogs, stuffing and leftovers)	74°C (165°F)

From source to tap

Drinking water systems in Canada vary greatly.[9] Water can come from surface water or ground water, as well as cisterns and water trucks in remote communities.[9, 68–70] Surface water refers to water collected in lakes, streams and rivers.[9, 68, 69] Ground water is commonly found in underground aquifers (geological formations of sand, gravel or permeable rock that can store and transmit water).[71] Accessing ground water requires drilling a well and using pumps to bring the water to the surface.[9, 68, 69] When not properly constructed or protected, wells may be contaminated by surface water or other contaminants.[72]

It is estimated that there are more than 45,000 drinking water systems in Canada, the majority being small systems serving populations of 5,000 people or less.[73] Providing safe drinking water requires an understanding of the drinking water supply and associated infrastructure, including identifying potential threats to water quality.[74–76] These threats can occur naturally (e.g. seasonal droughts or flooding), be created by human activity (e.g. agriculture, industrial practices or recreational activities) or as a result of operational breakdown or aging infrastructure of treatment plants or distribution systems.[75, 76]

Drinking water, recreational water (e.g. pools and lakes) and water used for food production can all become contaminated from multiple sources (see Figure 1).[17, 20, 77, 78] Factors that contribute to water-borne illness outbreaks include a lack of source water protection; contamination from weather events such as heavy precipitation and spring thaw; inadequacy or failure of water treatment; failure of water distribution systems; and other factors such as ongoing maintenance work (including repairs and replacements) and human error.[20] One of the difficulties of identifying the source of sporadic or outbreak related water-borne illnesses is that many of the pathogens spread by water are also spread by food, animals and person-to-person.[20]

Surveillance, detection and response

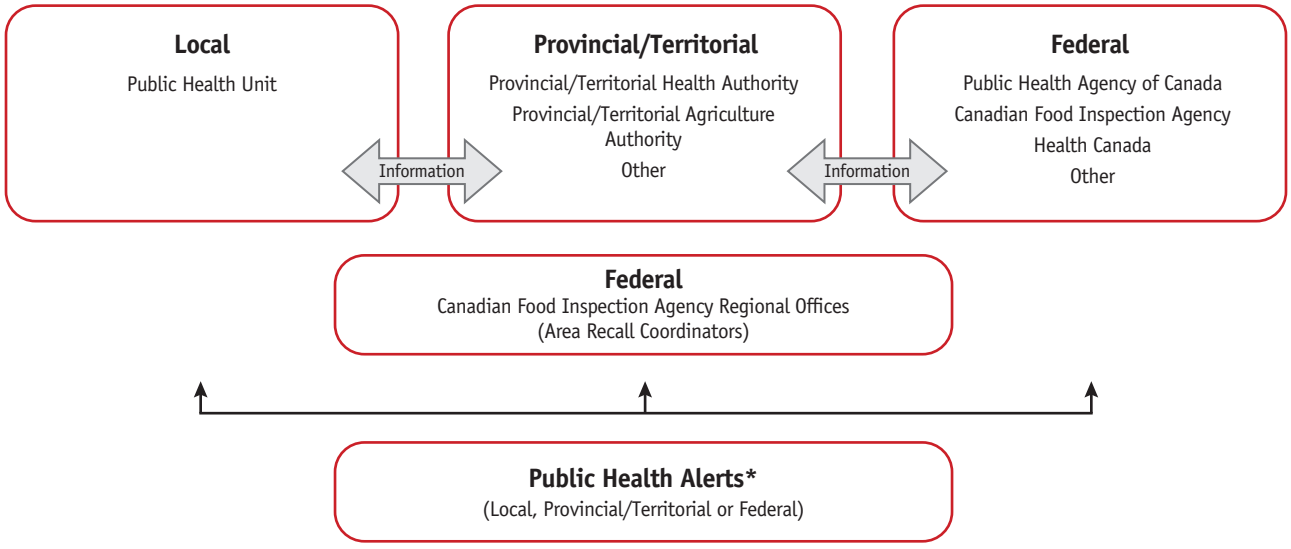
Despite the mild symptoms that most people experience, food-borne illnesses cost the healthcare system and the food industry billions of dollars every year.[7, 35, 79] While Canada's food safety system is robust and generally protects the health of Canadians, more can be done.[4]

While most cases of food-borne illnesses are sporadic and isolated, some will be part of an outbreak.[29] An outbreak of food-borne illness outbreak occurs when a group of people eat the same contaminated food and two or more of them become ill.[7, 29] Notification of a potential outbreak of food-borne illness can be triggered in many different ways: consumer complaints concerning a food; deviations in the way food is processed identified during inspection; laboratory reports showing the presence of a hazardous contaminant (biological or chemical) in food; notification from industry (e.g. manufacturer, processor, distributor, importer, common carrier) of a potential food safety problem; national surveillance of human illness; or information about a food safety problem from foreign health officials, industry or public health associations or academia.[7, 80] In some cases, these food safety investigations may lead to a food recall.[80]

While the source of most outbreaks of food-borne illness can be traced to food service establishments, risks to food safety can happen at any stage from "farm to fork" (see Figure 1).[4, 17] Identified food-borne pathogens should be reported to provincial and territorial health officials, who in turn, report these to federal health officials (see Figure 2).[7] Public health officials will then begin an investigation to determine the source of the outbreak through interviews and laboratory testing of suspected sources.[80] If a food source is identified, the Canadian Food Inspection Agency conducts an investigation and steps are taken to ensure that unsafe food products are recalled.[80]

When a multijurisdictional food-borne illness outbreak occurs, the various levels of government use the Foodborne Illness Outbreak Response Protocol (FIORP) to guide how they will manage the outbreak.[7, 81] FIORP is a technical and operational guide that sets out the key guiding principles and operating procedures for identifying and responding to multijurisdictional food-borne illness outbreaks.[7, 81] Using FIORP helps partners to work together and allows for a faster, more efficient and effective response to outbreaks.[5, 7, 81] Following the 2008 national listeriosis outbreak, FIORP was updated to further improve the response and management of outbreaks.[5, 7, 81] As a result, roles and responsibilities are clearer, additional information sharing and communication guidelines are now in place and additional public health personnel have been identified to help during outbreaks as needed.[5]

FIGURE 2 Overview of notification pathways (communication between partners to identify issues of concern)[7]



* Tool for early notification of possible or confirmed outbreaks that may become multijurisdictional used by federal, provincial or territorial health officials (some agricultural authorities also have access). It is an additional means of communication and does not replace normal notification as described above.

Increased surveillance is helping to improve detection of food-borne illnesses and the risks that cause them. A major factor in the increased surveillance is the improved ability to detect food-borne illness because of the greater capacity of the PulseNet Canada network across its laboratories.[5] The PulseNet Canada network of laboratories uses DNA fingerprinting technology to test for food-borne illnesses and detect outbreaks at the earliest possible stage.[5, 83, 84] Advances in science and technology, such as the Genomics Research and Development Initiative, have allowed officials to more easily investigate possible links between cases of food-borne illness that may not have previously been linked.[85, 86]

PulseNet CANADA is a critical national surveillance system that helps identify and respond to potential illness outbreaks as early as possible.[82] It is an electronic network that links all provincial public health laboratories and Canadian Food Inspection Agency laboratories with the Public Health Agency of Canada.[83] Cases of food-borne illness across the country are tested using genetic fingerprinting; these "fingerprints" are constantly monitored to look out for potential outbreaks.[83] Contaminated foods are also tested with the same genetic fingerprinting, which allows the source of an outbreak to be confirmed.[83]

The National Enteric Surveillance Program (NESP) is a laboratory-based surveillance system capturing weekly data on laboratory-confirmed enteric diseases to monitor trends and detect outbreaks that also includes an enhanced case-based surveillance program for invasive listeriosis cases.[87] C-EnterNet is a national integrated food safety surveillance system that tracks food- and water-borne gastrointestinal illnesses and their likely sources (e.g. food, water and livestock) to identify risks, to prevent diseases from occurring and to lessen the impact of illness on Canadians.[88]

Addressing food safety is a balancing act between many players and between real and perceived risk. Some technologies can improve food safety and reduce food-borne illnesses by reducing the levels of harmful bacteria in food, but implementing such technologies is not always straightforward or easy.[4] For example, food irradiation can greatly reduce or eliminate micro-organisms and bacteria from foods, while the food itself remains unchanged, becoming neither radioactive nor contaminated with dangerous substances.[89, 90] Currently, potatoes, onions, wheat, flour, whole wheat flour, whole and ground spices and dehydrated seasonings have been approved for irradiation in Canada, and all irradiated food must be labelled.[90] Also, the Guelph Food Research Centre, part of Agriculture and Agri-Food Canada's research network, focuses on mitigation of food safety risks in food production systems; development of food with enhanced health benefits; and structure and functional characteristics of food and food ingredients.[91]

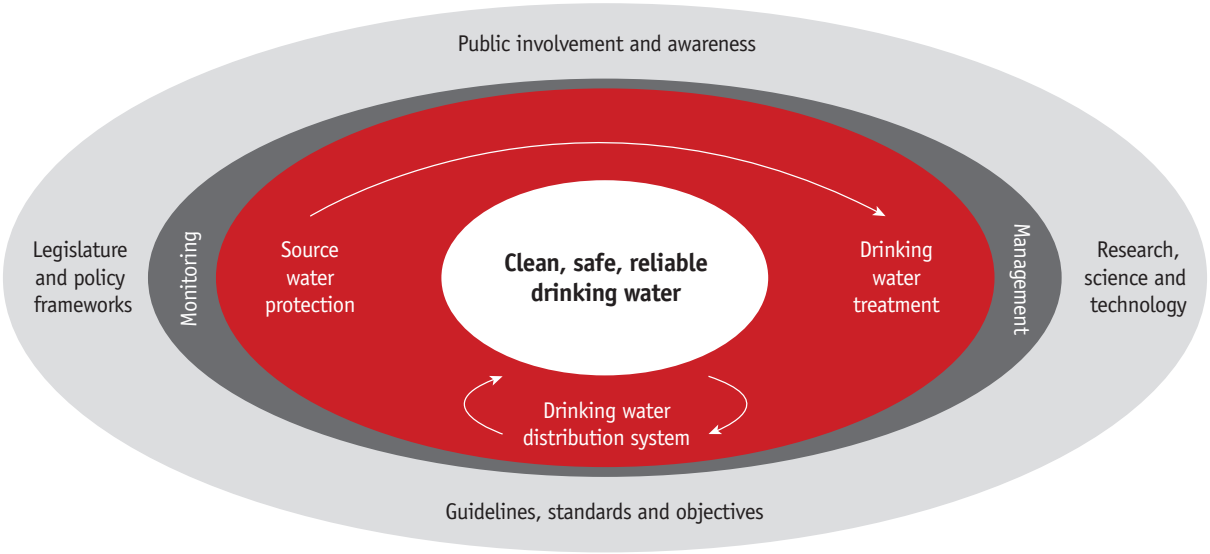
As with food, ensuring the safety of water in Canada involves many partners.[92, 93] Monitoring of drinking water quality, while typically done at the municipal level, may also be conducted at the provincial/territorial level.[92–94] However, water-borne disease surveillance is currently not standardized or consistently linked, making it difficult to understand the scope of water-borne illnesses.[95] Detecting water-borne illnesses includes patients identifying their illness and phone inquiries as well as reports by local public health authorities, physicians and laboratories.[20, 95] Outbreaks associated with small drinking water systems are also identified through monitoring of water quality, epidemiological investigations, laboratory confirmation or a combination of these methods.[20, 95] Outbreaks are not always reported beyond the local authorities.[95]

There are more than 1,000 active boil water advisories in Canada at any given time, most of which occur in small systems.[73, 96, 97] Advisories are primarily issued as a precaution when authorities are concerned that contamination may occur.[98] These notifications may also be issued when unacceptable levels of indicator bacteria, disease-causing bacteria, viruses or parasites are discovered in the water system anywhere from the source to the tap; unacceptable levels of cloudiness (turbidity) are measured; filtration or disinfection during treatment is inadequate; or water is re-contaminated during distribution.[98] Fecal contamination of water used for drinking, recreation and food production can have significant impacts on human health and local economies through disease outbreaks, beach and shellfish closures, and boil water advisories.[99]

Both surface water and ground water can be contaminated with chemicals and pathogens. Almost all water will require some type of treatment before it is safe to drink.[9, 100] Public drinking water systems use a variety of treatment processes to remove or inactivate contaminants and provide safe drinking water to communities.[101, 102] Since the quality of the source water and types of contaminant can vary, the types of treatment must also vary.[101, 102] Generally, the types of treatment used by a water system are based on the contaminants found in the source water.[101] The most common processes include coagulation/flocculation/sedimentation, filtration, and disinfection, often applied in sequence.[101] Occasionally the disinfectants used to treat the water can react with naturally occurring materials in the water to form unintended by-products that may pose health risks.[93]

The water system has three main parts: the source, the treatment system and the distribution system.[93, 103, 104] Contamination needs to be prevented in each of these areas.[104] The multi-barrier approach reflects this concept by considering the whole drinking water system (see Figure 3).[75, 76, 93, 103, 104] The best available water source (e.g. lake, river, aquifer) is selected and protected from contamination, the water is effectively treated, and finally, the water is kept clean and safe during distribution.[75, 76] This is done by ensuring that appropriate legislation, environmental policies and guidelines are in place, that staff are appropriately trained and supervised, and that proper monitoring is set up.[93, 103, 104] Investment in research to develop alternative solutions and approaches, such as microbial source tracking to prevent fecal contamination of source water, is also necessary.[99] The multi-barrier approach recognizes that, while each individual barrier may not be able to completely remove or prevent contamination, the barriers work together to make the water safe to drink over the long term.[75, 76]

FIGURE 3 The multi-barrier approach[76]



Roles and responsibilities

Food safety depends on the concerted actions of all levels of government, food industries and consumers (see the textbox "Food safety responsibilities in Canada").[4, 5] In 2012, the federal government passed the *Safe Food for Canadians Act*, which targets unsafe food practices and implements penalties for activities that put health and safety at risk.[105] The Act provides better control over imports, institutes more consistent inspections across all food commodities and strengthens food traceability.[105] In 2012, the government also amended the *Food and Drugs Act* (FDA) which will allow the government to make the food regulatory system more efficient and flexible.[106]

Food safety responsibilities in Canada[5–8]

Federal government

Canadian Food Inspection Agency:

- Inspects and enforces federal regulations about food.
- Investigates food safety (e.g. traceback).
- Tests food and recalls unsafe food.
- Informs Canadians of potential food hazards.

Health Canada:

- Sets food standards and policies governing safety and nutritional quality.
- Engages in research and health-risk-and-benefits assessments.
- Evaluates the safety of veterinary drugs in food-producing animals.
- Informs Canadians of potential health risks.

Public Health Agency of Canada:

- Conducts surveillance and identifies public health risk factors.
- Detects and responds to multijurisdictional food-borne illness outbreaks (e.g. epidemiological and laboratory).
- Informs Canadians on how to prevent illness.

Consumers

- Store, handle and prepare food safely.

Provincial/territorial governments

- Enact and enforce food safety laws within their jurisdiction.
- Regulate food processing within their jurisdictions.
- Implement food safety programs.
- Lead illness outbreak investigations within their jurisdictions.
- Communicate food safety messages to food handlers.

Local/regional public health authorities

- Inspect food establishments.
- Educate about food safety practices.
- Report confirmed cases of food-borne illnesses to province/territory.
- Investigate food-borne illness outbreaks, collect food samples and send samples to laboratories.
- Analyze findings.

Industry

- Complies with government standards in food production.
- Monitors and verifies the effectiveness of food safety systems to ensure that food is safely produced and distributed.
- Establishes and conducts food safety programs in keeping with regulatory requirements and industry practice.

In Canada, the federal, provincial/territorial, local and municipal governments, as well as First Nations band councils, industry, non-governmental organizations and individual Canadians have a role to play in protecting the quality of drinking water.[1, 9, 74, 104] Because of the number of steps involved in ensuring access to safe drinking water, effective collaboration is essential.[9]

The federal government's role in drinking water quality focuses on regulation, science, including risk assessment, and the provision of technical expertise.[9, 107] Most recently, the Government of Canada passed the *Act Respecting the Safety of Drinking Water on First Nation Lands*, which demonstrates a commitment to improving the health and safety of residents of First Nation lands.[108] Together with the provinces and territories, Health Canada continues to develop and update the *Guidelines for Canadian Drinking Water Quality*, which form the basis for drinking water quality requirements across the country.[9, 21] Today, the majority of Canadians get their drinking water supply from treated municipal water works.[68, 109] However, some people get their drinking water from wells and/or from surface water on their own property.[9, 109] In those situations, individuals are responsible for the safety of their drinking water and should have it tested regularly, which can be particularly difficult for those living in small and remote communities and on some First Nations reserves.[9, 110]

Responsibilities for drinking water are shared among First Nations band councils, Health Canada and Aboriginal Affairs and Northern Development Canada (AANDC) in First Nations communities south of 60° north latitude (see the textbox "Water quality roles and responsibilities in First Nations communities").[9–11, 110] Ensuring that water facilities are designed, built, maintained and operated in accordance with established federal or provincial standards are the responsibility of band councils.[11] Federally, AANDC funds construction or upgrading of water and wastewater facilities, and Health Canada helps ensure drinking water quality monitoring programs are in place in First Nations communities.[9–11, 111] While AANDC helps to protect water quality and water resources north of 60° north latitude, responsibilities for drinking water rest with territorial governments.[9, 10, 112, 113]

Water quality roles and responsibilities in First Nations communities[9–11]

Band councils

- Own, manage, monitor and operate water and wastewater services.
- Design and construct water and wastewater facilities.
- Issue Drinking Water Advisories.

Federal government

Aboriginal Affairs and Northern Development Canada:

- Provides funding for training, construction, operation and maintenance of water and wastewater facilities.
- Collaborates with Health Canada and Environment Canada to review designs.

Environment Canada:

- Regulates water treatment discharged into receiving waters.
- Provides advice and guidance on sustainable water use and protection.

Health Canada:

- Ensures that monitoring programs for water quality are in place on-reserves south of 60° north latitude.
- Assists in identifying possible drinking water quality problems.
- Advises and provides recommendations on drinking water safety and safe disposal of on-site domestic sewage.
- Reviews, interprets and disseminates results of the overall quality of drinking water.
- Reviews water and wastewater infrastructure project proposals from a public health perspective.

ACTIONS FOR SUCCESS

Safe food and water involves considering human, animal and environmental health; the complexity of food-borne and water-borne infections requires a comprehensive approach, relying on the integrated effort of multiple disciplines working locally, nationally and globally.[9, 68] A comprehensive approach includes an interdisciplinary, cross-sectoral approach to surveillance, monitoring, prevention, control and mitigation of public health risks associated with food and water.[7, 76]

- Robust cooperation among regulators, public health officials, municipalities, industry and researchers reduces the incidence of food- and water-borne illnesses.
- Effective surveillance of food- and water-borne illnesses and their sources is necessary to detect and control outbreaks.
- Greater public awareness and improved education for food consumers, producers and handlers prevents food-borne illnesses.
- Targeted efforts in science and technology can improve food and water safety.
- Better food handling and preparation prevents many cases of food-borne illnesses.
- Water safety measures including regular checks, appropriate treatment and adherence to boil water advisories (if necessary) are important to prevent water-borne illnesses.

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SEXUALLY TRANSMITTED INFECTIONS—A CONTINUED PUBLIC HEALTH CONCERN

HIGHLIGHTS

- Sexually transmitted infections are a significant and increasing public health concern in Canada and worldwide.
- In Canada, reported rates of chlamydia, gonorrhea and syphilis have been steadily rising since the late 1990s.
- Young Canadians have the highest reported rates of sexually transmitted infections; however, increasing numbers of cases are being reported among middle-aged and older adults.
- Untreated sexually transmitted infections can have long-term health outcomes.
- Preventing and reducing the spread and impact of infection involves individual and broader commitments.

Sexually transmitted infections are preventable but continue to be a significant public health issue in Canada.[1] Reported rates of chlamydia, gonorrhea and infectious syphilis have been rising since the late 1990s, and this trend is expected to continue.[1] While the majority of reported chlamydia and gonorrhea cases continue to be among younger Canadians, reported rates of infections have increased significantly among middle-aged and older adults.[1] If left untreated some STIs can have long-term health outcomes.[2, 3] Since STIs are preventable, public health opportunities to reduce and manage the transmission of infection do exist.

STIs in Canada—an ongoing presence

Rates of STIs reported to the Canadian Notifiable Disease Surveillance System (CNDSS) have increased since 1997.[1] It is unclear whether these increasing rates are a result of actual increase in the number of people with STIs or because of changes in diagnosing and reporting procedures (see the textbox "Monitoring infections in Canada").[6] Regardless, STIs remain a public health concern. In 2008, 70% of the 161,592 cases of notifiable diseases reported by the CNDSS were sexually transmitted and bloodborne infections.[6] In particular, chlamydia accounted for 51% of all cases of notifiable infectious diseases reported.[6] These trends are comparable to those observed in other similarly developed countries such as the United States, Australia and the United Kingdom.[1]

SEXUALLY TRANSMITTED INFECTIONS (STIs) are spread primarily through direct person-to-person sexual contact; however, some infections such as HIV and syphilis can be transmitted with other forms of contact such as from mother to child during pregnancy and birth.[4] Bloodborne infections are spread by contact with blood or other body fluids contaminated with blood from an infected person.[5]

Monitoring infections in Canada

Surveillance is the ongoing and timely systematic collection, analysis and interpretation of data essential to public health practice. The occurrences of infectious diseases that are deemed important (by the Advisory Committee on Epidemiology) need to be reported to public health officials.[7] The reporting of notifiable diseases is mandated by provinces and territories and is voluntarily reported to the CNDSS. The list of reported notifiable diseases is agreed upon by consensus among provincial, territorial and federal health officials against specified criteria.[1, 7]

Canada monitors a range of STIs through the CNDSS. Some STIs have been tracked for many years while others are more recent additions. For example, gonorrhea and infectious syphilis have been nationally notifiable infectious diseases since 1924 while chlamydia has only been a notifiable disease since 1990.[1] Other STIs, such as herpes and human papillomavirus (HPV) are not nationally reported.[1]

The number of STI cases reported to the CNDSS, and the population rates calculated as a result, do not account for all infections in the population.[8] For example, an infected individual may not show symptoms and thus may not be tested and recorded.[8] In addition, since women tend to interact more frequently with the healthcare system, they are more likely than men to be screened or to seek treatment for STIs.[9] This may partly explain why more infections are diagnosed and reported among women than among men. Changes in rates over time must also be interpreted cautiously because they are subject to changes in both screening practices and laboratory technology and diagnostic capabilities. In addition, when the number of cases is very small the rates are more prone to fluctuations over time.[1]

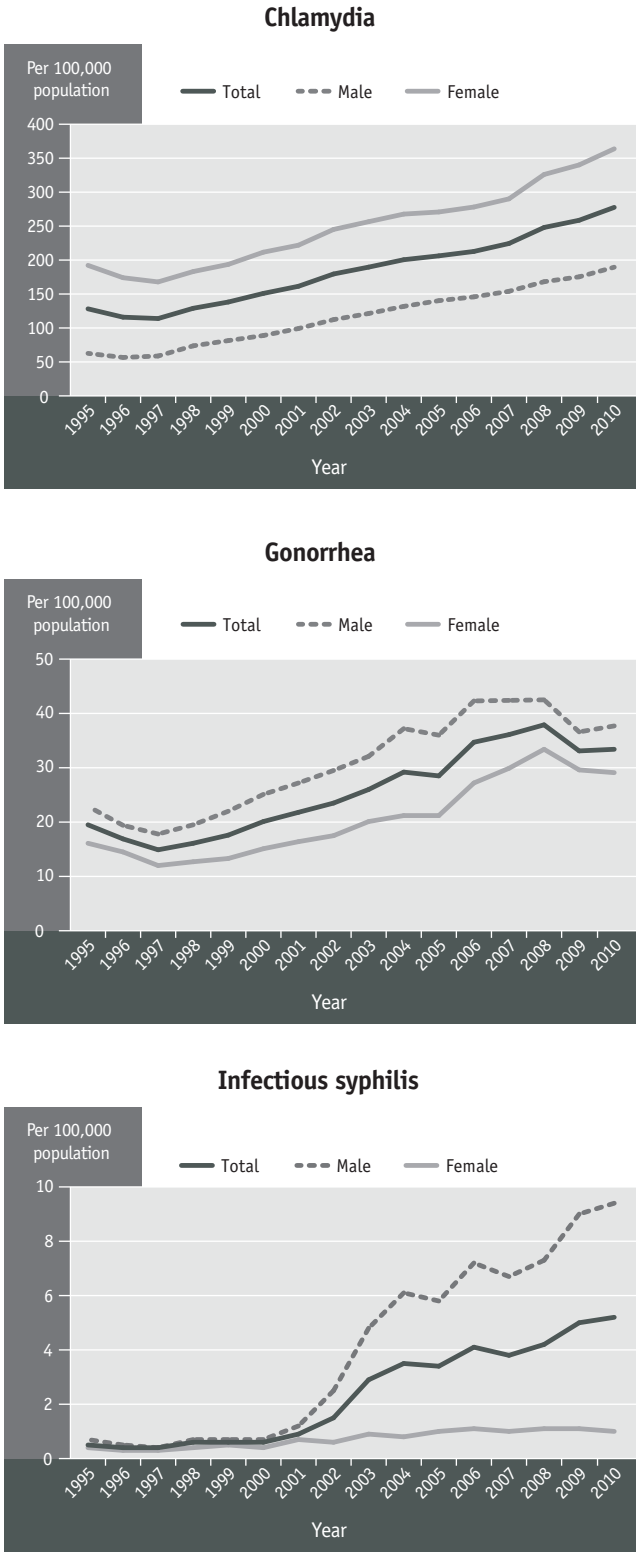
Chlamydia

Chlamydia, an infection caused by the bacterium *Chlamydia trachomatis*, is the most commonly reported bacterial STI in Canada.[1] Infection with chlamydia is frequently asymptomatic. In the absence of screening, a lack of symptoms can increase the risk of unknowingly spreading the disease as well the risk of longer-term health implications for infected individuals. Nationally reported chlamydia rates have increased each year since 1997, resulting in a relative increase of 72% between 2001 (161.4 per 100,000) and 2010 (277.6 per 100,000) (see Figure 1).[1] In 2010, 94,690 cases of chlamydia infection were reported in Canada.[1]

Common in both men and women, infections that are detected and reported (usually by screening people with no symptoms) disproportionately affect younger people, particularly women.[1] Between 2001 and 2010, reported rates of chlamydia infection increased for both men (91% from 99.2 to 189.5 per 100,000) and women (64% from 221.9 to 363.8 per 100,000).[1] In 2010, young women between 20 and 24 years old had the highest reported rate of chlamydia infections (2,005.5 cases per 100,000 population), more than seven times the overall national rate (277.6 cases per 100,000) and more than five times the overall rate for females (363.8 cases per 100,000 population).[1]

Most strains of chlamydia are laboratory diagnosed and are treatable with antibiotics. Longer-term complications of untreated chlamydia for women include pelvic inflammatory disease, which can lead to chronic pelvic pain, ectopic pregnancy and infertility.[1, 3, 10] If left untreated, pregnant women can transmit chlamydia to their infants during childbirth which may result in neonatal conjunctivitis (infection of eyelid), pneumonia and reinfection.[1, 3, 10, 11] Although complications of chlamydia are less common in men, they can experience health outcomes such as epididymoorchitis (a penile or testicular disorder) as a result.[1, 3]

FIGURE 1 Reported rates of chlamydia, gonorrhea and infectious syphilis by sex, Canada, 1995 to 2010[1]



Gonorrhea

Gonorrhea, an infection caused by the bacterium *Neisseria gonorrhoeae*, is the second most commonly reported bacterial STI in Canada.[1] In 2010, the highest rates of reported gonococcal infections (147.0 cases per 100,000 population) were among young women between 15 and 19 years old.[1] Reported rates among this young female population were more than four times the overall national average (33.4 cases per 100,000 population).[1] Reported rates of gonorrhea have also steadily increased over time—with an overall increase of 53.4% from 2001 to 2010 (see Figure 1).[1] However, during this same period of time, increases and advancements in diagnostic and screening practices have also influenced the effectiveness of reporting this disease.[1]

Untreated gonorrhea infections can lead to complications for both men and women. Health outcomes for women include pelvic inflammatory disease, infertility and ectopic pregnancy.[1, 3, 10] Although uncommon, gonorrhea can also infect the blood stream and joints.[1, 2] While gonorrhea is usually curable with antibiotics, resistance to treatment is on the rise (see "Antimicrobial Resistance—A Shared Responsibility").[12–15] Over the last 30 years, strains of gonorrhea have become less susceptible to certain treatments such as penicillin, erythromycin and tetracycline.[1, 2] Resistance to cephalosporins has recently been observed and which is of concern to public health practitioners.[1, 2]

Infectious syphilis

Syphilis is an infection caused by the bacterium *Treponema pallidum*.[1] If left untreated, syphilis will progress through stages of infection referred to as primary, secondary and early latent stages. If syphilis remains untreated, it will progress to the late latent phase, which while not infectious, may lead to serious complications including damage to the central nervous system, cardiovascular system, eyes, skin and other internal organs.[1, 2] Only infectious syphilis is nationally reported.[1]

From 1993 to 2000, reported rates of infectious syphilis were relatively stable but in 2001, the rates began to sharply increase (see Figure 1).[1] For the next 10 years, reported syphilis rates increased 456.7% (from 0.9 to 5.2 per 100,000).[1] In 2010, 1,757 cases of infectious syphilis were reported with an overall population rate of 5.2 per 100,000. In the same year, reported rates were higher in males than in females in all age groups.[1]

In particular, young men between 30 and 39 years had the highest reported rate with 16.2 cases per 100,000 population, more than three times the overall national average.[1] Dramatic increase in syphilis incidence has been most notable among men who have sex with men (MSM).[1, 16] Co-infection of syphilis among those who are HIV positive is increasing.[1, 16] Syphilis infection can increase vulnerability to HIV and with associated neurological outcomes.[1, 17, 18] Reported rates of congenital syphilis, where the bacterium is transmitted from an infected mother to her fetus, is very infrequent in Canada.[1, 19] The impact on the fetus can be significant, and sometimes even fatal.[19]

Human immunodeficiency virus

Human immunodeficiency virus (HIV) attacks the immune system and can develop into a chronic progressive illness that can make an individual vulnerable to other infections and to chronic diseases.[20] HIV is transmitted from one person to another through blood or body fluids during unprotected sexual intercourse or by sharing or using unsterilized needles. An HIV-infected mother can also transmit the virus to her infant during pregnancy, delivery or breastfeeding if she is not taking antiretroviral medication.[20, 21]

In 2011, there were an estimated 3,175 new HIV infections reported in Canada.[22] This number has remained relatively stable since 2008 (being slightly less than the 2008 estimate).[22] Some sub-populations, such as MSM (46.6% of new infections) and intravenous drug users (13.7%), disproportionately account for these estimated new HIV infections.[22] The rate among people originating from HIV-endemic countries is about nine times higher than that in the Canadian-born population.[22]

The Public Health Agency of Canada estimates that 71,300 Canadians were living with HIV infection (including AIDS) in 2011, an 11.4% increase from the 2008 estimate of 64,000.[22] The number of Canadians living with HIV is increasing, in part because new infections continue to occur and in part because fewer people are dying prematurely as a result of the disease due to the availability of effective antiretroviral treatments.[22] It is estimated, however, that 25% of Canadians infected with HIV, or 17,980 people, are unaware of their infection and thus not seeking treatment; they may also be unknowingly infecting others.[22] Having an STI such as chlamydia or syphilis can increase the risk of HIV transmission and infection.[1, 16, 17]

Data limitations and sub-populations

Data on other STIs, such as herpes and HPV, are not collected through national surveillance. HPV is estimated to be one of the most common STIs and more than 70% of sexually active Canadians (both men and women) are estimated to have a sexually transmitted HPV infection at some time over their lifecourse.[2] Most people have no symptoms and the infections disappear without treatment.[23] In cases where HPV infections persist the infections can lead to genital warts or cervical, penile and other types of cancer.[1, 23] In fact, HPV is the cause of almost all cervical and most anal cancers.[24] Young adults are most at risk for contracting HPV, and the prevalence among this population is expected to increase over time.[1] Women younger than 25 years old are more likely to test positively for oncogenic (potentially cancer-causing) HPV than are women over this age.[25, 26]

STI data for sub-populations tend to be limited and underreported, making it difficult to address health issues associated with these STIs. Laboratory-confirmed cases of STIs inconsistently report on demographic factors such as ethnicity. For example, First Nations, Inuit and Métis may be only broadly identified as Aboriginal.[27, 28] Sub-population data may be older data than those available for the overall population and therefore not comparable. As well, testing methods have changed over time, making results non-comparable across time (particularly with regard to infections such as HPV). Regardless of these data limitations, some sub-populations are thought to be at increased risk of certain STIs:

- STI prevalence among Aboriginal persons is estimated to be higher than that of the overall population.[28, 29] In particular, chlamydia is estimated to be almost seven times higher among First Nation adults than the rate of the overall population.[28] Rates of HIV and AIDS are also disproportionately higher among Aboriginal persons, and new HIV infections are occurring at a rate that is estimated to be 3.5 times higher than that of the non-Aboriginal population.[22]
- Recent immigrant populations underuse the healthcare system, and therefore, there are fewer opportunities for routine screening and treatment.[2] Citizenship and Immigration Canada tests individuals 15 years of age and older for syphilis and HIV upon entry into Canada.[2, 30]

- A proportion of Canada's incarcerated populations may be from vulnerable populations where risk behaviours (e.g. intravenous drug use and unprotected sex) are present. As a result, disproportionately high rates of sexually transmitted and bloodborne infections, including HIV and hepatitis B (HBV) and hepatitis C (HCV), prevail.[2]
- Among sexual minorities, particularly MSM, the prevalence of STIs has fluctuated over time. Within the last decade, outbreaks of syphilis have been reported among MSM, with a large proportion also co-infected with HIV and *lymphogranuloma venerum* (infection caused by certain strains of *Chlamydia trachomatis*).[2, 16, 31–35] Co-infection is an ongoing public health concern as syphilis and other STIs can increase the likelihood of transmitting and acquiring HIV as well as other infectious and chronic illnesses.[1, 16, 17]

STIs such as HIV, syphilis and HPV have some long-term outcomes or can develop into chronic conditions.[2] Being vigilant about infectious disease is not just about primary prevention; disease also needs to be monitored and managed over the lifecourse to improve overall health, well-being and life expectancy. Increases in STI cases as well as increases in the numbers of people living with these infectious diseases chronically points to the need for programs that adapt to this reality.

Changing outcomes

Preventing STIs is the first step to reducing them. Preventing and managing STIs is both an individual and community responsibility. Prevention typically focuses on individuals; however, broader structural interventions include a combination of education and awareness, biomedical interventions (e.g. immunization, medical research and screening programs) and population-based interventions such as those that invest in the determinants of health and related factors, for example, education, income, housing, mental health and anti-stigma programs.[36] Efforts are being made in these areas at all levels and jurisdictions (see the textbox "Prevention and control strategies").

Prevention and control strategies

The World Health Organization (WHO) suggests that efforts to control the spread of STIs have waned despite increasing global rates. Preventing and managing STIs and related health outcomes are linked and need to be part of broader, more comprehensive sexual and reproductive health services. The WHO's *Global strategy for the prevention and control of sexually transmitted infections: 2006–2015* was designed with technical and advocacy components in mind. The technical portion of the strategy focuses on practice of promoting healthy sexual behaviour and providing effective and accessible care for STI patients, and the upgrading of monitoring and evaluation of STI control.[36] Canada is a signatory on the WHO global strategy.[2]

The Canadian Guidelines on Sexually Transmitted Infections is a collaborative effort involving expert input from medicine, nursing, laboratories and public health to create evidence-based recommendations for preventing, diagnosing, treating and managing STIs in Canada.[2] The guidelines emphasize the need for collaboration efforts to have greatest impact on those at greatest risk of STIs. In addition, many recommendations focus on the role of healthcare providers and the need to provide a continuum of services including patient-centred STI screening, diagnosis and treatment options that also address longer-term chronic conditions.[2]

Individual responsibility

Many factors can influence individual risk behaviours. Risk reduction strategies range from abstinence; limiting sexual relations to long-term and monogamous partners; condom use; and sharing information on sexual history with partners. Seeking testing and treatment (where necessary) for sexually transmitted and bloodborne infections is also key to reducing risk of infection.[2, 4]

Increasing awareness and education interventions

A variety of sexual health education interventions target youth and young adults. Comprehensive in-school educational programs can be effective in changing youth behaviours when programs combine learning about sexual risk and protection with non-sexual factors such as building healthy relationships.[37, 38] Programs that address diversity (e.g. location, age, sex and gender, sexual orientation and culture) and provide access to health services can be more effective.[37] For example, in-school educational programs often focus on needs of girls. However, those programs that engage boys and encourage open discussions about sexual health are effective at building more respectful relationships among youth.[39, 40]

Despite increases in STIs among older adults, broad awareness campaigns tend to target youth and have not been widely used with older populations.[1, 41–44] All members of the community, regardless of age, benefit from sexual education combined with programs such as clinical services, counselling and social services. However, negative perceptions about older adults' sexuality persist, and stigma, embarrassment and discrimination can create barriers for older adults to discuss sexual health with their healthcare providers.[41, 42, 45] General practitioners also report being reluctant to discuss sex and STIs with older (particularly female) patients.[42, 45, 46]

Biomedical and management interventions

Primary care is necessary for the diagnosis and clinical management of infection. *The Canadian Guidelines on Sexually Transmitted Infections* highlight how important it is for public health practitioners to recognize individual STI risks and how these risks differ among individuals and across the lifecourse.[2] Healthcare providers can incorporate STI prevention into routine patient care by assessing and discussing their individual STI risks and how to minimize risks and recognize symptoms (if any). They should also offer patient-centred counselling about STI treatment and management as well as counselling on partner notification.[2] STI screening is important; however, use of tests is often based on patient history and known risk factors as well as symptoms. Patients are frequently reluctant to undergo screening, believing that STI screening is unnecessary because of previous negative results or being under the impression that routine physicals and blood tests include STI screening.[2]

Immunization can be used to prevent and control spread of infection including STIs (e.g. HPV, hepatitis and emerging vaccines for HIV and herpes simplex virus).[47] For example, the quadrivalent HPV vaccine protects against four types of HPV infections that can have known and significant health issues.[25] Generally, HPV is administered in three doses prior to sexual debut to maximize protective benefit; however, it is also being administered to women later in life.[25, 48] While there are a number of HPV strains, two vaccines have been developed to protect against the highest risk types of HPV that are associated with cancers.[1] Vaccine-preventable strains of HPV were found in 70.2% of these cervical cancer test cases.[49] By 2008, all provinces and territories had introduced HPV vaccinations for girls as part of their routine immunization.[25] In 2012, the National Advisory Committee on Immunization extended the recommended use of the HPV vaccine to include older females (up to 45 years old) and young males (9 to 26 years).[25] Future evaluations will need to measure how the vaccine affects men, women and various at-risk sub-populations as well as the long-term effectiveness in reducing incidence of related cancers.

Advancements in treatment have helped increase life expectancy for people living with HIV and may play a role in decreasing onward transmission of the virus. Antiretroviral therapies (ART) started to be used in the 1990s and continue to significantly change the way HIV affects the short- and long-term health of infected individuals. ARTs reduce the replication of HIV, allowing an individual's immune system to rebuild so as to fight disease.[20, 21] The near-elimination of mother-to-child HIV transmission and investment in a safe blood supply have been important advances in the HIV response.[20, 21]

Under-diagnosis due to asymptomatic characteristics and limited testing influence available data on incidence and prevalence of STIs in Canada.[1, 8] Provinces and territories collect physician data, where available, and report these nationally.[1] However, there are differences between federal and provincial/territorial reporting structures, data elements and reportable infections.[1, 7, 8] National data and trends inform public health guidelines and policies; as numbers increase, so does the need for broad interventions and policies that address serious public health problems. Regardless, some STIs, such as HPV and herpes simplex, are not subject to the same systematic surveillance.[1] As a result, less is known about the burden of these infections.[1]

Addressing the broader determinants of health

Making upstream investments in the health and social conditions that influence overall health outcomes can significantly reduce rates of STIs, their long-term health impacts and risk of comorbidities. Having an income, a place to live and social support can make a difference to health. For example, street-involved youth have higher rates of STIs and greater susceptibility to HBV and HCV infections than youth in the overall population.[50–53] At some point in their lives, many street involved youth have reported experiencing abuse and neglect; being involved in child welfare; a mental illness; inadequate income or housing; or lack of employment, parental support or income.[53, 54] Addressing determinants of health could have long term impacts for those vulnerable youth. Research indicates that there is a relationship between risky sexual behaviour and residential stability, and HIV risk behaviours decrease with residential stability.[54] Programs such as the Housing First approach and Canada's At Home/Chez Soi provide housing as the building block to reducing risks to health.[55]

Living with infections such as HIV can increase the risk of comorbidity over time. In general, individuals who can access health and social services have better health outcomes and as a result are less likely to develop additional illness (or comorbidities). There is a growing recognition among healthcare professionals of the importance of integrating services among the chronic infectious diseases such as HIV, HBV and HCV and channelling efforts where there are common risk factors.[21] In recognition of the common transmission routes, risk behaviours and socio-economic risk factors that affect transmission of these infections, those involved in the response are increasingly taking an integrated, holistic approach to prevention, care, treatment and support.[56]

Stigma for any reason—a health issue, culture, gender, sexual orientation—can negatively affect an individual's ability to develop holistically, socialize, go to school, work and volunteer, and seek care and treatment.[21, 57, 58] Stigma associated with sexually transmitted and bloodborne infections can lead people to avoid testing, treatment and talking about their health status with sexual partners. In addition, some people living with HIV or AIDS experience "stigma layering" because the stigma associated with HIV as well as other co-infections (e.g. HCV) is added to the stigma of having HIV or belonging to certain population groups (e.g. racial, ethnic or sexual minorities or people who inject drugs).[59] Having support networks and access to services can contribute to positive health outcomes.[21, 60]

ACTIONS FOR SUCCESS

Despite broad efforts to prevent, diagnose and treat STIs, reported rates continue be a health concern in Canada. Not only are increasing rates a concern but so too are the longer-term impacts. If STIs are left untreated, serious health effects may ensue. Making a difference to reduce incidence and impacts will involve changing perspectives, being vigilant and looking at disease beyond the point of infection. All Canadians can make individual and collective efforts to protect, prevent and manage the impact of STIs.

- Preventing and managing STIs is both an individual and community responsibility.
- Canadians must be vigilant about STIs before and after the point of infection.
- Healthcare professionals can provide patient-centred services, counselling and treatment.
- Canada can continue to improve STI screening and surveillance and can increase reporting on specific populations.
- Canada can continue to contribute to global reduction of STIs through research and development.

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CONCLUSION—CONTINUING EFFORTS

This report was not intended to cover all aspects of all infectious diseases in Canada. The topics chosen touched on issues that warrant further attention and illustrate key aspects of infection prevention and control. Themes emerged and common threads wove their way through the sections. Antimicrobial resistance recurred as an issue in the discussions on healthcare-associated infections and tuberculosis. Immunization was included in the piece on sexually transmitted infections. Overlaps occurred between the food-borne and water-borne infections and the antimicrobial resistance sections with the shared roles of industry and the healthcare sector in making progress on these issues. And the concept of shared responsibility—among industry, governments, healthcare and individuals—was woven throughout.

A century ago, it was not uncommon to die from an infectious disease. Today, as a result of advances in the prevention and control of infectious diseases, Canadians can expect to live long, vibrant and healthy lives in one of the healthiest nations in the world. Prevention is, as always, the first line of defence. Canada has made great strides in implementing public health initiatives to maintain and improve the health of Canadians. Success stories range from changes in healthcare (e.g. mass immunization programs) and infrastructure (e.g. water treatment systems) as well as education campaigns around safer sex, correct handwashing, protecting others when we cough and sneeze, and methods for safe food preparation. We also have better surveillance systems in place, giving us a clearer picture of immunization rates and the distribution of diseases.

But the fact remains that many of us are affected by infectious diseases. Recent decades have seen the rise of new diseases as well as the continuation of old problems that still threaten our health. To foster real progress in health and well-being, we need to manage disease at the individual and population level and mitigate its impact over the long term. Additionally we are discovering more and more diseases that were once thought non-infectious (chronic) to have an infectious cause or risk factor. Thus our growing understanding of infection and immunity will be critical to future prevention and treatment efforts.

These efforts, again, are a shared responsibility, and activities range from research into and the development of new drugs and treatments to appropriate antibiotic use and better surveillance and monitoring. We also need to maintain protection practices to prevent further infection and improve access for screening and timely diagnosis, especially in vulnerable populations.

Any long-term infectious disease strategy needs to address the social determinants of health. Both the onset and progression of disease are affected by the economic and social supports available to Canadians. Marginalized populations are affected differently by infectious diseases, and our knowledge of how they are affected is only just emerging through surveillance and monitoring activities.

Infectious diseases are not new. We have been facing such challenges throughout history—from the Plague of Athens in 430 BCE, to the Black Death in the 14th century, to the cholera pandemics in the 19th century, to the "Spanish flu" in 1918, to the H1N1 flu pandemic in 2009. We must remain vigilant. We must continue our efforts to prevent illness from the many known, harmful communicable agents in our midst and also plan for the unknown and unexpected threats that may also emerge. We can do this through active monitoring of diseases here and around the world and through improving our ability to flexibly respond to these diseases. By working together and sharing knowledge we can play a part in protecting global health. To stay ahead of emerging and re-emerging threats, infection prevention and control must evolve as the nature of infection evolves. It is clear that we will continue to be challenged by infectious diseases in the future, but further gains are possible if we focus on the actions suggested in this report.

Working Together

As the World Health Organization notes, good health is not necessarily about living a longer life, but living one free of disability and disease. At the end of the day, it comes down to us. Our society is only as healthy as the least healthy among us. Looking at the health of Canadians from a public health perspective makes it clear that everything is connected. Preventing or managing human disease without considering the context in which it occurs will not help us act. By better understanding the issues and connections that make some people sick while others stay well may, at the very least, help us avoid being part of the problem.

Centuries of dealing with infectious diseases have taught us that fighting them must take as broad a scope as possible. Every community is going to have a different experience with disease, reinforcing the need for every Canadian to be able to act. During the H1N1 flu pandemic, for example, as people coughed into their sleeves, stayed home if they were sick, washed hands and used sanitizers, we reduced the spread of illness. Our individual actions can and do make a difference every day.

It is true that the threat of infection in a developed country does not seem as critical as it does in a less developed one. However, Canadians are still getting sick from infectious disease. Some of the sickness is becoming long-term and treatment-resistant, and creates situations of vulnerability. Over the past 40 years, we have seen over 35 new diseases emerge, others that mutated in response to human actions and many that resulted from our interactions with animals and the environment. These threats make it clear that we cannot let our guard down.

We can work to reduce infectious diseases and be better prepared for unexpected events. Many infectious diseases are treatable and manageable, especially if we all work together. We must do our part to ensure a healthy population. All of us, from individuals, to employers to decision makers, have a part to play in improving public health. Our watchword going forward might be PACEM, which is Latin for "peace" and an acronym for Partnership, Advocacy, Cheerleading, Enabling and Mitigating. Partnership means taking the shared view to respond to infectious disease. Advocacy means bringing forward practical solutions for individuals and industry, government and healthcare sectors so that they can begin to make a difference. Cheerleading involves stepping aside to help others focus on their successes in infectious disease prevention and control. Enabling is providing the evidence that different sectors need in order to take correct action. And Mitigating means minimizing risks to health, so that we don't have to pick up the pieces later. As we each take ownership of this issue, to the best of our capabilities, we can help to ensure that all Canadians have the opportunity to be as healthy as possible.

Dr. David Butler-Jones

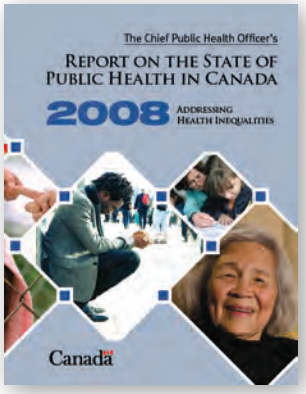
APPENDIX A: THE CHIEF PUBLIC HEALTH OFFICER'S REPORTS ON THE STATE OF PUBLIC HEALTH IN CANADA

As detailed in the *Public Health Agency of Canada Act*, the Chief Public Health Officer is required to submit an annual report on the state of public health in Canada to the Minister of Health within six months of the end of each fiscal year. Upon receipt, the Minister shall lay the report before Parliament on any of the first 15 days on which the House is sitting.[1]

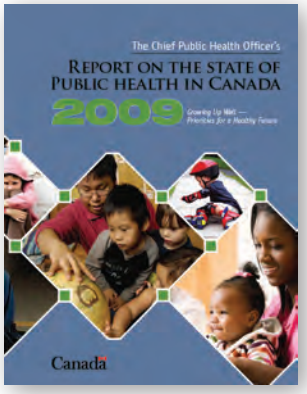
The PHAC Act specifies that the CPHO:

- may prepare and publish reports on any issue related to public health;
- may, in any report, refer to public health problems and their causes, as well as any measures that may, in his or her opinion, be effective in preventing or resolving those problems; and
- must set out the source of the data and information used in the preparation of the report and methodology employed to arrive at the report's findings, conclusions or recommendations.[1]

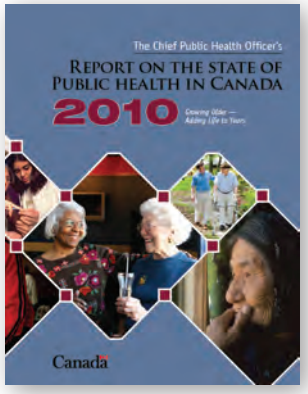
Previous reports from the Chief Public Health Office of Canada are shown below.



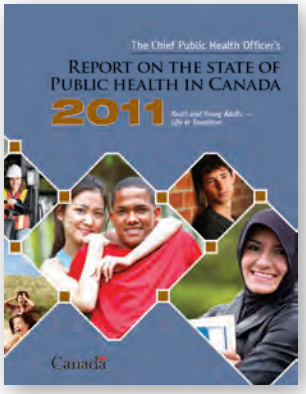
ADDRESSING HEALTH INEQUALITIES



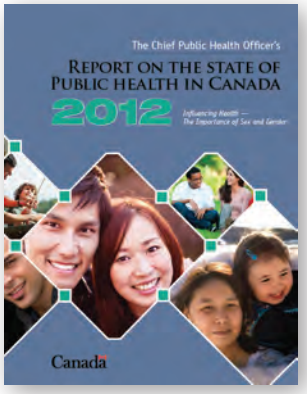
GROWING UP WELL—
PRIORITIES FOR A HEALTHY FUTURE



GROWING OLDER—
ADDING LIFE TO YEARS



YOUTH AND YOUNG ADULTS—
LIFE IN TRANSITION



INFLUENCING HEALTH—
THE IMPORTANCE OF SEX AND GENDER

APPENDIX B: THE HEALTH AND WELL-BEING OF CANADIANS

Presented below is an overview of the demographics of the Canadian population, including their life expectancy and patterns of ill health, disability and mortality. Also discussed are determinants that influence health—income, employment, education, health behaviours and access to healthcare. Although some health challenges can be related to our genetic make-up, evidence shows that income, education, employment and other social determinants of health can cause or influence the health outcomes of individuals and communities.

Who we are

As shown in Table B.1, the Canadian population was 34.9 million in 2012, of which an estimated 1.4 million were Aboriginal (61% First Nations, 32% Métis and 4% Inuit) and an estimated 6.8 million were foreign-born.[2–5] Approximately 84% of Canadians lived in population centres* in 2011.[7, 8]

The life expectancy of Canadians has increased dramatically over the past century to the point where a person born in Canada today has an estimated life expectancy of 81 years.[9] While Canadian women continue to experience greater longevity, having an estimated life expectancy of 83 years compared to 79 years for men, between 1992 to 1994 and 2007 to 2009 the difference in life expectancy at birth between them decreased from 6.1 years to 4.5 years.[9]

Our health

This section explores the current health status of Canadians including mental health, physical health, health behaviours and other influential factors (see Table B.3 for a list of indicators). According to the 2011 Canadian Community Health Survey (CCHS), the majority of Canadians 12 years and older reported their health as either very good or excellent (60%).[10] Despite relatively high rates of very good or excellent perceived health and mental health, not all years are spent in good health.[10–12] The health-adjusted life expectancy (HALE) from 2005 to 2007 shows that, of their 78.3 years of expected life, males spend the equivalent of 68.9 years in full health.[12] During the same period, females with a life expectancy of 83.0 years had a HALE of 71.2 years.[12]

Chronic conditions

The proportion of Canadians living with specific diseases and health conditions varies across the population. Although chronic health conditions are most often experienced by—and associated with—older members of the population, more than one-half (56%) of Canadians 12 years and older reported living with at least one of a number of chronic health conditions in 2011.[13, 14]

More specifically, chronic health conditions such as asthma, diabetes and cancer affect many people. Asthma, which is characterized by coughing, shortness of breath, chest tightness and wheezing, was reported by 9% of the population aged 12 years and older in 2011.[10, 15] Early onset of asthma has been linked to low birth-weight, exposure to tobacco smoke (including second-hand smoke and parental smoking) and family history, whereas later onset has been linked to genetic predisposition, obesity and increased exposure to allergens and environmental factors such as pollution.[15–18] According to the 2008/2009 Canadian Chronic Disease Surveillance System, close to 2.4 million Canadians aged one year and older were living with diagnosed diabetes.[19] Although both type 1 and type 2 diabetes have been linked to genetic anomalies, type 2 diabetes is also associated with being overweight or obese.[19–21] About 186,400 new cases of cancer were expected to be diagnosed in 2012.[22] Cancers of the breast, lung, colon/rectum and prostate were expected to account for more than one-half (53%) of all cancers diagnosed in the same year.[22]

Sexually transmitted infections

Rates of sexually transmitted infections (STIs) officially reported to the Canadian Notifiable Disease Surveillance System (CNDSS) increased in the overall Canadian population over the past 15 years.[23] Untreated STIs, whether symptomatic or not, can have long-lasting effects on health. STIs have been linked to pelvic inflammatory disease, infertility, ectopic pregnancies, miscarriages and low birth-weight babies as well as genital warts and various types of cancers including cervical, anal and penile.[24, 25]

* Population centres are classified into one of three population size groups: small population centres, with a population of between 1,000 and 29,999; medium population centres, with a population of between 30,000 and 99,999; and large urban population centres, consisting of a population of 100,000 and over.[6]

TABLE B.1 Who we are

Who we are (million people)		Year
Population (as of July 1, 2012)	34.9	2012
Aboriginal peoples	1.40	2011
First Nations (single identity)	0.85	2011
Inuit (single identity)	0.06	2011
Métis (single identity)	0.45	2011
Multiple Aboriginal identity	0.01	2011
Other Aboriginal identities	0.03	2011
Immigrant	6.78	2011
By birthplace		
Africa	0.49	2011
Asia	3.04	2011
Caribbean and Bermuda	0.35	2011
Central America	0.15	2011
Europe	2.13	2011
Oceania and other*	0.05	2011
South America	0.29	2011
United States	0.26	2011
By years since immigration		
Recent (≤ 10 years)	2.15	2011
Long-term (> 10 years)	4.62	2011
Population centre	*28.1*	*2011*
Life expectancy at birth (years of expected life)	81.1	2007–2009

* 'Other' includes Greenland, Saint Pierre and Miquelon, the category 'Other country,' as well as immigrants born in Canada.

Note: Italicized information denotes indicators that have not changed from *The Chief Public Health Officer's Report on the State of Public Health in Canada, 2012*. Some data may not be comparable. More detailed information can be found in Appendix C: Definition and Data Sources for Indicators.

Source: Statistics Canada.

In 2010, young women between 20 and 24 years had the highest reported rate of chlamydia infections (2,005.5 cases per 100,000 population), more than seven times the overall national rate (277.6 cases per 100,000) and more than five times the overall female rate (363.8 cases per 100,000 population).[23] In the same year, the highest rates of reported gonococcal infections (147.0 cases per 100,000 population) were among young women between 15 and 19 years, more than four times the overall national average (33.4 cases per 100,000 population).[23] Unlike chlamydia and gonorrhea, reported rates of infectious syphilis in 2010 were higher in males than in females in all age groups.[23] Young men between 30 and 39 years had the highest reported rate with 16.2 cases per 100,000 population, which is more than three times the overall national average (5.2 cases per 100,000 population).[23]

An estimated 71,300 people were living with HIV infection at the end of 2011.[26] More than three-quarters (77%) of all new HIV infections reported in 2011 were among men, with the highest proportion of all new cases being among men between 30 and 39 years (29%).[26] In 2011, men who have sex with men accounted for the largest proportion of new positive test reports (49%).[26] Women represent an increasing proportion of those with positive HIV test reports in Canada, and represented 23% of all new cases reported in 2011.[26] Among women, heterosexual contact was the most reported exposure category (65%) followed by intravenous drug use (30%) in 2011.[26]

Healthy weights

Less healthy eating, including over-consumption, combined with inadequate physical activity can lead to increased body weight.[27, 28] Body mass index (BMI) is a common measure based on height and weight that is used to determine healthy and unhealthy weights. As measured in the 2009 to 2011 Canadian Health Measures Survey (CHMS), 26% of Canadians 18 years and older were obese and 34% were overweight based on their measured height and weight.[29] Obesity is not only a problem for adult Canadians; measured heights and weights of Canadian children in the same period showed that 9% of 6- to 17-year-olds were obese and 17% were overweight.[29]

While BMI is considered an adequate measure for portions of the population, standard BMI categories may not accurately reflect the rate of overweight and obesity in all populations.[30–34] Using BMI in conjunction with waist circumference, as suggested by the World Health Organization (WHO), can more clearly identify populations who are at increased risk of ill health related to obesity and waist circumference.[35, 36] Using measured values from the 2009 to 2011 CHMS, it is estimated that more than one-half (56%) of Canadians between 20 and 69 years were, at minimum, at increased risk of obesity-related ill health (see Table B.2).[29, 37] Obesity is a risk factor for many chronic health conditions including high blood pressure, type 2 diabetes, gallbladder disease, coronary artery disease, osteoarthritis and certain types of cancer.[27, 35, 36]

Mental health and mental illness

Mental health is an important aspect of the overall health and well-being for all Canadians.[38] Mental health and mental illness can affect many lives and influence health throughout the lifecourse. A considerable body of scientific research supports the idea that mental health and mental illness are not on opposite ends of a single continuum with mental health increasing only as mental illness decreases.[39] Rather mental health and mental illness are best conceived as existing on two separate but related continua; therefore, mental health is more than the absence of mental illness.[40] Mental illness can affect people of all ages, cultures, education and income levels.[39, 41] However, those with a family history of mental illness, substance abuse issues, certain chronic health conditions or who have experienced stressful life events are more at risk.[41]

It is difficult to accurately determine the mental health state or rates of mental illness because data are limited. Nevertheless, the data available through surveys, studies and databases provide us with some understanding of the mental health of Canadians. According to the 2011 CCHS, the majority of Canadians 12 years and older reported their mental health as very good or excellent (73%).[10] Rates of mental illness in Canada may be underestimated as many people remain undiagnosed and those with severe conditions may not be captured at all.[39]

TABLE B.2 Health risk categories by BMI and waist circumference, population aged 20 to 69 years, Canada, 2009 to 2011[29, 37]

	Waist circumference		
BMI	Men: < 94 cm Women: < 80 cm **Low risk**	Men: 94–102 cm Women: 80–88 cm **High risk**	Men: > 102 cm Women: > 88 cm **Very high risk**
Normal weight (18.5–24.9 kg/m²)	No increased risk (8.6%)	No increased risk (29.2%)	Increased risk (0.5%)
Overweight (25.0–29.9 kg/m²)	No increased risk (6.4%)	Increased risk (17.4%)	High risk (11.2%)
Obese Class I (30.0–34.9 kg/m²)	Increased risk (0.5%)	High risk (2.4%)	Very high risk (13.2%)
Obese Class II & III (≥ 35.0 kg/m²)	Very high risk (0.0%)	Very high risk (0.0%)	Very high risk (10.5%)

Note: Risk associated with waist circumference and underweight BMI (< 18.5 kg/m²) is not applicable.
Source: Public Health Agency of Canada using data from Canadian Health Measures Survey, Statistics Canada.

The most commonly self-reported mental health conditions in 2011 were mood disorders such as depression, bipolar disorder, mania or dysthymia.[13, 14] The overall percentage of Canadians 15 years and older who reported having been diagnosed with a mood disorder was 7.3%.[13, 14] A greater percentage of females (9.5%) than males (5.2%) reported mood disorders, overall and within different age groups.[13, 14] Older adults between 55 and 64 years old had the highest reported rates (9.4%) in the same year.[13, 14]

Approximately 6.5% of Canadians 15 years and older reported having an anxiety disorder, such as a phobia, obsessive-compulsive disorder or a panic disorder, in 2011.[13, 14] As with mood disorders a greater percentage of females (8.2%) than males (4.7%) reported anxiety disorders, overall and within different age groups.[13, 14] Persons between 20 and 54 years reported having the highest rates of anxiety (7.2%).[13, 14]

Causes of death

In 2009, cancers were the leading overall cause of death in Canada (30%), followed by circulatory diseases (29%) and respiratory diseases (9%).[42–61] Since population distributions are not identical, age-standardized mortality rates (ASMR) provide a better indication of mortality risk within a population. Between 2000 and 2009, the ASMR have decreased for each of these diseases: cancers from 185.4 to 163.8 per 100,000 population; circulatory diseases from 212.3 to 140.9 per 100,000 population; and respiratory diseases from 49.2 to 44.2 per 100,000 population.[4, 42–44] During the same period, deaths from infectious diseases increased from 9.0 to 10.7 per 100,000 population.[4, 45]

While knowing the number of deaths due to a particular disease or condition is important to understanding the health of the Canadian population, so too is knowing the age at which those deaths occur. Measuring the number of potential years of life lost (PYLL) to premature death provides a better sense of the impact a given disease or condition has on the health of the population. For example, if a Canadian dies of cancer at age 45 years, he or she has potentially lost 30 years of life (conservatively assuming a life expectancy of 75 years at birth, as is commonly done in these calculations).[62] In 2009, most years of lost life were due to premature deaths associated with cancers (1,504 years per 100,000 population), circulatory diseases (755 years per 100,000 population) and unintentional injuries (546 years per 100,000 population).[63]

Behavioural, social and economic factors influencing health

Individual behaviours, such as physical inactivity, tobacco use, high-risk drinking, and drug misuse, can have negative health effects. Education and income are key determinants of health across the lifecourse.[64, 65] While behaviours are individual choices that people make, the physical, social and economic environments where individuals live, work and learn influence these choices.[66, 67] In general, an improvement in any of these can produce an improvement in both health behaviours and outcomes at the individual, group or population level (see Table B.4 for a list of indicators).

Physical activity

While many factors can affect a person's health, research studies report that people who are the most physically active are at a lower risk for poor health.[68, 69] Physical inactivity is a modifiable risk factor for a wide range of chronic health conditions including coronary heart disease, stroke, hypertension, colon cancer, breast cancer, type 2 diabetes and osteoporosis.[68, 70]

In order to maximize the health benefits associated with being physically active, World Health Organization (WHO) and Canadian guidelines suggest that adults should accumulate at least 150 minutes of moderate-to-vigorous physical activity per week; 60 minutes of moderate-to-vigorous physical activity every day is recommend for children and youth between 5 and 17 years.[71–74] According to the 2007 to 2009 CHMS, only 17% of males and 14% of females between 20 and 79 years achieved this level of physical activity.[71] While only 7% of children and youth (9% of boys and 4% of girls) attained the suggested level of activity at least six days a week, 44% (53% of boys and 35% of girls) were engaged in at least 60 minutes of moderate-to-vigorous physical activity at least three days a week.[72]

TABLE B.3 Our health status

Our health status		Year
Health-adjusted life expectancy and reported health		
Health-adjusted life expectancy at birth (years of expected health life, females)	71.2	2005–2007
Health-adjusted life expectancy at birth (years of expected health life, males)	68.9	2005–2007
Infant mortality rate (under one year) (deaths per 1,000 live births)	4.9	2009
Perceived health, very good or excellent* (percent of population aged 12+ years)	59.9	2011
Perceived mental health, very good or excellent* (percent of population aged 12+ years)	72.6	2011
Leading causes of mortality (deaths per 100,000 population per year)		
Cancers	210.9	2009
Circulatory diseases	203.7	2009
Respiratory diseases	63.1	2009
Causes of premature mortality, aged 0 to 74 years (potential years of life lost per 100,000 population per year)		
Cancers	1,504	2009
Circulatory diseases	755	2009
Unintentional injuries	546	2009
Suicide and self-inflicted injuries	322	2009
Respiratory diseases	208	2009
HIV	28	2009
Living with chronic conditions		
Cancer incidence (new cases age-standardized per 100,000 population per year)	406	2012
Diabetes prevalence (percent of the population aged 1+ years)	*6.8*	*2008–2009*
Obesity (percent of the population aged 18+ years)	26.3	2009–2011
Arthritis* (percent of the population aged 15+ years)	17.0	2011
Asthma* (percent of population aged 12+ years)	8.6	2011
Heart diseases* (percent of the population aged 12+ years)	4.9	2011
High blood pressure* (percent of the population aged 20+ years)	20.8	2011
Chronic obstructive pulmonary disease* (percent of the population aged 35+ years)	4.2	2011
Living with mental illness, population aged 15+ years (percent)		
*Schizophrenia**	*0.3*	*2005*
*Major depression**	*4.8*	*2002*
*Alcohol dependence**	*2.6*	*2002*
Anxiety disorders*	6.5	2011
Alzheimer's and other dementias (estimated percent of the population aged 65+ years)*	*8.9*	*2008*
Acquiring infectious diseases		
HIV (number of positive HIV tests)	2,221	2011
Chlamydia (new cases per 100,000 population annually)	277.6	2010
Gonorrhea (new cases per 100,000 population annually)	33.4	2010
Infectious syphilis (new cases per 100,000 population annually)	5.2	2010

* Denotes self-reported data.

Note: Italicized information denotes indicators that have not changed from *The Chief Public Health Officer's Report in the State of Public Health in Canada, 2012*. Some data may not be comparable. More detailed information can be found in Appendix C: Definitions and Data Sources for Indicators.

Sources: Statistics Canada, Canadian Cancer Society, Public Health Agency of Canada and Alzheimer Society of Canada.

Smoking, alcohol consumption and drug use

The effects of smoking on health and well-being are well documented and remain a leading cause of preventable disease and premature death.[75, 76] Smoking and exposure to second-hand smoke have been linked to an increased risk of developing a number of diseases and conditions that can affect the cardiovascular system and respiratory systems as well as being a known carcinogen.[76, 77] Smoking can also interfere with various drug therapies, causing medications, including antidepressants, to be less effective.[78, 79] While the overall smoking rate has declined since 1985, 17% of Canadians aged 15 years and older reported being current smokers (15% of females and 20% of males) in 2011.[80, 81]

Alcohol is the psychoactive substance used by the highest proportion of Canadians.[82] Alcohol intoxication can lead to a variety of risks including harmful effects on physical and mental health, personal relationships, work and education; in extreme cases, it can even cause death.[83–85] In 2011, guidelines for low-risk alcohol drinking in Canada were released defining short- and long-term effects of alcohol consumption for men and women.[85] In 2011, 78% of Canadians ages 15 years and older reported drinking in the past year.[82] Of those who consumed alcohol, 19% exceeded the guidelines for long-term effects (e.g. increased risk of liver diseases and certain cancers) and 13% exceeded guidelines for short-term effects (e.g. increased risk of injury and overdose).[82]

Short- and long-term effects of illicit drug use vary. Short-term effects of cannabis use, for example, can include an increase in heart rate and decrease in blood pressure.[86, 87] It can interfere with concentration, depth perception and reaction time, affecting driving, among other things.[86, 87] Cannabis use may also trigger psychosis in vulnerable individuals and may aggravate the course of psychiatric diseases such as schizophrenia.[86, 88] Long-term use of cannabis can lead to respiratory distress and increased risk of cancer and may cause impaired memory and information processing.[86–89] Other illicit drugs—cocaine, hallucinogens and ecstasy—have been linked to various health and social problems including panic attacks, hallucinations, psychosis, paranoia and risky or violent behaviour.[87, 90–93] Physical effects associated with these drugs include convulsions, increased blood pressure and increased heart rate, all of which have the potential to be fatal.[90–93] Over the long-term, and depending on the substance, harmful effects can include impaired brain function affecting memory, and lung and nasal tissue damage.[90–95] The use of illicit drugs (i.e. abuse, misuse or dependence) can affect performance at school and work, and in extreme cases even cause death.[90–93]

The illicit drug most commonly used by Canadians in 2011 was cannabis.[82, 96] Nearly one-in-ten Canadians aged 15 years and older (12% of males and 6% of females) reported having used cannabis in the past year.[82, 96] The prevalence of cannabis use among Canadians 15 years of age and older has been in decline since 2008.[97] Other than cannabis, the illegal drugs most commonly used in 2011 were hallucinogens (0.9%), crack/cocaine (0.9%) and ecstasy (0.7%).[96] Pharmaceutical drugs prescribed for therapeutic purposes, including opioid pain relievers, stimulants, tranquillizers and sedatives, may also be abused due to their psychoactive properties.[82] In 2011, 1.5% of those who used psychoactive pharmaceutical drugs did so to get high.[82]

Education, employment and income

Between the 1990/1991 and 2010/2011 school years, the percentage of Canadians between 20 and 24 years who had completed high school increased from 81% to 90%.[98] Men, however, continue to have consistently higher non-completion rates when compared with women, with 89% versus 92% completing high school in 2011.[98] Between the 1990/1991 and 2010/2011 school years, the percentage of Canadians between 25 and 34 years who had completed a post-secondary education increased from 44% to 68%.[98]

Unemployment and a stressful or unsafe workplace have been associated with poorer health outcomes.[65, 99] People who have more control over their work and fewer stress-related demands tend to be healthier with increased longevity than those in more stressful or riskier work environments.[65, 99] In 2012, the unemployment rate was highest (14.3%) among young Canadians between 15 and 24 years; the lowest rates (4.6%) were among those aged 65 years and older.[100]

Canadians have seen an overall increase in personal income (adjusted for inflation) over time, but increases have not been consistent for everyone. In fact, the gap between those with the highest and lowest income has widened significantly between 1976 and 2010.[101, 102]

Although women face living in low income more often than do men, the difference in these rates has decreased considerably over time. As of 2010, the low income rates stood at 8.7% for men and 9.3% for women.[101, 103] The number of children under the age of 18 years living in low income households has declined from a peak of 18.4% in 1996 to 8.2% in 2010.[101, 103] The 5.3% of Canadian seniors living in low income (3.4% of men and 6.8% of women) in 2010 was also a large decrease from 30.4% in 1977.[101, 103]

TABLE B.4 Factors influencing our health

Factors influencing our health		Year
Income (percent of the population, based on 1992 low income cut-off)		
Persons living in low income (after tax)	9.0	2010
Employment, population aged 15+ years (percent)		
Unemployment rate	7.2	2012
Food security, population aged 12+ years (percent)		
Households reporting moderate to severe food insecurity*	7.6	2011
Environment and housing		
Ground-level ozone concentrations (parts per billion [population weighted warm season average])	38.2	2010
Fine particulate matter concentrations (micrograms per cubic metre [population weighted warm season average])	8.7	2010
Core housing need (percent of the households)	*12.7*	*2006*
Education, population aged 25+ years (percent)		
High school graduates	83.7	2012
Some post-secondary education	64.3	2012
Post-secondary graduates	59.2	2012
Social support and connectedness		
Sense of community belonging, somewhat or very strong* (percent of population aged 12+ years)	64.8	2011
Violent crime incidents (per 100,000 population per year)	1,231	2011
Health behaviours		
Current smoker* (percent of the population aged 15+ years)	17.3	2011
Engaged in leisure time physical activity, moderately active or active* (percent of population aged 12+ years)	53.8	2011
Fruit and vegetable consumption (5+ times per day)* (percent of the population aged 12+ years)	40.4	2011
Exceeds short-term low-risk drinking guidelines* (percent of the population aged 15+ years)	10.1	2011
Exceeds long-term low-risk drinking guidelines* (percent of the population aged 15+ years)	14.4	2011
Illicit drug use in the past year* (percent of the population aged 25+ years)	6.9	2011
Teen pregnancy rate (live births per 1,000 female population aged 15 to 19 years per year)	13.5	2010
Access to healthcare, population aged 12+ years (percent)		
Regular physician*	84.7	2011
Contact with dental professional*	68.6	2011

* Denotes self-reported data.

Note: Italicized information denotes indicators that have not changed from *The Chief Public Health Officer's Report in the State of Public Health in Canada, 2012*. Some data may not be comparable. More detailed information can be found in Appendix C: Definitions and Data Sources for Indicators.

Sources: Statistics Canada, Health Canada, Environment Canada and Canada Mortgage and Housing Corporation.

Summary

Although the health of Canada's population is considered to be very good, a closer inspection of differing rates of death, disease and disability among various groups shows that some Canadians experience worse health and a lower quality of life than do others. Many factors influence these outcomes, including the aging of the population, increasing survival rates for potentially fatal conditions and changes in personal choices about eating, physical activity and the use of substances such as drugs, tobacco and alcohol. These are not the only factors at play; evidence shows that income, education, employment and working conditions can affect individual health behaviours and outcomes.

APPENDIX C: DEFINITIONS AND DATA SOURCES FOR INDICATORS

— A —

Aboriginal people(s) (2011)[104]
This is a collective name for the original peoples of North America and their descendants. The *Constitution Act* (1982) recognizes three groups of Aboriginal peoples—Indians, Inuit and Métis.

Data Source
Table B.1: Statistics Canada. (2013). *Aboriginal Peoples in Canada: First Nations People, Métis and Inuit*. (Ottawa: Statistics Canada).

First Nations (single identity) (2011)[104]
A term commonly used beginning in the 1970s to replace Indian. Although the term First Nation is widely used, no legal definition of it exists. Among its uses, the term 'First Nations peoples' refers generally to the Indian peoples in Canada, both Status and Non-Status. Single identity refers to those persons who reported identifying with First Nations identity only.

Data Source
Table B.1: Statistics Canada. (2013). *Aboriginal Peoples in Canada: First Nations People, Métis and Inuit*. (Ottawa: Statistics Canada).

Inuit (single identity) (2011)[104]
Inuit are the Aboriginal People of Arctic Canada who live primarily in Nunavut, the Northwest Territories and northern parts of Labrador and Quebec. Single identity refers to those persons who reported identifying with an Inuit identity only.

Data Source
Table B.1: Statistics Canada. (2013). *Aboriginal Peoples in Canada: First Nations People, Métis and Inuit*. (Ottawa: Statistics Canada).

Métis (single identity) (2011)[104]
A term which is used broadly to describe people with mixed First Nations and European ancestry who identify themselves as Métis, distinct from Indian people, Inuit or non-Aboriginal people. Single identity refers to those persons who reported identifying with a Métis identity only.

Data Source
Table B.1: Statistics Canada. (2013). *Aboriginal Peoples in Canada: First Nations People, Métis and Inuit*. (Ottawa: Statistics Canada).

Multiple Aboriginal identity (2011)[2]
Includes persons who reported more than one Aboriginal identity group.

Data Source
Table B.1: Statistics Canada. (2013). *Aboriginal Peoples in Canada: First Nations People, Métis and Inuit*. (Ottawa: Statistics Canada).

Other Aboriginal identities (2011)[2]
Includes persons who reported being Registered Indians and/or band members without reporting an Aboriginal identity.

Data Source
Table B.1: Statistics Canada. (2013). *Aboriginal Peoples in Canada: First Nations People, Métis and Inuit*. (Ottawa: Statistics Canada).

Alcohol dependence (2002)[39]
Alcohol dependence is defined as tolerance, withdrawal, loss of control or social or physical problems related to alcohol use. This measure was estimated using the Alcohol Dependence Scale (Short Form Score) based on a subset of items from the Composite International Diagnostic Interview developed by Kessler and Mroczek for those aged 15 years and older.

Data Source
Table B.3: Government of Canada. (2006). *The Human Face of Mental Health and Mental Illness in Canada*.

Alzheimer's disease and other dementias (2008)[105]
The DSM-III-R criteria were used to classify people as demented or not. Differential diagnoses used the NINCDS-ADRDA and DSM-IV criteria for Alzheimer's disease; the ICD-10 and the NINDS-AIREN criteria were used to define vascular dementia; operational criteria for Lewy body dementia were taken from McKeith et al. (1996). Those without dementia were classified as cognitively impaired but not demented (CIND), or as cognitively normal. Reisberg's Global Deterioration Scale was used for rating cognitive and functional capacity in all diagnoses.

Data Source
Table B.3: Smetanin, P., Kobak, P., Briante, C., Stiff, D. et al. (2009). *Rising Tide: The Impact of Dementia in Canada 2008 to 2038*. (RiskAnalytica).

Anxiety disorders (2011)[14, 39]
Individuals with anxiety disorders experience excessive anxiety, fear or worry, causing them to either avoid situations that might precipitate the anxiety or develop compulsive rituals that lessen the anxiety. This measure was estimated as the population who reported that they have been diagnosed by a health professional as having a phobia, obsessive-compulsive disorder or a panic disorder.

Data Source
Table B.3: Statistics Canada. *Canadian Community Health Survey, 2011: Annual* [Share Microdata File]. Ottawa, Ontario: Statistics Canada. All computations on these microdata were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

Arthritis (2011)[10]
Population who reported having arthritis, including rheumatoid arthritis and osteoarthritis, but excluding fibromyalgia, as diagnosed by a health professional.

Data Source
Table B.3: Statistics Canada. (2012–06–18). *Table 105–0501—Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2011 boundaries) and peer groups, occasional, CANSIM (database)* [Data File].

Asthma (2011)[10]
Population who reported having asthma as diagnosed by a health professional.

Data Source
Table B.3: Statistics Canada. (2012–06–18). *Table 105–0501—Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2011 boundaries) and peer groups, occasional, CANSIM (database)* [Data File].

— C —

Cancer incidence (2012)[22]
Estimated number of new cancer cases diagnosed in a given population during a specific period of time.

Data Source
Table B.3: Canadian Cancer Society's Steering Committee on Cancer Statistics. (2012). *Canadian Cancer Statistics 2012*. (Toronto: Canadian Cancer Society).

Cancers (2009)[42]
Deaths associated with malignant cancers (ICD-10 C00-C97).

Data Source
Table B.3: Statistics Canada. (2012–05–30). *Table 102–0522—Deaths, by cause, Chapter II: Neoplasms (C00 to D48), age group and sex, Canada, annual (number), CANSIM (database)* [Data File] and; Statistics Canada. (2011–09–27). *Table 051–0001—Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual (persons unless otherwise noted), CANSIM (database)* [Data File].

Chlamydia (2010)[23]
Estimated rate per 100,000 population, where chlamydia (*Chlamydia trachomatis*) was reported to the Public Health Agency of Canada by provinces and territories.

Data Source
Table B.3: Public Health Agency of Canada. (2012). *Report on Sexually Transmitted Infections in Canada: 2010*. (Ottawa: Public Health Agency of Canada).

Chronic obstructive pulmonary disease (2011)[14]
Respondents who reported having chronic obstructive pulmonary disease, chronic bronchitis or emphysema.

Data Source
Table B.3: Statistics Canada. *Canadian Community Health Survey, 2011: Annual* [Share Microdata File]. Ottawa, Ontario: Statistics Canada. All computations on these microdata were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

Circulatory diseases (2009)[43]
Deaths associated with circulatory diseases (ICD-10 I00-I99).

Data Source
Table B.3: Statistics Canada. (2012–05–30). *Table 102–0529—Deaths, by cause, Chapter IX: Diseases of the circulatory system (I00 to I99), age group and sex, Canada, annual (number), CANSIM (database)* [Data File] and; Statistics Canada. (2011–09–27). *Table 051–0001—Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual (persons unless otherwise noted), CANSIM (database)* [Data File].

Contact with dental professional (2011)[14]
Persons who have consulted with a dental professional (dentist, dental hygienist or orthodontist) in the past 12 months.

Data Source
Table B.4: Statistics Canada. Canadian *Community Health Survey, 2011: Annual* [Share Microdata File]. Ottawa, Ontario: Statistics Canada. All computations on these microdata were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

Core housing need (2006)[106]
A household is in core housing need if it does not meet one or more of the adequacy, suitability or affordability standards and it would have to spend 30 per cent or more of its before-tax income to pay the median rent (including utility costs) of alternative local market housing that meets all three standards:

- Adequate housing does not require any major repairs, according to residents. Major repairs include defective plumbing or electrical wiring, or structural repairs to walls, floors or ceilings.
- Suitable housing has enough bedrooms for the size and make-up of resident households according to National Occupancy Standard (NOS) requirements. Enough bedrooms based on NOS requirements means one bedroom for each cohabiting adult couple; unattached household member 18 years of age and over; same-sex pair of children under age 18; and additional boy or girl in the family, unless there are two opposite sex children under 5 years of age, in which case they are expected to share a bedroom. A household of one individual can occupy a bachelor unit (i.e. a unit with no bedroom).
- Affordable housing costs less than 30 per cent of before-tax household income. For renters, shelter costs include rent and any payments for electricity, fuel, water and other municipal services. For owners, shelter costs include mortgage payments (principal and interest), property taxes, and any condominium fees, along with payments for electricity, fuel, water and other municipal services.

Data Source
Table B.4: Canada Mortgage and Housing Corporation. (2009). *2006 Census Housing Series: Issue 3 — The Adequacy, Suitability, and Affordability of Canadian Housing, 1991–2006*. (Canada: Canada Mortgage and Housing Corporation).

Current smoker (2011)[81]
Respondents who have identified themselves as daily smokers and non-daily smokers (also known as occasional smokers).

Data Source
Table B.4: Health Canada. (2012–09–19). *Table 1. Smoking status and average number of cigarettes smoked per day, by age group and sex, age 15+ years, Canada 2011* [Data File].

— D —

Diabetes prevalence (2008–2009)[19]
The proportion of individuals that are affected by diabetes at a given point in time.

Data Source
Table B.3: Public Health Agency of Canada. (2011). *Diabetes in Canada: Facts and figures from a public health perspective*. (Ottawa: Public Health Agency of Canada).

— E —

Engaged in leisure-time physical activity, moderately active or active (2011)[10]
Population who reported a level of physical activity, based on their responses to questions about the nature, frequency and duration of their participation in leisure-time physical activity. Respondents are classified as active, moderately active or inactive based on an index of average daily physical activity over the past three months. For each leisure-time physical activity engaged in by the respondent, average daily energy expenditure is calculated by multiplying the number of times the activity was performed by the average duration of the activity by the energy cost (kilocalories per kilogram of body weight per hour) of the activity. The index is calculated as the sum of the average daily energy expenditures of all activities. Respondents are classified as follows:

- 3.0 kcal/kg/day or more = physically active
- 1.5 to 2.9 kcal/kg/day = moderately active
- less than 1.5 kcal/kg/day = inactive

Data Source
Table B.4: Statistics Canada. (2012–06–18). *Table 105–0501— Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2011 boundaries) and peer groups, occasional, CANSIM (database)* [Data File].

Exceeds long-term low-risk drinking guidelines (2011)[82]
Population who consume in excess of 10 drinks a week for women, with more than 2 drinks a day most days; and 15 drinks a week for men, with more than 3 drinks a day most days.

Data Source
Table B.4: Health Canada. (2012–07–03). *Canadian Alcohol and Drug Use Monitoring Survey. Summary of Results for 2011*.

Exceeds short-term low-risk drinking guidelines (2011)[82]
Population who consume more than 3 drinks for women and 4 drinks for men on any single occasion.

Data Source
Table B.4: Health Canada. (2012–07–03). *Canadian Alcohol and Drug Use Monitoring Survey. Summary of Results for 2011*.

— F —

Fine particulate matter concentrations (2010)[107]
This national $PM_{2.5}$ indicator uses the warm seasonal (April 1 to September 30) average of 24-hour daily average concentrations, which is population-weighted to calculate trends and averages across 66 monitoring stations located throughout the country.

Data Source
Table B.4: Environment Canada. (2013–07–12). *Ground-Level Ozone and Fine Particulate Matter Air Quality Indicators Data* [Data File].

First Nations (2011)
See Aboriginal people(s).

Fruit and vegetable consumption (2011)[10]
Indicates the usual number of times (frequency) per day a person reported eating fruits and vegetables. Measure does not take into account the amount consumed.

Data Source
Table B.4: Statistics Canada. (2012–06–18). *Table 105–0501—Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2011 boundaries) and peer groups, occasional, CANSIM (database)* [Data File].

— G —

Gonorrhea (2010)[23]
Estimated rate per 100,000 population, where gonorrhea (*Neisseria gonorrhoeae*) was reported to the Public Health Agency of Canada by provinces and territories.

Data Source
Table B.3: Public Health Agency of Canada. (2012). *Report on Sexually Transmitted Infections in Canada: 2010*. (Ottawa: Public Health Agency of Canada).

Ground-level ozone concentrations (2010)[107]
This indicator uses the warm seasonal (April 1 to September 30) average of daily eight-hour maximum average concentrations, which is population-weighted to calculate trends and averages across monitoring stations located throughout the country.

Data Source
Table B.4: Environment Canada. (2013–07–12). *Ground-Level Ozone and Fine Particulate Matter Air Quality Indicators Data* [Data File].

— H —

Health-adjusted life expectancy (2005–2007)[12]
An indicator of overall population health that combines measures of both age- and sex-specific health status, and age- and sex-specific mortality into a single statistic. It represents the number of expected years of life equivalent to years lived in full health, based on the average experience in a population. Quebec, Nunavut and Northwest Territories are not represented.

Data Source
Table B.3: Statistics Canada. (2012–05–23). *Table 102–0122—Health-adjusted life expectancy, at birth and at age 65, by sex and income, Canada and provinces occasional (years), CANSIM (database)* [Data File].

Heart disease (2011)[14]
Respondents who reported having heart disease.

Data Source
Table B.3: Statistics Canada. *Canadian Community Health Survey, 2011: Annual* [Share Microdata File]. Ottawa, Ontario: Statistics Canada. All computations on these microdata were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

High blood pressure (2011)[14]

Respondents who reported having high blood pressure or having used blood pressure medication in the past month, excluding those who reported high blood pressure during pregnancy only.

Data Source

Table B.3: Statistics Canada. *Canadian Community Health Survey, 2011: Annual* [Share Microdata File]. Ottawa, Ontario: Statistics Canada. All computations on these microdata were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

High school graduates (2012)[100]

Persons who have received, at minimum, a high school diploma or, in Quebec, completed Secondary V or, in Newfoundland and Labrador, completed fourth year of secondary.

Data Source

Table B.4: Statistics Canada. (2013–01–03). *Table 282–0004—Labour force survey estimates (LFS), by educational attainment, sex and age group, annual (persons unless otherwise noted), CANSIM (database)* [Data File].

HIV (2011)[26]

The number of new HIV diagnoses in the population reported to the Public Health Agency of Canada during a specified time.

Data Source

Table B.3: Public Health Agency of Canada. (2012–11–22). *At a Glance—HIV and AIDS in Canada: Surveillance Report to December 31st, 2011*.

Households reporting moderate to severe food insecurity (2011)[108]

A situation that exists when people lack physical and economic access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life.

Data Source

Table B.4: Statistics Canada. *Canadian Community Health Survey, 2011: Annual* [Share Microdata File]. Ottawa, Ontario: Statistics Canada. All computations on these microdata were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

— I —

Illicit drug use in the past year (2011)[96]

Persons who reported using an illicit drug (cannabis, cocaine, speed, ecstasy, hallucinogens, salvia or heroin) in the 12 months preceding the interview.

Data Source

Table B.4: Health Canada. (2012–08–02). *Table 1: Main 2011 CADUMS indicators by sex and by age—Drugs, CADUMS* [Data File].

Immigrant (2011)[3]

Applies to a person who is or has ever been a landed immigrant or permanent resident. This person has been granted the right to permanently live in Canada by immigration authorities. While it usually applies to persons born outside Canada, it may also apply to a small number of persons born inside Canada to parents who are foreign-born.

Data Source

Table B.1: Statistics Canada. (2013). *Immigration and Ethnocultural Diversity in Canada*. (Ottawa: Statistics Canada).

By birth place (2011)[109]

Refers to the country of a respondent if born outside Canada. Respondents are to report their place of birth according to international boundaries in effect at the time of enumeration not at the time of birth.

Data Source

Table B.1: Statistics Canada. (2013–07–24). *Citizenship, Place of Birth, Immigrant Status and Period of Immigration, Age Groups and Sex for the Population in Private Households of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2011 National Household Survey* [Data File].

By years since immigration (2011)[110]

Refers to the period in which the immigrant first obtained his or her landed immigrant/permanent resident status.

Data Source

Table B.1: Statistics Canada. (2013–07–24). *Citizenship, Place of Birth, Immigrant Status and Period of Immigration, Age Groups and Sex for the Population in Private Households of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2011 National Household Survey* [Data File].

Infant mortality rate (under one year) (2009)[111]
Infant mortality rate is the number of infant deaths occurring within the first year of life during a given year per 1,000 live births in the same year.

Data Source
Table B.3: Statistics Canada. (2012–05–30). *Table 102–0504—Deaths and mortality rates, by age group and sex, Canada, provinces and territories, annual, CANSIM (database)* [Data File].

Infectious syphilis (2010)[23]
Estimated rate per 100,000 population, where infectious syphilis (including primary, secondary and early latent stages) was reported to the Public Health Agency of Canada by provinces and territories.

Data Source
Table B.3: Public Health Agency of Canada. (2012). *Report on Sexually Transmitted Infections in Canada: 2010*. (Ottawa: Public Health Agency of Canada).

Inuit (2011)
See Aboriginal people(s).

— L —

Life expectancy at birth (2007–2009)[9]
Life expectancy is the number of years a person would be expected to live, starting at birth if the age- and sex-specific mortality rates for a given observation period (such as a calendar year) were held constant over his/her life span.

Data Source
Table B.1: Statistics Canada. (2012–05–30). *Table 102–0512—Life expectancy, at birth and at age 65, by sex, Canada, provinces and territories, annual (years), CANSIM (database)* [Data File].

— M —

Major depression (2002)[39, 112]
Persons who met all criteria for a major depressive episode in the 12 months prior to the interview. A major depressive episode is defined as at least two weeks of depressed mood and/or loss of interest in usual activities accompanied by at least four additional symptoms of depression:

- depressed mood most of the day, nearly every day, as indicated by either subjective report (for example, feels sad or empty) or observation made by others (for example, appears tearful);
- markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation made by others);
- significant weight loss when not dieting, or weight gain (for example, a change of more than 5% of body weight in a month), or decrease or increase in appetite nearly every day;
- insomnia or hypersomnia nearly every day;
- psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down);
- fatigue or loss of energy nearly every day;
- feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick);
- diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others); and
- recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide.

Data Source
Table B.3: Government of Canada. (2006). *The Human Face of Mental Health and Mental Illness in Canada*.

Métis (2011)
See Aboriginal people(s).

— O —

Obesity (2009–2011)[113]
According to Health Canada guidelines, the index for body weight classification for the population aged 18 years and over, excluding pregnant females and persons less than 3 feet (0.914 metres) tall or greater than 6 feet 11 inches (2.108 metres) is: less than 18.50 (underweight); 18.5 to 24.9 (normal weight); 25.0 to 29.9 (overweight); 30.0 to 34.9 (obese, class I); 35.0 to 39.9 (obese, class II); 40.0 or greater (obese, class III). Body mass index (BMI) is calculated by dividing the respondent's body weight (in kilograms) by their height (in metres) squared.

Data Source
Table B.3: Statistics Canada. *Canadian Health Measures Survey, 2009: Cycle 1* [Share Microdata File]. Ottawa, Ontario: Statistics Canada. All computations on these microdata were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

— P —

Perceived health, very good or excellent (2011)[10]
Population who reported perceiving their own health status as being either excellent or very good. Perceived health refers to the perception of a person's health in general, either by the person himself or herself, or, in the case of a proxy response, by the person responding. Health means not only the absence of disease or injury but also physical, mental and social well-being.

Data Source
Table B.3: Statistics Canada. (2012–06–18). *Table 105–0501— Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2011 boundaries) and peer groups, occasional, CANSIM (database)* [Data File].

Perceived mental health, very good or excellent (2011)[10]
Population who reported perceiving their own mental health status as being either excellent or very good. Perceived mental health refers to the perception of a person's mental health in general. Perceived mental health provides a general indication of the population suffering from some form of mental disease, mental or emotional problems, or distress, not necessarily reflected in perceived health.

Data Source
Table B.3: Statistics Canada. (2012–06–18). *Table 105–0501— Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2011 boundaries) and peer groups, occasional, CANSIM (database)* [Data File].

Persons living in low income (after tax) (2010)[101]
The percentage of Canadian families who are likely to spend 20 percentage points more of their total post-tax income on necessities (food, clothing and footwear, and shelter) when compared to an average family of the same size, in the same broad community size. Low income is based on the consumption patterns for 1992 and adjusted for family size, community sizes and inflation based on the national Consumer Price Index. After-tax income is total income, which includes government transfers, less income tax (see Table C.1).

Data Source
Table B.4: Statistics Canada. (2012–06–15). *Table 202–0801— Low income cut-offs before and after tax by community and family size, 2010 constant dollars, annual (dollars), CANSIM (database)* [Data File].

Population (2012)[5]
Estimated population and population according to the census are both defined as being the number of Canadians whose usual place of residence is in that area, regardless of where they happened to be on Census Day. Also included are any Canadians staying in a dwelling in that area on Census Day and having no usual place of residence elsewhere in Canada, as well as those considered non-permanent residents.

Data Source
Table B.1: Statistics Canada. (2011–09–27). *Table 051–0001— Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual (persons unless otherwise noted), CANSIM (database)* [Data File].

TABLE C.1 Low income cut-offs after tax, Canada, 2010[114]

	Rural Areas	Community Size			
		Census Agglomeration		Census Metropolitan Area	
Size of family unit	**($)**	**Less than 30,000 population ($)**	**30,000 to 99,999 population ($)**	**100,000 to 499,999 population ($)**	**500,000 and over population ($)**
1 person	12,271	14,044	15,666	15,865	18,759
2 persons	14,936	17,094	19,069	19,308	22,831
3 persons	18,598	21,283	23,744	24,043	28,430
4 persons	23,202	26,554	29,623	29,996	35,469
5 persons	26,421	30,237	33,732	34,157	40,388
6 persons	29,301	33,534	37,410	37,881	44,791
7 or more persons	32,182	36,831	41,087	41,604	49,195

Population centre (2011)[6]
A population centre has a minimum population concentration of 1,000 persons and a population density of at least 400 persons per square kilometre, based on the current census population count.

Data Source
Table B.1: Statistics Canada. (2013-01-30). *Population and dwelling counts, for population centres, 2011 and 2006 censuses* [Data File].

Post-secondary graduates (2012)[100]
Persons who have completed a certificate (including a trade certificate) or diploma from an educational institution beyond the secondary level. This includes certificates from vocational schools, apprenticeship training, community colleges, Collège d'Enseignement Général et Professionnel (CEGEP) and schools of nursing, as well as certificates below a bachelor's degree obtained at a university.

Data Source
Table B.4: Statistics Canada. (2013–01–03). *Table 282–0004—Labour force survey estimates (LFS), by educational attainment, sex and age group, annual (persons unless otherwise noted), CANSIM (database)* [Data File].

Potential years of life lost[62]
Potential years of life lost are the number of years of life lost when a person dies prematurely from any cause—before age 75. A person dying at age 25, for example, has lost 50 years of life.

Premature mortality due to cancers (2009)[62]
Potential years of life lost for all malignant neoplasms (ICD-10 C00-C97) is the number of years of life lost when a person dies prematurely from any cancer before age 75.

Data Source
Table B.3: Statistics Canada. *Canadian Vital Statistics, Death Database, 2009*. All computations on these data were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

Premature mortality due to circulatory diseases (2009)[62]
Potential years of life lost for all circulatory disease deaths (ICD-10 I00-I99) is the number of years of life lost when a person dies prematurely from any circulatory disease before age 75.

Data Source
Table B.3: Statistics Canada. *Canadian Vital Statistics, Death Database, 2009*. All computations on these data were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

Premature mortality due to HIV (2009)[62]
Potential years of life lost for human immunodeficiency virus (HIV) infection deaths (ICD-10 B20-B24) is the number of years of life lost when a person dies prematurely from AIDS/HIV before age 75.

Data Source
Table B.3: Statistics Canada. *Canadian Vital Statistics, Death Database, 2009*. All computations on these data were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

Premature mortality due to respiratory diseases (2009)[62]
Potential years of life lost for all respiratory disease deaths (ICD-10 J00-J99) is the number of years of life lost when a person dies prematurely from any respiratory disease before age 75.

Data Source
Table B.3: Statistics Canada. *Canadian Vital Statistics, Death Database, 2009*. All computations on these data were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

Premature mortality due to suicide and self-inflicted injuries (2009)[62]
Potential years of life lost for suicides (ICD-10 X60-X71, X75-X84, Y87.0) is the number of years of life lost when a person dies prematurely from suicide before age 75.

Data Source
Table B.3: Statistics Canada. *Canadian Vital Statistics, Death Database, 2009*. All computations on these data were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

Premature mortality due to unintentional injuries (2009)[62]

Potential years of life lost for unintentional injuries (ICD-10 V01-X59, Y85-Y86) is the number of years of life lost when a person dies prematurely from unintentional injuries before age 75.

Data Source

Table B.3: Statistics Canada. *Canadian Vital Statistics, Death Database, 2009*. All computations on these data were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

— R —

Regular physician (2011)[10]

Population who reported that they have a regular medical doctor. In 2003 and 2005, the indicator in French only included "médecin de famille." Starting in 2007, this concept was widened to "médecin régulier," which includes "médecin de famille."

Data Source

Table B.4: Statistics Canada. (2012–06–18). *Table 105–0501—Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2011 boundaries) and peer groups, occasional, CANSIM (database)* [Data File].

Respiratory diseases (2009)[44]

Deaths associated with respiratory diseases (ICD-10 J00-J99).

Data Source

Table B.3: Statistics Canada. (2012–05–30). *Table 102–0530—Deaths, by cause, Chapter X: Diseases of the respiratory system (J00 to J99), age group and sex, Canada, annual (number), CANSIM (database)* [Data File] and; Statistics Canada. (2011–09–27). *Table 051–0001—Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual (persons unless otherwise noted), CANSIM (database)* [Data File].

— S —

Schizophrenia (2005)[39, 115]

Respondents who reported having been diagnosed with schizophrenia by a health professional. This is believed to underestimate the true prevalence since some people do not report that they have schizophrenia and the survey did not reach individuals who were homeless, in hospital or supervised residential settings.

Data Source

Table B.3: Statistics Canada. *Canadian Community Health Survey, 2005: Cycle 3.1* [Share Microdata File]. Ottawa, Ontario: Statistics Canada. All computations on these microdata were prepared by the Public Health Agency of Canada and the responsibility for the use and interpretation of these data is entirely that of the author(s).

Sense of community belonging, somewhat or very strong (2011)[10]

Population who reported their sense of belonging to their local community as being very strong or somewhat strong.

Data Source

Table B.4: Statistics Canada. (2012–06–18). *Table 105–0501—Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2011 boundaries) and peer groups, occasional, CANSIM (database)* [Data File].

Some post-secondary education (2012)[100]

Persons who worked towards, but did not complete, a degree, certificate (including a trade certificate) or diploma from an educational institution, including a university, beyond the secondary level. This includes vocational schools, apprenticeship training, community colleges, Collège d'Enseignement Général et Professionnel (CEGEP), and schools of nursing.

Data Source

Table B.4: Statistics Canada. (2013–01–03). *Table 282–0004—Labour force survey estimates (LFS), by educational attainment, sex and age group, annual (persons unless otherwise noted), CANSIM (database)* [Data File].

— T —

Teen pregnancy rate (2010)[116]

Number of live births per 1,000 female population aged 15 to 19 years.

Data Source

Table B.4: Statistics Canada. (2012–09–26). *Table 102–4505—Crude birth rate, age-specific and total fertility rates (live births), Canada, provinces and territories, annual (rate), CANSIM (database)* [Data File].

— U —

Unemployment rate (2012)[100]

The unemployment rate is the number of unemployed persons expressed as a percentage of the labour force.

Data Source

Table B.4: Statistics Canada. (2013–01–03). *Table 282–0004—Labour force survey estimates (LFS), by educational attainment, sex and age group, annual (persons unless otherwise noted), CANSIM (database)* [Data File].

— V —

Violent crime incidents (2011)[118]

Offences that deal with the application or threat of application, of force to a person including homicide, attempted murder, various forms of sexual and non-sexual assault, robbery and abduction.

Data Source

Table B.4: Brennan, S. (2012). *Police-reported crime statistics in Canada, 2011*. (Ottawa: Statistics Canada).

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