



CHAPTER 1

Climate Change and Health Linkages

HEALTH OF CANADIANS IN A CHANGING CLIMATE:
ADVANCING OUR KNOWLEDGE FOR ACTION



Health
Canada

Santé
Canada

Canada



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1.1 Introduction

A broad range of risks to the health and well-being of Canadians from climate change were identified over two decades ago by scientists (Royal Society of Canada, 1995; Koshida & Avis, 1998; Health Canada, 1999). Subsequent science assessments and related studies, from national to local levels, have suggested that health risks are increasing, that they are posing serious threats to populations, and that impacts on some individuals and communities from current climate variability are significant (Séguin, 2008; Gosselin, 2010; Berry et al., 2014a; Berry et al., 2014b; Levison et al., 2018). An increase in some diseases, such as Lyme disease, due in part to a changing climate (Hoegh-Guldberg et al., 2018); the observed increase in the frequency and severity of extreme weather events and disasters such as extreme heat events and wildfires; and the expected increases in extreme precipitation with a warmer climate and associated flood risks in some areas, all call for a better understanding of the populations and regions at higher risk to impacts on health. New information about growing risks, key vulnerability factors, and promising adaptation options is needed to support efforts to increase the resilience of Canadians, their communities, and their health systems.

Canadians are concerned about climate change impacts on health. In 2017, 93% of Canadians who accept the reality of climate change indicated that it is either a health risk now (53%), or will be in the future (40%), and over half (55%) felt personally vulnerable to its impacts (Environics, 2017). In addition, health authorities and medical organizations in and outside of Canada have called for concerted efforts to reduce risks and increase the climate resilience of health systems (WHO, 2015; Health Care without Harm, 2017; Medical Society Consortium on Climate & Health, 2017; Howard, 2018; WMA, 2018; Claudel et al., 2020; Global Climate and Health Alliance, 2020). Adaptation actions based on robust evidence of risks to health can be effective in protecting people, including those that experience disproportionate impacts, from the effects of climate change (Ebi & Burton, 2008; WHO, 2015). However, important limits to adaptation may exist as warming increases (Ebi et al., 2021).

1.2 Canada's Changing Climate

Greenhouse gases (GHGs) that cause warming of the globe continue to increase rapidly. In 2019, globally averaged atmospheric concentrations of carbon dioxide (CO₂), the main driver of long-term climate change, reached a record high of 409.8 parts per million (ppm), up from 400.1 ppm in 2015 (WMO, 2018a; Lindsey, 2020). Such levels of CO₂ are unprecedented; similar levels only existed 3 to 5 million years ago, when the Earth was 2°C to 3°C warmer and sea level was 10 m to 20 m higher (WMO, 2018b). Global CO₂ emissions rose by 1.7% in 2018 (IEA, 2019). Atmospheric concentrations of the other two important long-lived GHGs, methane (CH₄) and nitrous oxide (N₂O), also continue to increase rapidly. In 2018, CH₄ reached 259% and N₂O reached 123% of pre-industrial (1750) levels (WMO, 2020).

Due to global anthropogenic emissions of GHGs, Canada's climate has changed and is projected to continue to do so over the coming decades. On average, Canada is warming at approximately twice the rate of the

global average, and the Northern region is warming even faster (Bush & Lemmen, 2019). Since 1948, annual average temperatures over the Canadian landmass have increased by 1.7°C, while the North has warmed on average by 2.3°C over the same time period. In addition, extreme warm temperatures have become hotter while extreme cold temperatures have become less cold (Bush & Lemmen, 2019).

Climate models project that temperatures across Canada will continue to increase, with the largest warming occurring in the winter. The continued warming is “virtually certain” (Zhang et al., 2019), but the magnitude will vary, depending on the future rate of GHG emissions. Under a low global emissions scenario (RCP2.6), an additional annual warming of about 2°C is projected for most of this century compared to the 1986 to 2005 base period, whereas, under the high emissions scenario (RCP8.5), additional warming of over 6°C is projected for the country as a whole by late century, with even larger changes projected in the North (Figure 1.1).

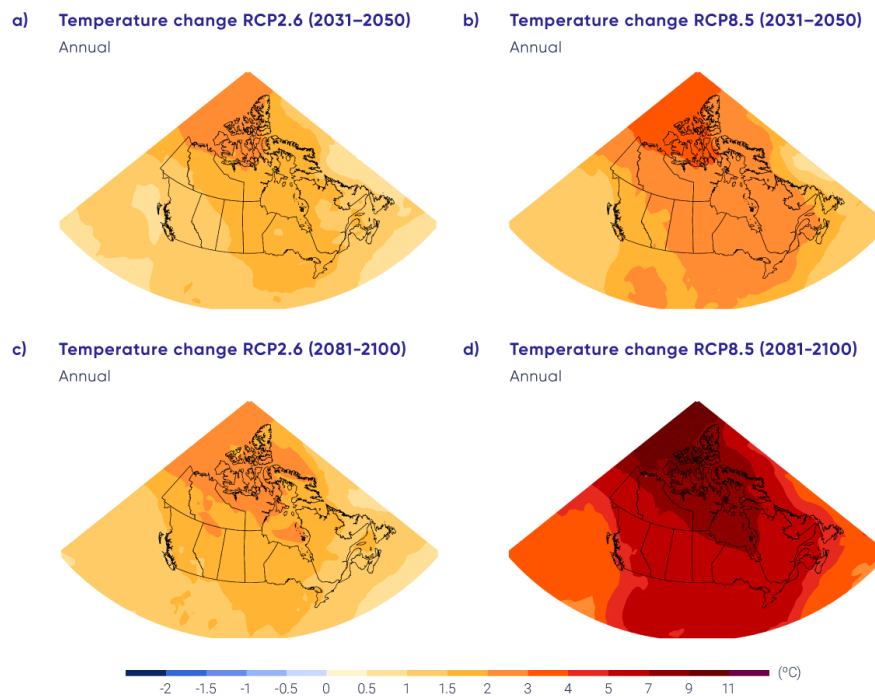


Figure 1.1 Projected change in annual mean temperature across Canada. The figure shows projected annual temperature change for Canada under a low emissions scenario (RCP2.6) (left panel) and a high emissions scenario (RCP8.5) (right panel) for the near term (top row) and the late century (bottom row). Projections are represented by the median of the Coupled Model Intercomparison Project (CMIP5) multi-model ensemble. Changes are relative to the 1986 to 2005 period. Source: Zhang et al., 2019.

In many parts of Canada, there has been an increase in precipitation and a shift toward less snowfall and more rainfall. There has been no observed increase, for Canada as a whole, of extreme precipitation (accumulated amounts over a day or less); however, in the future, daily extreme precipitation is projected to increase (Zhang et al., 2019). Continued warming means that total precipitation is expected to increase for much of Canada (Figure 1.2), while some areas might experience decreases in the summer, particularly in Southern Canada under a high emission scenario and toward late century (Zhang et al., 2019). The availability

of freshwater may be reduced as warming continues, increasing risks of summer water supply shortages in some regions (Bonsal et al., 2019; Bush & Lemmen, 2019).

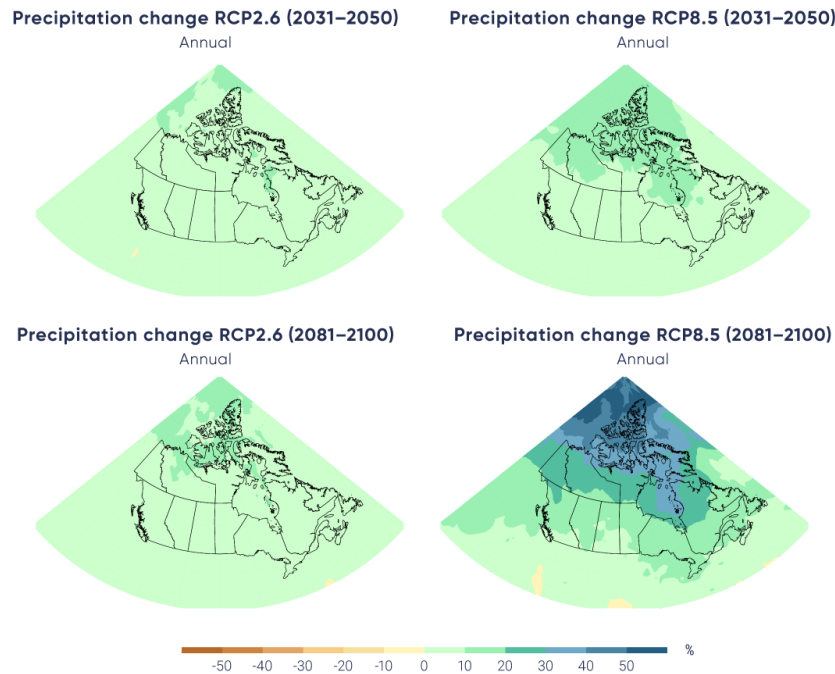


Figure 1.2 Projected annual precipitation changes across Canada. The figure shows projected annual precipitation changes for Canada under a low emissions scenario (RCP2.6) (left panel) and under a high emissions scenario (RCP8.5) (right panel) for the near term (top row) and the late century (bottom row). Maps and time series of projected annual mean precipitation change (%) as represented by the median of the fifth phase of the Coupled Model Intercomparison Project (CMIP5) multi-model ensemble. Changes are relative to the 1986 to 2005 period. Source: Zhang et al., 2019.

Daily extreme precipitation is projected to increase and the return periods – the time between events – for given extreme precipitation events are projected to decrease. Under a high GHG emissions scenario, a current once in 20-year rainfall extreme will become a once in 10-year event by mid-century (a two-fold increase in frequency) (Zhang et al., 2019). Urban areas will therefore need to manage increased flood risks and attendant health threats (e.g., contaminated water supplies) due to more severe rainfalls. Local sea level is projected to rise along much of the Canadian coastline, which will increase the frequency and magnitude of extreme high water level events and increase coastal flooding (Greenan et al., 2019).

Given that some additional warming is unavoidable, many current trends in climate change impacts relevant for health will continue, including (Bush & Lemmen, 2019):

- more frequent and intense extreme hot temperatures;



- increased severity of extreme heat events;
- less extreme cold;
- increased risk of drought;
- increased risk of wildfires;
- increasing length of the growing season;
- reduced seasonal lake ice cover across the Arctic;
- reduced sea ice extent;
- thinning of glaciers; and
- warming and melting of permafrost.

Increased variability in weather and climate is more challenging for people to adapt to. Profound effects on the Canadian climate are expected, should global GHGs continue to increase this century. Limiting warming globally, and in Canada, requires global action to reduce GHG emissions to near zero within a few decades (Bush & Lemmen, 2019).

1.3 Climate Change and Health

Evidence of the risks to health from climate change and the pathways through which people are affected has grown with publication of reports from the Intergovernmental Panel on Climate Change (IPCC) (Confalonieri et al., 2007; Smith et al., 2014; WHO, 2014; WHO, 2018) and related studies (Watts et al., 2015; Crimmins et al., 2016; Watts et al., 2018). Climate drivers of poor health that need to be understood to adapt are complex and mediated by a range of determinants of health and other situational, behavioural, and organizational factors (Figure 1.3). This makes the management of current risks to health, and of projected impacts, by public health officials challenging and requires close partnerships with officials within and outside the health sector.

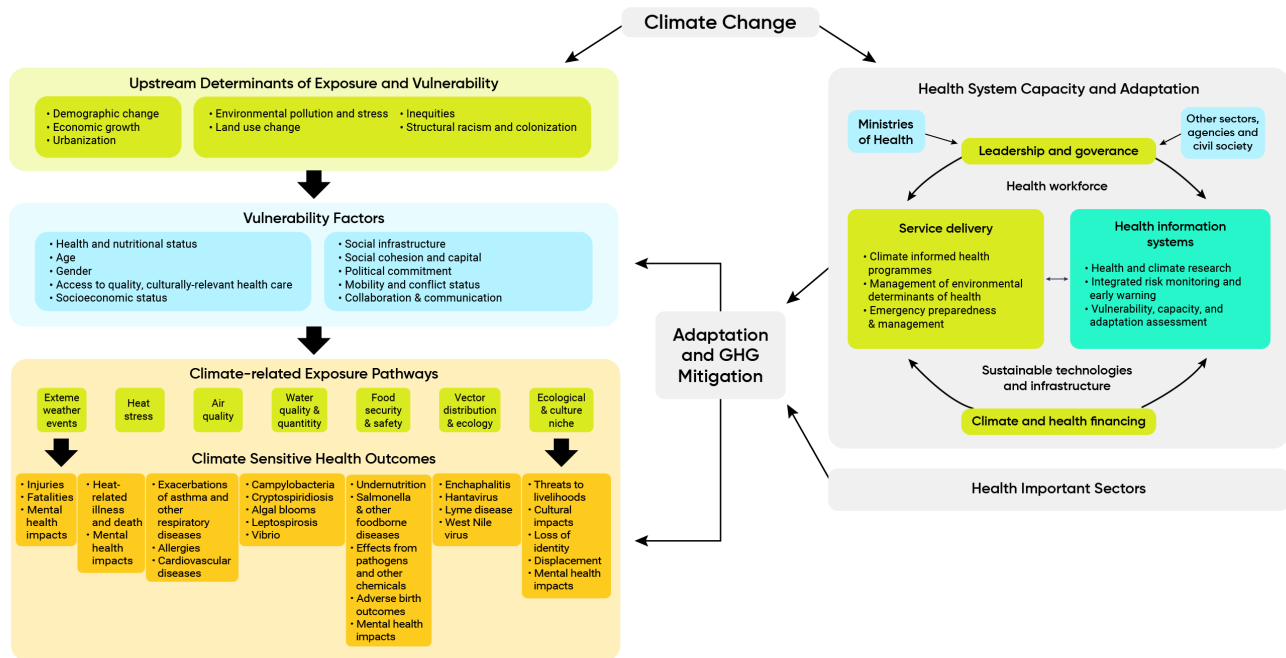


Figure 1.3 Pathways through which climate change affects the health of Canadians. Source: Adapted from WHO, 2022, Working paper on measuring climate resilience of health systems; Haines & Ebi, 2019.

Upstream drivers related to trends such as population growth, economic growth, urbanization, colonialism, and racism can put pressures on a range of factors that can increase or decrease vulnerability to the health impacts of climate change. Health can be affected by climate change directly or indirectly, through a range of exposure pathways, as temperatures continue to rise, precipitation patterns change, and the frequency and severity of extreme weather events increase, resulting in more natural disasters (IPCC, 2012; Smith et al., 2014; Watts et al., 2015; Hoegh-Guldberg et al., 2018).

Direct impacts on health can include non-communicable diseases (e.g., respiratory and cardiovascular diseases, mental health impacts) and injuries and deaths associated with extreme weather events such as wildfires, storms, extreme heat events, floods, and droughts. Less obvious effects of climate change on health arise from changes to ecosystems that support the spread of disease, pathogens, or contaminants to people, for example, the expansion of vector-borne diseases in new geographical regions, more water and air pollution due to warmer temperatures, or greater risks to food insecurity. Climate change is increasing vulnerability to multiple simultaneous hazards that threaten health (Mora et al., 2018), and continued global warming beyond 1.5°C increases risks of exceeding critical thresholds that would lead to more severe damage of natural systems and human societies (Haines & Ebi, 2019).

Health and social services play an important role in protecting Canadians from climate change impacts. They are the first lines of defence, whether through primary prevention (e.g., reducing GHG emissions in health care and reducing the urban heat island effect), secondary prevention (e.g., warning systems and public



education campaigns), or tertiary prevention (e.g., treating injuries and illnesses associated with climate-related hazards) (see Chapter 10: Adaptation and Health System Resilience). The failure of such services during an extreme event, or the diminished capacity to provide services over time, would have direct impacts on health and well-being. There is increasing recognition of the impacts that climate change can have on health systems (WHO, 2015; Balbus et al., 2016; Haines & Ebi, 2019), as evidenced by recent disasters such as Hurricanes Katrina and Sandy in the United States (Health Care without Harm, 2018) and catastrophic wildfires in Alberta and British Columbia (Purdy, 2016; Toews, 2018).

Certain populations in and outside Canada bear a disproportionate burden of the health impacts from climate change (Berry et al., 2014; Hoegh-Guldberg et al., 2018; Shultz et al., 2020) (see Chapter 2: Climate Change and Indigenous Peoples' Health in Canada; Chapter 9: Climate Change and Health Equity). Globally, it has been estimated that children bear 88% of the burden of disease from climate change (WHO & UNEP, 2010). Climate change is a threat to the health of people in all countries. Some dynamics that drive risks, such as infectious diseases, effects on water and food systems, or supply chain disruptions, can transcend borders (Balbus et al., 2016; Friel, 2019), thereby affecting Canadians.

Climate change is increasing the risk of humanitarian crises (Jochum et al., 2018) and threatening the global health gains achieved over the past century (Smith et al., 2014). From 2014 to 2017, climate shocks were partly responsible for the increase in food-insecure people in the world to more than 800 million – a growth of between 37 million and 122 million (GCA, 2019). Globally, it has been estimated that 200 million people every year by 2050 could need international humanitarian aid because of the impacts of climate change, which is almost double the number of people (108 million) that required assistance in 2018 to recover from floods, storms, and wildfires (IFRCRCS, 2019). Possible linkages exist between climate-related hazards and human migration (UNHCR, 2015; Haines & Ebi, 2019; McLeman, 2020) – for example, the 2018 droughts in Central America coincided with international migration patterns (CRED, 2019). Impacts have also been linked with conflict (Schleussner et al., 2016; Werrell & Femia, 2017) – for example, droughts in Ethiopia have been indirectly linked to decreased food security and areas of conflict (WHO, 2018) and the 2006 drought in Syria contributed to the deterioration of economic conditions and subsequent conflict (Gleick, 2014; Kelley et al., 2015).

Climate change is considered a “threat multiplier” (Hallegatte et al., 2015) and is expected to lead to increased poverty, dislocation, and forced migration among many populations (Hoegh-Guldberg et al., 2018). It is also recognized as an increasingly important national health security issue, given the potential interplay between climate change and infectious diseases (Hawa, 2017) (see Chapter 6: Infectious Diseases). However, the way in which climate change shocks and stresses can compound other drivers of conflict and migration is complex, as are implications for human health, and research in these areas is still emerging (Hsiang, 2013; Bowles et al., 2015).

Impacts on the health of populations and communities may be immediate or may last years (e.g., non-communicable diseases such as mental health; see Chapter 4: Mental Health and Well-Being); they may also be long-lived, multi-generational, or irreversible, such as impacts on or the loss of cultures (WHO, 2018) (see Chapter 2: Climate Change and Indigenous Peoples' Health in Canada). In addition, researchers are starting to link specific events that have affected health directly to climate change. For instance, specific extreme weather events, including the hot and dry conditions that contributed to record wildfires in British Columbia in 2016, or the record heat wave in that province in June 2021 have been attributed to climate change (Herring et al., 2018; World Weather Attribution, 2021), allowing researchers to also make linkages to the health



impacts of such events (Ebi et al., 2017; Hoegh-Guldberg et al., 2018). In addition, Vicedo-Cabrera et al. (2021) estimate that, between 1991 and 2018, 38.5% of heat-related mortality in 25 census metropolitan areas in Canada could be attributed to human-induced climate change.

Scientists are also learning more about the very large short-term and longer-term health co-benefits of well-designed GHG mitigation measures and of proactive adaptation actions in other sectors. Actions to address climate change in the agriculture, water and sanitation, infrastructure, energy, urban design, and transportation sectors, for example, can reduce environmental pollution and support healthy lifestyles and communities (Haines et al., 2009; Smith et al., 2014; Martinez et al., 2018). The potential benefits of reduced deaths from air pollution, are so large that the Lancet Commission on Climate and Health has called climate change the “greatest global health opportunity of the 21st century” (Watts et al., 2015, p.1) (see Chapter 5: Air Quality). Research suggests that, for a range of future scenarios, the value of the benefits to health resulting from policies and activities in line with meeting the United Nations Framework Convention on Climate Change Paris Agreement targets could exceed their costs (Markandya et al., 2018). Canada is a signatory to the Paris Agreement and has pledged to reduce its GHG emissions to 511 Mt CO₂ equivalent by 2030¹ and to achieve a net-zero-emissions economy by 2050 (Government of Canada, 2021).

Health system infrastructure and services in Canada are being affected by climate-related hazards; reduced pressures and costs to health systems from improved population health through such measures can free up resources to build climate-resilient health systems and recover from the unavoidable impacts (Martinez et al., 2018). Greater understanding of how to gauge the climate resilience of health systems (e.g., indicators), tools to facilitate needed adaptation, and roles and responsibilities of key actors and partnership opportunities will support preparedness efforts (see Chapter 10: Adaptation and Health System Resilience).

1.4 Growing Knowledge of Climate Change Impacts on the Health of Canadians

Over two decades ago, the first national assessment of climate change impacts on Canadians that included information on human health and well-being was conducted (Koshida & Avis, 1998). Since that time, two national-level climate change and health assessments, led by Health Canada, were completed (Séguin, 2008; Berry et al., 2014), contributing to a growing foundation of scientific knowledge. The 2014 study provided updated knowledge about climate change-related health concerns included in previous reports (e.g., air pollution, infectious diseases, water and food-borne diseases, and climate-related natural hazards), populations that experience disproportionate impacts, and adaptation options.

The 2014 assessment also provided new information about health challenges faced by people living in specific communities and regions – urban, rural, coastal and Northern – and included a list of key research

¹ Canada’s GHG emissions were 729 Mt CO₂ eq in 2018 (Government of Canada, 2020).



gaps that require investigation to inform efforts to protect health. All people in Canada are at risk from the health impacts of climate change. However, the experience of impacts and the ability to adapt are not uniform and vary across populations, communities, and regions. An individual's sensitivity to climate change impacts, exposure to climate change hazards, and ability to take protective measures all contribute to climate change vulnerability. Upstream drivers of inequity (e.g., colonialism, racism, social and economic inequities) interact with and shape determinants of health. Health inequities and determinants of poor health compound vulnerability, and thus, some individuals and population groups face disproportionate health risks and challenges with adapting. In addition, the COVID-19 pandemic has intensified pre-existing inequities in Canadian society (Statistics Canada, 2020a).

Efforts to protect health from climate change through adaptation and GHG mitigation measures can inadvertently exacerbate population vulnerability, or present opportunities to strengthen health equity and reduce disproportionate health risks in society (see Chapter 9: Climate Change and Health Equity). Broad population groups that are commonly at higher risk to the health impacts of climate change in Canada include seniors, children and youth, people that are socially and economically disadvantaged, Indigenous Peoples, people with chronic diseases and compromised immune systems, people with disabilities, emergency first responders and support workers, and residents of northern and remote communities (Berry et al., 2014a). There is much variation within and among these groups in Canada. Populations at higher risk, and those on the front lines of climate change have historically been labelled as "victims," when, in reality, many people have a long history of demonstrated adaptive capacity, despite existing health inequities and discrimination.

1.5 Demographic and Socio-Economic Trends in the Canadian Population

Most Canadians enjoy good health, which increases resilience to the impacts of climate change. Specific demographic, social, and economic trends are important for understanding current and future health risks associated with climate change, as they can affect vulnerability and lead to inequitable health outcomes as risks increase (Balbus et al., 2016). For example, health and income disparities can increase the risk of some health impacts of climate change (Balbus et al., 2016; WHO, 2018). Trends in Canada relevant to the understanding of current and future impacts of climate change health risks are provided below.

1.5.1 Population Growth

- Canada's population is estimated to have increased by 23.7% from 2000 (30.7 million) to 2020 (38 million) (Statistics Canada, 2020b).



- Much of Canada's population is also aging. According to the 2016 Census, adults over the age of 65 years (5.9 million) now outnumber children under the age of 15 (5.8 million). The number of Canadians over the age of 85 years is growing rapidly – four times more quickly than the general population (PHAC, 2017).
- In contrast, younger Indigenous population cohorts are growing quickly, and Indigenous communities have proportionally more children than older adults (PHAC, 2017).

1.5.2 Social Capital and Networks

- Many more Canadians now are living alone. In 2016, 4 million Canadians were living alone, which is double the number in 1981 (Statistics Canada, 2019b).
- Social isolation is increasing in Canada. In 2017, 44% of Canadians visited friends at least a few times a week, while in 2003, 58% did so. In addition, visits to family also declined over that time period, from 38% to 26% (PHAC, 2017).
- In 2018, 86% of Canadians had access to high-speed broadband internet (CRTC, 2019).

1.5.3 Racial and Ethnic Diversity

- In 2011, almost one in five Canadians (19.1%) belonged to a visible minority group, which was up from 16.2% in 2006. In 2011, the South Asian (25% of the visible minority population), Chinese (21.1%), and Black populations (15.1%) were the three largest visible minority groups. By 2031, Statistics Canada estimates that visible minority groups will make up between 29% and 32% of the population (Statistics Canada, 2018).

1.5.4 Economic Disparity and Inequity

- The percentage of Canadians considered low-income after tax was 12.3% in 2018, which is just slightly lower than in 2000 (12.8%) (Statistics Canada, 2020c).
- A significant number of Canadians struggle with food and water insecurity, and levels vary across Canada, with higher rates in the North. It was estimated that, in 2017–2018, 12.7% of Canadian households experienced food insecurity at some point during the previous year, an increase from previous national estimates (Tarasuk & Mitchell, 2020). This is likely an underestimate, as not all populations were captured in the survey (e.g., on-reserve Indigenous Peoples and homeless people) and not all provinces and territories monitor rates of food insecurity (PHAC, 2017).
- In 2016, 1.7 million households were in core housing need; that is, their dwelling is considered unsuitable, inadequate, or unaffordable (Statistics Canada, 2016), and there were 22,190 Canadians living in 995 shelters (Statistics Canada, 2019c).



1.5.5 Health Status

- Life expectancy has continued to climb in Canada, with an increase of 5.3 years for men and 3.3 years for women from 1995 to 2019 (PAHO, 2019). From 2016 to 2017, for the first time, life expectancy did not increase, as a result of the opioid epidemic (Statistics Canada, 2019a).
- In 2016, 44% of all Canadians over 20 years of age had at least one chronic health condition, including hypertension (25%), mood and/or anxiety disorders (13%), diabetes (11%), asthma (11%), chronic obstructive pulmonary disease (10%), ischemic heart disease (8%), cancer (8%), and dementia (7%) (PHAC, 2019b).
- The number of Canadians who report they are obese, living with diabetes, or have a mood disorder has been increasing in Canada. Over the past three decades, the number of obese children has tripled (PHAC, 2019a), and the number of all Canadians who are obese rose from 23.1% in 2004 to 26.7% in 2015 (Statistics Canada, 2017). These conditions are linked to increased health risks related to cancer, cardiovascular disease, and respiratory disease (PHAC, 2017).
- There are important differences in health status between rural and urban populations. People living in urban areas tend to have lower mortality rates for injury, suicide, and motor vehicle accidents, as well as lower rates of smoking and being overweight or obese. However, urban populations tend to have higher rates of cancer, infectious disease and stress, as well as a weaker sense of community belonging. Fully 80% of Canadians live in urban or suburban areas, with almost 36% (12.5 million) living in Toronto, Montreal, or Vancouver (PHAC, 2017). In contrast, rural Canadians tend to be in poor or fair health, less stressed, and have a stronger sense of community belonging. In addition, they have the highest rates of mortality from all causes as well as from respiratory disease (PHAC, 2017).

1.6 Climate Change Impacts on Indigenous Peoples' Health

The health and well-being of Canada's Indigenous Peoples² continues to be affected by Canada's history of systemic racism, colonization, and discrimination. This has included forced displacement from traditional territories, residential school experiences of abuse and neglect, and the disruption of traditional culture, language, and practices (PHAC, 2020). Compared to non-Indigenous people, First Nations, Inuit, and Métis peoples face greater challenges from climate change impacts on health due to existing disparities, such as shorter lifespans, higher rates of chronic diseases, and greater food and water insecurity in many communities (PHSA, 2011; FNHA, 2018; PHAC, 2018). Sharp divisions in health status exist between some

2 The term Indigenous Peoples is used throughout this report to refer to the original inhabitants of Canada and their descendants, including First Nations, Inuit, and Métis peoples, as defined under Section 35 of the *Constitution Act, 1982*.



Indigenous and non-Indigenous Canadians. Many serious health challenges face Indigenous Peoples living in remote communities because of less access to safe drinking water, health care, and quality housing, as well as challenges with food security and safety (PHAC, 2017). Several factors increase risks to First Nations, Inuit, and Métis peoples from climate change impacts, including (Furgal & Séguin, 2006; Furgal et al., 2008; Turner & Clifton, 2009):

- close cultural connection and dependence on the natural environment;
- historic and ongoing burdens of colonialism;
- vast distances between communities;
- small service centres;
- harsher climates;
- remoteness and isolation;
- limited social, educational, and employment opportunities;
- poorer transportation systems;
- infrastructure vulnerabilities (e.g., unstable housing, water, sewage);
- food costs;
- effects of industrial resource extraction; and
- the unique and relatively complex legal, governance, and service structures for First Nations, Inuit, and Métis peoples and communities.

Drawing on studies using Indigenous knowledge and Western science, this assessment includes an examination of how climate change is expected to exacerbate health risks among Indigenous Peoples living in Canada. For example, health may be affected through climate effects on food and water, or less directly through an erosion of diverse cultures, language, and traditional livelihoods. However, the cultural and social factors unique to First Nations, Inuit, and Métis peoples, including the inextricable connection to and reliance on land and water for food, medicines, identity, and spirituality and a holistic, interconnected view of health and well-being, may also convey important and unique adaptive capabilities that all Canadians can learn and benefit from (PHAC, 2017) (see Chapter 2: Climate Change and Indigenous Peoples' Health in Canada). Consideration of the unique perspectives and disproportionate impacts experienced by Indigenous Peoples in Canada in this assessment can support efforts to further the recommendations in the *Truth and Reconciliation Commission of Canada: Calls to Action* (TRC, 2015) and the *United Nations Declaration on the Rights of Indigenous Peoples* as they relate to climate change action (UN, 2007).



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