# Canada

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# Country Report
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**Geography and Population**

      Canada, by landmass, is the second largest country in the world. It spans 9,984,670 square kilometers and is surrounded by three oceans: the Pacific Ocean on the west coast, the Atlantic Ocean on the east coast and the Arctic Ocean to the north. Canada shares a boarder with the United States of America to the south and top north-west corner. The international boarder between Canada and the United States is the longest in the world at 8,891km (NationsOnline, 2022).

**Figure 1**

*Map of Canada*



From NationsOnline (2022)

      Canada (Figure 1) has been subdivided into ten provinces and three territories. The physiographic regions of Canada (Figure 2) include Arctic, Cordillera, Interior Plains, Hudson Bay Lowlands, Canadian Shield, St Lawrence Lowlands, and the Appalachia. Northern Canada experiences a drier climate, with long cold winters and large amounts of snow. The southern interior tends to have dry winters and hot summers. Winter on the west coast can be wet and damp, with little snowfall, while the summers are warm and humid. The east coast experiences

snow but not as much as the interior. The summers are warm with humid air. Canada's Arctic can be found above the tree line, trees cannot survive in the frozen Tundra. The Cordillera is mountainous and has high peaks, whereas the Interior Plains are rolling hills and prairie land for farming. The Hudson Bay Lowlands are marshy wetlands and near  sea level. The Canadian Shield consumes most of Canada with its boreal forest and rugged terrain, thousands of lakes primarily with rocky shores. The St Lawrence Lowlands are boggy with marshes, another area of wetlands. The Appalachia area is the east coast with high cliffs, rocky shores, forests, and sandy beaches (Acton et al., 2015).

**Figure 2**

*Physiographic Regions*



From Acton et al (2015).

With a population of only thirty-eight million people, Canada is less densely populated with regard to its area. However, nearly 82% of the Canadian population is located in urban regions, mostly located near the southern boarder of the country, leaving the northern region of Canada widely unpopulated (O'Neill, 2022).

**History and Culture**

The Indigenous of Canada inhabited the land long before any settlers arrived. The Indigenous lived off the land; they hunted, fished, and farmed. The Vikings from Iceland arrived at an eastern Island around 1,000's. In the late 1400s, Britain and France had their sights on land in Canada and both countries began to settle in various parts of the east. During the 1700 and 1800's, Canada's economy developed and was driven by the fur trade. Trading posts throughout the region were established, extending to the west coast. The Hudson's Bay Company and the North West Company rivaled for control of the flourishing fur trade (Government of Canada, 2017a).

On July 1, 1867, Confederation of Canada became official. The British North America Act was established, and British Parliament would support the newly founded Canada. Two levels of government were created, provincial and federal, with the provinces electing their own legislature to manage matters such as health care and education. The first provinces to join Confederation in 1867 were Nova Scotia, New Brunswick, Ontario, and Quebec. The final province was Newfoundland and Labrador in 1949. In 1999 Northwest Territories was divided, and Canada's third territory, Nunavut was named (Government of Canada, 2017a).

As a promise to the west for joining the confederation, building of the railway began, uniting the country from east to west. The Canadian Pacific Railway was completed in November of 1885. Completion of the railroad drove the economy and industrialized the west. It was also during this time when immigration increased to Canada and a movement to the west where there was agricultural growth (Government of Canada, 2017a).

In 1982, Canada claimed official independence from Britain. The updated Constitution Act removed British Parliament's authority. The position of Governor General in the Canadian Government represents the Queen of the British Monarchy.

September 30, 2021 marked the first National Day of Truth and Reconciliation, which recognizes a tragic past, while honouring lives lost and educating on the history of the Indigenous. During Confederation in the 1800's, founding fathers set out to remove the culture and language of those who had inhabited the land before settlers arrived. There were 140 Residential schools established throughout the country, which operated from 1831 until the last one closed in 1998, which saw Indigenous children removed from their homes and stripped of their culture. Canada is acknowledging its past and working to restore the Indigenous culture.

English and French are the national languages established in Canada and are used at the government levels. However, there are areas of the country where traditional Indigenous languages are still spoken, such as Cree in northern Manitoba. Immigrants are known to practice their home-country languages with family and cultural gatherings (Government of Canada, 2022a).

The National Holidays of Canada include New Years (January 1st), Good Friday and Easter (following vernal equinox), Victoria Day (3rd Monday of May), Canada Day (July 1st),

Terry Fox Day (first Monday of August), Labour Day (first Monday of September), National Day for Truth and Reconciliation (September 30th), Thanksgiving (2nd Monday of October), Remembrance Day (November 11th), Christmas (December 25th) and Boxing Day (December 26th). There is a federal holiday in February, on the 3rd Monday, in which each province has its own name for the day.
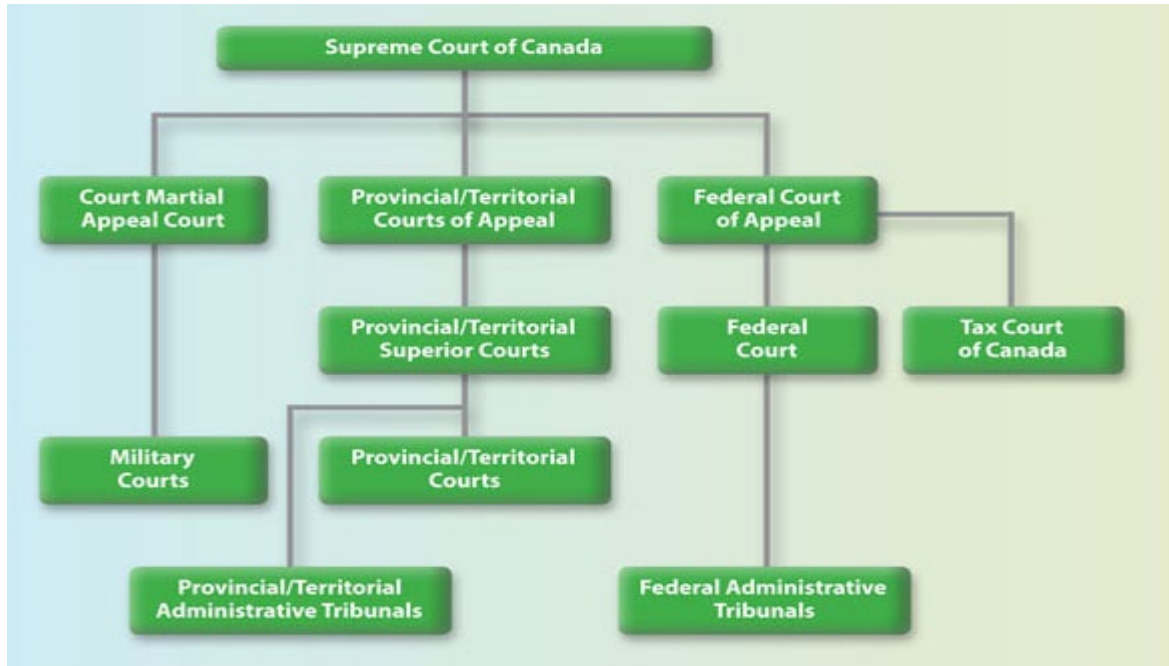
## Government and Legal system

Canada has a parliamentary government system. While independent, Canada is still under the monarchy and considers Queen Elizabeth its current Head of State. At the time of publication, the prime minister, Mr. Justin Trudeau, is the Head of the Government. This level of government is the federal system, and deals with decisions and laws for the country. This includes areas such as criminal justice, international trade, citizenship, national defence, and policing. The country is divided into ridings, and voters cast their vote in the riding they live in, for the political candidate they wish to have represent them. The federal party with the majority votes makes the majority government, while the party with the second-highest votes forms the Opposition. There are 337 elected members of parliament that make up the government (Government of Canada, 2021).

Each province has its own provincial government, elected by provincial citizens, which manages education, health care, property rights, road regulations, and natural resources. The provinces are divided into ridings, and votes are cast for the candidate that citizens would like to represent them within their riding. The three territories have their own governments with duties directed to them by the federal government. The provincial and federal governments share selected responsibilities such as agriculture, environment, and immigration.

The municipal government level is smaller districts, usually represented by cities, towns, or areas. This level is responsible for its community water system, waste removal, local parks, parking, and roadways. These elected officials are selected by the people who live in the area. Band councils govern Indigenous communities. A council is elected by the people within the community and decisions are made that affect the community (Government of Canada, 2021).

**Figure 3**

*Canada's Legal System*



From Government of Canada (2021).

The Supreme Court of Canada oversees the provincial and territory courts (Figure 3), which each have their own court system. The judiciary's task is to prosecute impartially and in accordance with Canada's constitution (Government of Canada, 2021).

**Economy and Employment**

The Government of Canada (2017a) describes its industries as manufacturing, service, and natural resources. Manufacturing includes paper, machinery, food, technology equipment and several other products. Canada does most of its international trading with the United States. The Service industry includes health care, education, construction, retail, tourism, and government services. Canada is rich in natural resources with its dynamic land, which includes mining, forestry, fishing, agriculture, and electric energy.

Canada is considered a high-income country. However, there is a disproportionate divide within the country. There are areas with the country that have more opportunities than others, not just for employment but overall basic needs. Statistics Canada (2021) discloses that 10.1% of Canadians in 2019 were living below the poverty line.  Not all Canadians have access to basic

needs. Predominantly Indigenous communities have housing that is less than optimal and overcrowded. Food insecurity is a threat in northern, remote communities' healthy food costs are above the average household income.
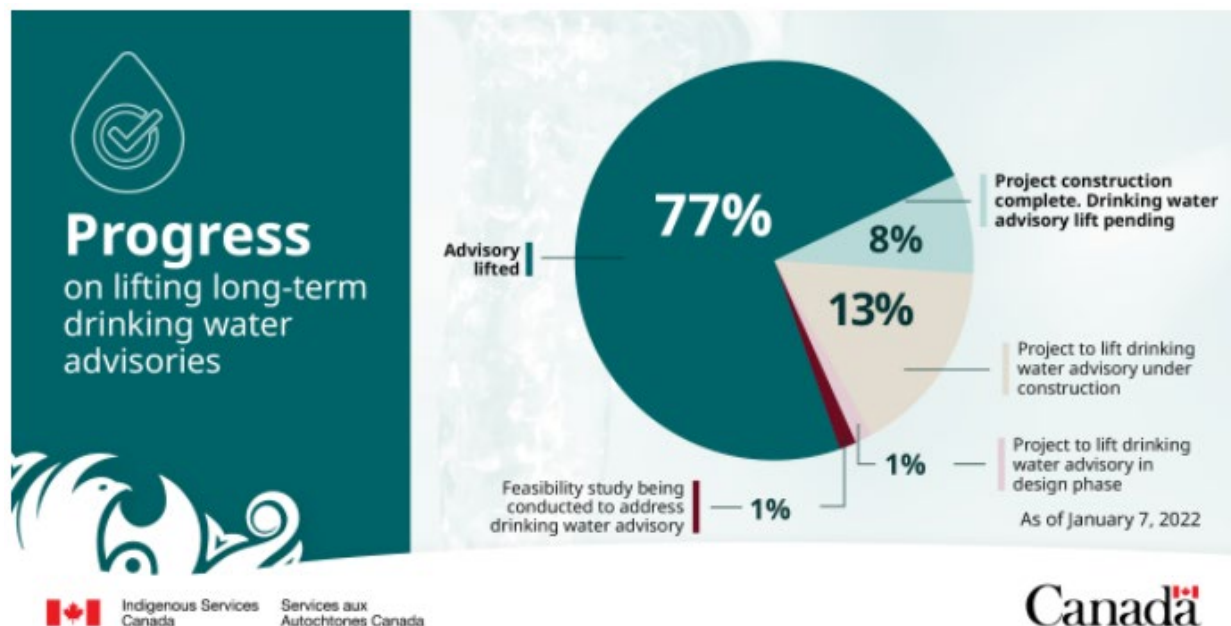
**Physical and Technological Infrastructure**

Sources indicate that 100% of Canadians have access to electricity, produced in multiple forms, hydro-electric, natural gas, wind and solar (The World Bank, 2020; The World Factbook, 2022). Additional information was limited to confirm if all Indigenous communities have access to electricity. Due to the cost of electricity (varies by province), there are households that rely on other means to provide heat, such as wood-burning stoves.

The Government of Canada (Government of Canada, 2022b) is working towards lifting the water advisories that have been ongoing in the Indigenous communities (Figure 4). Several Indigenous communities throughout Canada have never had access to potable drinking water.

**Figure 4**

*Drinking Water Advisories - Progress*



From Government of Canada (2022b).

Mobile cell phones are the common mode of telephone communication compared to the previously standard landline telephone. Over thirty million Canadians are using a smart

cellphone. (O'Dea, 2020). However, cellular and internet service is not equally accessible to all Canadians. According to the Government of Canada, there are large areas where mobile signals are weak or non-existent, which poses a risk (Government of Canada, 2019b).  Internet connections are no better. "In 2017, only 37% of rural households had access to 50/10 Mbps, compared with 97% of urban homes. Only about 24% of households in Indigenous communities have access to 50/10 Mbps." (Government of Canada, 2019b), putting the population in remote or rural locations, especially Indigenous communities, at a disadvantage for opportunities such as online education and connections to the world outside their area.

Transportation within Canada is a mix of roadways, rail lines and flying. Canada ranks eighth in the world when it comes to roadways having 1,042,300 kilometers of accessible roads in 2011 (The World Factbook, 2022). Several of these roads are paves and situated to the southern part of the country from one urban location to the next. Due to the drastic changes in northern temperature, permafrost affects the roads of the north. Resulting in many roads being unpaved due to the cost of upkeep. There are locations in the north that have no year-round road access at all and rely on winter conditions that allow for a winter road to be plowed. This limits accessibility for this population to basic needs such as food, supplies and health care. Regarding railway accessibility, Canada was fourth in the world in 2013, only behind the United States, China, and Russia (The World Factbook, 2022). There are 77,932 kilometers of rail lines that stretch across Canada, but again this is mostly seen running west to east from one urban area to the next. Canada also ranked fourth in 2013, behind the United Stated, Brazil and Mexico when it came to available airports (The World Factbook, 2022). There are 523 paved airports and 944 unpaved airports, with several public airline options. The cost of travelling by air drastically increases further north within Canada. Again, making it challenging for the northern population to access urban centres.

**National Health Care**

**National Health Care Profile**

The average life expectancy in Canada is eighty-three years old, with females living on average longer than males. The highest populated age range for both females and males in 2021 was age twenty-five to forty-four years old, with age forty-five to sixty-four years old close behind (Figure 5). In 2019, 81.2% of Canadians were living in an urban area of the country. The three largest populated cities are Toronto Ontario, Montreal Quebec, and Calgary Alberta. (Statista Research Department, 2022).
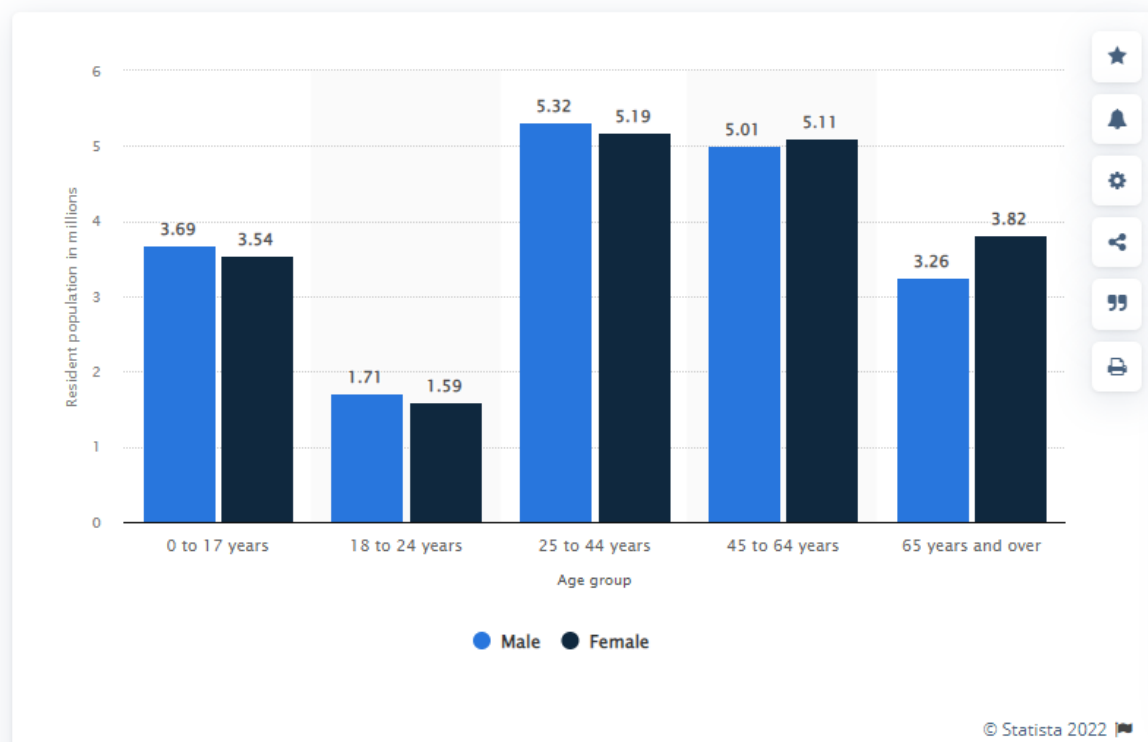
The World Health Organization indicates that the total deaths in Canada in 2017 were 276,689, equally divided between males and females. Cardiovascular disease and cancer were the top cause of death among Canadians, with the most affected age group of seventy-five and older as seen in Figure 6 (The World Health Organization, 2019).    The infant mortality rate is

3.9 per 1000 live births and the death rate under the age of five is 4.8 per 1000 live births (Worldometer, 2020).
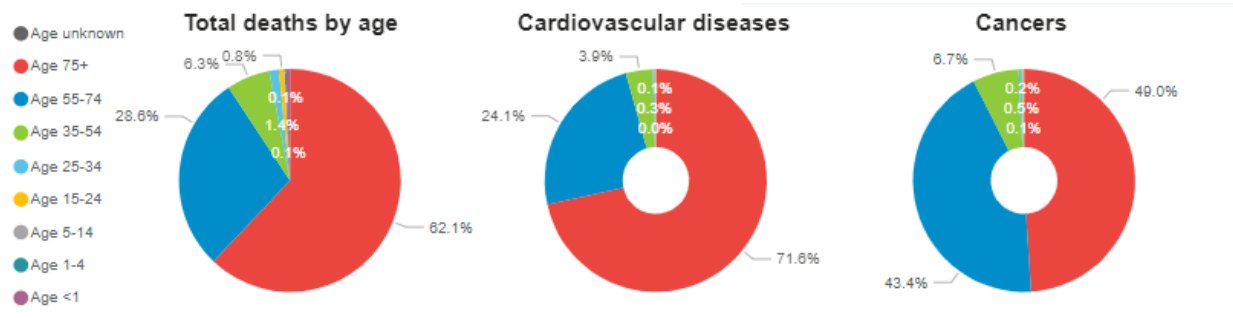
**Figure 5**

*Age-Stratified Canadian Population - 2021*



## Resident population of Canada in 2021, by gender and age group
*(in millions)*

From Statista Research Department (2022).

**Figure 6**

*Cauases of Death - Canada*



From The World Health Organization (2019).

**National Health Care Structure**

Canada has a universal health care system, which means that citizens and permanent residents can access medically required services, however not all medical procedures are covered equally throughout Canada and not all medical needs are met, unfortunately. The provincial and territorial governments hold the most responsibility for delivering health care and social services. Criteria must be followed for Federal support and funding to be received. (Government of Canada, 2019a).

The Federal government's role is to set and administer national principles, provide financial support to the provinces and territories, and fund and deliver to a specific group of the population, such as Indigenous people living on reserves, Inuit, members of the Canadian Armed Forces, veterans, inmates in federal prisons and some refugees. The First Nations or Indigenous and Inuit have primary and emergency services supported by the Federal government on remote and isolated reserves where no provincial-funded services are available. These services are provided at nursing stations in the communities. However, nursing stations are often only staffed by nurses, without access to physicians. In many of these communities, basic x-ray services are available but not necessarily performed by a trained radiology technologist. However, different professional associations and governments work with remote communities to provide vital medical services. For example, the Ontario Association of Medical Radiation Sciences works closely with the Nunavut government to provide training within communities to offer basic x-ray services by trained individuals.

The provincial and territory governments offer health care insurance to cover hospital and doctor services. Funding is also available to help supplement benefits for low-income residents and seniors for items not covered, such as prescriptions, ambulance services, dental care, vision,

and hearing care. Provinces may charge a premium to assist in paying for services but are not to limit access to basic services (Government of Canada, 2019a).

The Canadian Health Care system is financed through taxes at all levels of government: federal, provincial, territorial and some at the municipal level. When it comes to concerns such as sanitation, infectious diseases and health education, this responsibility is shared by all government levels.

## Radiology Resources and Services

### Radiology in Canada

The Canadian Association of Medical Radiology Technologists (CAMRT) has approximately 12,000 members consisting of technologists practicing in radiological imaging, magnetic resonance imaging (MRI), nuclear medicine, and radiation (CAMRT, 2021). The CAMRT's mission certifies that "medical radiation technologists (MRTs) have the required competencies to enter practice.  CAMRT supports its members and advances the profession through leadership in advocacy, education, and research enabling MRTs to provide the highest quality of care." (CAMRT, n.d.).  Membership with CAMRT is not mandatory; therefore the number of working technologists and therapists throughout Canada is higher.  Some provinces have provincial associations while others have a regulatory body.  Within Canada there are twenty-two programs that offer radiology imaging programs (X-ray), eight MRI programs, five nuclear medicine and nine programs for radiation therapy (Accreditation Canada, 2022). Institutions across Canada offer diploma, degree, and associate degrees programs, which vary in length from two to four years. Additionally, more than twenty educational institutions across Canada offer sonography programs, varying in length from one to two years (Sonography Canada, 2022). Further, after completing their medical studies, radiologists must complete a 5-year radiology residency program (excluding fellowships). There are sixteen residency programs for radiologists, and approximately 2100 practicing radiologists across the country (CAR, n.d.).

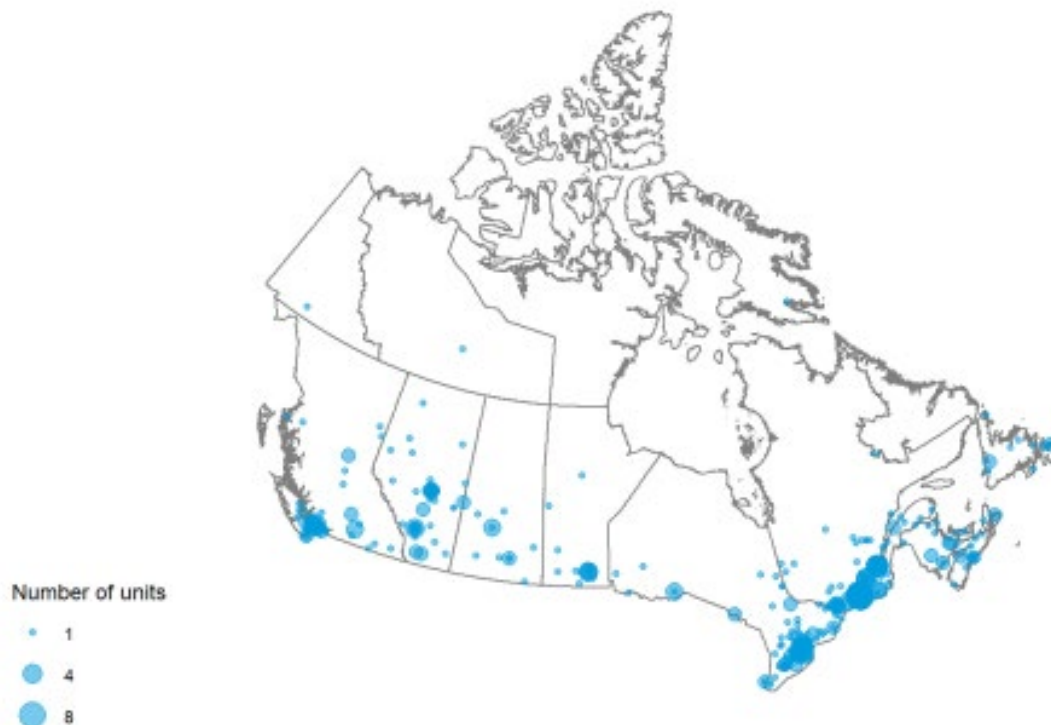### Disparities in Northern Canada – Lack of Access and Availability of Radiology

The Canadian Agency for Drugs and Technologies in Health (CADTH) recently published the Canadian Medical Imaging Inventory 2019-2020.  The Northwest Territories only has one CT scanner located in Yellowknife, its capital city. The 1 CT scan serves a population of 44,895 people, with over half not residing in Yellowknife. This means that over half of the population living in the Northwest Territories must travel to access CT imaging.  Further, CADTH (2021) reports that there are no MRI units in the Northwest Territories.   The Yukon, with a population of 41,022 people, has one CT scanner and one MRI scanner on its territory and Nunavut has one CT scanner, but no MRI scanner for a population of 38,873 People (CADTH, 2021).

CADTH's report brings forward the lack of equal access to CT (Figure 7) and MRI (Figure 8) in the provinces and territories.  For example, the province of Manitoba has a total population of 1,373,859 people, with 8 MRI scanners - all of which are located in the southern, more populated urban areas. Additionally, there are sixteen CT scanners in Manitoba, with only two located in the north region.  It is also reported that in 2019-2020, there were 288 MRI sites across Canada, with an average of 1.4 scanners per site. CADTH (2021) reported 2,330,223 MRI scans performed in Canada, averaging 6,164.6 scans per scanner. While in the same year, Canada had 369 CT sites with an average of 1.5 scanners per site. A total of 5,419,821 CT scans were performed across Canada with an average of 9,872.2 scans per scanner (CADTH, 2021).

**Figure 7**

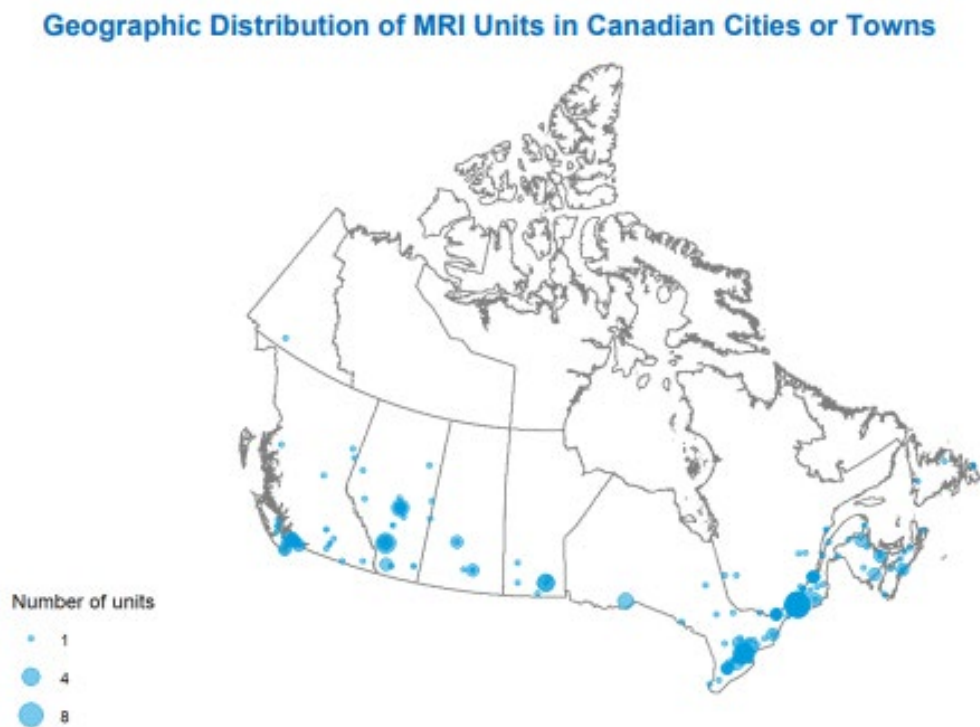*Geographic Distribution of CT Units in Canada*



Geographic Distribution of CT Units in Canadian Cities or Towns

Number of units
- 1
- 4
- 8

From CADTH (2021)

**Figure 8**

*Geographic Distribution of MRI Units in Canada*

**Geographic Distribution of MRI Units in Canadian Cities or Towns**
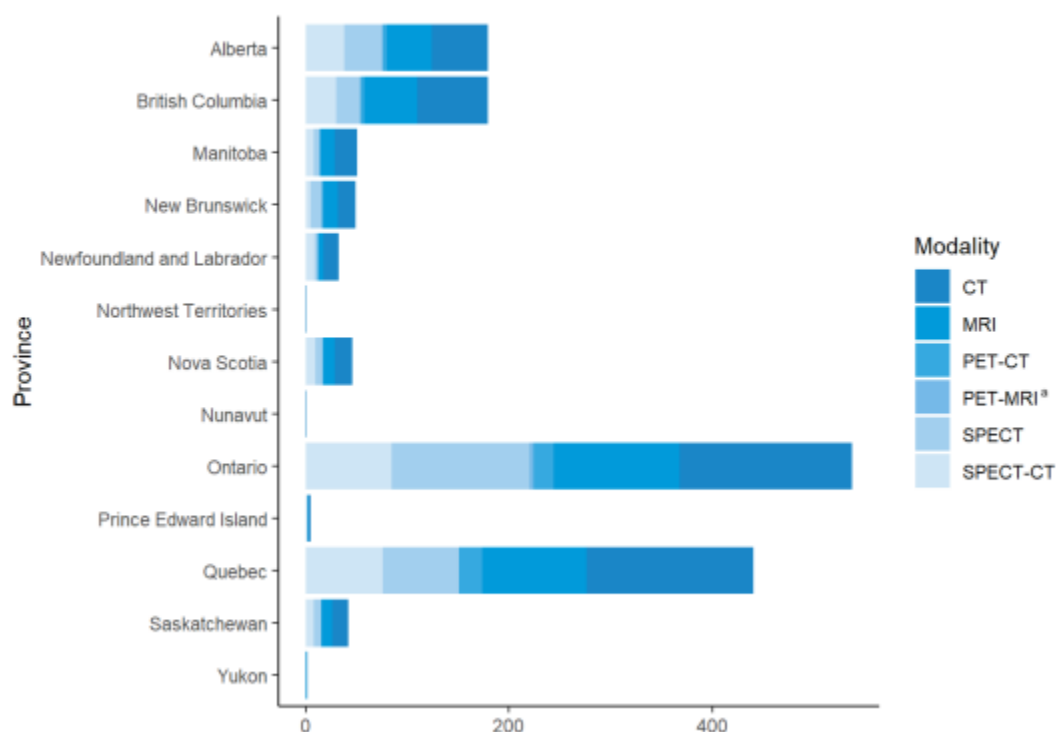
Number of units
· 1
● 4
● 8

From CADTH (2021)

**Figure 9**

*Canadian Medical Imaging Inventory*



Overall Provincial or Territorial Inventory of CT, MRI, PET or PET-CT, PET-MRI, SPECT, and SPECT-CT

From CADTH (2021)

It is not reported is how many of these scans were performed on individuals who had to travel for their imaging appointment. It would be interesting to know how many patients travelled over 300 km for their imaging needs. For example, residents of Thompson, Manitoba travel over 700 km to Winnipeg for an MRI scan. Even within provinces, radiology services are predominately located in the southern urban regions leaving the northern parts of the provinces without readily accessible healthcare. Patients in Yellowknife, the capital of the Northwest Territories, must travel to Edmonton, Alberta for an MRI which is nearly 1,500 km away (GlobeFeed.com, 2021). That is approximately a fifteen-hour drive on northern roads, in northern weather for access to MRI imaging. In consideration of the vast geographical extent of the country, Canadians in northern regions often need to travel a great distance to access imaging services.

To further exacerbate access to health services, travel in northern and remote regions of Canada can often be challenging. For example, many northern roads are not paved, which creates maintenance challenges due to the natural, unpreventable destruction caused by permafrost, or

winter roads that are only accessible during the coldest months with proper freeze up. Small engine planes fly throughout the north, but extreme cold weather and high winds often leave planes grounded. It would be interesting to record the impact of travel conditions on missed medical imaging appointments. Factors such as availability and accessibility to imaging services should be thoroughly considered when planning radiology services in northern Canada.

**RAD-AID Opportunities in Canada**

RAD-AID International's mission is "to improve and optimize access to medical imaging and radiology in low resource regions of the world for increasing radiology's contribution to global public health initiatives and patient care." (RAD-AID International, 2022). Undoubtedly, Canada's northern regions, predominately populated with Indigenous communities who have historically experienced challenges accessing basic health care, would benefit from RAD-AID's presence. Although availability and accessibility of services remains challenging, as denoted in previous sections, a recent publication by Sachdev et al. (2021) indicates that "regions in northern Canada with limited access to medical imaging may benefit from the delivery of mobile radiology services using a hybrid medical airship (MHA)", such as seen in Figure 10. An MHA operates as a mobile radiology clinic, bringing vital resources to underserved populations, mitigating the challenges with access and availability of resources. When operationalized, the RAD-AID MHA may be able to bring radiology health care services, helping reduce disparities to northern Canadian populations which represent nearly 20% of the Canadian population (O'Neill, 2022).

**Figure 10**

*Rendering of RAD-AID Medical Hybrid Airship*



From RAD-AID International (2022)

## Conclusion

"Access to radiology services is critical for disease prevention, surveillance and treatment. Despite the importance of such services, residents of northern Canada, including the territories and northern regions of the provinces face significant health care disparities such as decreased health care utilization, lower life expectancy, and increase mortality" (Sachdev et al., 2021).  Although Canada has radiology resources and services to support its population, most radiology services are located in urban regions, making it challenging for those living in remote locations to access radiology services and at times basic health care. There are parts of northern Canada where health care remains underdeveloped and can be compared to other under-resourced regions of the world.  The cost to travel from the north to urban regions to access care adds to these challenges of accessing basic needs. Work needs to be done to increase the availability  and accessibility of radiology services to the population living in northern Canada.

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