



The socioeconomic cost of, and impact of COVID-19 on, multiple sclerosis in Canada

MS Canada

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Glossary

Acronym	Full name
AWE	Average weekly earnings
CCC	Canada caregiver credit
CCDSS	Canadian Chronic Disease Surveillance System
CCHS	Canadian Community Health Survey
CCRS	Continuing Care Reporting System
CDMS	Clinically definite multiple sclerosis
CIHI	Canadian Institute for Health Information
CIS	Clinically isolated syndrome
CNS	Central nervous system
CPP-D	Canada Pension Plan disability benefit
DAD	Discharge Abstract Database
DALY	Disability-adjusted life years
DIN	Drug identification number
DMT	Disease-modifying therapy
DTC	Disability tax credit
ED	Emergency department
EDSS	Expanded disability status scale
GP	General practitioner
HCRS	Home Care Reporting System
LHS	Left-hand side
MRI	Magnetic resonance imaging
MS	Multiple sclerosis
NACRS	National Ambulatory Care Reporting System
NPDUIS	National Prescription Drug Utilization Information System
NPV	Net present value
NRS	National Rehabilitation Reporting System (NRS)
PHAC	Public Health Agency of Canada
PPMS	Primary progressive multiple sclerosis
RHS	Right-hand side
RRMS	Relapsing-remitting multiple sclerosis
SME	Subject matter expert
SPMS	Secondary progressive multiple sclerosis
TRIBUNE	Treatment, experience, burden, and unmet needs
VSLY	Value of a statistical life year
YLD	Years of healthy life lost due to living with a disability
YLL	Years of life lost due to premature death

Executive summary

Canada has one of the highest rates of MS in the world, with around 305 cases per 100,000 persons. This study and its findings estimated the socioeconomic cost of MS to be \$3.4 billion in 2019. A reduction in service delivery between 2020 and 2022 was estimated to have decreased expenditure by nearly \$566 million. This reduction in health expenditure created a backlog in health services estimated to require \$73 million in incremental costs in 2024 alone, and this will continue in future years.

Background

Canada has one of the highest rates of multiple sclerosis (MS) in the world.¹ It is the most common neurological disease among young adults in Canada, imposing a considerable cost on the health system and Canadian society more broadly.² The economic cost of MS has been estimated in other countries such as the U.S., the Netherlands and Australia, yet few studies have assessed the cost of MS in Canada, with an exception being a microsimulation modelling study published in 2017.^{3,4}

The COVID-19 pandemic significantly disrupted the delivery of health care to Canadians, including the 90,000 people living with MS.¹ A range of restrictions put in place to limit the spread of COVID-19, combined with behavioural changes stemming from these restrictions, led to significant changes in the way that services were delivered and accessed. These changes are likely to have led to a reduction in the total cost of MS in Canada during years directly affected by the restrictions. It is likely that costs in future years will increase as the longer-term consequences of the pandemic arise. The uncertainty of the extent and duration of these impacts limits the ability of health advocates and policymakers to respond effectively to meet the needs of people with MS.

MS Canada commissioned Deloitte Access Economics to undertake this study with two broad objectives:

1. Provide an up-to-date estimate of the socioeconomic cost of MS in Canada in a typical year before the pandemic (2019).
2. Estimate the health-related economic impact of COVID-19 on the MS community in Canada between 2020 and 2024. This component also considers impacts of changes to disease-modifying therapy (DMT) schedules and delayed diagnosis on the health outcomes of people living with MS.

The purpose of the report is to improve advocacy nationally and provincially and to inform policy decisions with an improved understanding of the consequences of the COVID-19 for people with MS and their caregivers.

Prevalence of MS in Canada

There are approximately **90,000 people living with MS in Canada**, equivalent to **1 in every 400 people**, or around 305 per 100,000 in the adult population.¹ Around three quarters of people living with MS in Canada are women, higher than the global average of two thirds.¹ Data from the Canadian Chronic Disease Surveillance System (CCDSS) shows there is some variation in MS prevalence across province and territories.⁵ Nova Scotia is shown to have the highest prevalence (355 persons per 100,000 population), while Newfoundland & Labrador is reported to have the lowest (169 per 100,000).

While this report recognizes the total number of people living with MS in Canada to be approximately 90,000, as reported by the Atlas of MS,¹ data from the CCDSS were used for the purpose of estimating the annual cost of MS. Figure i explains the differences between these two data sources and the reasoning for using the CCDSS data for costing.

Figure i: Prevalence-related considerations for estimating the costs attributable to MS in Canada

There are two main data sources available for estimating the number of people living with MS in Canada. These are the CCDSS and the Canadian Community Health Survey (CCHS). The CCDSS is a survey maintained by the Public Health Agency of Canada (PHAC),⁵ while the CCHS is maintained by Statistics Canada.

The two surveys use different sampling methodologies and produce different estimates of the number of people with MS in Canada. The CCDSS is based on health claims administrative data, in which people are required to have accessed multiple health services over a given period to be recorded as having MS. In contrast, the CCHS is a household survey in which participants self-report having MS. The CCHS was most recently conducted in 2010/11 and the CCDSS in 2014/15. Using the CCDSS data, it is estimated that just over 80,000 people in Canada are living with MS. The CCHS suggests that

this number could be 90,000 or more, as reported in the Atlas of MS.¹

For the purposes of this study, it was decided that the CCDSS survey methodology aligns more closely with the objectives of the current work (estimating the cost of MS in a single year) and other literature and data used as inputs to the modelling.

While the use of the CCDSS data was considered the most appropriate choice from a modelling perspective given the current study's parameters, it is acknowledged that some estimates presented within this study may be conservative due to potential omission of individuals who have less frequent interaction with the health system.

Annual cost of illness of MS in Canada

MS was estimated to cost more than **\$3.4 billion** in Canada in 2019. This comprises direct expenditure on the health system (38% of total), productivity losses (39%), and a range of other financial costs (e.g., aids and home modifications; 23%). This is equivalent to a cost of over **\$42,880 per case of MS**. This estimate is consistent with those from the TRIBUNE in MS study in 2012 which found that the average costs for people with mild, moderate, and severe disability were approximately \$30,800, \$46,600, and \$78,000 respectively.²

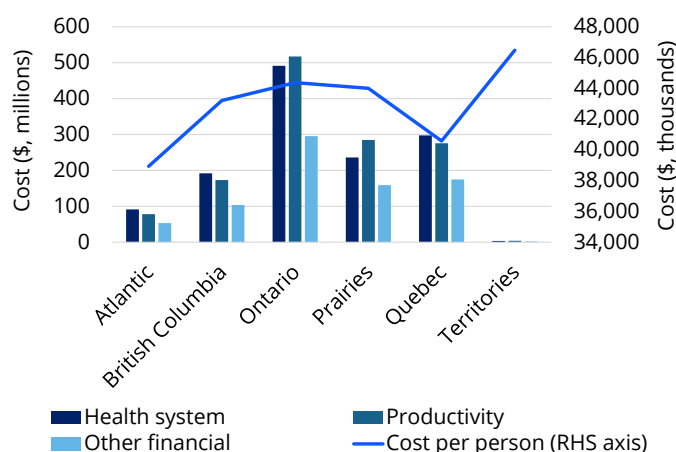
Pharmaceuticals were responsible for most of the cost to the health system, with an estimated **\$1.1 billion (or 87% of health system costs)** in expenditure in 2019. The substantial expenditure on pharmaceuticals largely relates to the scientific innovation and access to DMTs in the last two decades. DMTs are revolutionary treatment options that can slow progression and change the trajectory of MS, a condition which was previously considered non-treatable. The annual costs of DMTs range from \$6,000 to over \$50,000,⁶ where the majority is covered by government programs.⁷ A recent study estimated that the excess (i.e., out-of-pocket) cost of medications associated with MS was approximately \$11,300 in DMT users, which decreased to \$450 in non-DMT users, suggesting that DMT imposes significant out-of-pocket costs to people with MS.⁸

While DMTs are generally subsidised through provincial and territorial health plans, there are significant differences across provinces. The high out-of-pocket cost of MS and the difficulty in navigating the claim system can make it difficult to access DMT among people with MS. There are also other barriers to access, like the approval lag time between a DMT entering the market and its inclusion on the public drug reimbursement list.⁹ Many people with MS also claim DMT reimbursement through their private health insurance. However, some private insurance plans do not cover DMTs, requiring an individual to acquire provincial health plans in addition to their private plans to access DMTs.

Beyond pharmaceutical costs, around **\$170 million in expenditure was made in 2019 on other components of the health system**. This includes inpatient care, outpatient care, emergency department presentations, general practitioner and specialist consultations, and attributable expenditure on

falls and depression. There was a further **\$1.3 billion in indirect costs relating to productivity losses**, including reduced employment, absenteeism, presenteeism, premature mortality, and informal care. Finally, nearly **\$790 million in other financial costs** related to aids and modifications, formal home-based and long-term care, support payments, and deadweight losses (the burden of excess taxation), much of which was borne by individuals.

Chart i: Socioeconomic costs of MS in Canada in 2019



Source: Deloitte Access Economics analysis.

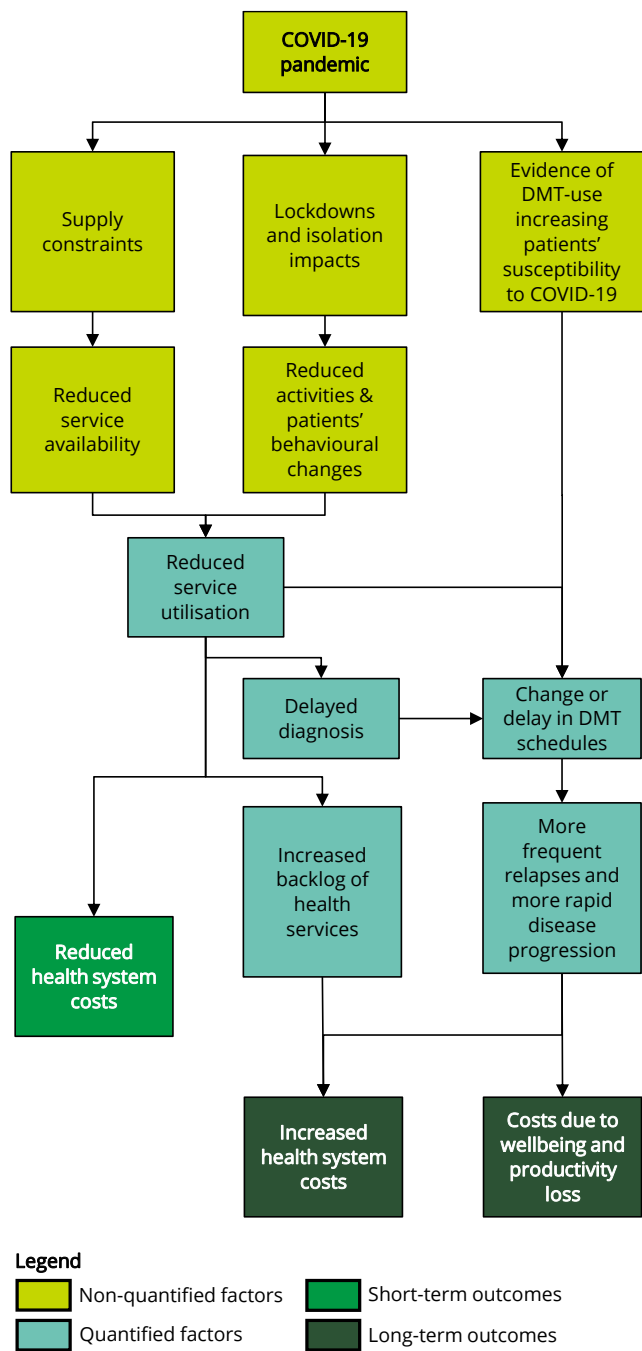
The COVID-19 pandemic and expenditure on MS in Canada

The substantial cost of MS in a typical undisrupted year (i.e., 2019) relates to its management (of symptoms, comorbidities, and complications) and treatment (e.g., use of DMTs) intersecting with many parts of the health system. This report evaluates whether the pandemic has resulted in significant change in the types and quality of health care received by people living with MS. It considers three of the most experienced impacts:

1. Supply constraints within the health system due to the reallocation of resources to address COVID-19
2. Changes in service utilization driven by public health mandates (e.g., lockdowns and social isolation) and related behavioural changes (e.g., hesitancy to visit clinics) designed to slow the transmission of COVID-19
3. Changes in treatments with certain classes of DMTs (anti-CD20 and S1Ps) due to emerging evidence of the potential risks of poorer outcomes from COVID-19 infection and vaccination.

Figure ii depicts these three impacts and the pathways through which they affected people living with MS. It was designed based on analysis and interpretation of data collected through desktop review of publicly available information, data requested from the Canadian Institute for Health Information (CIHI), and stakeholder engagement. As shown, the impacts created service backlogs and negatively affected MS patient outcomes in terms of relapse management, disease progression and disability accumulation. This is due in large part to delayed diagnosis and treatment of the disease as timeliness of diagnosis is known to be an important factor in disease outcomes.

Figure ii: Impact of COVID-19 pandemic on MS outcomes



Source: Deloitte Access Economics.

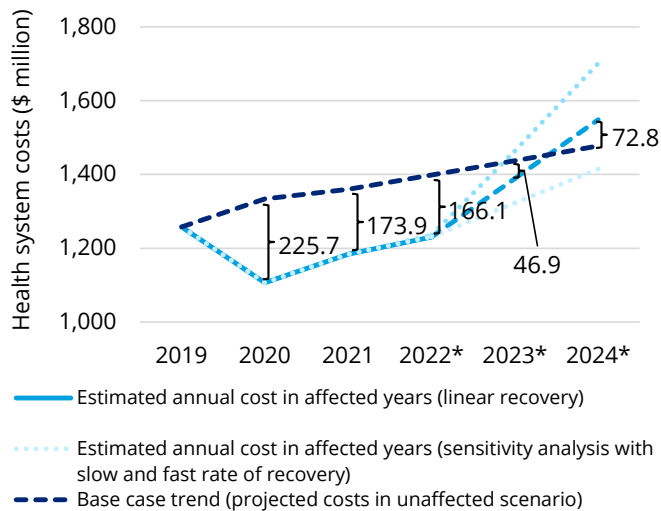
This study estimated that changes in the provision of health services between 2020 and 2022 **reduced MS-related health expenditure by \$566 million** (Chart ii). This represents a 13% reduction compared to the expenditure that would have been expected (“base case” in Chart ii) in these years had COVID-related disruptions not occurred.

This not only includes individuals who missed services during the impacted period but also those who received virtual rather than in-person care. The proportion of the Canadian population that received virtual care between March 2020 and March 2021 was estimated to be in the range of 24% to 42%.¹⁰ The backlog in health service provision impacted on MS treatment and diagnosis and led

to an overall worsening in the health state of many people with MS. This is likely to have long-term consequences for people with MS and create considerable strain on the health system during the post-pandemic recovery, leading to additional costs in future years.

It was found that the reduction in health system costs (relative to expected “base case” costs) was likely to persist until mid-2023 due to the time required for the health system to recalibrate from the impacts of the pandemic. Beyond this point, **health system costs related to MS are estimated to rise to \$1.47 billion in 2024, representing an incremental cost of \$72.8 million compared to the base case of an unaffected year**. Projections also indicate that this effect is likely to extend beyond the timeframe modelled in this study due to the lasting effects of the backlog in health services.

Chart ii: Incremental health system costs, estimated actual vs base trend, 2019 to 2024



Source: Deloitte Access Economics analysis.

Notes: *Figures for 2022, 2023 and 2024 in affected years are projected.

Sensitivity analysis was applied with fast (1.5 times) and slow (0.5 times) rate of recovery.

Timely and effective treatment of MS is important in managing disease activity to maintain function and wellbeing of people with MS. While management and treatment of MS symptoms, complications and progression involve a multidisciplinary health care team, in terms of the impact of the pandemic, this study specifically explored the **impacts of changes to DMT schedules and delayed diagnosis on the health outcomes** of people living with MS and attempted to quantify the associated costs. Analysis found that delays and changes to existing DMT courses were estimated to lead to an additional **\$35 million** in costs to the Canadian health system, \$89 million in productivity loss, and \$401 million in loss of wellbeing between 2020 and 2024. Delayed diagnosis of MS during the pandemic was estimated to cost a total of **\$5.3 million** to the Canadian health system, \$8.9 million in productivity losses and \$40.2 million in lost wellbeing between 2020 and 2024.

Consultations with MS clinicians and review of research literature validated findings from this modelling analysis: evidence suggested that delays and changes to DMT schedule can lead to irreversible disease progression.¹¹ The additional costs associated with these alterations are widely thought to persist into the future.

Reduction in rehabilitation, coupled with a lack of social and cognitive stimulation during the pandemic, are also expected to result in increased disability progression.¹² While there was insufficient data available to allow quantitative modelling, the effects of rehabilitation and social interaction were assessed qualitatively through literature review and stakeholder engagement. According to several MS clinicians interviewed in this study, the impact was particularly significant for people with a moderate disability level who were at risk of progressing to a high disability level.

Where to from here?

This study provided an updated estimate of the socioeconomic costs of MS in Canada in 2019, along with a modelled estimate of the impact of the pandemic on those costs. As these events are ongoing, the assessment of the impact of the pandemic was based on best available evidence at the time of report preparation (May 2023). This study highlighted the significant reduction in health service access among people with MS during the pandemic. As a chronic disease that requires consistent treatment and management, unmet health needs of people with MS accumulated during the pandemic-affected years, primarily between 2020 and 2022. Based on findings from this study, these impacts will have a long-lasting impact on the health outcomes of people with MS.

Findings presented here are expected to provide a framework to understand and assess the potential consequences of the pandemic on people with MS. Informed predictions on these potential consequences may guide swift and timely policy decisions related to MS health care services to mitigate “snowballing” of negative outcomes. Policymakers and advocacy groups can utilise findings from this report to identify areas of MS health care that require further investments and/or changes for the benefit of both people with MS and their families, and the broader society in Canada.

Further data collection and evidence generation are required to uncover the true extent of the impact of the pandemic on MS in Canada for years to come. This study identified several gaps in data collection, including utilization of neurologist visits, utilization of rehabilitation and a more comprehensive and complete pharmaceutical data. The approach and results from this study should serve as a guide for researchers to expand and update the model as more data becomes available.

Deloitte Access Economics

1 Introduction

This chapter provides background information on MS including its causes, symptoms, and treatment, as well as a summary of the impacts of the COVID-19 pandemic on the MS community and an overview of the contents of this report.

MS is a chronic immune-mediated disease of the central nervous system (CNS).¹ Estimates suggest that there are between 80,000 and 90,000 people living with MS in Canada, equating to around 1 in every 400 people.¹³ Around three quarters of people living with MS in Canada are women.¹ This proportion is higher than the global average (approximately 69%), although the reasons for this remain unclear.¹

On average, 12 Canadians are diagnosed with MS every day.¹ The average age of an MS diagnosis in Canada is 43, with most people diagnosed between the ages of 20 and 49.¹ Although there is no cure at present, people with MS can utilise health care to manage the disease.¹

1.1 Causes of MS

For people living with MS, the immune system incorrectly attacks the myelin sheath of nerve fibers in the CNS, including the brain, spinal cord and optic nerve.¹ This attack causes inflammation, which impacts nerve cell processes and alters electrical message transmission from the brain to the rest of the body.¹⁴ As a result, MS can affect vision, cognition, balance and mobility. MS is unpredictable and it affects each person differently depending on the site and severity of the nerve inflammation.¹⁴ MS can appear as both an episodic disability and progressive disease.¹

While the exact cause(s) of MS is incompletely understood, current evidence points to a range of risk factors that may increase the chance of developing the disease. This includes environmental and lifestyle risk factors such as vitamin D deficiency, obesity, and smoking, as well as infectious risk factors like the Epstein-Barr virus. Variations in specific genes are also being studied as possible risk factors for MS, as are changes in the gut microbiome.^{15, 16}

1.1.1 Types of MS

MS has traditionally been categorised into four types as defined by the International Advisory Committee on Clinical Trials in Multiple Sclerosis:¹⁷

- **Clinically isolated syndrome (CIS):** CIS refers to a single episode of neurological symptoms suggestive of MS. It is the earliest form of the disease. Initial diagnosis of CIS is challenging as the symptom(s) can be easily overlooked or attributed to other underlying conditions, making the actual rate of CIS unclear. Evidence has shown that the annual incidence of two of the most common types of CIS, optic neuritis and transverse myelitis, may be around 75.9 per 100,000 people and 18.3 per 100,000 people respectively.¹⁸ The proportion of people with CIS that progress to relapsing-remitting MS varies by type of CIS and magnetic resonance imaging (MRI) observations. Approximately 85% of individuals with CIS experience a second clinical demyelinating event and are diagnosed with clinically definite MS (CDMS).¹⁹ The overall proportion of people progressing to CDMS may be much lower when accounting for the diagnosis challenges.
- **Relapsing-remitting MS (RRMS):** RRMS is the most common subtype of MS at the time of diagnosis, affecting around 85-90% of people living with MS.²⁰ RRMS is characterised by clear onset of the symptoms over a period of hours to days. These are termed relapses, attacks or flare-ups. Symptoms typically persist for days or weeks, before a period of remission when the symptoms dissipate and the patient recovers to near pre-relapse function. Without treatment, most people with RRMS will experience new or existing symptoms that gradually worsen.
- **Secondary progressive MS (SPMS):** Over time, most people with RRMS will transition to a phase of the disease called secondary progressive MS (SPMS). This phase of the disease commonly has fewer relapses with variable disability progression.²¹ The time taken for people with RRMS to transition to SPMS varies widely.
- **Primary progressive MS (PPMS):** Around 10% of people living with MS at diagnosis will have primary progressive MS.²² It is characterized by a slow accumulation of disability from the start of their MS disease. About five per cent of people diagnosed with PPMS experience occasional relapses with steadily worsening disease from the beginning. At present, the pathological distinction between SPMS and PPMS remains clinically challenging.²³

While these MS types are commonly used in both clinical and research settings, recent evidence suggests that MS should be considered as a continuum rather than distinct subtypes.²⁴ Under the evolving mechanism-driven approach, MS progression is considered a result of changes in the relative expression and locations of concurrent pathophysiological processes driven by factors such as sex, age, genetic factors and environmental exposures.²⁴ This continuum MS framework is supported by

emerging evidence that people with MS share pathology features such as inflammation and neurodegeneration at disease onset.²⁵ In the near future, the International Advisory Committee on Clinical Trials in Multiple Sclerosis is expected to update the MS classifications based on a more comprehensive disease framework.

1.1.2 Symptoms of MS

Symptoms of MS are unpredictable. They vary greatly from person to person and can fluctuate over time and in intensity.¹ Common symptoms of MS include impaired cognition; mood disorders; fatigue; impaired coordination and mobility; vision problems; difficulty swallowing; speech impairment; sensory deficits; and bowel, bladder, and sexual dysfunction.^{1, 26}

These primary symptoms of MS can also lead to secondary complications. For example, urinary tract infections are a common result of bladder dysfunction, while decreased bone density and increased risk of fracture can arise due to reduced mobility.²⁷

The presence of MS and its symptoms can impact on various aspects of an individual's life. It may cause people to withdraw from social interactions and negatively affect their social networks.¹ It can also pose challenges to maintaining continued and long-term employment. As a result, MS can lead to significant downstream social, psychological, emotional and financial impacts for people living with the disease.

1.2 Treatment, management, and care for people with MS

MS is a complex disease that can significantly impact a person's health, wellbeing, and life. It necessitates a multidisciplinary approach to deliver effective care. The typical health care for MS incorporates diagnosis, treatment using DMT, management of the symptoms, comorbidities and complications, rehabilitation and caring.

As shown in Figure 1.1, people with MS commonly receive treatment of acute relapses, management of chronic symptoms, support and rehabilitation to assist in coping and maintaining function, and where possible, DMTs to modify the course of the disease by reducing relapses and disability progression.²⁸ Early diagnosis of MS is important as starting appropriate treatments as soon as possible can lead to improved outcomes for people with MS, thereby offsetting some of the costs associated with the disease.

Due to the complex and layered needs of people with MS, it is recommended that people with MS have access to multidisciplinary MS care that includes MS nurses, MS neurologists, neuropsychologists, physiotherapists, occupational therapists, social workers, speech and language therapists, and clinical psychologists.²⁹

In addition to costs incurred through the Canadian health system, it should also be noted that people with MS often pick up additional self-care costs through nutrition and exercise to maintain health as part of the "medical model+", although this is not modelled in this study due to the relatively limited data in this area.³⁰

Figure 1.1: Diagnosis, treatment, rehabilitation, and care for people with MS in Canada

Areas	Diagnosis	Pharmaceutical treatment and management	Non-pharmaceutical treatment and management	Caring and activity-based programs
Descriptions	There is currently no single test that can diagnose MS by itself. The diagnosis of MS is based on careful history, examination and diagnostic testing, including MRI and possibly cerebrospinal fluid examination. Early diagnosis of MS is important: starting appropriate treatments as soon as possible leads to improved outcome.	Pharmaceuticals are used for the treatment of MS (DMT) through immunomodulation and to manage relapses and MS symptoms and complications. Slowing the accumulation of nerve damage can also reduce or prevent further disability as a result of MS progression.	People with MS also require non-pharmaceutical treatment including rehabilitation and mental health care. Rehabilitation is essential for many people with MS to maintain various functions and improve their general day-to-day wellbeing. Psychological therapy provides support to people with MS to maintain their mental health.	People with MS often require physical care, emotional support and social support as a result of MS symptoms and increased disability. The level of care needs varies from person to person. It can include medical support and daily activities, as well as aids and modifications to living areas.
Components	Neurologic examination refers to testings of the functioning of an individual's nervous system, in areas such as mental status, motor function, sensory, reflexes, and coordination. This is usually conducted by a neurologist. Magnetic resonance imaging (MRI) is a non-invasive imaging technology that produces three dimensional detailed anatomical images. MRI of the brain and/or spinal cord allows identification of lesions or scars typical of MS. Other laboratory test: lumbar puncture evaluates the presence of immunological abnormalities in cerebrospinal fluid.	Disease-modifying therapies (DMTs), are used to modify the disease course through immunomodulation, thereby reducing relapses and disability progression. Relapse management therapies are short-course medications that help to reduce the inflammation in the CNS. A standard steroid treatment is typically a three to five-day course methylprednisolone or prednisone. Symptom management therapies are provided by specialists such as urologists, orthopedists, gastroenterologists. Medications include those that target symptoms. E.g., painkillers to relief pain, CNS stimulant to address fatigue.	Examples include (non-exhaustive list): • Physiotherapy to improve mobility, strength, balance, and pain • occupational therapy to enhance independence, productivity, and safety • speech therapy to treat speech and/or swallowing problems • neuropsychological testing to determine cognitive abilities and functional management • cognitive rehabilitation to improve ability to think, reason, concentrate or remember • vocational rehabilitation to support employment through training and job placement assistance • psychological therapy to address mood disorders and mental health issues.	Formal care: (1) day programs provide supervised community activities, (2) home care and visiting nurses provide personal assistance in the privacy of their own home, (3) long-term care facilities provide a range of care services, including medical services, personal services, accommodations, meals, and access to 24-hour professional nursing services Informal care is also commonly provided by friends and family for people with MS. They usually provide ongoing care and emotional support for people with MS on a day-to-day basis. Caregiving may incur additional mental, emotional and financial costs for caregivers. Modifications to living areas are also used to improve accessibility, safety and independence.

Source: Embrey (2014).³¹

1.2.1 MS health care in Canada

The health system in Canada is made up of 13 interlinked provincial and territorial health systems, as well as federal health care (for indigenous peoples, Royal Canadian Mounted Police and Canadian forces).³² The roles and responsibilities are shared between federal and provincial governments, where the provincial and territorial governments have the jurisdictions over most of the management, organization, and delivery of health services in Canada, while the federal government is partially responsible for the funding of health system through the Canada Health Transfer and for people under federal care.

In Canada, people with MS can access services through tertiary MS clinics across the country.¹ These clinics are part of a connected Canadian Network of MS Clinics. These are health-authority funded, with variable resources in multi-disciplinary health care professionals, but all having MS specialized neurologists and MS nurses. There are also community neurologists who provide care to people living with MS across Canada.

People with MS also access general practitioners (GPs) and other types of health care to manage symptoms, complications, and comorbidities. Under Canada's national health insurance program, Medicare, payments for medical services including GP visits, specialist visit, hospitalization, and emergency department (ED) visits are generally fully covered.³² Coverage for other types of health care services such as rehabilitation and aids are excluded in most public health insurance programs. However, depending on an individual's financial status, aids can be fully or partially covered under other provincial support programs (i.e., income support).

While prescription medications and pharmaceuticals are generally not covered under Medicare, many types of DMTs can be reimbursed through provincial medication programs and private insurance plans.³³ The Canadian drug reimbursement system is fragmented and can be difficult to navigate, with over 100 government-run public drug insurance programs and thousands of private drug benefit plans.⁷ The breadth of coverage of these programs also varies significantly across provinces. Canadians over 65 years of age are generally enrolled in a public plan, and those under 25 years of age may access public drug insurance programs if they are not a beneficiary of their parents' private employer-based plan (around 75% of working-age adults are enrolled in a private group plan through their employer).⁷ People without access to an employer-based group plan or a public drug insurance program must either purchase their own prescription drug insurance or pay for medications out-of-pocket.

The Canadian health system was facing financing and workforce sustainability challenges (e.g., to meet the increasing health care needs of its ageing population) prior to the onset of COVID-19.³⁴ Despite having the second highest (out of 28 developed countries) health expenditure as a percentage of gross domestic product (GDP), Canada ranks low on lists of physician availability, acute care beds, and hospital activity measured through discharges rates from curative care.³⁵ These challenges also relate specifically to MS health care, with concerns arising regarding the affordability of treatments and equity of access to MS specialists and rehabilitation services across Canada.³⁶ People living with MS also face the persistent issue of long wait times for treatments and diagnostic services which can adversely impact health outcomes.³⁷

1.3 MS and the COVID-19 pandemic

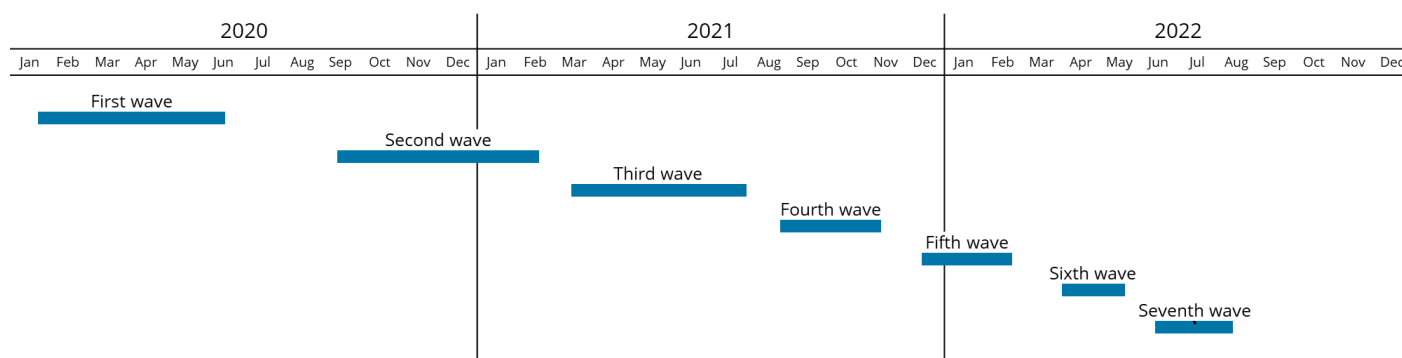
The COVID-19 pandemic and associated public health restrictions during 2020-2022 caused substantial disruption to the provision of health care services in Canada, adversely impacting people living with MS.

Canada experienced seven waves of infections since the onset of COVID-19, as shown in Figure 1.2.^{38,39} Public health measures designed to reduce the spread of infections varied across provinces and territories.³⁸ From March 2020, social restrictions were implemented at least in some parts of the country to limit the spread of infections. These included:

- school, workplace and public transport closures
- stay-at-home requirements
- cancellation of public events
- restrictions on public gatherings
- public information campaigns
- restrictions on internal movements
- the closure of the US-Canada border for non-essential travel and other international travel controls.⁴⁰

The Oxford stringency index (a measure of societal restrictions to reduce the spread of the virus) ranks Canada to have implemented the second most stringent measures among G10 countries.⁴⁰ However, this was not necessarily consistent across all provinces and territories, or across rural and urban settings. In addition to these official public health measures, research suggests that the fear of contracting COVID-19 resulted in anxiety among people with chronic diseases and created hesitancy to visit clinics and hospitals.⁴¹

Figure 1.2: Timing of COVID-19 waves of infection in Canada (2020-2022)



Source: Deloitte Access Economics based on Detsky (2021) and Detsky (2022).

With the onset of the COVID-19 pandemic, health resources in Canada were reallocated with the aim of responding to a potential surge in cases. This posed a challenge in balancing the treatment of patients with COVID-19 and those with other health issues. Hospital systems in Canada prioritized urgent and life-saving treatments and relocated human resources to areas of greatest need, such as ICUs.⁴² Changes to health care services resulted in significant disruption to the treatment and management of patients with chronic diseases, such as MS. A national survey found that two thirds of Canadians living with a chronic condition had difficulty accessing care in 2020.⁴²

The level of care in long-term care facilities also greatly deteriorated during the pandemic. Long-term care residents had fewer visits from physicians, less contact with unpaid caregivers such as family and friends, and fewer transfers to hospital for medical care.⁴³ The pandemic response also saw many health services move to the virtual space, with virtual care becoming a primary tool for specialists and primary care physicians. Between 27% and 57% of physician services took place online in this period.⁴²

The pandemic also caused other adverse consequences, including worsening self-reported mental health among adults. Survey research found that positive mental health outcomes declined compared to 2019 levels.⁴⁴ The erosion of protective factors such as social interaction, daily routines and access to health care due to social restrictions may explain the adverse mental health outcomes during the pandemic. Some people living with MS felt these adverse impacts more acutely, as research suggested that their anxiety and depression had worsened during the COVID-19 pandemic.⁴⁵

1.4 Purpose and scope of this report

MS Canada commissioned Deloitte Access Economics to undertake this study with two broad objectives:

1. Provide an up-to-date estimate of the **socioeconomic cost of MS** in Canada in a typical year before the pandemic (2019).
2. Estimate the **health-related economic impact of COVID-19 on the MS community** in Canada between 2020 and 2024. This component also considers impacts of changes to disease-modifying therapy (DMT) schedules and delayed diagnosis on the health outcomes of people living with MS.

The epidemiology (disease prevalence) of MS in Canada informs this study. The socioeconomic cost of MS includes its associated costs to the health system, productivity losses, other financial costs (such as expenditure on aids and modifications), and non-financial costs (i.e., the value of lost wellbeing). The first part of this report describes the socioeconomic cost of MS in 2019 to represent a typical year prior to the pandemic. The second part of this report estimates the effect of the pandemic on the MS health care and subsequently quantifies the change in some components of the socioeconomic cost of MS between 2020 and 2024. As MS is a chronic disease, the impact of the pandemic is expected to last into the longer term (e.g., >5 years). However, due to data limitations and the time of publication, this report focuses on the impact between 2020 and 2024.

The remainder of the report is organised as follows:

- **Chapter 2 – Methodology:** Summarises the approach and methods of this study. More detailed description of the methodology is available in the appendix.
- **Chapter 3 – Epidemiology of MS in Canada:** Describes the prevalence of, and the number of deaths from, MS in 2019.
- **Chapter 4 – Costing the impacts of MS:** Presents estimates of the socioeconomic cost of MS in 2019, organised by cost component.
- **Chapter 5 – MS and the COVID-19 pandemic:** Presents findings from the COVID-19 impact modelling.
- **Chapter 6 – Conclusion:** Describes the key findings and implications from this study.

2 Methodology

This chapter presents a summary of the methodology and data sources used to estimate the socioeconomic cost of MS in Canada in 2019, and the impact of COVID-19 on the MS community.

2.1 Project scope

This study includes two broad analytical components:

- **The socioeconomic cost of MS**, which considers the costs relating to the socioeconomic impact of MS that occurred in the calendar year 2019. It includes the costs incurred during 2019 for people with MS (e.g., direct expenditure on health care, indirect costs relating to productivity losses, other out-of-pocket costs to the individual such as aids and modifications) and some costs incurred in future years which were directly related to impacts occurring in 2019 (e.g., premature deaths). The costs in future years were discounted to 2019 values.
- **The impact of COVID-19 on the MS community**, which seeks to understand how the pandemic has affected people living with MS, relative to the baseline of 2019. This component draws on emerging evidence of changes in individuals' interaction with health services and lifestyles (e.g., social isolation, physical activity levels). It also leverages information about the prescription of, and adherence to, DMTs to identify changes in the severity of their disease. Costs relating to changes in disease state were estimated using inputs from the socioeconomic cost component.

A summary of the approaches for these two modelling components is provided in the following sub-sections, while detailed discussion is provided in Appendix B and Appendix C for the cost of illness and COVID impact modelling, respectively.

All monetary figures are expressed in Canadian dollars in the relevant years adjusted to account for inflation (e.g., growth in consumer prices, wages, health prices etc.) unless specified otherwise. This means that all monetary figures in Chapter 4: 'Costing the impacts of MS' are expressed in 2019 dollars. Monetary figures in Chapter 5: 'MS and the COVID-19 pandemic' are expressed in dollars of the respective years between 2019 and 2024, except for when real values are compared across years, in which case it was specified that they were converted to 2019 values.

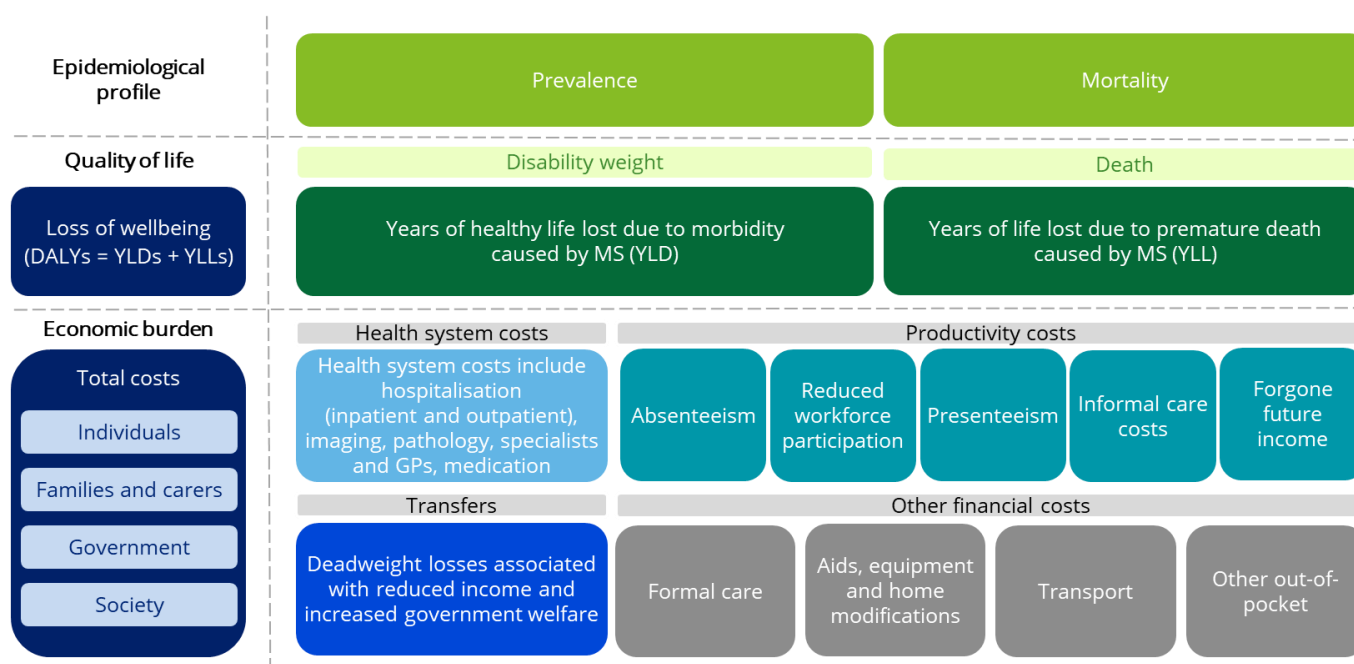
2.2 Cost of illness methodology

A cost of illness methodology was used to estimate the socioeconomic cost of MS in Canada in 2019. Figure 2.1 provides an overview of the cost of illness model framework based on a prevalence approach.

The components of the cost of illness model framework include:

- The prevalence of MS
- Premature mortality attributable to MS
- Economic costs including health system costs, productivity costs, other financial costs (e.g., aids and modifications) and transfer costs
- Loss of wellbeing arising from the premature death and increasing disability associated with MS.

Figure 2.1: Cost of illness model framework overview



Source: Deloitte Access Economics.

The costs for each of these components are stratified by age, sex, and location (province and territory) throughout the report. The costs have also been stratified by cost bearer, including individuals living with the disease, their families and caregivers, the government, and society. The exact distribution depends on the nature of the cost component (e.g., wellbeing costs are solely borne by individuals living with MS). It is noted that MS is also likely to cause reduced wellbeing among spouses, family members, and other people close to an individual living with the disease. These impacts were not quantified in this report due to a lack of available data; it is not intended to minimize the impacts on other individuals' wellbeing.

Grouping of some provinces and territories was deemed necessary due to the volume of data available. The main results presented throughout the body of this report use the following groupings:

- Atlantic: New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island.
- British Columbia
- Ontario
- Prairies: Alberta, Manitoba, and Saskatchewan.
- Quebec
- Territories: Northwest Territories, Nunavut, and Yukon.

Detailed results for each province and territory are provided in the appendix. Some results, particularly for territories, are omitted owing to poor data quality or availability.

Further description of each component of the framework is provided in the following sub-sections, and a detailed methodology discussion is available in Appendix B.

2.2.1 Literature and data review

A comprehensive review of the existing literature and data was conducted to understand the available research on the impacts of MS on the individual, their families and caregivers, and the broader community. These impacts are financial, economic, and intangible in nature. They include health system costs, productivity losses, other financial costs, and loss of wellbeing. The review also covered the impacts of COVID-19 on people living with MS in Canada. The review included any emerging academic or grey literature relating to changes in service utilization, impacts of these changes, and how the system is recovering.

Data requests were submitted to CIHI for the utilization of health services by people with MS. Data were received from the Discharge Abstract Database (DAD), National Ambulatory Care Reporting System (NACRS), National Prescription Drug Utilization Information System (NPDUIS), National Rehabilitation Reporting System (NRS), Home Care Reporting System (HCRS) and Continuing Care Reporting System (CCRS) in fiscal years 2019/20, 2020/21 and 2021/22. All data received were used in the modelling for their respective cost components, except for the NRS. The NRS does not include private or community practices, so the data were deemed too sparse to use.

Where possible, data for MS (coded ICD-10-CA 'G35') were disaggregated by age groups in 5-year intervals, sex, province and territory, and time series on a quarterly basis. For pharmaceutical data, a full list of medications including DMT and MS relapse management therapies were requested and received.⁴⁶ A complete list of drugs for which data were obtained is provided in Table A.16.

Some of the data in the outputs received from CIHI was suppressed due to small cell counts. The reporting process used by CIHI to avoid identification of individuals is such that cell counts of between 1 and 4 are suppressed. The decision was made to exclude a dataset (e.g., data for a specific province / territory or for a specific age-sex group) when more than 20% of observations were suppressed due to counts less than 5. In other datasets, a midpoint of 2.5 was used for suppressed cells.

All literature and data were reviewed against an evidence hierarchy to ensure high-quality studies and data sources were used to inform the methodology where possible. For example, articles from reputable academic journals were prioritized when conducting literature reviews for both international and Canadian studies. Population-based, longitudinal studies conducted within the last 10 years were preferred for the identification of inputs to the modelling. Where such evidence was unavailable, the relative strengths and weaknesses of studies were considered in their selection (e.g., relevance, recency, representativeness, robustness etc.).

2.2.2 Stakeholder engagement

A range of stakeholders across the MS community in Canada were engaged to better understand the data and literature environment, as well as potential considerations relating to the modelling. This included clinicians, researchers, and data custodians covering a range of institutions, clinics, and provinces and territories across Canada. This process was also used to obtain expert opinion on modelling assumptions and data gaps. Expert opinion was sought on issues including the duration of COVID-19 impacts, rate of system catch-up, and the magnitude of impacts on the disease. A complete list of stakeholders who participated in the consultation process is available in Appendix A.1.

2.3 COVID-19 impacts methodology

2.3.1 Scope of the modelling

Canada, like many other countries, implemented restrictions on physical movement (or lockdowns) as a public health response to contain the rapid spread of COVID-19 and slow the outbreak. The lockdowns that occurred periodically between 2020 and early 2022 limited the delivery of health services and impacted Canadians' ability to access a range of services. This reduced access to health services throughout the pandemic for people with MS, coupled with the reallocation of resources towards COVID-19, is likely to have decreased the MS-related health system expenditure during that period.

The resulting backlog in the provision of health services from delays and postponements during the pandemic continues to impose significant strain on the sector as it works to recalibrate, particularly for non-acute care. This includes services such as neurologist (and other specialist) visits, pharmaceutical treatments, and rehabilitation services.

Among those whose MS diagnosis was delayed, the commencement of appropriate treatment will have occurred later than it otherwise would. Some people with existing MS diagnosis would have also experienced delays or modifications to their treatment. In both cases, these delays and modifications are likely to have caused negative impacts on their health, including in their disease progression and symptom management. These outcomes are likely to increase the demand for MS-related health care over the longer-term, leading to expenditure being higher than would have been expected in future years.

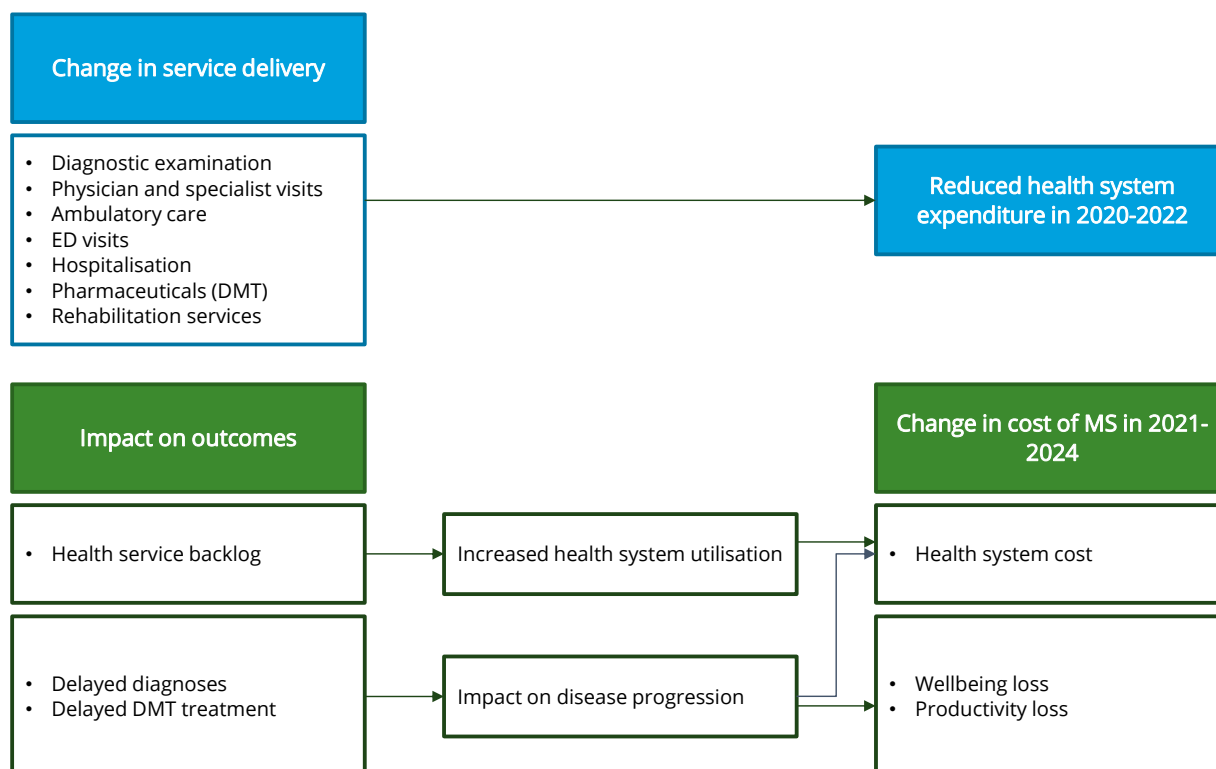
The overall effect of the pandemic is anticipated to have occurred in three ways:

1. Decreased service utilization during the earlier stages of the pandemic as the system and individuals navigated challenges relating to lockdowns and social distancing
2. An increase in service utilization in later years as treatments and diagnoses begin to re-normalize
3. Changes in individuals' disease state due to disruptions to DMT schedules, physical activity, and physiotherapy, and from increased social isolation. It is hypothesised that ultimately this will drive service utilization to levels higher than would have occurred in a base state (in the absence of a pandemic).

It should be noted that, for the third component, only the impact of changes to DMT use was quantified. This was due to the availability of data from clinical trials and the relative sparseness of data regarding the impacts of other changes that would have occurred (e.g., physical activity, physiotherapy, social isolation).

These impact pathways are visualized in Figure 2.2. Detailed discussion of the methodology is available in Appendix B.

Figure 2.2: COVID-19 impacts model framework overview



Source: Deloitte Access Economics.

2.3.2 Estimating cohort sizes

Cohort sizes were estimated based on the prevalence of MS according to disease types (i.e., RRMS, SPMS and PPMS) and disability scale (in terms of expanded disability status scale (EDSS)). Data from Statistics Canada and CIHI was used to determine the proportion of people with MS treated with a DMT in Canada and the estimated number of changes to DMT schedules during COVID-19. This includes people who were unable to initiate treatment with, or renew a prescription for, a DMT, and those who were unable to switch to a different DMT due to concerns regarding interactions with COVID-19 infection and vaccination. This was used to estimate the number of people with MS who had discontinued or made changes to existing DMT treatment courses and those whose diagnoses were delayed during COVID-19. Evidence from literature was used to inform the risk of disease progression attributable to delays in DMT use.

2.3.3 Estimating changes in health system expenditure

The health system expenditure impact attributable to the pandemic was driven by the delay in service utilization, its subsequent backlog, and increased health needs associated with disease progression. Health events modelled include hospitalization, GP visits, specialist visits, ED visits, pharmaceutical treatments, and non-pharmaceutical treatments (e.g., rehabilitation and mental health).

Changes in health system expenditure caused by delays in DMT use and MS diagnoses were measured using the costs of increased relapses and health care needs due to disease progression. Costs associated with reduced productivity and quality of life due to irreversible accrued disability were also modelled. Detailed methods and sources are available in the appendices.

Stakeholder engagement with clinicians (e.g., neurologists) and MS researchers were conducted to gather information on the impact of the pandemic on MS health care services and to discuss the impacts on patient outcomes. These consultations, along with data and reports published by CIHI and the Engagement Survey commissioned by MS Canada, were used to inform some assumptions and logic used in the modelling.

2.3.4 Assumptions and limitations

Several key assumptions were made in this modelling exercise based on available evidence.

- Some trends observed in the CIHI data (e.g., service utilization rates by year) were generalized across Canada due to the unavailability of data for all provinces and territories. The specific assumptions are noted in Appendix C.
- It was assumed that the Canadian health system would recover from the pandemic's disruption in a linear manner from 2022 to 2024. It is noted that the backlog of health services and delayed DMT treatments may have created a 'bottleneck'

as more individuals seek to resume treatments than there are available services. In this case, it is likely that the exact trajectory of the recovery is non-linear. However, due to the absence data, this study applied a linear assumption in its modelling and conducted sensitivity analysis modelling both a faster (1.5 times the central rate) and a slower (0.5 times the central rate) recovery scenario.

- Data regarding the utilization of some health services, such as specialist and GP visits, were unavailable through CIHI. An assumption was made that the trend in these services would match that observed in outpatient clinic data due to similarities in the way those services are delivered.
- While the capacity and availability of health services were assumed to return to pre-pandemic levels by mid-2022, it was assumed that the backlog would result in a 12-month delay for each diagnosis delayed in 2020-2022.
- To account for escalation strategies that are common in practice for the treatment of MS, it was assumed there is a 12-month delay in treatment that can be expected in DMT changes with progression in disease trajectory.
- Effort was made to include as many components as possible of the cost of MS in the COVID-19 impact analysis. However, limitations in the evidence regarding the impacts of COVID-19 on people with MS meant that certain components were unable to be modelled. This includes informal care, long-term care, formal home care, and aids and modifications.

3 Epidemiology of MS in Canada

Approximately 90,000 people were living with MS in Canada in 2019, nearly three quarters of whom were female. MS was found to be most common among people aged of 50 and 69. It was also directly responsible for nearly 600 deaths in the same year.

3.1 Prevalence of MS

There are approximately **90,000 people living with MS in Canada**, equivalent to **1 in every 400 people**,¹ or around 305 per 100,000 in the adult population. Around three quarters of people living with MS in Canada are women, higher than the global average of two thirds.¹ Data from the Canadian Chronic Disease Surveillance System (CCDSS) shows there is some variation in MS prevalence across province and territories.⁴⁷ Nova Scotia is shown to have the highest prevalence (355 persons per 100,000 adult population), while Newfoundland & Labrador is reported to have the lowest (169 per 100,000).

While this report recognizes the total number of people living with MS in Canada to be approximately 90,000, as reported by the Atlas of MS,¹ data from the CCDSS were used for the purpose of estimating the annual cost of MS. Figure 3.1 explains the differences between these two data sources and the reasoning for using the CCDSS data for costing. When using CCDSS data, the prevalence of MS was estimated to be **272 per 100,000 people in the adult population**, equivalent to **more than 80,000 total cases**. Table 3.1 provides a detailed breakdown by age, sex, and region. Additional information on the number and proportion of people living with MS is available in Appendix A.2.1.

Figure 3.1: Prevalence-related considerations for estimating the annual cost of MS in Canada

There are two main data sources available for estimating the number of people living with MS in Canada. These are the CCDSS and the CCHS. The CCDSS is a survey maintained by the PHAC,⁵ while the CCHS is maintained by Statistics Canada.

The two surveys use different sampling methodologies and produce different estimates of the number of people with MS in Canada. The CCDSS is based on health claims administrative data, in which people are required to have accessed multiple health services over a given period to be recorded as having MS. In contrast, the CCHS is a household survey in which participants self-report having MS. The CCHS was most recently conducted in 2010/11 and the CCDSS in 2014/15. Using the CCDSS data, it is estimated that just over 80,000 people in Canada are living with MS. The CCHS suggests that this number could be 90,000 or more, as reported in the Atlas of MS.¹

For the purposes of this study, it was decided that the CCDSS survey methodology aligns more closely with the objectives of the current work (estimating the cost of MS in a single year) and other literature and data used as inputs to the modelling. For example, requiring multiple interactions with the health system in a given year relates more closely to some inputs to the health system expenditure modelling, which are based on data from individuals who access health services. Given the uncertainty, it was also decided that using the more conservative estimate was most appropriate.

While the use of the CCDSS data was considered the most appropriate choice from a modelling perspective given the current study's parameters, it is acknowledged that some estimates presented within this study may be conservative due to potential omission of individuals who have less frequent interaction with the health system.

Table 3.1: Cases of MS in Canada in 2019

Age / sex	Atlantic	British Columbia	Ontario	Prairies	Quebec	Territories	Total
Males							
20-29	50	142	647	231	276	5	1,351
30-39	132	319	1,112	574	607	11	2,755
40-49	232	442	1,539	759	880	14	3,866
50-59	387	742	2,146	1,100	1,333	19	5,726
60-69	356	656	1,632	936	1,173	16	4,769
70-79	219	398	915	513	690	8	2,743
80+	56	68	232	128	141	1	625
<i>Males total</i>	<i>1,432</i>	<i>2,768</i>	<i>8,221</i>	<i>4,242</i>	<i>5,100</i>	<i>72</i>	<i>21,835</i>
Females							
20-29	151	330	1,298	577	619	11	2,985
30-39	446	897	2,651	1,548	1,540	24	7,106
40-49	782	1,356	3,904	2,046	2,294	31	10,413
50-59	1,233	2,265	5,924	3,088	3,657	37	16,204
60-69	1,019	1,921	4,417	2,387	3,068	25	12,837
70-79	538	1,095	2,384	1,205	1,738	9	6,970
80+	122	210	580	352	408	1	1,673
<i>Females total</i>	<i>4,291</i>	<i>8,073</i>	<i>21,158</i>	<i>11,202</i>	<i>13,324</i>	<i>138</i>	<i>58,186</i>
Total	5,723	10,841	29,380	15,444	18,425	210	80,021

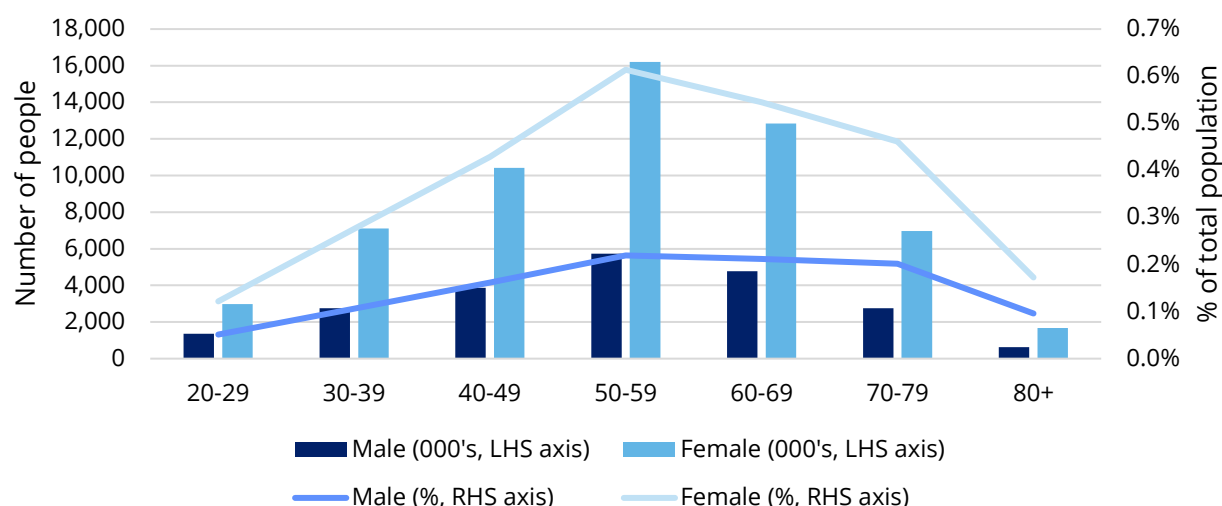
Source: Deloitte Access Economics analysis based on data from the Canadian Chronic Disease Surveillance System.

These estimates show that nearly three quarters of people living with MS are female. The prevalence among females was 389 per 100,000 population, compared to 150 per 100,000 population among males. This sex distribution was broadly consistent across all provinces, with the female-to-male ratio varying between 3.3 in Nova Scotia and 2.6 in Saskatchewan. Territories exhibited much lower ratios, with just 1.3 and 2.1 females per male in Northwest Territories and Nunavut, respectively. However, this is likely driven by the much smaller population bases in those territories.

The number of people living with MS is also shown to increase with age until a peak between the ages of 50 and 59 for both females and males, beyond which the number of people with MS in any one age group declines. This reflects the shortened life expectancy for people living with MS, as people are most diagnosed between the ages of 20 and 49.⁴⁸

Cases were distributed by province and territory largely according to population. However, there was some variation in prevalence across the country. These rates ranged between 355 persons per 100,000 population in Nova Scotia, and 169 per 100,000 in Newfoundland and Labrador. Nonetheless, most cases were in Ontario and Quebec, with nearly 29,000 (257 per 100,000) and 18,000 (274 per 100,000) cases, respectively. The average prevalence across all provinces and territories was 272 persons per 100,000 population.

Chart 3.1: Cases of MS in Canada in 2019, by age group and sex



Source: Deloitte Access Economics estimates based on data from the CCDSS.

Note: LHS = Left-hand side; RHS = Right-hand side.

3.2 Mortality due to MS

MS was directly responsible for nearly 600 deaths in Canada in 2019. The distribution of these deaths by age, sex, and province/territory is shown in Table 3.2. Information on how deaths due to MS are determined is available in Appendix A.2.2.

Most deaths were among females, among whom 372 of the 593 deaths occurred. However, this sex split is lower than that observed for the prevalence of MS. The overall mortality rate per 100,000 population is higher among females (23 deaths compared to 14 among males), reflecting the higher prevalence. The case fatality rate is higher among males, among whom there are 1,012 deaths per 100,000 cases compared to 639 for females). Other studies of MS-related mortality have found that females with MS tend to have longer life expectancies, and this may reflect (at least in part) longer life expectancies in the general population.⁴⁹

Table 3.2: Mortality from MS in Canada in 2019

Age / sex	Mortality rate (per 100,000 population)	Case fatality rate (per 100,000 cases)	Deaths
Males			
20-29	0	0	0
30-39	1	145	4
40-49	5	362	14
50-59	16	751	43
60-69	29	1,384	66
70-79	58	2,479	68
80+	47	4,163	26
<i>Males total</i>	<i>14</i>	<i>1,012</i>	<i>221</i>
Females			
20-29	1	67	2
30-39	1	56	4
40-49	8	211	22
50-59	23	389	63

Age / sex	Mortality rate (per 100,000 population)	Case fatality rate (per 100,000 cases)	Deaths
60-69	54	974	125
70-79	69	1,277	89
80+	84	4,005	67
<i>Females total</i>	<i>23</i>	<i>639</i>	<i>372</i>
Total	19	741	593

Source: Deloitte Access Economics analysis based on CCDSS data.

4 Costing the impacts of MS

MS is a chronic disease of the central nervous system that can lead to increased multidisciplinary care needs, limited ability to participate in the workforce, and reduced quality of life. This report estimates that the annual cost of MS was \$3.4 billion in Canada in 2019, equivalent to an average annual cost of more than \$42,880 per person.

4.1 Cost summary

This analysis estimated the annual socioeconomic cost of MS in Canada in 2019. The cost estimate includes expenditure on health services; losses arising from productivity impacts; and other costs such as expenditure on aids, home modifications, formal care, long-term care, and support payments.

The total annual cost of MS in Canada in 2019 was estimated to be **\$3.4 billion**. The largest contributor to this cost was productivity losses, which accounted for nearly 39% of the total. Ontario was found to be the province with the largest share of the cost; however, the Prairies and Territories were found to have the highest average cost per person living with MS. The average cost per person across Canada was estimated to be just over **\$42,880**.

Table 4.1 provides a summary of the estimated costs of MS in Canada in 2019.

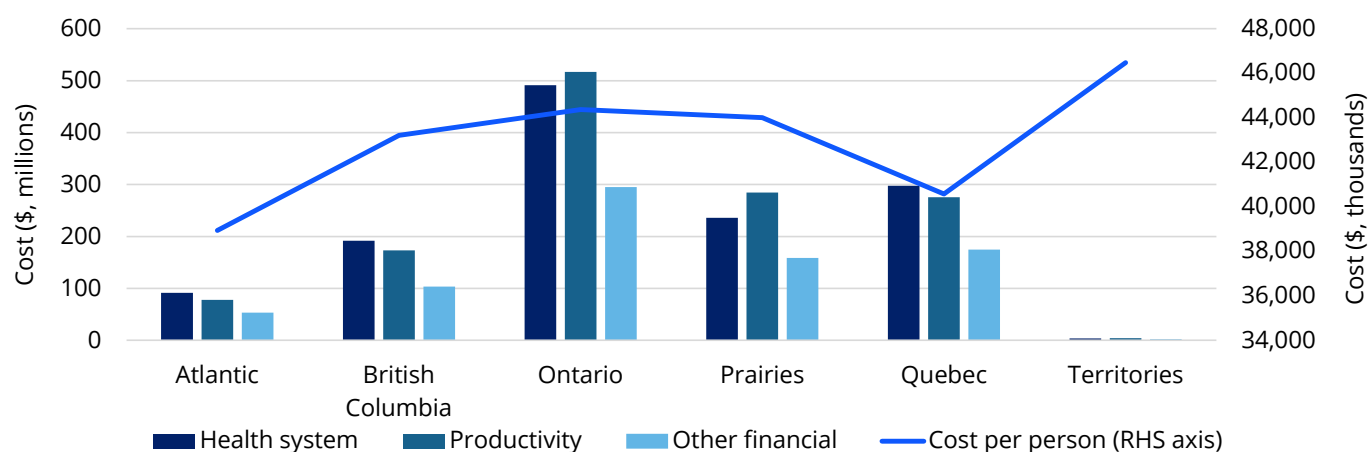
Table 4.1: Socioeconomic costs of MS in Canada in 2019

Cost component (\$ millions)	Atlantic	British Columbia	Ontario	Prairies	Quebec	Territories	Total	% of total	Cost per person (\$)
Health system	91.4	192.0	491.2	236.1	297.4	3.7	1,311.8	38.2%	16,393
Productivity	78.1	172.9	517.0	284.7	275.7	3.9	1,332.2	38.8%	16,649
Other costs	53.4	103.5	295.2	158.7	174.6	2.2	787.5	22.9%	9,842
Total	222.8	468.4	1,303.4	679.5	747.7	9.8	3,431.6	100.0%	42,884
% of total	6.5%	13.7%	38.0%	19.8%	21.8%	0.3%	100.0%	-	-
Cost per person (\$)	38,934	43,210	44,364	44,000	40,580	46,472	42,884	-	-

Source: Deloitte Access Economics analysis based on various sources.

Note: All figures in millions of dollars unless otherwise specified.

Chart 4.1: Socioeconomic costs of MS in Canada in 2019



Source: Deloitte Access Economics analysis.

Note: RHS = Right-hand side.

4.2 Financial and economic costs

4.2.1 Health system costs

The following areas of health expenditure are captured in the health system costs:

- Inpatient (admitted) and outpatient (non-admitted) hospital care
- Other outpatient care, such as that delivered in clinic settings
- Presentations to emergency departments
- Consultations with specialists (e.g., neurologists, urologists, ophthalmologists) and general practitioners
- Rehabilitation services
- Prescribed and over-the-counter pharmaceuticals
- Complications and comorbidities attributable to MS, such as falls and depression, respectively.

Health system costs in Canada are primarily paid by governments, with individuals and their families contributing through out-of-pocket payments. Private health insurers and other payers (e.g., worker's compensation) also pay for some health services. Most rehabilitation services are not funded by the government, meaning that people primarily pay out-of-pocket for these services. However, private rehabilitation services were not included in this analysis due to a lack of data.

The utilization of services and the proportion of individuals with MS using the services were estimated using national datasets and academic literature. The unit costs of each item were determined through a range of sources such as CIHI's Patient Cost Estimator tool and other published reports from CIHI. Data from academic literature was used to triangulate and to fill remaining gaps.

The total annual health system expenditure due to MS was estimated to more than **\$1.3 billion** in 2019. This equates to nearly **\$16,400 per person** living with MS. Most of this expenditure was attributable to pharmaceuticals such as DMTs and steroids, which accounted for 88% of the total health system expenditure. DMTs are generally subsidized through provincial health plans in Canada, but there are significant differences across provinces. Previous research found that provinces with the highest incidence of MS, such as Nova Scotia and Ontario, appear to have the lowest proportion of DMT claims reimbursed by public drug plans.³³ In Canada, the reimbursement costs have increased from \$387 million in 2010 to \$607 million in 2018.³³

Table 4.2 summarizes the costs of each of the health system expenditure component attributed to MS in 2019.

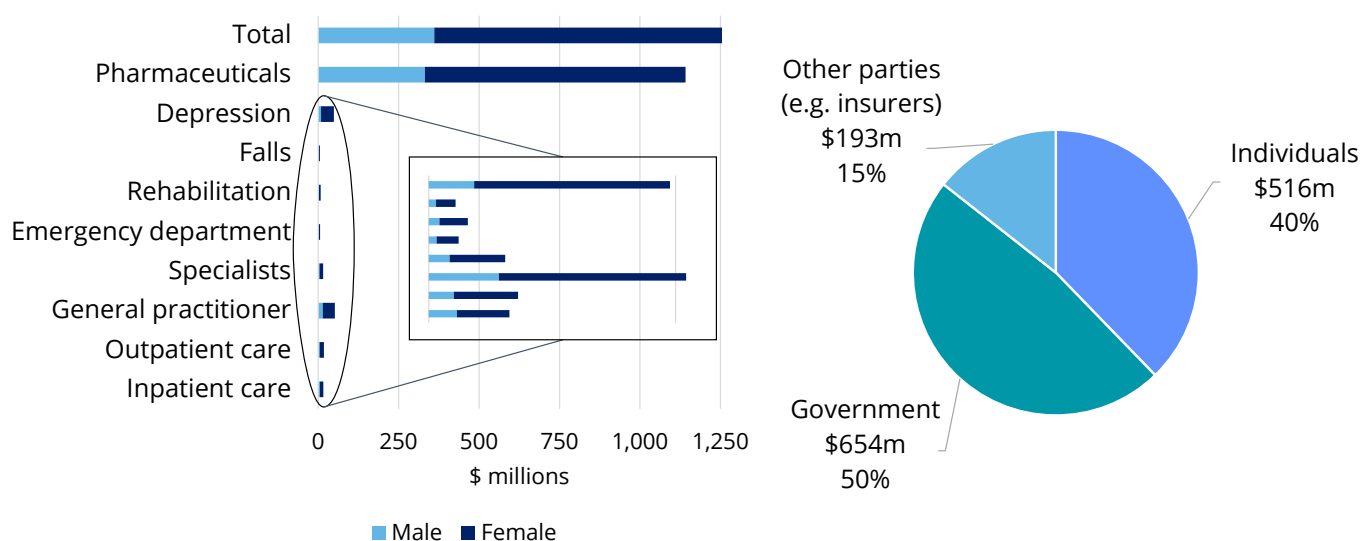
Table 4.2: Health system expenditure due to MS in 2019, by province / territory and cost component

Cost component (\$ millions)	Atlantic	British Columbia	Ontario	Prairies	Quebec	Territories	Total	% of total	Cost per person (\$)
Inpatient care	1.1	2.2	6.1	3.2	3.7	0.0	16.3	1.2%	204
Outpatient care	1.2	2.4	6.8	3.6	4.1	0.1	18.1	1.4%	226
Emergency department	0.4	0.8	2.2	1.2	1.4	0.0	6.1	0.5%	76
Specialists	1.1	2.1	5.7	3.0	3.6	0.0	15.5	1.2%	194
Rehabilitation	3.7	7.1	19.1	10.1	12.0	0.1	52.1	4.0%	651
General practitioners	0.6	1.1	2.9	1.5	1.8	0.0	7.9	0.6%	99
Pharmaceuticals	79.5	169.3	428.1	202.9	258.4	3.2	1,141.4	87.0%	14,264
Falls	0.3	0.7	2.0	1.1	1.3	0.0	5.5	0.4%	68
Depression	3.4	6.5	18.2	9.5	11.1	0.1	48.9	3.7%	611
Total	91.4	192.0	491.2	236.1	297.4	3.7	1,311.8	100.0%	16,393
% of total	7.0%	14.6%	37.4%	18.0%	22.7%	0.3%	100.0%	-	-
Cost per person (\$)	15,971	17,707	16,720	15,289	16,142	17,568	16,393	-	-

Source: Deloitte Access Economics analysis.

Note: All figures in millions of dollars unless otherwise specified.

Chart 4.2: Health system costs of MS in 2019, by cost component and sex (LHS) and payer (RHS)



Source: Deloitte Access Economics analysis.

Notes: LHS = Left-hand side; RHS = Right-hand side.

Details on the approach used to estimate the cost of each of these health system costs is provided in Table A.15 and Table A.16. Supplementary tables for health system costs are available in Table A.4.

4.2.2 Productivity losses

MS can significantly impact on an individual's ability to participate in the workforce. Even among those who are employed, it can affect their ability to attend work and their productivity while at work. These impacts lead to real costs to the economy that are borne by the individual themselves, their employers, and different levels of government.

This report estimates the cost of five sources of productivity loss:

- **Reduced employment:** Classified as early retirement or workforce withdrawal and represented by lower average employment rates among those living with MS relative to the general population.
- **Absenteeism:** Where a worker may be unwell more often than those in the general population and take more time off work, while remaining in the workforce.
- **Presenteeism:** Where a worker produces less output while at work, possibly due to physical limitations or difficulty focusing on tasks.
- **Premature mortality:** The loss of future income streams that would have been realized had the individual not died earlier than they would have otherwise been expected to (measured in present value terms).
- **Informal care:** Loss of income experienced by family members, spouses and any other individual who provides informal care that impacts on their ability to participate in the workforce.

The total cost of these productivity impacts was estimated to be **\$1.3 billion** in 2019, equivalent to over **\$16,600 per person** living with MS. The costliest productivity impact was reduced employment, accounting for just over 69% of the total estimated productivity cost.

Table 4.3 summarizes the costs of each of the productivity impacts attributed to MS in 2019. These estimates all represent excess costs; that is, additional costs above any that would be expected to be generated by a person without MS. This is because the calculations account for the employment rates, days of absence, and regular output of the general population, and premature mortality and informal would not occur in the absence of MS.

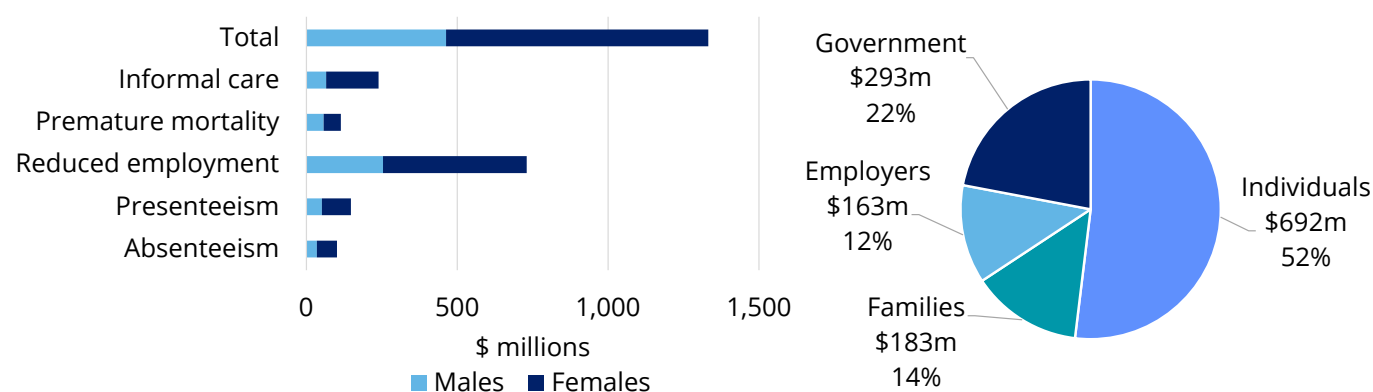
Table 4.3: Productivity costs due to MS in 2019, by province / territory and cost component

Cost component (\$ millions)	Atlantic	British Columbia	Ontario	Prairies	Quebec	Territories	Total	% of total	Cost per person (\$)
Absenteeism	5.9	13.2	39.3	22.0	20.6	0.3	101.3	7.6%	1,266
Presenteeism	8.5	19.1	56.8	31.8	31.0	0.4	147.4	11.1%	1,843
Reduced employment	41.8	94.4	281.2	157.2	153.3	2.1	730.1	54.8%	9,124
Premature mortality	6.2	16.6	46.6	24.0	20.4	0.3	114.2	8.6%	1,427
Informal care	15.6	29.7	93.1	49.7	50.4	0.6	239.2	18.0%	2,989
Total	78.1	172.9	517.0	284.7	275.7	3.9	1,332.2	100.0%	16,649
% of total	5.9%	13.0%	38.8%	21.4%	20.7%	0.3%	100.0%	-	-
Cost per person (\$)	13,639	15,952	17,598	18,434	14,962	18,507	16,649	-	-

Source: Deloitte Access Economics analysis.

Note: All figures in millions of dollars unless otherwise specified.

Chart 4.3: Productivity costs of MS in 2019, by cost component and sex (LHS) and payer (RHS)



Source: Deloitte Access Economics analysis.

Notes: LHS = Left-hand side; RHS = Right-hand side.

Chart 4.3 shows that females accounted for the larger share of productivity costs (65% compared with 35% for males). This largely reflects the higher prevalence of MS among females who account for around 73% of all cases. The smaller share of

productivity costs relative to prevalence is driven by higher average employment rates and earnings among males in the general population.

The chart also shows that the majority (52%) of the productivity losses incurred due to MS are borne by individuals living with the disease. This comprises the portion of absenteeism, reduced employment, and premature mortality costs that would have been received as wages by the individuals. Government, both federal and provincial/territorial, bears the next largest share of the costs at 22%. This comprises the remaining share of the absenteeism, reduced employment, and premature mortality costs that would have been collected as taxes by the government, as well as the taxation loss associated with presenteeism and informal care. The employer cost of 12% reflects the lost output from absenteeism and presenteeism, while the cost to families represents the lost earnings among informal caregivers.

Details on the approach used to estimate the cost of each of these productivity impacts is provided in Table A.17. Supplementary tables for productivity costs are available in Table A.5.

4.2.3 Other financial costs

Living with MS incurs a range of other costs beyond the direct health system expenditure and productivity losses. These costs are both financial and economic in nature. They include costs relating to aids and home modifications, formal care requirements, long-term care, support payments, and efficiency losses from excess taxation (known as deadweight losses).

People living with MS often require aids and modifications in their home and day-to-day life. This may include mobility aids such as wheelchairs, walkers, and scooters; vehicle adaptations; and other modifications to the home including bathing aids, lift chairs, and ramps among others. These are typically covered at least in part by individuals, often in a cost sharing arrangement with government-funded programs, and the out-of-pocket contributions can cause significant financial burden for people living with MS. The total cost of these items was estimated to be **\$191.6 million** in 2019, equivalent to a cost per person of \$2,394. This cost per person is likely to vary significantly across the disease course, increasing with disease progression and age as mobility supports and other assistance needs increases.

Many people living with MS also need formal care delivered in the home or in continuing and other long-term care environments. Formal home care services may include private nursing, housework assistance, childcare and any other care provided within the home setting not delivered by an informal caregiver. Some people with MS also require long-term care earlier than they otherwise would, creating an additional cost attributable to the disease. The total cost of formal home care was estimated to be **\$49.8 million** and a further **\$47.9 million** in long-term care costs were estimated to be attributable to MS in 2019. These values are equivalent to per person costs of \$622 and \$598 respectively, reflecting the relatively small share of individuals accessing these care systems directly due to their MS. CIHI data show that approximately 5% of people with MS are living in long-term care.

Government income support and benefits are also available for people living with MS and their caregivers. The most accessed payment for individuals is the Canada Pension Plan disability benefit (CPP-D) and the disability tax credit (DTC), while caregivers have access to the Canada caregiver credit (CCC). The CPP-D is a monthly payment available to those aged under 65 who have a mental or physical disability that is long-term and of indefinite duration that prevents them from undertaking substantially gainful work. The CCC is a non-refundable tax credit available to the spouses or partner of an individual with a physical or mental impairment. These support payments were estimated to cost **\$344.1 million** in 2019, with approximately 97% attributable to the CPP-D. The non-refundable nature of the tax credits means that they are often unable to be utilised due to individuals and/or their spouses or partners having insufficient income, lowering its overall cost.

A subset of other costs are deadweight losses, which are losses of economic efficiency that occur when equilibrium is not achieved in a market. In the case of MS, this arises due to the government's need to collect additional tax revenue to cover costs that would otherwise not have been incurred. These costs include the lost consumer, company and informal caregiver taxes, and government health expenditure. These efficiency losses were estimated to total **\$154.1 million** in 2019.

The total cost of these other financial costs was estimated to be **\$787.5 million** in 2019, equivalent to **\$9,842 per person** living with MS. Table 4.4 summarizes the costs of each of the other financial impacts attributed to MS in 2019.

Table 4.4: Other costs due to MS in 2019, by province / territory and cost component

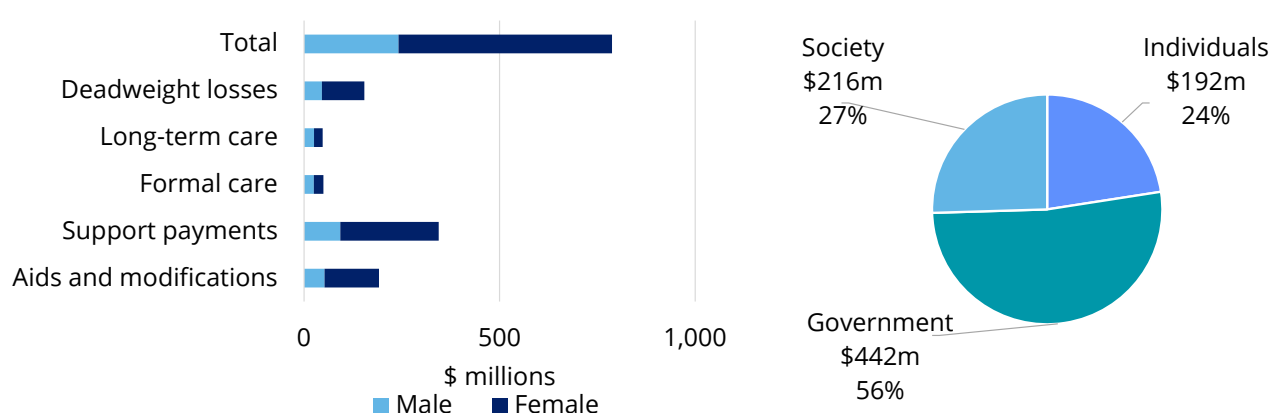
Cost component (\$ millions)	Atlantic	British Columbia	Ontario	Prairies	Quebec	Territories	Total	% of total	Cost per person (\$)
Aids and modifications	13.7	26.0	70.3	37.0	44.1	0.5	191.6	24.3%	2,394
Formal home care	3.0	5.8	19.9	10.4	10.6	0.2	49.8	6.3%	622
Long-term care	2.4	5.6	17.3	14.4	8.1	0.1	47.9	6.1%	598

Cost component (\$ millions)	Atlantic	British Columbia	Ontario	Prairies	Quebec	Territories	Total	% of total	Cost per person (\$)
Support payments	24.0	45.0	129.3	67.2	77.6	1.0	344.1	43.7%	4,300
Deadweight losses	10.3	21.2	58.3	29.8	34.1	0.4	154.2	19.6%	1,927
Total	53.4	103.5	295.2	158.7	174.6	2.2	787.5	100.0%	9,842
% of total	6.8%	13.1%	37.5%	20.2%	22.2%	0.3%	100.0%	-	-
Cost per person (\$)	9,323	9,551	10,046	10,276	9,476	10,397	9,842	-	-

Source: Deloitte Access Economics analysis.

Note: All figures in millions of dollars unless otherwise specified. Deadweight losses refers to the

Chart 4.4: Other costs of MS in 2019, by cost component and sex (LHS) and payer (RHS)



Source: Deloitte Access Economics analysis.

Notes: Left-hand side = LHS; Right-hand side = RHS.

Details on the approach used to estimate the cost of each of these other costs is provided in Table A.18. Supplementary tables for other costs are available in Table A.6.

4.3 Loss of wellbeing

Beyond its economic and financial impacts, MS can also lead to significant losses of wellbeing. This arises from both lowered quality of life among those living with the disease and the years of healthy life lost due to premature deaths caused by the disease. This loss of wellbeing is not a financial or monetary cost, but it can be valued using the burden of disease approach.

4.3.1.1 Valuing life and health

The burden of disease methodology is a non-financial approach to quantifying the loss of wellbeing, where life and health are measured in terms of disability-adjusted life years (DALYs). DALYs combine the years of healthy life lost due to living with a disability (YLDs) and the years of life lost due to premature death (YLLs). One DALY (the summation of YLDs and YLLs) is equivalent to one year of healthy life lost.

In the burden of disease methodology, various health states are assigned a disability weight, where zero represents perfect health and one is equivalent to death. Other health states are given a weight between zero and one that reflects the loss of wellbeing from a particular condition relative to perfect health. For example, a disability weight of 0.2 is interpreted as a 20% loss in wellbeing relative to perfect health for the duration of the condition. The disability weights for MS depend on the severity of the disease and are:

- Mild: 0.18
- Moderate: 0.46
- Severe: 0.72

DALYs can be converted into a dollar figure using an estimate of the value of a statistical life year (VSLY), an estimate of the value society places on an anonymous life. The Government of Canada's Cost Benefit Analysis Guide for Regulatory Proposals placed this value at \$305,000 in 2019.⁵⁰

4.3.1.2 The loss of wellbeing from MS in 2019

MS was estimated to incur a total of **41,487 DALYs** in Canada in 2019. Converted to a dollar estimate using the VSLY, the total cost associated with this loss of wellbeing was estimated to be **\$12.7 billion**. It is important to note that this is a non-financial cost that is not measured within GDP.

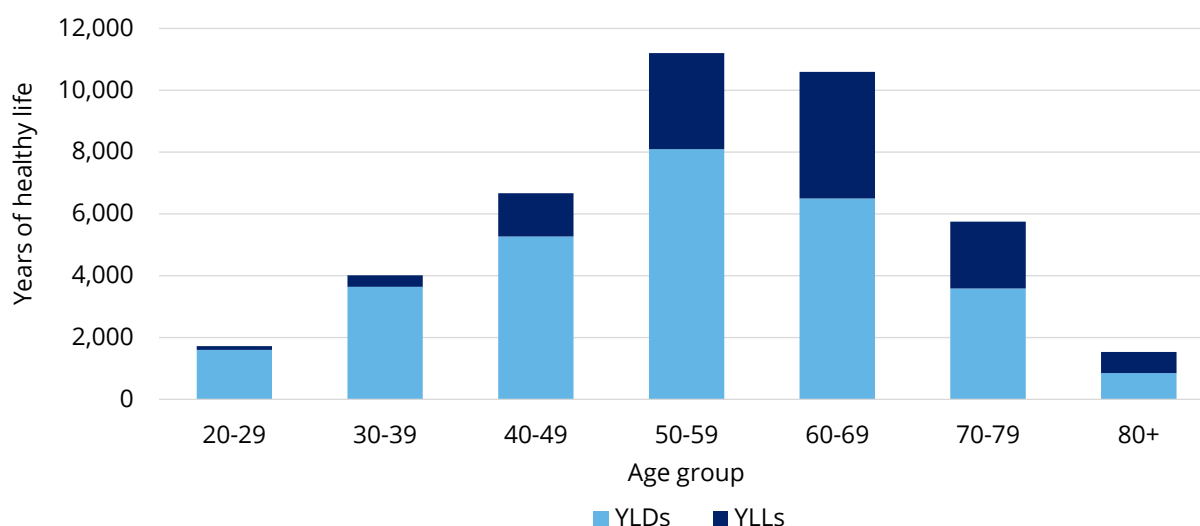
Table 4.5 presents the breakdown of the loss of wellbeing by province / territory and component. There was a total of 0.37 YLDs and 0.15 YLLs per person, for an average DALYs of 0.52 per person. This means that each individual living with MS in Canada in 2019 lost an average of half a year of healthy life due to disability or premature death over a lifetime. Ontario and Quebec accounted for the largest shares of the lost wellbeing cost; however, British Columbia had the highest cost per person. This implies that individuals living with MS in British Columbia had the highest average rates of morbidity and mortality, likely reflecting differences in demographics (primarily age profile) across provinces and territories. Overall, there was a total of 29,528 YLDs and 11,959 YLLs due to MS across Canada in 2019.

Table 4.5: DALYs and cost of lost wellbeing due to MS in 2019, by province / territory and component

Cost component	Atlantic	British Columbia	Ontario	Prairies	Quebec	Territories	Total	No. per person
YLDs	2,112	4,000	10,841	5,699	6,799	77	29,528	0.37
YLLs	845	1,737	4,626	1,916	2,807	28	11,959	0.15
DALYs	2,956	5,737	15,468	7,615	9,606	106	41,487	0.52
Cost of DALYs (\$ millions)	902	1,750	4,718	2,322	2,930	32	12,654	158,129
% of total	7.1%	13.8%	37.3%	18.4%	23.2%	0.3%	100.0%	-
Cost per person (\$)	157,564	161,418	160,576	150,381	159,016	153,421	158,129	-

Source: Deloitte Access Economics analysis.

Chart 4.5: DALYs due to MS in Canada by age and component



Source: Deloitte Access Economics analysis.

A detailed discussion of the methodology used to estimate the loss of wellbeing due to MS is provided in Table A.19. Supplementary tables for the loss of wellbeing are available in Table A.7.

5 MS and the COVID-19 pandemic

The COVID-19 pandemic has disrupted care for people with MS since its onset, causing a nearly \$566 million reduction in service delivery from 2020 to 2022. This reduction in expenditure has created a backlog in health services estimated to incur \$73 million in incremental costs in 2024 alone. It has also worsened the disease state of many people with MS due to treatment changes and delayed diagnoses, which are estimated to cost \$138 million in direct health costs and productivity losses from 2020 to 2024. With many of these impacts being irreversible, excess costs are expected to continue for years to come.

5.1 Cost summary

Chapter 4 of this report presented estimates of the cost of MS in a typical undisrupted year (2019). This cost relates to its management (of symptoms, comorbidities, and complications) and treatments (e.g., using DMTs) intersecting with many parts of the health system. This chapter evaluates whether the pandemic has resulted in significant change in the types and quality of health care received by people living with MS. It considers three of the most experienced impacts:

1. Supply constraints within the health system due to the reallocation of resources to address COVID-19
2. Changes in service utilization driven by public health mandates (e.g., lockdowns and social isolation) and related behavioural changes (e.g., hesitancy to visit clinics) designed to slow the transmission of COVID-19
3. Changes in treatments with certain classes of DMTs (anti-CD20 and S1Ps) due to emerging evidence of the potential risks of poorer outcomes from COVID-19 infection and vaccination.

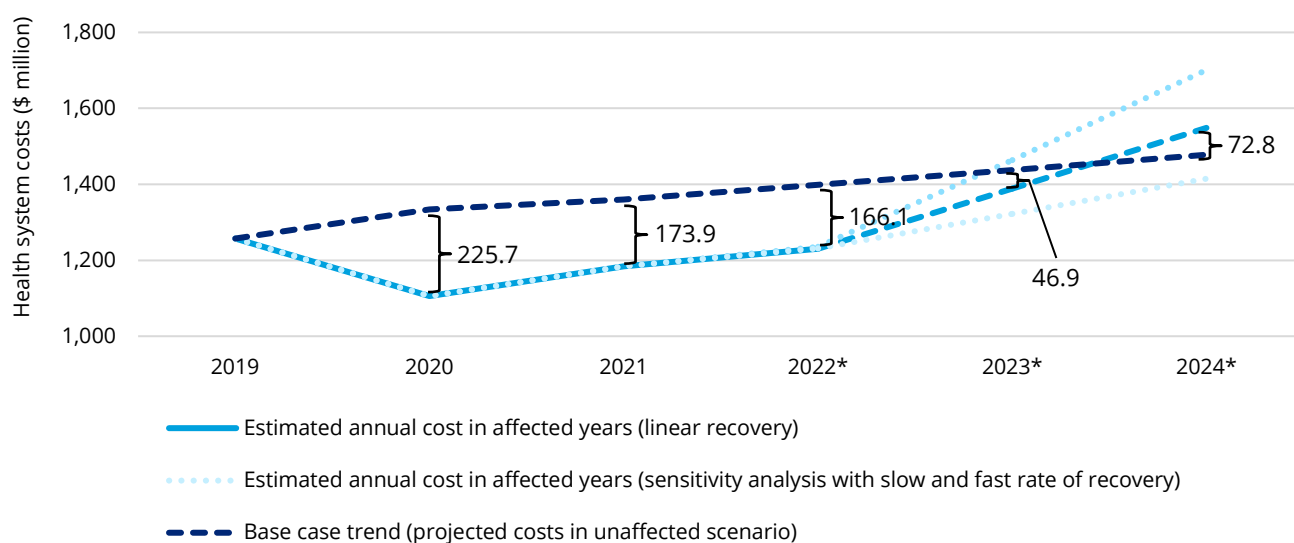
It was estimated that the changes in the provision of health services between 2020 and 2022 **reduced MS-related health expenditure by \$566 million over this period**. Longer-term, the existence of backlogs in the provision of health services is projected to lead to an **excess cost of approximately \$73 million above what would have been expected in 2024 alone**, had the pandemic not occurred. Changes in treatments were also estimated to cause an additional \$35 million in health system expenditure, \$89 million in productivity losses, and \$400 million in lost wellbeing between 2020 and 2024. Finally, delayed diagnosis of MS was estimated to cost a total of \$5 million to the health system, \$9 million in productivity losses, and \$40 million in lost wellbeing over this same period. Table 5.1 presents a summary of these findings.

Table 5.1: Summary of findings from COVID-19 impact modelling

Component (\$ millions)	2020	2021	2022	2023	2024	Total
Reduced health service utilization						
Health system	-225.7	-173.9	-166.1	-46.9	72.8	-539.8
Treatment changes						
Health system	5.9	7.1	14.5	3.5	3.5	34.5
Productivity	0.0	9.5	20.9	29.2	29.2	88.9
Loss of wellbeing	0.0	42.8	94.4	131.7	131.7	400.5
Delayed diagnosis						
Health system	1.0	2.6	0.9	0.4	0.4	5.2
Productivity	0.0	0.6	2.4	2.9	3.0	8.9
Loss of wellbeing	0.0	2.9	10.9	13.1	13.3	40.2

Source: Deloitte Access Economics analysis

Chart 5.1: Incremental health system costs, estimated actual vs base case trend, 2019 to 2024



Source: Deloitte Access Economics analysis.

Notes: *Figures for 2022, 2023 and 2024 in affected years are projected. Sensitivity analysis was applied with fast (1.5 times) and slow (0.5 times) rate of recovery.

Figure 5.1: Guidance for interpreting COVID-19 impact costings

This study was conducted throughout 2022 and early 2023, at which point there was limited evidence regarding some of the impacts of the pandemic on people with MS and on the health system more broadly. This means that there were a range of gaps and limitations in the data and literature available to use as inputs to the modelling. Data for this study were primarily drawn from health service utilization datasets routinely collected by CIHI. These datasets enabled detailed modelling of the costs to health system from 2020 to mid-2022, the results of which are presented in Section 5.3.

The predictive nature of this study also required assumptions to be made about events occurring beyond mid-2022, the latest available quarter of data at the time this report was prepared. This included the timing and pace of recovery of the health system following the pandemic. It was assumed that the health system started to recover from mid-2022 (when most pandemic-related restrictions had eased) and that the pace of this recovery was linear, such that the capacity returned to 2019 levels in 2022/23. Beyond this point, it was assumed that capacity would be sufficient to begin clearing the backlog in health service provision and additional needs caused by the supply constraints from 2020 to 2022.

This rate of recovery assumption was subject to significant uncertainty due to the limited information available to understand emerging and longer-term changes in health system capacity. Sensitivity analysis was undertaken as a result to provide a range of estimates based on three scenarios for the recovery rate:

- Central scenario: Linear rate of recovery.
- Fast recovery: 1.5x the linear rate of recovery.
- Slower recovery: 0.5x the linear rate of recovery.

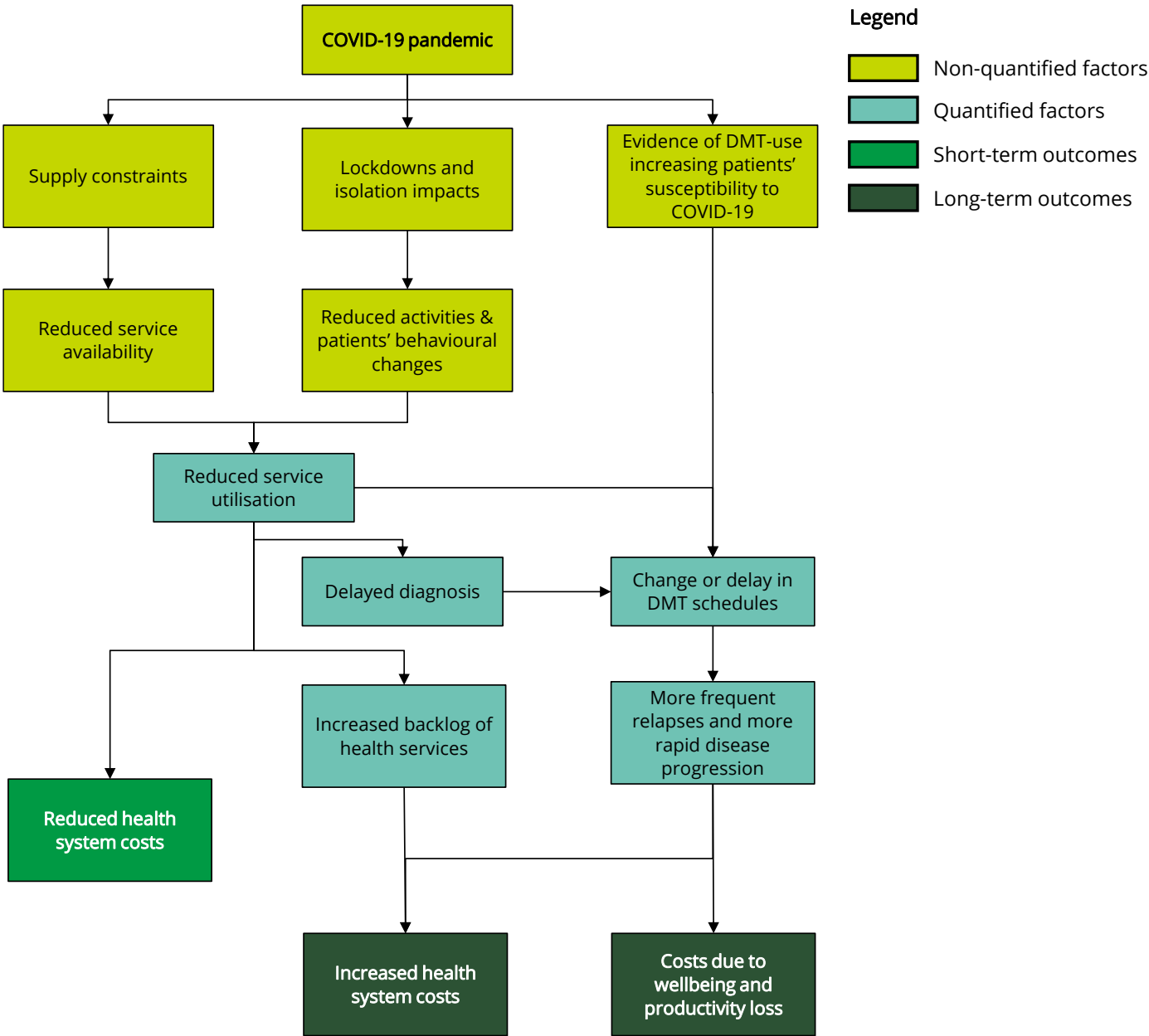
The modelling in the first section of the chapter focuses on quantifying changes in costs for which data were available to observe trends in service utilization by quarter pre-, during- and post-pandemic. This was limited to health system costs, owing to the data available from CIHI. The second section of the chapter includes modelling of the additional costs associated with increased health needs following the reduction in health care provided to the MS population during the pandemic. This section considers costs relating to health service utilization, productivity losses, and reduced wellbeing.

Source: Deloitte Access Economics.

5.2 Impact pathways

Figure 5.2 depicts the three modelled impact pathways through which people with MS were affected by the pandemic. It was designed based on analysis and interpretation of data collected through desktop review of publicly available information, data requested from CIHI, and stakeholder consultation. The impacts created backlogs in the provision of health services and negatively affected MS patient outcomes in terms of relapse management, disease progression and disability accumulation.

Figure 5.2: Impact of COVID-19 on MS outcomes



Source: Deloitte Access Economics analysis.

This study sought to quantify the incremental costs associated with clearing the backlog in health services, changes, and delays in DMT usage, and delayed diagnosis of MS between 2020 and 2024. It is recognised that there are likely to be other ways in which the pandemic has impacted the MS community. The components included in this analysis are those for which sufficient data and literature were available to support robust estimates.

The additional costs from the COVID-19 pandemic were also assessed and analysed qualitatively. This model was constructed based on analysis and interpretation of data collected via desktop review, literature review, data from CIHI, and stakeholder engagement. In recognition of the state of the Canadian health system prior to the COVID-19 pandemic (described in Section 1.3), results from this study should also be viewed in this context, as the pandemic had caused further negative impacts on an already strained health system.

The following sections describe in detail the process taken to estimate the costs relating to the three impact pathways. A detailed discussion of the methodology used to estimate the impact on the health system due to the pandemic is provided in Appendix C. Supplementary tables for the impact on health system costs, including a breakdown of costs by components for the fast and slow recovery scenarios are available in Appendix A.3.

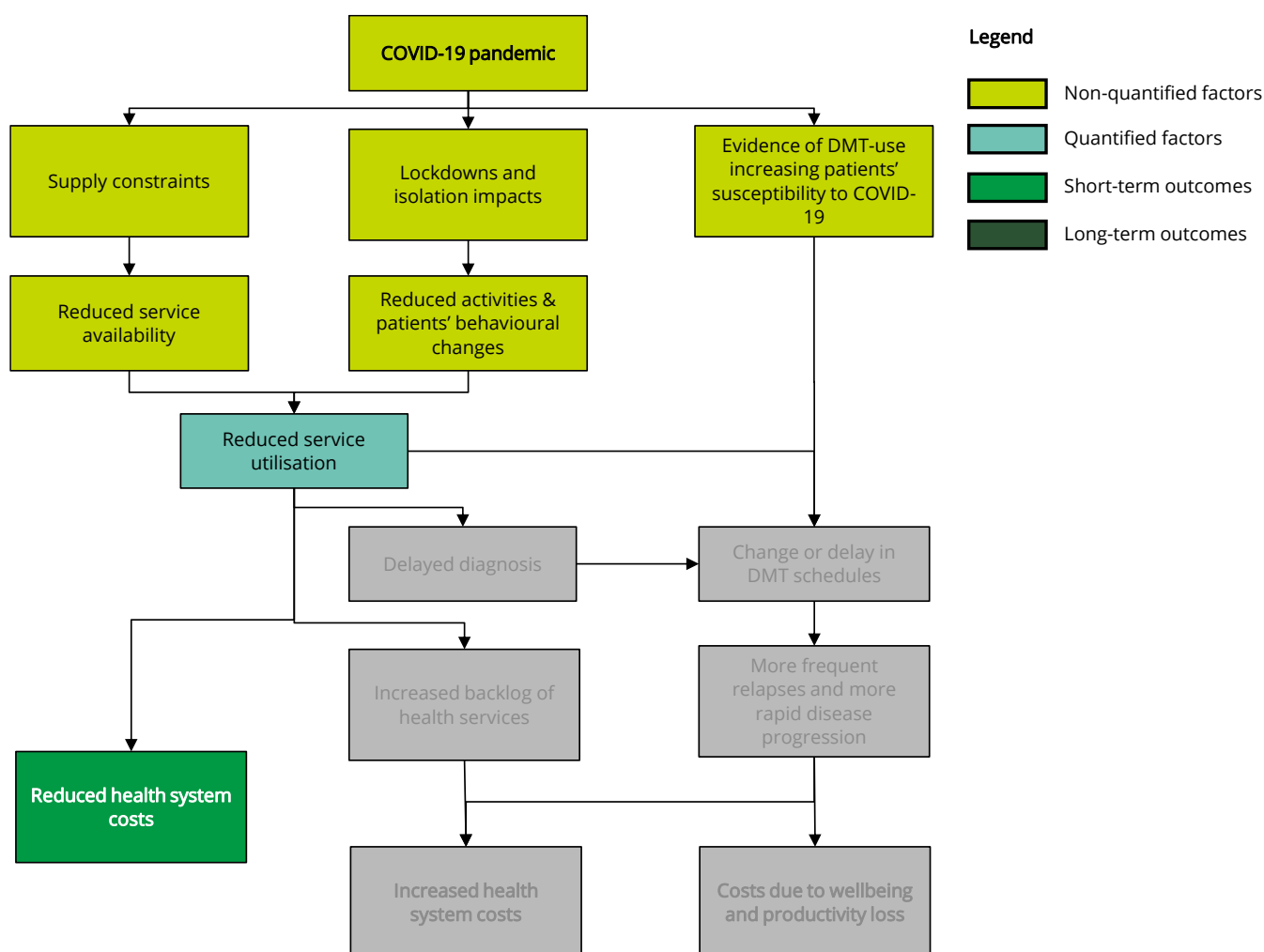
5.3 Reduced health service utilization

This section discusses the impact of the pandemic on MS-related health system expenditure. As discussed earlier, changes in health system expenditure were driven by two factors:

- Supply constraints within the health system due to the reallocation of resources to address COVID-19
- Changes in service utilization driven by public health mandates (e.g., lockdowns and social isolation) and related behavioural changes (e.g., hesitancy to visit clinics) designed to slow the transmission of COVID-19

Figure 5.3 describes how these factors resulted in changes to MS-related health system expenditure.

Figure 5.3: Pathway through which the pandemic impacted MS-related health system expenditure



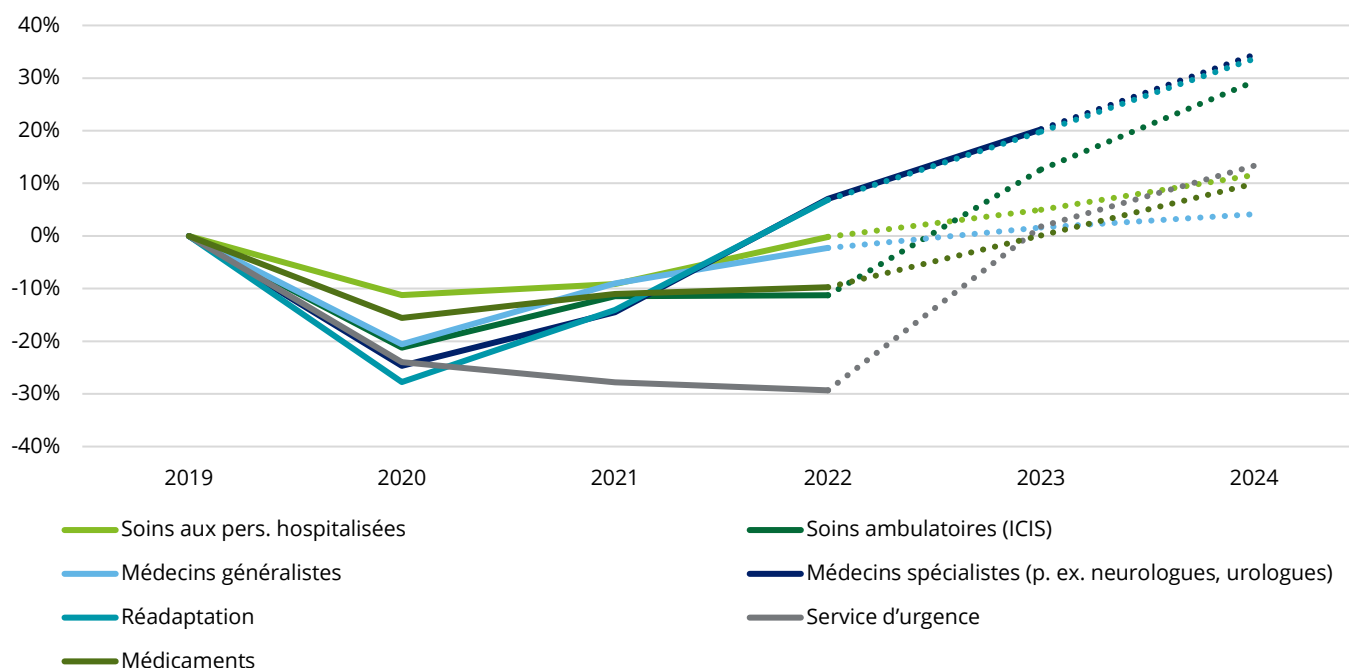
Source: Deloitte Access Economics.

As shown in Chart 5.2, the utilization of health services by people with MS decreased across all service types in 2020. Inpatient and outpatient hospital care reduced by a smaller degree at around 10%, while services such as rehabilitation and specialist visits, including MS clinic visits, reduced by around 25%. Most of these services started to recover in 2021 and either remained constant or increased gradually in 2022. These observations align with the timing of lockdowns across most parts of Canada in 2020 and 2021. It should be noted that clinic outpatient data presented here (from CIHI) includes virtual consultations. Virtual care substantially improved access to health care during the pandemic and in general for people who experience other challenges in visiting a clinic physically. However, the significant reduction in in-person care, especially for people with MS, indicates an even more significant backlog of in-person health care services post-pandemic.⁵¹

ED visits were a notable exception to this trend, decreasing substantially in 2021 and continuing to decrease in 2022 to around 30% of the 'base case'. Through stakeholder consultation, it was hypothesized that this reflects changes in the way in which people with chronic conditions utilize ED facilities and that it is yet to re-normalize.

It was projected that the backlog in health service provision and the increased health needs of people with MS will drive an increase in health system utilization in future years. ED presentations, GP visits, inpatient hospitalization, and pharmaceutical use were estimated to return to pre-pandemic around 2023 and continue to increase in 2024. Other services such as specialist visits, rehabilitation, and outpatient care were estimated to increase more rapidly following the pandemic, likely due to the immediate and urgent care needs of many people living with MS.

Chart 5.2: Changes to health system costs by component (2020-2024)



Source: Deloitte Access Economics analysis.

This study estimated that the changes in the provision of health services between 2020 and 2022 **reduced MS-related health expenditure by \$566 million**. This represents a 13% reduction compared to the expenditure that would have been expected in these years had COVID-related disruptions not occurred ("base case trend"). This was driven in large part by the reduction in the provision of health services during this period (described in detail in Section 5.3). The gap between actual expenditure on MS health care and the base case trend was projected to narrow after 2022, reaching \$46.9 million in 2023.

The changes in the provision of health services and in utilization created a backlog in the provision of critical health services to people with MS. This backlog not only includes individuals who missed services during the impacted period but also those who received virtual rather than in-person care. The proportion of the Canadian population that received virtual care between March 2020 and March 2021 was estimated to be in the range of 24% to 42%.⁵² This backlog has impacted on MS treatment and diagnosis and led to an overall worsening in the health state of many people with MS.

There are likely to be long-term consequences to this for people with MS and for the health system, with actual health expenditure projected to exceed the base case trend in the years to come. It was found that the reduction in health system expenditure was likely to persist until mid-2023 due to the time required for the health system to recalibrate from the impacts of the pandemic. Beyond this point, **health system costs related to MS are estimated to rise to \$1.47 billion in 2024, representing an incremental cost of \$72.8 million compared to the base case trend**. This excess cost is likely to extend beyond the timeframe modelled in this study due to the lasting effects of the backlog in health services.

These estimates are the results from a central scenario driven by an assumed linear recovery in the capacity and availability of MS health care. It is noted that the backlog of health services and delayed DMT treatments may have created a 'bottleneck' as more individuals than there are available services seek to resume treatments. It is also possible that capacity will be re-added to the system faster than anticipated. In this case, the exact trajectory of the recovery would be non-linear.

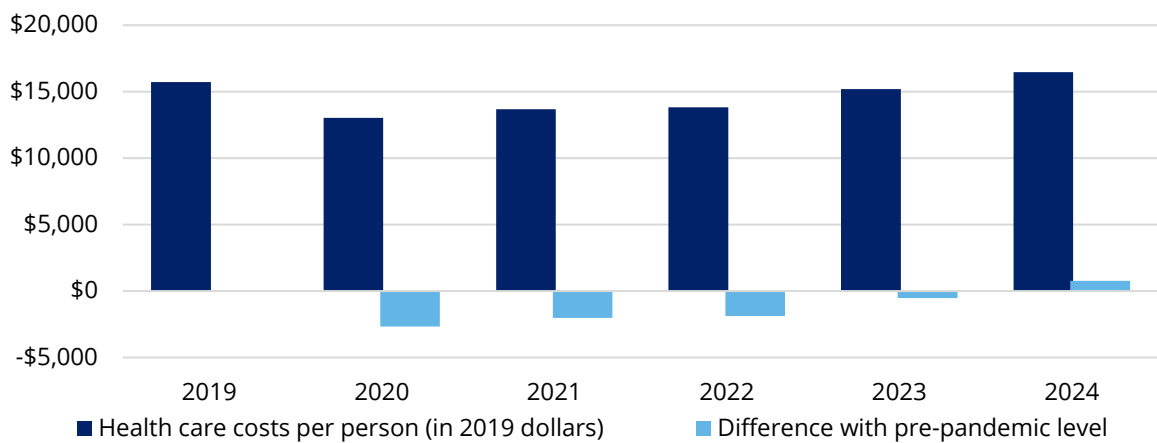
Sensitivity analysis with two alternative scenarios were modelled to account for this possibility. The first scenario considers a case in which the health system recovers faster than expected, while the second considers the case of a slower recovery. The

incremental costs to the health system in 2024 were estimated to be an additional cost of \$234.3 million and a reduced cost of \$52.1 million for fast and slow recovery scenarios, respectively. It should be noted that in the case of a “slow recovery”, the service utilization rate and the costs associated were expected to return to 2019 level post-2024.

The cost estimates for each of the health system components in the fast and slow recovery scenarios are presented Table A.9 and Table A.10, respectively. The trends in these scenarios broadly mirror those observed in the total health system costs, where the costs in the faster recovery scenario accumulated faster and were more substantial due to the higher projected service utilization rate, while the costs for the slower recovery scenario accumulate slower due to the slower projected service utilization rate.

Chart 5.3 shows the estimated per person health system costs across the period considered in this analysis. This was estimated to be approximately \$15,600 (excluding the costs of falls and depression) in 2019, falling to just over \$13,000 in 2020, or approximately 17% lower than the pre-pandemic per person cost. This reduction is reflective of the delay in health care services received by people with MS. The per person costs remained lower than the pre-pandemic level across 2021 and 2022, at \$14,500 and \$14,900 (in real terms), respectively. This gap was projected to close at some point between 2023 and 2024 in the central scenario, where the per person cost will reach around \$18,500, exceeding the comparable amount in 2019. The per person costs were estimated to be approximately \$20,165 in the fast recovery scenario and \$16,770 in the slow recovery scenario.

Chart 5.3: Health system costs per person (2019-2024)



Source: Deloitte Access Economics analysis.

Figure 5.4: Non-quantifiable impacts of the COVID-19 pandemic on people with MS

In addition to the costs modelled above, reduced health service utilization also caused negative impacts to people living with MS that were not quantifiable with existing evidence. These included occurrences like **untreated relapses, untreated symptoms, and increase in severity of comorbidity status**. In a typical year without disruption, regular GP visits, neurologist visits, and rehabilitation provide ongoing care and longitudinal symptom oversight for people with MS. This allows care providers to detect and address some of these occurrences before they progress into more impactful ailments. In this way, ongoing health service utilization represents a critical element of ongoing care and disease management for people with MS.

Untreated symptoms and complications of MS can exacerbate comorbidities. Health care utilization reduced significantly during the pandemic among people with MS. This means that a portion of people living with MS who required medical attention for MS symptoms, relapses, or comorbidities were not being treated. Studies suggested that untreated relapses can contribute to neurological disability substantially in the short term and possibly carry on into the long-term.⁵³ In terms of comorbidities such as mental health, diabetes, hypertension, and hyperlipidemia, during the pandemic GPs were limited in their ability to meet the needs. Subject matter experts (SME) engaged for this study highlighted that people with MS were at a loss for day to day symptoms, secondary complications, and comorbidities. Untreated poor mental health, one of the biggest comorbidities among people with MS, alongside increased mental health risk factors caused by the pandemic, was likely to incur negative impacts on the MS population. Due to the variety of MS symptoms and comorbidities, it is difficult to quantify the true extent of this phenomenon.

Reduced access to rehabilitation has a devastating effect for people with MS, particularly those with moderate levels of disability. Rehabilitation for people with MS includes services like physiotherapy, occupational therapy and cognitive

rehabilitation that assist them in retaining and regaining their functional independence.¹² Anecdotal evidence gathered through stakeholder engagement suggested that in the absence of rehabilitation over 1-2 years of the pandemic, a portion of people with moderate disability had irreversibly lost critical function such as mobility, hand dexterity and cognition. This results in a loss of wellbeing and productivity in the immediate as well as longer term.

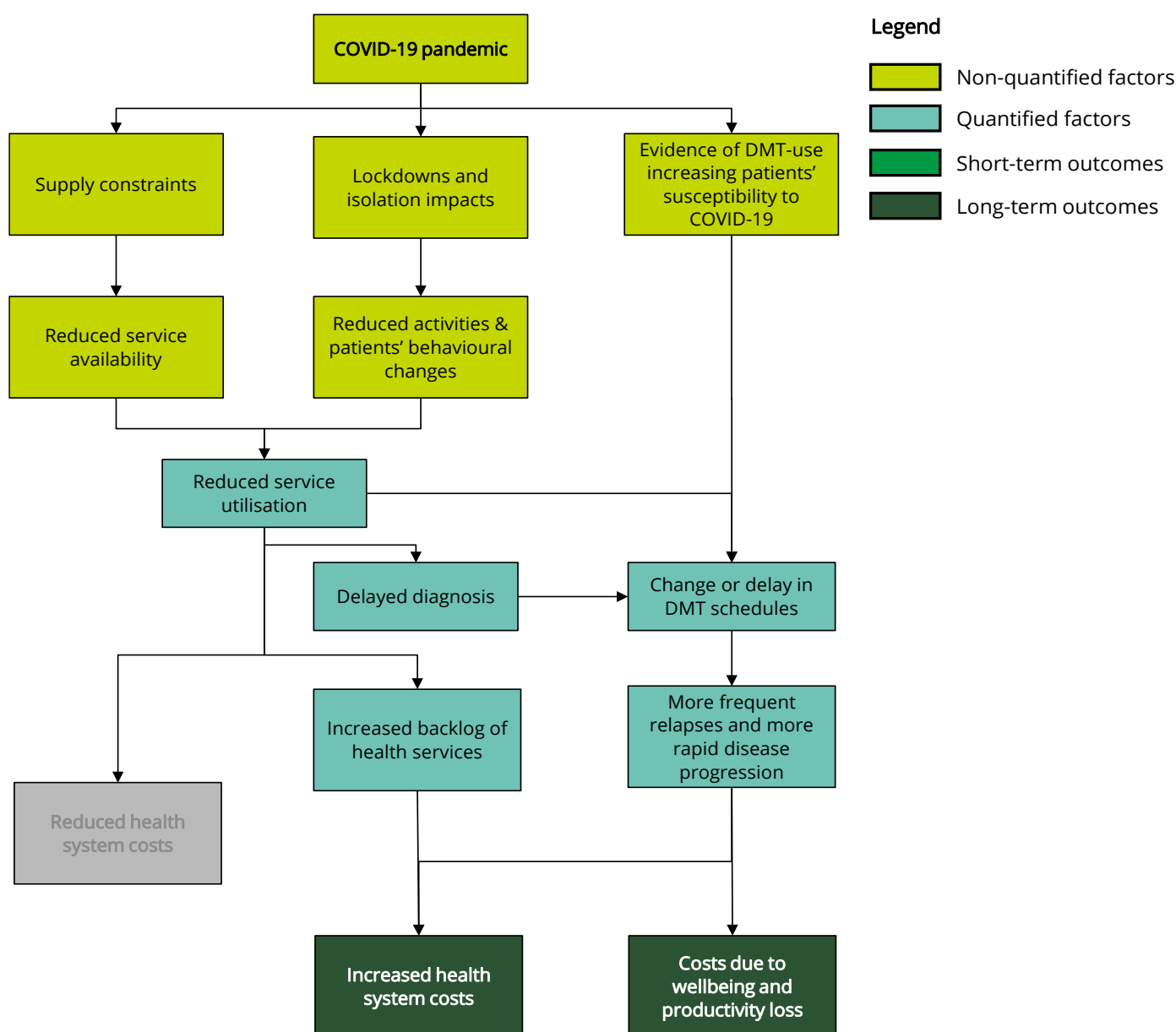
5.4 Increased health needs due to delayed DMT use and delayed diagnosis

This section discusses the impact of the pandemic on people living with MS. As discussed earlier, these changes were brought about by the following factor:

- Changes in treatments with certain classes of DMTs (anti-CD20 and S1Ps) due to emerging evidence of the potential risks of poorer outcomes from COVID-19 infection and vaccination.

Figure 5.5 describes how these factors resulted in changes and delays to DMT treatments and in delayed diagnoses.

Figure 5.5: Impact of COVID-19 on MS outcomes from delayed DMT use and delayed diagnosis



Source: Deloitte Access Economics.

Timely diagnosis and treatment is critical in the management of MS. As such, pandemic-related delays in critical health services such as diagnostics and specialist consultations were expected to accelerate disability accumulation and adversely impact symptom management. The costs associated with these increased health needs were considered in three ways: 1)

increased health system expenditure due to greater health care needs, 2) greater difficulty participating in the workforce, and 3) poorer quality of life.

These impacts were estimated to cost Canada approximately **\$578.3 million between 2020 and 2024** (Table 5.2). Around three quarters of this was attributable to the intangible loss of wellbeing, and the remaining quarter were either direct financial costs relating to health system expenditure or indirect costs from reduced productivity. The costs were estimated to increase drastically from 2020 to 2023 (by around \$40-60 million each year), and remain relatively constant between 2023 and 2024 (and likely beyond).

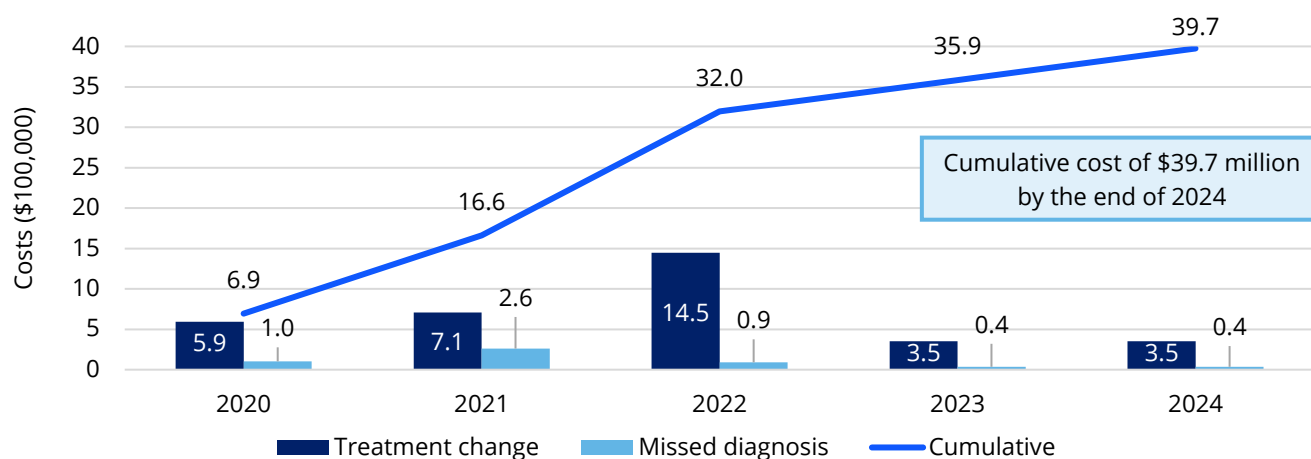
Table 5.2: Costs associated with increased health needs, 2020 to 2024

Cost component (\$ millions)	Year					Total
	2020	2021	2022	2023	2024	
Treatment changes						
Health system	5.9	7.1	14.5	3.5	3.5	34.5
Productivity	0.0	9.5	20.9	29.2	29.2	88.9
Loss of wellbeing	0.0	42.8	94.4	131.7	131.7	400.5
Delayed diagnosis						
Health system	1.0	2.6	0.9	0.4	0.4	5.2
Productivity	0.0	0.6	2.4	2.9	3.0	8.9
Loss of wellbeing	0.0	2.9	10.9	13.1	13.3	40.2
Total	6.9	65.5	144.0	180.8	181.0	578.3

Source: Deloitte Access Economics.

Changes and delays in DMT treatments were estimated to result in an annual health care cost of between **\$6 million to \$15 million during pandemic-affected years (2020-2022)**. Their effects were projected to cost approximately **\$3.5 million per year in 2023 and 2024**. Delayed MS diagnosis during the pandemic was estimated to cause between **\$900,000 and \$2.6 million in 2020-2022**. The ongoing impact beyond the pandemic was estimated to be **\$0.4 million per year**, due to worsened disease progression for people who missed timely treatment. As discussed above, the impact of delayed diagnosis and treatment is likely to continue into the future, contributing to the lifetime estimate of additional costs.

Chart 5.4: Health system costs associated with treatment change and delayed diagnosis, 2020 to 2024



Source: Deloitte Access Economics analysis.

The costs were relatively consistent under the fast recovery and slow recovery scenarios. This likely reflects a persistent level of health needs in the short-term and the impact of delayed health care in terms of DMT use will likely to be cumulative over a long period of time.

While the scope of this study precluded the estimation of costs beyond 2024, previous studies have demonstrated that delayed diagnosis and treatment of MS can result in significant costs over a life course, which can vary greatly depending on individual circumstances. A Canadian study found that early treatment of MS could result in savings of up to \$123,000 per person over a 10-year period,⁵⁴ while a different study conducted in the U.S. estimated a cost savings of up to \$316,340 per patient over a lifetime when compared to delayed initiation of DMT.⁵⁵

A detailed discussion of the methodology used to estimate the cost impact on health system due to the pandemic is provided in Appendix A.6. Supplementary tables for the impact on health system costs are available in Table A.4.

5.4.1 Costs incurred by delays and changes to DMT use

Delays and changes to existing DMT treatments during the pandemic were estimated to lead to additional costs of **\$35 million to the health system, \$89 million in productivity loss, and \$401 million in loss of wellbeing** between 2020 and 2024 (Table 5.3).

Table 5.3: Estimated impact on the annual cost of MS from changes to DMTs, 2020 to 2024

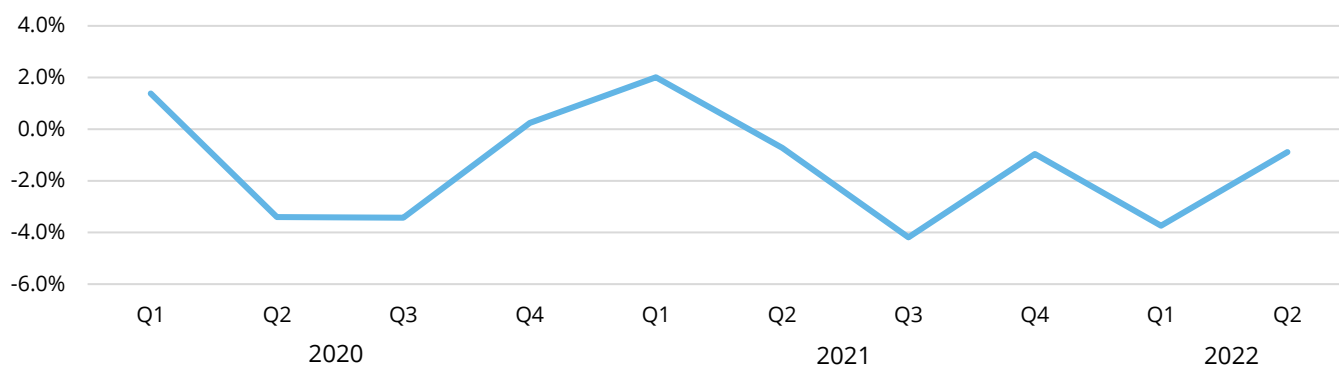
Cost component (\$ millions)		2020	2021	2022	2023	2024	Total
Financial cost	Health system	5.9	7.1	14.5	3.5	3.5	34.5
	Productivity	0.0	9.5	20.9	29.2	29.2	88.9
	<i>Sub-total</i>	<i>5.9</i>	<i>16.6</i>	<i>35.4</i>	<i>32.8</i>	<i>32.8</i>	<i>123.4</i>
Non-financial cost	Loss of wellbeing	0.0	42.8	94.4	131.7	131.7	400.5
Total		5.9	59.4	129.8	164.4	164.4	523.9
% of total		1%	11%	25%	31%	31%	100%

Source: Deloitte Access Economics analysis.

Health system costs were estimated to have increased steadily between 2020 and 2022 due to the increased rate of relapses experienced by a portion of people with MS whose DMT treatments were disrupted. This was estimated to have occurred to approximately 1,796 people with MS. Health system costs from 2021 onwards were compounded by disease progression experienced by a proportion of this cohort, who were expected to need a higher level of health care (see Appendix B for details).

The extent and duration of the reductions in DMT treatments were informed by CIHI NPDUIS data. These data showed a decline in the number of pharmaceutical claims aligning with the timing of lockdowns in Canada (Chart 5.5). In the period between 2020 Q2 and Q3, an estimated 1,240 (3.4%) people stopped their DMT course for six months. A similar magnitude of impact was also identified in 2021 Q3 (4.2%) and 2022 Q1 (3.7%).

Chart 5.5: Percentage changes to MS pharmaceutical claims (2020 Q1 to 2022 Q2)



Source: Deloitte Access Economics analysis.

CIHI data showed that the number of visits to physicians due to MS dropped by 21% across Canada in 2020, compared to the same period in 2019. While the number increased slightly in 2021 and 2022, both year's figures represent a 12% and 10% reduction compared to levels in a typical year prior to the pandemic (i.e., 2019). This mirrors the overall reduction across Canadian provinces. The number of visits to physicians due to MS dropped by ~15% in British Columbia, ~35% in Ontario and Alberta, and up to 57% in Saskatchewan in April 2020 compared to the same period in 2019.⁵⁶ This reduction is caused by a combination of reduced service availability and people's hesitancy to visit a clinic. It should be noted that the data presented by CIHI includes virtual care, where an estimated 24-42% of these visits were conducted via virtual consultations.⁵⁷

A study commissioned by MS Canada surveying a total of 2,689 people with MS reported that 5% of respondents paused or stopped their DMT temporarily during the pandemic (data not released publicly). Another 4% switched to a different DMT. Research has found that among 250 neurologists in Canada and the U.S., 65% altered their prescribing patterns during the pandemic based on perceived safety, including 9% switching a DMT, and 8% discontinuing DMTs.⁵⁸ These data are supported by consultations with clinicians who indicated that roughly 10-20% of their patients had delayed their DMTs. This study also found that high-efficacy DMT such as alemtuzumab, cladribine, and ocrelizumab were avoided by neurologists in favour of lower efficacy agents due to their mechanisms of action. More than 50% of surveyed neurologists believed that high-efficacy DMTs prolong viral shedding of the coronavirus and that B-cell therapies might blunt protective vaccine effects based on preliminary research data at the time.

5.4.2 Costs incurred by delayed diagnosis of MS

Delayed diagnosis of MS during the pandemic was estimated to cost a total of **\$5.3 million to the health system, \$8.9 million in productivity losses, and \$40.2 million in lost wellbeing** between 2020 and 2024 (Table 5.4). The health system costs were driven by increased health needs due to more severe and unmanaged symptoms, and faster disease progression for a portion of undiagnosed people with MS. Modelling indicated that this applied to approximately 330 people. Faster disease progression was also modelled to increase productivity losses and reduce wellbeing due to increased disability.

Informal carer costs were not included in the productivity losses in this section of the report due to a lack of data regarding changes in the experiences of caregivers during the pandemic. It is acknowledged that caregivers likely experienced impacts on their wellbeing during the pandemic, possibly due to more burdensome care requirements. This is further discussed in terms of qualitative evidence in Section 5.5.

Table 5.4: Estimated impact on the annual cost of MS from delayed diagnosis, 2020 to 2024

Cost component (\$ millions)		2020	2021	2022	2023	2024	Total
Financial cost	Health system	1.0	2.6	0.9	0.4	0.4	5.3
	Productivity	0.0	0.6	2.4	2.9	3.0	8.9
	<i>Sub-total</i>	1.0	3.2	3.3	3.3	3.3	14.2
Non-financial cost	Loss of wellbeing	0.0	2.9	10.9	13.1	13.3	40.2
Total		1.0	6.1	14.3	16.4	16.6	54.4
% of total		2%	11%	26%	30%	31%	100%

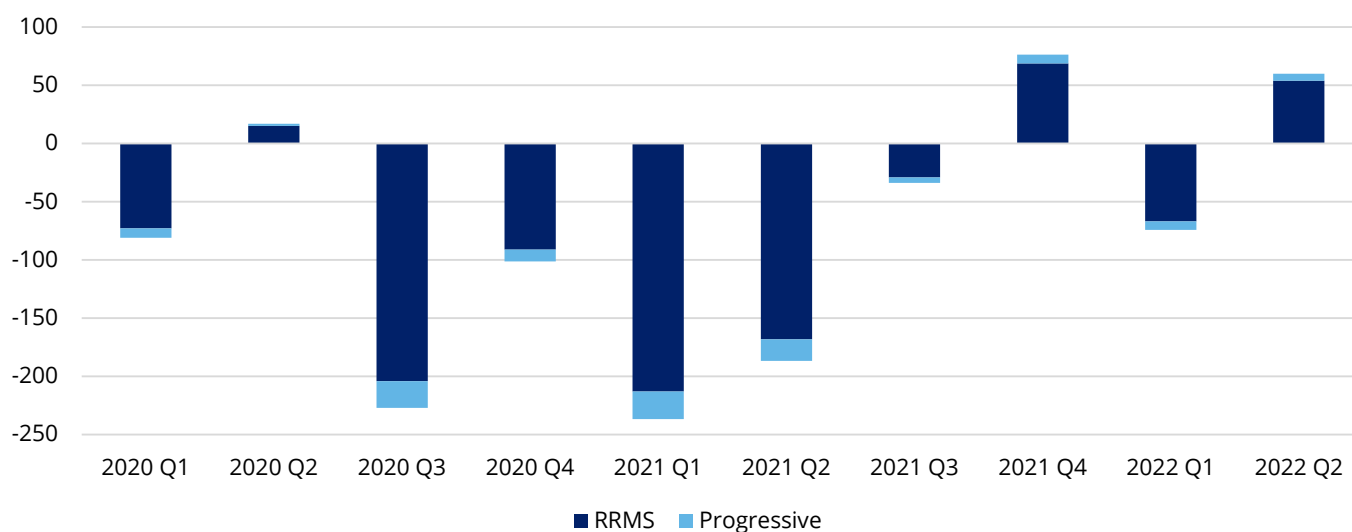
Source: Deloitte Access Economics analysis.

Delayed diagnosis of MS was projected to increase the incidence and severity of MS when a diagnosis is made. This was due to the reduction in service availability and utilization during the pandemic. The diagnostic process of MS (discussed in Section 1.2) is often not straightforward due to the absence of a single deterministic test. A patient is likely to visit a GP and/or neurologist multiple times before a diagnosis is made. The process is also likely to involve steps including neurologist examination, MRI examination, and possibly a lumbar puncture. As the diagnostic process involves several different health care service providers, it is susceptible to disruption caused by the pandemic.

To account for the complexity of diagnostic process and data limitations, this study makes a conservative assumption that the rate of reduction in diagnosis mirrors that of outpatient clinic data from CIHI. It is possible that disruptions in other diagnostic steps further reduce MS diagnosis during the pandemic, in which case the costs would increase further beyond the estimate presented in this report. It was assumed that the capacity and availability of diagnostic services returned to pre-pandemic levels by mid-2022, although the backlog would take additional time to resolve even in this circumstance (it was assumed there was a 12-month delay for any diagnosis missed during the pandemic).

The number of newly diagnosed cases of MS was estimated to be roughly 4,216 in 2020. Due to reduced health care service utilization, it was estimated that nearly 950 MS diagnoses were delayed due to the pandemic (Chart 5.6). RRMS (n=846, 90%) likely accounted for the majority of delayed diagnoses, with the remainder attributable to progressive MS.

Chart 5.6: Changes in the number of diagnoses, relative to projected MS incidence



Source: Deloitte Access Economics analysis.

Delays in diagnosis result in treatment, management, and care for MS commencing later than is optimal. A delay in commencing DMTs can have profound and long-lasting impacts on a person with MS. People with RRMS that experienced delays in treatment with a DMT are susceptible to a higher rate of relapses and irreversible neural impairment. This increases the speed and probability of their progression to SPMS. Modelling suggests that pandemic-induced delays in diagnoses resulted in irreversible disease progression that will carry impacts into future years.

5.5 Other impacts

While this section of the report largely focused on the disruption to health service access and utilization, the pandemic also affected people with MS in other ways. This includes deterioration of wellbeing from reduced rehabilitation, caring, and social needs, as well as adverse impacts on informal caregivers (often friends and family).

Access to allied health services, including physiotherapy, dietitians, and certain procedures (such as orthopaedic replacement) was severely restricted during the pandemic. Stakeholders consulted highlighted the important consequences of people with MS not having access to these services. Many multidisciplinary rehabilitation programs halted indefinitely when the public health restrictions were enforced, and those that managed to continue providing services virtually were limited in their effectiveness. Some people living with MS (e.g., elderly people) whose accessibility to virtual care can be limited were unable to effectively engage in this alternate form of service delivery. Overall, many people with MS lost access to their rehabilitation programs, resulting in poorer symptom management and reduced quality of life.

Home care and long-term care form an important part of health care for people with advanced MS. Many home care services and long-term care facilities were limited by social distancing measures introduced during the pandemic. CIHI data showed that both home care and long-term care services had reduced by 7-11% in 2020 and 4-11% in 2021. While the trend was projected to start recovering in 2022, the rate remained 4-7% lower compared to 2019 levels at the time of this report.

A reduction in home care and long-term care services during the pandemic meant that people with MS did not receive adequate care. As those care services are associated with their mobility and socialization, the lack of care also contributes to the points discussed above. The impact of restrictions on care goes beyond people with MS. In the absence of formal care, the informal care needs fall on to family and friends, for those who have access to it. A report into the impacts of COVID-19 on women by Canada's House of Common Standing Committee on the Status of Women found that the burden of care was disproportionately shouldered by women.⁵⁹ It should also be noted that some people with MS did not have access to informal care, for example those that do not live close to family. This group of people with MS are likely to have been most acutely affected by the impacts on home and long-term care.

People with MS were among the vulnerable population with chronic diseases who faced a higher degree of social isolation during the pandemic. This stemmed from a heightened fear of contracting coronavirus, limited mobility, and a lack of paid caregivers. Previous studies have showed that depression, anxiety and mood disorders are more prevalent in people with

MS compared to the general population due to stress and MS-related symptoms.⁶⁰ Stakeholder consultation suggested that social isolation can add to known mental health risk factors for people with MS. As mental health conditions are one of the primary co-morbidities in the MS population, the impact of the COVID-19 pandemic is likely to have led to worsened outcomes for people with MS.

A rapid review into the impact of the pandemic on people with disabilities, including three studies involving people with MS reported a decrease in access to health care.^{61, 62,63,64} Changes in social and lifestyle habits, mood changes and decreased levels of physical activity were also reported, although the authors noted there is a lack of research data in this area.

The disruption of the pandemic on Canadian health services was most significant during 2020 and 2021. While a portion of the services, especially those prioritized as urgent, returned in the following months, the effect of social distancing measures lingered due to patients' fear of contracting the virus. Stakeholder consultation identified that while virtual care was in place for many GP and neurologist providers to partially address MS health care needs, virtual assessments were challenging in accurately identifying some relapses and disease progression. There were physical appearance or movement symptoms that physicians would have noticed more obviously in in-person visits compared to virtual consultations. Stakeholders reflected that once the restrictions had eased, seeing their patients became more complicated visits as there was a backlog of issues to address. These pointed to additional impacts and costs to the MS population and the Canadian society that likely will continue for years to come.

6 Conclusion

MS Canada commissioned Deloitte Access Economics to undertake this study with two broad objectives:

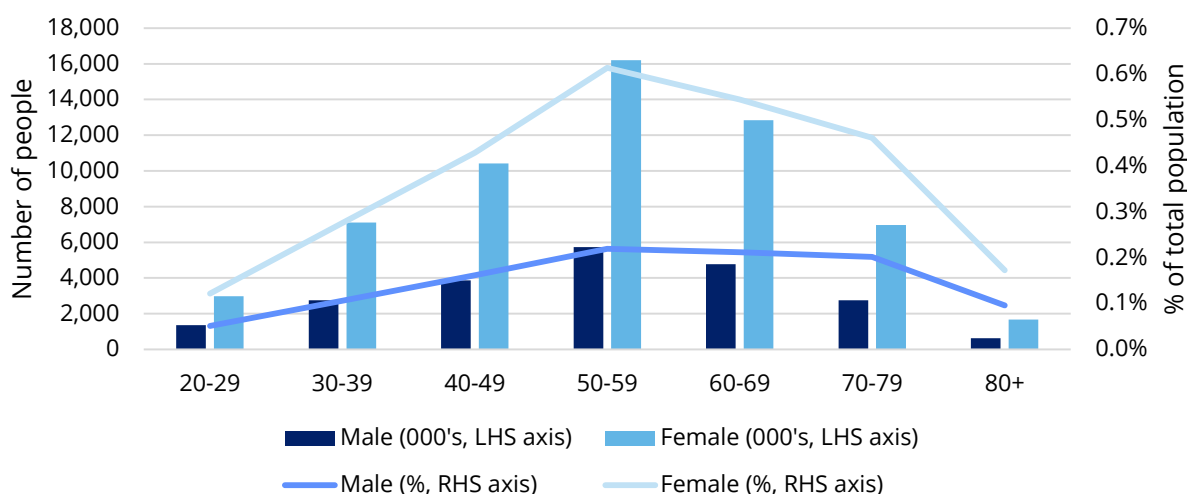
1. Provide an up-to-date estimate of the socioeconomic cost of MS in Canada in a typical year before the pandemic (2019).
2. Estimate the health-related economic impact of COVID-19 on the MS community in Canada between 2020 and 2024. This component also considers impacts of changes to DMT schedules and delayed diagnosis on the health outcomes of people living with MS.

The key findings from this study are:

MS is highly prevalent across Canada, with around 305 cases per 100,000 adults in 2019. This is equivalent to **approximately 90,000 total cases of MS**,¹ and it was found that nearly three quarters of these cases were among females. While this report recognizes these data as representative of the total number of people living with MS in Canada, data from the CCDSS were used for the purposes of costing (the reasons for which were described in Figure 3.1).

Based on CCDSS data, Nova Scotia was found to have the highest rate of MS with 355 cases per 100,000 population, while Newfoundland and Labrador had the lowest rate at 169 cases per 100,000 population. Cases were shown to increase with age until a peak between 50 and 59 for both females and males, beyond which the number of people with MS in any one group declines. This reflects the shortened life expectancy for people with MS, as people are most diagnosed between ages 20 and 49. Chart 6.1 presents the estimated number of cases of MS in Canada in 2019 based on CCDSS data.

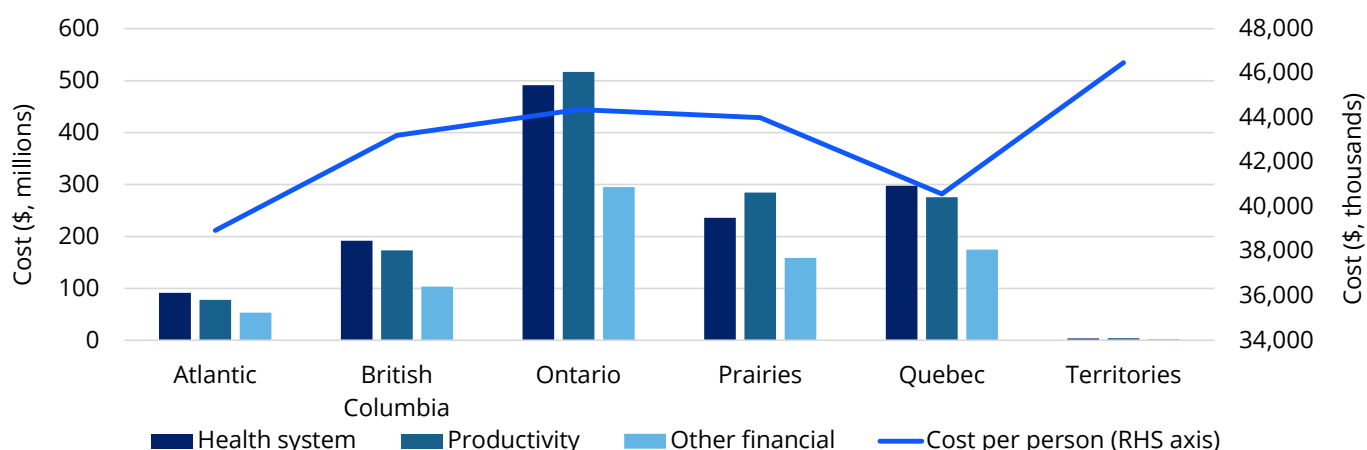
Chart 6.1: Cases of MS in Canada in 2019, by age group and sex



Source: Deloitte Access Economics analysis.

These cases of MS carry a significant financial, economic, and intangible cost, estimated to be \$3.4 billion in 2019. The total cost estimate comprises approximately **\$1.3 billion in direct health system expenditure**, **\$1.3 billion in indirect costs relating to reduced productivity**, and nearly **\$800 million in other financial costs**. This equates to around **\$42,880 per person with MS**. Ontario and Quebec were found to have the highest overall cost, owing to their population shares, while the highest per person costs were in the Territories, likely reflecting the costs associated with services in remote regions.

Chart 6.2: Socioeconomic costs of MS in Canada in 2019



Source: Deloitte Access Economics analysis.

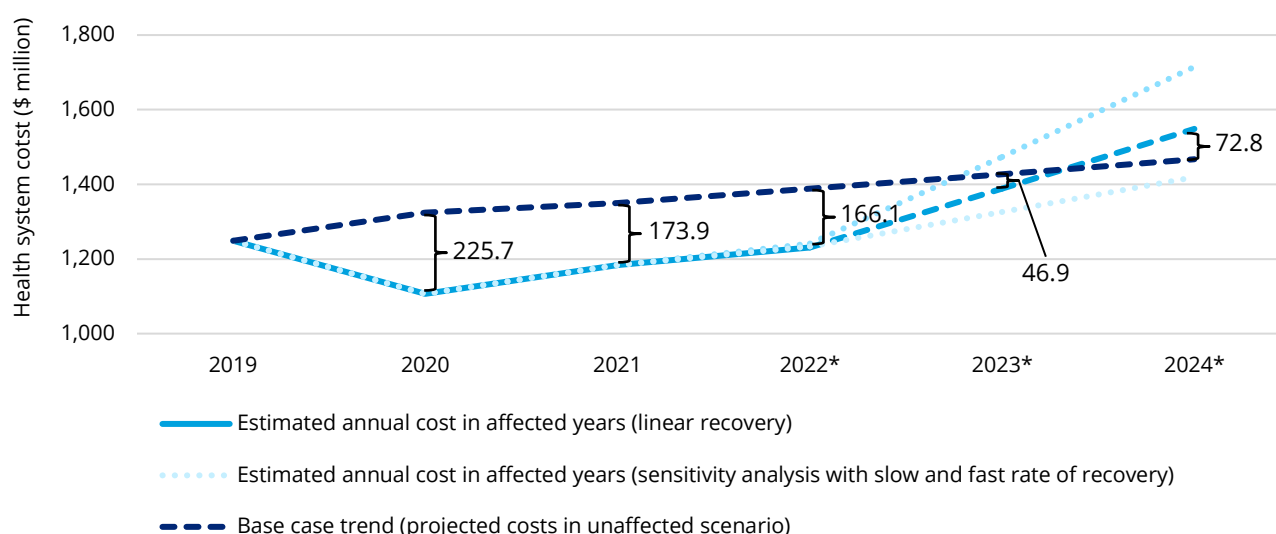
These estimates are relatively consistent with other studies. For example, a study published in the UK reported the average per person cost of MS to be approximately \$48,800 when converted to Canadian dollars (CAD) and inflated to 2019.⁶⁵ Another study published by the Menzies Institute for Medical Research in Australia reported the average per person cost of MS across 16 studies (from Australia, Europe, and North America) to be \$55,125 Australian dollars (AUD) in 2017.⁶⁶ This is equivalent to approximately \$50,200 CAD in 2017, or \$52,700 CAD in 2019.

Specific studies by the Menzies Institute reported substantially higher average per person costs. The average per person cost of MS in Australia was estimated to be \$68,382 AUD in 2017,⁶⁶ equivalent to approximately \$62,200 CAD in 2019. This was based on a sample of 488 people with MS and the estimated indirect costs due to lost wages were substantially higher than estimated in this report due to methodological differences. A study published in the US reported the average per person cost to be nearly \$90,000 USD in 2019, with more than a third of this attributable to DMTs.⁶⁷ This was again based on a relatively small sample of 946 people with MS; however, the main difference is likely to be in the health system and resultant costs of DMTs, which were reported to account for more than one third of the \$90,000 USD average cost per person.

The COVID-19 pandemic significantly restricted the delivery of MS-related health services, leading to a \$566 million reduction in the cost of MS between 2020 and 2022. This represents a **13% reduction in health expenditure** relative to what would have been expected had the pandemic not occurred. The gap between actual costs and those that would have been expected was projected to narrow to \$46.9 million in 2023.

A backlog in the provision of health services and increased needs of people with MS is likely to necessitate additional health system expenditure in future years. Health system costs are projected to rise to around \$1.5 billion in 2024, representing an **incremental increase of \$72.8 million** compared to what would have been expected had the pandemic not occurred. This excess cost is **likely to extend beyond the timeframe modelled in this study** due to the lasting effects of the backlog in health services and the increased health care needs of people with MS. The costs are also likely to be a conservative estimate due to (1) the timeframe considered in this study, and (2) data limitations restricting the number of factors that could be modelled (e.g., costs related to comorbidities and informal caregiver burden).

Chart 6.3: Incremental health system costs, estimated actual vs base case trend, 2019 to 2024



Source: Deloitte Access Economics analysis.

Delays in the diagnosis and treatment of MS are likely to have caused irreversible disease and disability progression, contributing to further excess costs in future years. These factors were estimated to generate an additional **\$39.7 million in MS-related health system expenditure, \$97.8 million in productivity losses, and \$440.7 million in lost wellbeing** between 2020 and 2024. Other unquantified effects of the pandemic, such as a reduction in rehabilitation services and a lack of social and cognitive stimulation, are also expected to worsen MS disease states. These impacts and their associated costs are likely to grow beyond the timeframe modelled in this study.

This study highlights the significant socioeconomic cost of MS to Canada each year. While the changes in the provision of health services reduced MS-related health expenditure between 2020 and 2022, evidence from this study suggests that these costs are now rising above the level that would have been expected in the absence of the pandemic to clear the backlog in health services. Coupled with significant excess costs related to a worsening in the disease state of many people with MS due to treatment changes and delayed diagnoses, this trend towards higher costs is expected to continue – and rise – in future years.

The findings presented in this report are intended to contribute to better understanding to costs associated with MS and how the pandemic has affected people living with the disease. They will help to inform policy decisions and improve advocacy nationally and provincially to assist in the MS-community's recovery from the pandemic. The study also highlights the need for further data collection and research to fill the gaps noted throughout and to update estimates as the longer-term outcomes from the pandemic are realised.

Appendix A: Supplementary tables

A.1. Stakeholder engagement process

Table A.1 presents the list of stakeholders who participated in consultation for this study. The stakeholder engagement process was critical to the development of the methodology for the modelling and in better understanding the MS community, the impacts of COVID on people living with MS, and the health system more broadly. Their participation in this study, including reviewing of outputs, is acknowledged with gratitude.

Table A.1: Stakeholders engaged in this study

Stakeholder	Affiliations
Dr. Ruth Ann Marrie	Professor of Medicine & Community Health Sciences Max Rady College of Medicine, Rady Faculty of Health Sciences University of Manitoba Director Multiple Sclerosis Clinic
Dr. Helen Tremlett	Faculty of Medicine (Neurology), and the Djavad Mowafaghian Centre for Brain Health University of British Columbia, Vancouver, Canada
Dr. Marcia Finlayson	Professor – School of Rehabilitation Therapy Faculty of Health Sciences, Queen's University Kingston, Ontario, Canada
Dr. Sarah Morrow	London Health Sciences Centre University of Western Ontario (Western) London, Ontario, Canada
Dr. Penny Smyth	Associate Professor, Division of Neurology Department of Medicine Associate Dean, Professionalism University of Alberta, Edmonton, Alberta, Canada College of Health Sciences Faculty of Medicine & Dentistry

A.2. Cost of illness modelling

The following sections provide more detailed outputs for sections of the modelling. This includes outputs for each province and territory (rather than grouped) for the proportion of people living with MS, mortality from MS, health system costs, productivity losses, other financial costs, and the loss of wellbeing from MS.

A.2.1. Prevalence of MS

The prevalence of MS was estimated using data from the CCDSS.⁵ The CCDSS provides the rates of prevalence for chronic diseases across Canada, stratified by province and territory, age, and sex. Table A.2 presents these rates (excluding age disaggregation), showing that the highest prevalence is found in Nova Scotia and Prince Edward Island. Overall, nearly 0.3% of Canadians were living with MS in 2019, and females were much more likely to have MS than males.

Table A.2: Proportion of population with MS in Canada in 2019, by province and sex

Province / territory	Male	Female	Total
Alberta	0.17%	0.45%	0.31%
British Columbia	0.14%	0.39%	0.27%
Manitoba	0.16%	0.41%	0.29%
New Brunswick	0.16%	0.42%	0.29%
Newfoundland and Labrador	0.09%	0.25%	0.17%
Northwest Territories	0.19%	0.26%	0.23%

Province / territory	Male	Female	Total
Nova Scotia	0.17%	0.53%	0.35%
Nunavut	0.13%	0.29%	0.21%
Ontario	0.15%	0.36%	0.26%
Prince Edward Island	0.19%	0.46%	0.33%
Quebec	0.15%	0.39%	0.27%
Saskatchewan	0.15%	0.38%	0.26%
Yukon	0.15%	0.40%	0.27%
Total	0.15%	0.39%	0.27%

Source: Deloitte Access Economics analysis based on CCDSS data.

A.2.2. Mortality due to MS

Mortality due to MS was estimated using data from Statistics Canada regarding deaths by cause for diseases of the nervous system.⁶⁸ This dataset documents the number of deaths in Canada each year where the primary cause of death was recorded as being MS.

The underlying source of data for the Statistics Canada publication is the central Vital Statistics Registry operated in each province and territory across Canada. The registration of all live births, stillbirths, deaths, and marriages in this registry is compulsory. The administrative survey that feeds into this registry collects demographic and medical (cause of death) information annually and monthly on all deaths for residents and non-residents living in Canada.

The cause of death listed in the database is classified according to the World Health Organization's International Statistical Classification of Diseases and Related Health Problems – 10th edition (ICD-10). The registration of a death, including its cause, relies on information in the medical certificate completed by the medical practitioner last in attendance, or by a coroner (if an inquest or enquiry was held). The determination of what constitutes a death due to MS is therefore reliant on the information recorded within the medical certificate.

These data showed that there were 593 deaths in Canada in 2019 for which the primary cause of death was recorded as being MS. This translates to a mortality rate of approximately 1.6 per 100,000 persons in the population. The mortality rate for females was 2.0 per 100,000 persons compared to 1.2 per 100,000 persons for males.

Table A.3: Mortality rates of MS in Canada in 2019 by province and sex (per 100,000 persons)

Province / territory	Male	Female	Total
Alberta	1.0	1.6	1.3
British Columbia	1.3	2.1	1.7
Manitoba	1.1	1.8	1.4
New Brunswick	1.4	2.3	1.8
Newfoundland and Labrador	1.4	2.3	1.9
Northwest Territories	0.9	1.3	1.0
Nova Scotia	1.4	2.2	1.8
Nunavut	0.5	0.7	0.6
Ontario	1.2	2.0	1.6
Prince Edward Island	1.3	2.2	1.7
Quebec	1.3	2.1	1.7
Saskatchewan	1.1	1.8	1.4

Province / territory	Male	Female	Total
Yukon	1.1	1.6	1.3
Total	1.2	2.0	1.6

Source: Deloitte Access Economics analysis based on Statistics Canada data.

A.2.3. Health system costs

Table A.4 presents the detailed distribution of health system costs across all provinces and territories.

Table A.4: Health system costs for all provinces and territories (\$ millions)

Province	Inpatient care	Outpatient care	Emergency department	Specialists	General practitioners	Drugs	Rehabilitation	Falls	Depression	Total	% of total
Alberta	2.1	1.2	0.8	2.0	6.7	149.1	1.0	0.8	6.4	170.1	13.1%
British Columbia	2.2	1.2	0.8	2.1	7.1	169.3	1.1	0.7	6.5	190.8	14.6%
Manitoba	0.6	0.3	0.2	0.6	1.9	24.3	0.3	0.2	1.7	30.1	2.3%
New Brunswick	0.4	0.2	0.1	0.4	1.2	25.8	0.2	0.1	1.1	29.5	2.3%
Newfoundland and Labrador	0.1	0.1	0.1	0.1	0.5	10.7	0.1	0.0	0.5	12.2	0.9%
Northwest Territories	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	1.2	0.1%
Nova Scotia	0.5	0.3	0.2	0.5	1.8	37.7	0.3	0.1	1.7	43.1	3.3%
Nunavut	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.9	0.1%
Ontario	6.1	3.4	2.2	5.7	19.1	428.1	2.9	2.0	18.2	487.8	37.4%
Prince Edward Island	0.1	0.0	0.0	0.1	0.3	5.2	0.0	0.0	0.2	6.0	0.5%
Quebec	3.7	2.0	1.4	3.6	12.0	258.4	1.8	1.3	11.1	295.4	22.7%
Saskatchewan	0.5	0.3	0.2	0.4	1.5	29.5	0.2	0.1	1.4	34.1	2.6%
Yukon	0.0	0.0	0.0	0.0	0.1	1.3	0.0	0.0	0.1	1.5	0.1%
Total	16.3	9.0	6.1	15.5	52.1	1,141.4	7.9	5.5	48.9	1,302.8	100.0%
% of total	1.3%	0.7%	0.5%	1.2%	4.0%	87.6%	0.6%	0.4%	3.8%	100.0%	-
Cost per person (\$)	204	113	76	194	651	14,264	99	68	611	16,280	-

Source: Deloitte Access Economics analysis.

A.2.4. Productivity costs

Table A.5: Productivity costs for all provinces and territories (\$ millions)

Province	Absenteeism	Presenteeism	Reduced employment	Premature mortality	Informal care	Total	% of total
Alberta	15.6	22.5	123.9	16.4	35.8	214.2	15.1%
British Columbia	13.2	19.1	105.1	16.6	29.7	183.6	13.0%
Manitoba	3.3	4.8	26.4	3.8	7.7	46.0	3.3%
New Brunswick	1.9	2.8	15.2	1.9	4.3	26.1	1.8%
Newfoundland and Labrador	0.8	1.2	6.5	1.4	1.9	11.7	0.8%
Northwest Territories	0.1	0.2	0.8	0.1	0.2	1.5	0.1%
Nova Scotia	2.7	3.9	21.7	2.5	8.2	39.1	2.8%
Nunavut	0.1	0.1	0.4	0.1	0.1	0.8	0.1%
Ontario	39.3	56.8	313.0	46.6	93.1	548.8	38.8%
Prince Edward Island	0.4	0.6	3.2	0.4	1.2	5.8	0.4%
Quebec	20.6	31.0	170.6	20.4	50.4	293.0	20.7%
Saskatchewan	3.1	4.5	24.6	3.8	6.2	42.2	3.0%
Yukon	0.2	0.2	1.1	0.1	0.3	1.8	0.1%
Total	101.3	147.4	812.5	114.2	239.2	1,414.7	100.0%
% of total	7.2%	10.4%	57.4%	8.1%	16.9%	100.0%	-
Cost per person (\$)	1,266	1,843	10,154	1,427	2,989	17,679	-

Source: Deloitte Access Economics analysis.

A.2.5. Other costs

Table A.6: Other costs for all provinces and territories (\$ millions)

Province	Aids and modifications	Formal care	Long-term care	Support payments	Deadweight losses	Total	% of total
Alberta	24.5	7.4	12.1	45.2	20.9	110.1	14.0%
British Columbia	26.0	5.8	5.6	45.0	21.1	103.5	13.1%
Manitoba	7.0	1.6	1.3	12.0	4.5	26.4	3.4%
New Brunswick	4.4	0.9	0.8	7.8	3.3	17.2	2.2%
Newfoundland and Labrador	1.7	0.4	0.3	3.3	1.4	7.1	0.9%
Northwest Territories	0.2	0.1	0.0	0.3	0.1	0.8	0.1%
Nova Scotia	6.6	1.5	1.1	11.4	4.9	25.5	3.2%
Nunavut	0.1	0.0	0.0	0.2	0.1	0.5	0.1%
Ontario	70.3	19.9	17.3	129.3	58.2	295.0	37.5%
Prince Edward Island	1.0	0.3	0.2	1.6	0.7	3.6	0.5%
Quebec	44.1	10.6	8.1	77.6	34.0	174.5	22.2%
Saskatchewan	5.5	1.3	1.0	10.0	4.3	22.2	2.8%

Province	Aids and modifications	Formal care	Long-term care	Support payments	Deadweight losses	Total	% of total
Yukon	0.2	0.1	0.0	0.4	0.2	0.9	0.1%
Total	191.6	49.8	47.9	344.1	153.7	787.1	100.0%
% of total	24.3%	6.3%	6.1%	43.7%	19.5%	100.0%	-
Cost per person (\$)	2,394	622	598	4,300	1,921	9,836	-

Source: Deloitte Access Economics analysis.

Note: Support payments includes the Canada Pension Plan disability benefit (CPP-D), the Disability Tax Credit (DTC), and the Canada caregiver credit (CCC).

A.2.6. Loss of wellbeing

Table A.7: Loss of wellbeing for all provinces and territories (\$ millions)

Province	YLLs	YLDs	DALYs	Cost of DALYs (\$ millions)	% of total
Alberta	3,770	1,205	4,975	1,517.4	12.0%
British Columbia	4,000	1,737	5,737	1,749.9	13.8%
Manitoba	1,082	380	1,462	445.8	3.5%
New Brunswick	676	279	955	291.2	2.3%
Newfoundland and Labrador	266	182	449	136.8	1.1%
Northwest Territories	28	11	38	11.7	0.1%
Nova Scotia	1,021	327	1,348	411.2	3.2%
Nunavut	18	5	23	6.9	0.1%
Ontario	10,841	4,626	15,468	4,717.6	37.3%
Prince Edward Island	148	57	205	62.5	0.5%
Quebec	6,799	2,807	9,606	2,929.8	23.2%
Saskatchewan	846	332	1,178	359.3	2.8%
Yukon	32	12	44	13.6	0.1%
Total	29,528	11,959	41,487	12,653.7	100.0%
% of total	-	-	-	-	-
Cost per person (\$)	-	-	-	158,129	-

Source: Deloitte Access Economics analysis.

A.3. Impact of the COVID-19 pandemic

Table A.8: Health system costs in affected and unaffected years by components, 2019-2024 (\$ millions) – central recovery scenario

Cost component	2019	2020	2021	2022	2023	2024	Total
Inpatient care	16.3	15.2	15.7	17.6	18.8	20.3	103.9
Outpatient care	18.1	14.9	17.0	17.3	22.3	26.1	115.7
General	52.1	43.4	50.2	54.9	58.0	60.5	319.1
Specialists	15.5	12.2	14.0	17.9	20.4	23.2	103.3

Cost component	2019	2020	2021	2022	2023	2024	Total
Rehabilitation	7.9	6.0	7.2	9.1	10.4	11.8	52.6
Emergency	6.1	4.8	4.6	4.6	6.7	7.6	34.5
Pharmaceuticals	1,141.4	1,009.7	1,075.1	1,109.3	1,251.7	1,398.6	6,985.8
Total	1,257.5	1,106.3	1,183.9	1,230.6	1,388.5	1,548.2	7,715.0
Expected values in unaffected	1,257.5	1,334.0	1,359.7	1,398.7	1,437.4	1,477.5	8,264.8
Difference between affected and unaffected years	0.0	-227.7	-175.9	-168.1	-48.9	70.7	-549.8

Source: Deloitte Access Economics

Note: *Adjusted by prevalence and inflation

Table A.9: Health system costs in affected and unaffected years by components, 2019-2024 (\$ millions) – fast recovery scenario

Cost component	2019	2020	2021	2022	2023	2024	Total
Inpatient care	16.3	15.2	15.7	17.6	19.8	21.9	106.5
Outpatient care	18.1	14.9	17.0	17.3	23.6	29.0	119.9
General	52.1	43.4	50.2	58.4	64.8	76.3	345.2
Specialists	15.5	12.2	14.0	18.7	22.4	26.6	109.5
Rehabilitation	7.9	6.0	7.2	9.6	11.4	13.5	55.7
Emergency	6.1	4.8	4.6	4.6	6.9	8.2	35.1
Pharmaceuticals	1,141.4	1,009.7	1,075.1	1,109.3	1,314.3	1,525.7	7,175.6
Total	1,257.5	1,106.3	1,183.9	1,235.3	1,463.2	1,701.2	7947.4
Expected values in unaffected	1,257.5	1,334.0	1,359.7	1,398.7	1,437.4	1,477.5	8264.8
Difference between affected and unaffected years	0.0	-227.7	-175.9	-163.3	25.8	223.7	-317.3

Source: Deloitte Access Economics

Note: *Adjusted by prevalence and inflation

Table A.10: Health system costs in affected and unaffected years by components, 2019-2024 (\$ millions) – slow recovery scenario

Cost component	2019	2020	2021	2022	2023	2024	Total
Inpatient care	16.3	15.2	15.7	17.6	17.8	18.8	101.3
Outpatient care	18.1	14.9	17.0	17.3	21.1	23.1	111.5
General	52.1	43.4	50.2	56.8	59.7	64.2	326.5
Specialists	15.5	12.2	14.0	17.1	18.5	19.9	97.2
Rehabilitation	7.9	6.0	7.2	8.7	9.4	10.1	49.5

Cost component	2019	2020	2021	2022	2023	2024	Total
Emergency	6.1	4.8	4.6	4.6	6.6	7.1	33.8
Pharmaceuticals	1,141.4	1,009.7	1,075.1	1,109.3	1,189.1	1,271.5	6796.1
Total	1,257.5	1,106.3	1,183.9	1,231.3	1,322.3	1,414.7	7516.0
Expected values in unaffected	1,257.5	1,334.0	1,359.7	1,398.7	1,437.4	1,477.5	8264.8
Difference between affected and unaffected years	0.0	-227.7	-175.9	-167.4	-115.1	-62.8	-748.8

Source: Deloitte Access Economics

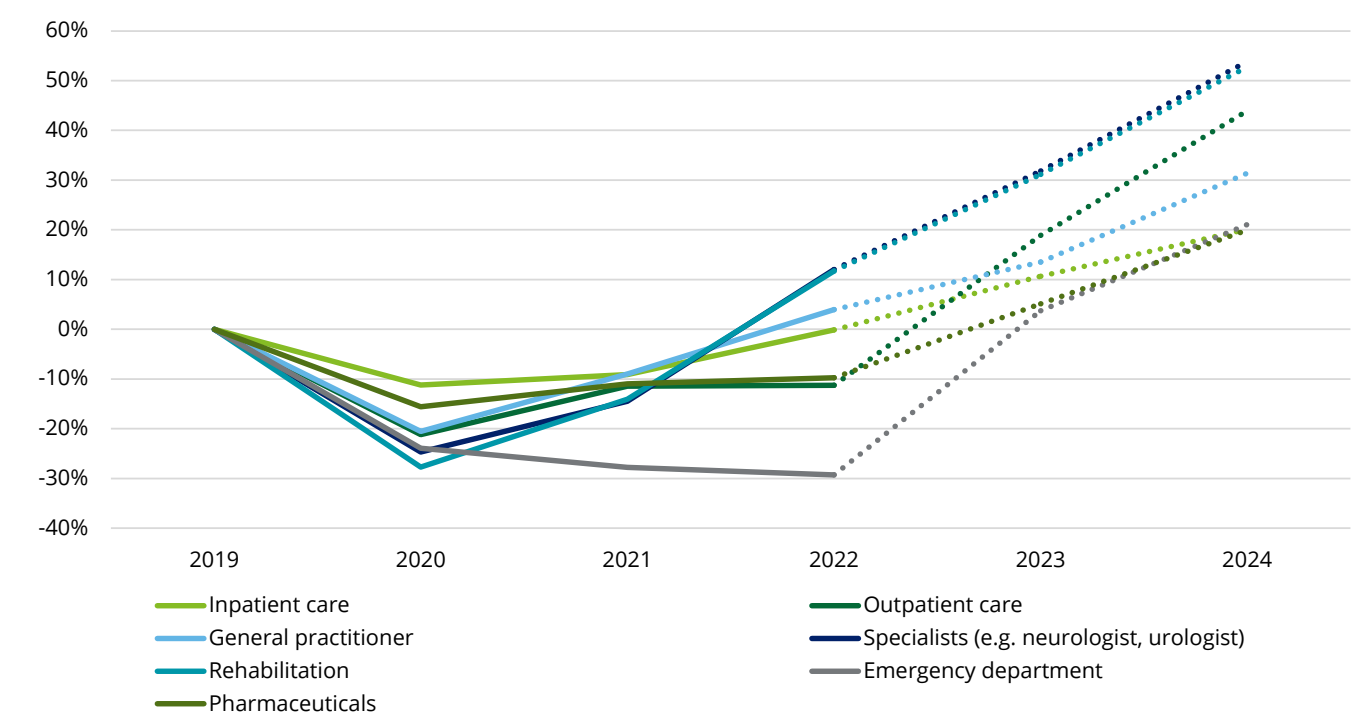
Note: *Adjusted by prevalence and inflation

Table A.11: Health system costs in affected years by province, 2020-2024 (\$ millions)

Province	2020	2021	2022	2023	2024	Total	% of total
Alberta	144.0	154.6	161.9	181.2	203.5	845.3	13.1%
British Columbia	142.6	145.0	161.7	187.9	210.5	847.7	13.1%
Manitoba	37.7	43.0	40.9	48.4	54.0	224.1	3.5%
New Brunswick	24.9	26.5	27.7	30.5	33.8	143.4	2.2%
Newfoundland and Labrador	10.1	10.7	11.0	11.9	13.0	56.7	0.9%
Northwest Territories	1.1	1.1	1.2	1.3	1.5	6.2	0.1%
Nova Scotia	36.6	39.0	40.8	45.7	50.7	212.9	3.3%
Nunavut	0.8	0.9	0.9	1.0	1.2	4.8	0.1%
Ontario	415.2	444.8	462.8	524.2	586.1	2,433.3	37.7%
Prince Edward Island	5.1	5.5	5.8	6.5	7.3	30.3	0.5%
Quebec	250.4	266.3	274.5	308.8	341.1	1441.1	22.3%
Saskatchewan	36.8	45.0	40.1	39.2	43.6	204.6	3.2%
Yukon	1.3	1.4	1.5	1.7	1.9	7.7	0.1%
Total	1,106.6	1,183.9	1,230.6	1,388.5	1,548.2	6457.8	100.00%
Cost per person (\$)	13,655	14,481	14,888	16,629	18,351	-	-

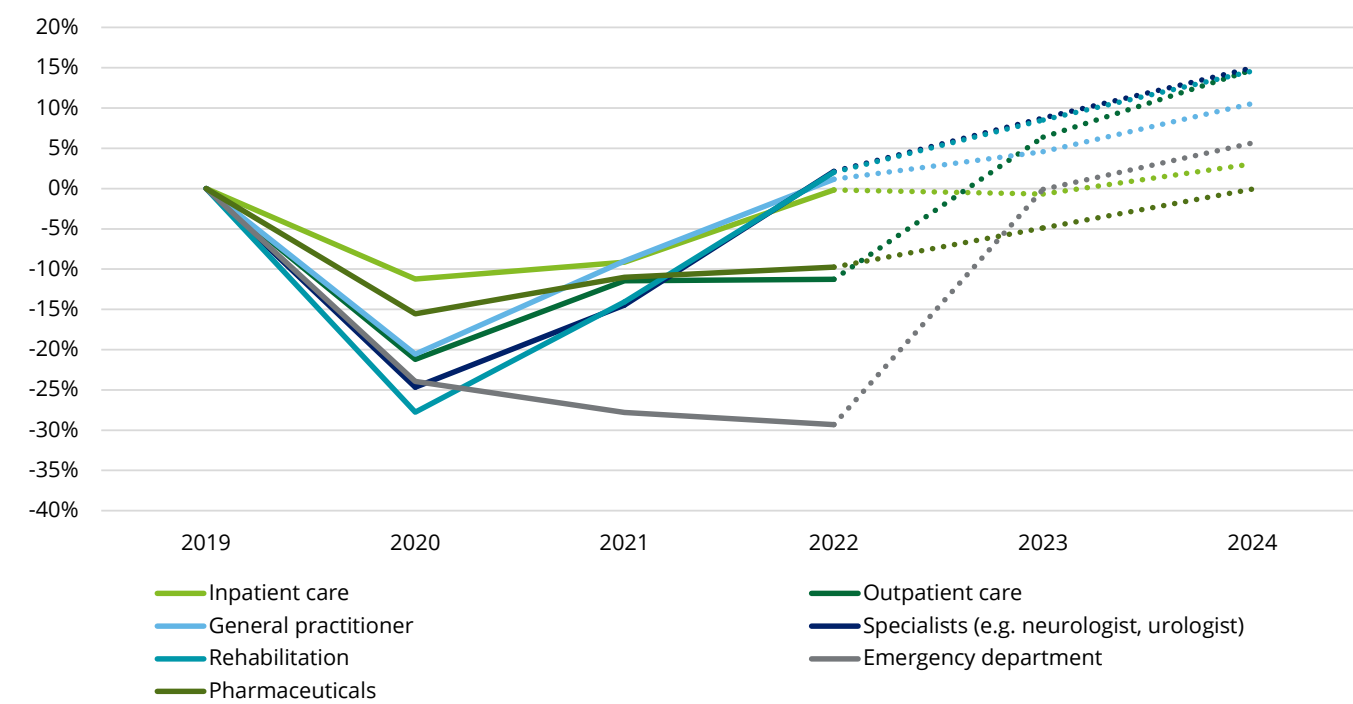
Source: Deloitte Access Economics

Chart A.1: Changes to health system costs by component (2020-2024; \$ millions) – fast recovery scenario



Source: Deloitte Access Economics analysis.

Chart A.2: Changes to health system costs by component (2020-2024; \$ millions) – slow recovery scenario



Source: Deloitte Access Economics analysis.

Table A.12: Estimated impact on the annual cost of MS, 2021-2024 (\$ millions)

Cost component		Treatment change	Delayed diagnosis	Total	% of total financial cost	% of total
Financial cost	Health system	31.0	4.9	35.9	35.0%	9.0%
	Productivity	59.7	6.0	65.6	65.0%	16.5%
	<i>Sub-total</i>	<i>90.7</i>	<i>10.9</i>	<i>101.5</i>	<i>100.0%</i>	-
Non-financial cost	Loss of wellbeing	268.8	26.9	295.7	-	74.4%
Total		359.5	48.6	397.3	-	-
% of total		84.4%	15.6%	-	-	100.0%

Source: Deloitte Access Economics analysis.

Table A.13: Estimated impact on the health system cost of MS, 2020-2024 (\$ millions)

Year	Quarter	Delayed diagnosis		Treatment change		Total	
		Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative
2020	1	9.6	9.6	0.0	0.0	9.6	9.6
	2	9.6	19.2	197.4	197.4	207.0	414.0
	3	35.2	54.4	197.4	394.8	232.5	646.6
	4	47.1	101.5	197.4	592.2	244.5	891.0
2021	1	63.1	164.5	220.3	812.4	283.3	1,197.2
	2	83.1	247.6	26.7	839.2	109.8	1,113.5
	3	63.2	310.8	228.0	1067.1	291.2	1,605.9
	4	52.1	362.9	231.8	1299.0	284.0	1,893.7
2022	1	37.7	400.6	435.3	1734.3	473.0	2,570.1
	2	19.3	419.9	458.2	2192.4	477.5	3,070.5
	3	16.3	436.2	264.6	2457.0	280.9	3,157.8
	4	16.5	452.6	287.7	2744.7	304.1	3,485.0
2023	1	8.5	461.2	88.1	2832.8	96.7	3,382.1
	2	8.8	470.0	88.1	2921.0	97.0	3,479.1
	3	8.9	478.9	88.1	3009.1	97.0	3,576.1
	4	8.9	487.8	88.1	3097.2	97.0	3,673.2
2024	1	8.9	496.7	88.1	3185.3	97.0	3,770.2
	2	8.9	505.6	88.1	3273.4	97.0	3,867.2
	3	8.9	514.5	88.1	3361.6	97.0	3,964.2
	4	8.9	523.4	88.1	3449.7	97.0	4,061.2

Source: Deloitte Access Economics analysis.

Table A.14: Estimated impact on the health system cost of MS, 2020 to 2024 (\$ millions)

Year	Quarter	Delayed diagnosis		Treatment change		Total	
		Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative
2020	1	0.0	0.0	0.0	0.0	0	0
	2	0.0	0.0	0.0	0.0	0	0
	3	0.0	0.0	0.0	0.0	0	0
	4	0.0	0.0	0.0	0.0	0	0
2021	1	0.0	0.0	0.0	0.0	0	0
	2	0.0	0.0	0.0	0.0	0	0
	3	0.0	0.0	0.0	0.0	0	0
	4	0.0	0.0	0.0	0.0	0	0
2022	1	2.0	2.0	8.8	8.8	10.8	10.8
	2	2.3	4.2	10.2	19.1	12.5	23.3
	3	2.8	7.0	12.4	31.5	15.2	38.5
	4	3.1	10.1	14.2	45.6	17.3	55.7
2023	1	3.6	13.8	16.4	62.1	20	75.9
	2	5.7	19.5	25.6	87.7	31.3	107.2
	3	6.1	25.5	27.3	115.0	33.4	140.5
	4	8.0	33.5	36.0	150.9	44	184.4
2024	1	8.0	41.5	36.1	187.0	44.1	228.5
	2	8.0	49.6	36.2	223.3	44.2	272.9
	3	8.0	57.6	36.2	259.5	44.2	317.1
	4	8.0	65.6	36.2	295.7	44.2	361.3

Source: Deloitte Access Economics analysis.

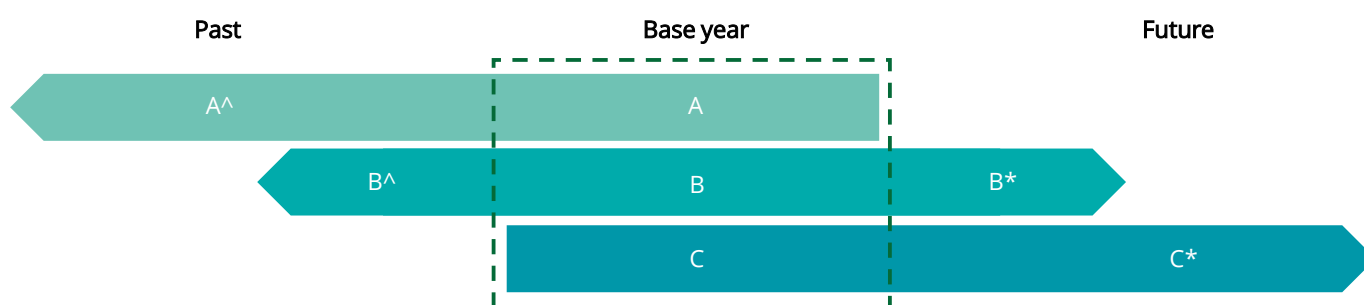
Appendix B: Technical cost of illness appendix

A.4. Time horizons for estimates

The length of time captured in the analysis, known as the time horizon, directly impacts the number of people included in the study. It also has important implications for how impacts are considered, and costs are calculated. Figure A.1 demonstrates the conceptual differences between approaches to measuring the prevalence and costs of MS. These include:

- People who have MS in the past and up to the base year, where the associated lifetime costs include $A^{\wedge}$ and A.
- People who have MS in the base year, the past and in future years, with associated lifetime costs equal to the sum of $B^{\wedge}$, B and $B^{\star}$.
- People who have MS in the base year, with lifetime costs equal to the sum of C and $C^{\star}$.

Figure A.1: Conceptual differences between approaches to measuring prevalence



Source: Deloitte Access Economics.

This study is based on case C - people who have MS in the base year, with lifetime costs equal to the sum of C and $C^{\star}$. It considered the costs associated with MS that occur in 2019, and future lifetime costs associated with MS. Costing time horizons vary across cost components. As the horizon grows, there is greater scope for long-term outcomes to be confounded by other factors that are not directly associated with MS. As such, it becomes difficult to precisely estimate the impacts and costs associated with MS continuing into subsequent years.

A.5. Estimating prevalence

The costs of MS in Canada were estimated for the 2019 calendar year using a prevalence approach. A prevalence approach measures the number of people with MS at a point in time and estimates costs incurred due to MS in the associated year.

A targeted review of scientific literature and publicly available databases was conducted to identify relevant data. The prevalence of MS in Canada was obtained from the CCDSS maintained by PHAC.⁵ PHAC collects administrative data from every province and territory (excluding Quebec and Yukon) to generate national estimates on the prevalence and incidence of MS among other chronic diseases. Data for Quebec and Yukon was estimated based on the national prevalence. PHAC released data on the incidence and prevalence of MS in Canada from data that was collected between 2014 and 2015. The data obtained from CCDSS was segregated by age, sex, and province/territory, and is most suitable for the analysis undertaken in this study.

The CCDSS uses an algorithmic approach based on health claims data to determine the prevalence of MS.⁶⁹ This is applied in each Canadian province and territory where data are collected (excludes Quebec and Yukon). It was determined that the most accurate data on MS prevalence in Canada were achieved through the following combination of administrative data:

- residents covered by public health insurance, and
- with one hospitalization, or
- five physician billing records,
- over a two-year period.

In Canada, a different source of MS prevalence estimate is also available based on the CCHS 2010/11 survey, which included a question about whether the respondent or a member of their household had a neurological condition including MS – providing effectively a “lifetime” estimate of people with MS. However, as this estimate is not validated by administrative data and not segregated by age and sex, it is used as a secondary comparison data in this study. A variety of other literature sources were also utilized to estimate prevalence of MS by disability severity and types, reflecting a triangulation of multiple data sources.

In estimating the prevalence of MS in Canada in 2019, the prevalence has been considered by the following disaggregation:

- Age: 5-year groupings from 0-5 year to 80+ years
- Sex: Male and female
- Geography: Province / territory
- Disease: MS.

A.6. Health system costs

Health system costs for MS include inpatient and outpatient (i.e., non-admitted) hospitalization, emergency department admissions, primary health care services (e.g., general and rehabilitation practitioners, pharmaceuticals) and referred medical services (e.g., specialists, rehabilitation).

The health system costs described in this report are those borne by the government, individuals (through out-of-pocket costs) and private health insurers. A summary of the estimate approach for each health system cost component is provided in Table A.15.

Table A.15: Calculation method and data sources for health system costs

Component	Calculation	Information source	Assumptions and notes
Inpatient (admitted) care	Number of people with MS x rate of admission x average cost of admission	• Canadian Chronic Disease Surveillance System (CCDSS)⁵ • Data request to the Canadian Institute for Health Information (CIHI) • CIHI Patient Cost Estimator	• Admission rates in Ontario are generalised to all provinces and territories due to unavailability of data in other jurisdictions. • Average admission rate of 2.3% for males and 1.6% for females; 1.8% overall admission rate, equivalent to 0.018 inpatient admissions per person in 2019.
Outpatient (non-admitted) care	Number of people with MS stratified by age and sex x age- and sex-specific rates of service use x weighted average cost of relevant outpatient services	• Canadian Chronic Disease Surveillance System (CCDSS)⁵ • Data request to the Canadian Institute for Health Information (CIHI) • National Physician Database tables for cost per service and number of services for major and other outpatient assessments conducted by neurologists	• Rates of service use in Alberta are generalised to all provinces and territories due to unavailability of data in other jurisdictions. • Neurologist outpatient assessments generalised to all outpatient assessments performed for people with MS. • Average clinic outpatient utilization rate of 241% for males and 237% for females; overall utilization rate of 238%, equivalent to 2.4 clinic outpatient visits per person in 2019.
Emergency department	Number of people with MS stratified by age and sex x age- and sex-specific rates	• Canadian Chronic Disease Surveillance System (CCDSS)⁵	• Presentation rates in Alberta are generalised to all provinces and territories due

Component	Calculation	Information source	Assumptions and notes
	of emergency department presentation x average cost per emergency department presentation	- Data request to the Canadian Institute for Health Information (CIHI) - CIHI Patient Cost Estimator	to unavailability of data in other jurisdictions. Average presentation rates of 4.7% for males and 4.9% for females; overall presentation rate of 4.9%, equivalent of 0.05 ED presentations per person in 2019.
General practitioner	Number of people with MS stratified by age and sex x average annual use of general practitioners x average cost per service	- Canadian Chronic Disease Surveillance System (CCDSS)⁵ - Roux et al. (2022)⁹⁶ - CIHI (2020) Physicians in Canada, data tables for average cost per service	Roux et al. (2022) reported an average of 8.5 GP visits per year.
Specialist consultations	Number of people with MS stratified by age and sex x average annual use of specialists x weighted average cost per service for relevant specialists	- Canadian Chronic Disease Surveillance System (CCDSS)⁵ - Roux et al. (2022)⁹⁶ - CIHI (2020) Physicians in Canada, data tables for average cost per service	- Usage rates and weighted average cost captures visits to neurologists, urologists, and ophthalmologists. - Roux et al. (2022) reported an average of 1.3 specialist visits per year.
Rehabilitation services	Number of people with MS stratified by age and sex x average annual use of rehabilitation services x weighted average cost per service	- Canadian Chronic Disease Surveillance System (CCDSS)⁵ - Roux et al. (2022)⁹⁶ - CIHI (2020) Physicians in Canada, data tables for average cost per service	- Unit cost represents average cost per service for physical medicine. - Private rehabilitation services excluded due to a lack of data. - Roux et al. (2022) reported an average of 0.5 rehabilitation visits per year.
Pharmaceuticals	Average expenditure on medication per person x Number of people with MS stratified by age and sex	- Data request to the Canadian Institute for Health Information (CIHI) - Canadian Chronic Disease Surveillance System (CCDSS)⁵	
Falls	Attributed admitted hospitalisations and emergency department presentations for falls due to MS x average cost per admission or presentation	- CIHI (2020), Injury and Trauma Emergency Department and Hospitalization Statistics, 2018-19⁷⁰ - Nilsagard et al. (2009)⁷¹	Uses a population attributable fraction derived from odds ratios reported by Nilsagard et al. (2009) to determine the total hospitalisations and emergency department presentations for falls attributable to MS.
Depression	Attributed admitted hospitalisations and emergency department presentations for depression due to MS x	- Statistics Canada (2014), Mental health indicators⁷² - Patten et al. (2003)⁷³	Uses a population attributable fraction derived from odds ratios reported by Patten et al. (2003) to determine the total hospitalisations and emergency department

Component	Calculation	Information source	Assumptions and notes
	average cost per admission or presentation		presentations for depression attributable to MS.

Table A.16: List of drugs included in pharmaceutical cost analysis

Drug identification number (DIN)	Drug name	Grouping
02237770	Avonex	Interferon Beta-1A
02269201	Avonex	Interferon Beta-1A
02169649	Betaseron	Interferon Beta-1B
02245619	Copaxone	Glatiramer Acetate
02456915	Copaxone	Glatiramer Acetate
02337819	Extavia	Interferon Beta-1B
02460661	Glatect	Glatiramer Acetate
02511355	Kesimpta	Ofatumumab
02444399	Plegridy	Peginterferon Beta-1A
02237319	Rebif	Interferon Beta-1A
02237320	Rebif	Interferon Beta-1A
02281708	Rebif	Interferon Beta-1A
02318253	Rebif	Interferon Beta-1A
02318261	Rebif	Interferon Beta-1A
02416328	Aubagio	Teriflunomide
02365480	Gilenya	Fingolimod
02482533	Gilenya	Fingolimod
02475669	Ach-Fingolimod	Fingolimod
02469936	Apo-Fingolimod	Fingolimod
02500914	Asn-Fingolimod	Fingolimod
02487772	Jamp Fingolimod	Fingolimod
02474743	Mar-Fingolimod	Fingolimod
02469715	Mylan-Fingolimod	Fingolimod
02469782	Pms-Fingolimod	Fingolimod
02482606	Sandoz Fingolimod	Fingolimod
02469618	Taro-Fingolimod	Fingolimod
02469561	Teva-Fingolimod	Fingolimod
02470179	Mavenclad	Cladribine
02496429	Mayzent	Siponimod
02496437	Mayzent	Siponimod

Drug identification number (DIN)	Drug name	Grouping
02404508	Tecfidera	Dimethyl Fumarate
02505991	Zeposia	Ozanimod
02418320	Lemtrada	Alemtuzumab
02467224	Ocrevus	Ocrelizumab
02286386	Tysabri	Natalizumab
02495341	Ach-Dimethyl Fumarate	Dimethyl Fumarate
02495368	Ach-Dimethyl Fumarate	Dimethyl Fumarate
02505762	Apo-Dimethyl Fumarate	Dimethyl Fumarate
02505770	Apo-Dimethyl Fumarate	Dimethyl Fumarate
02494809	Gln-Dimethyl Fumarate	Dimethyl Fumarate
02494817	Gln-Dimethyl Fumarate	Dimethyl Fumarate
02516047	Jamp Dimethyl Fumarate	Dimethyl Fumarate
02516055	Jamp Dimethyl Fumarate	Dimethyl Fumarate
02502690	Mar-Dimethyl Fumarate	Dimethyl Fumarate
02502704	Mar-Dimethyl Fumarate	Dimethyl Fumarate
02497026	Pms-Dimethyl Fumarate	Dimethyl Fumarate
02497034	Pms-Dimethyl Fumarate	Dimethyl Fumarate
02513781	Sandoz Dimethyl Fumarate	Dimethyl Fumarate
02513803	Sandoz Dimethyl Fumarate	Dimethyl Fumarate
02493586	Teva-Dimethyl Fumarate	Dimethyl Fumarate
02493594	Teva-Dimethyl Fumarate	Dimethyl Fumarate

Source: MS Canada (2023)⁷⁴ and Government of Canada (2023)⁷⁵

A.7. Productivity costs

A human capital approach was adopted to estimate productivity losses. This involves the calculation of the difference in employment or production of people living with MS compared to that of the general population, multiplied by average weekly earnings (AWE). Productivity losses from premature mortality are estimated in terms of the net present value (NPV) of the foregone stream of future income. A summary of the estimate approach for each health system cost component is provided in Table A.17.

Table A.17: Calculation method and data sources for productivity losses

Component	Calculation	Source	Assumptions and notes
Reduced employment	Relative reduction in employment * average weekly earnings in general population	- Dorstyn et al. (2018)⁷⁶ - Statistics Canada (2019)⁷⁷ - Statistics Canada (2019)⁷⁸	- Wages and employment rates for Northwest Territories, Nunavut and Yukon are equal to weighted average of other provinces and territories due to unavailability of data. - Dorstyn et al. (2018) reported that employment rates among people with mild MS (EDSS 0-3) are approximately equivalent with the general population. Those with moderate (EDSS 3.5-6) and severe (EDSS>6) have a 60% and 9% change of being employed relative to the general population.

Component	Calculation	Source	Assumptions and notes
Absenteeism	Absenteeism days x Average weekly earnings x 52	Salter et al. (2016)⁷⁹	- Absenteeism reflects the work time missed due to impairment from MS. It is calculated as hours missed as a percentage of total work hours. - Salter et al. (2016) report an average of 7.64 days of work missed every 6 months, or 15.28 annually.
Presenteeism	Presenteeism days x Average weekly earnings x 52	Chen et al. (2019)⁸⁰	- People living with MS may be less productive while at work compared to their colleagues. Presenteeism captures this loss in productivity due to MS by multiplying the estimated loss of productive time by average earnings. - Chen et al. (2019) found that the output of people with MS is reduced by approximately 9% relative to the general population.
Premature mortality	Number of deaths x expected lifetime earnings	- Canadian Chronic Disease Surveillance System (CCDSS)⁵ - Statistics Canada (2019)⁷⁷ - Statistics Canada (2019)⁷⁸	- There were an estimated 593 deaths due to MS in 2019. - Based on the age and gender distribution of these deaths and incorporating employment rates and average lifetime earnings for different age-gender groups, the present value of lost earnings due to premature mortality was estimated. - Age at death is the midpoint of the five-year age group within which the death occurred (e.g., 67 for the 65-69 age group)
Informal care	Hours of informal care per week x employment probability x average weekly earnings	- Zhang and Sun (2020)⁸¹ - Statistics Canada (2019)⁷⁷ - Statistics Canada (2019)⁸²	- People living with MS may require additional support in their everyday lives. This support may be provided by an informal caregiver, typically a spouse, friend, or another member of the family. - Though informal care is provided free of charge, the services are not free from an economic perspective. There is an opportunity cost to providing informal care, which is measured by what the caregiver could have earned had they been in the workforce. - Zhang and Sun (2020) report that informal caregivers for people with MS provide, on average, 479 hours of care annually. They also report that approximately 33% of people living with MS require informal care.

A.8. Other financial costs

A summary of the estimate approach for each health system cost component is provided in Table A.18.

Table A.18: Calculation method and data sources for other financial costs

Component	Calculation	Source	Assumptions and notes
Aids and modifications	Number of people with MS x weighted average annual cost of aids and modifications	- Bishop et al. (2015)⁸³ - Iezzoni et al. (2009)⁸⁴	- Bishop et al. (2015) reported proportions of people using different home modifications in the US. This information was used due to the lack of similar data in the Canadian setting. - Iezzoni et al. (2009) reported proportions of people using mobility aids in the US. This information was used due to the lack of similar data in the Canadian setting. - It is acknowledged that patterns of aid usage and home modifications are likely to be different in the US compared to Canada due to different costs and funding arrangements.
Support payments	Number of people with MS x proportion	Salter et al. (2016)⁷⁹	Salter et al. (2016) reported the proportion of people with MS receiving support payments by disability level and MS

Component	Calculation	Source	Assumptions and notes
	of people with MS receiving support payments x average amount received	- Statistics Canada (2015)⁸⁵ - Statistics Canada (2015)⁸⁶ - Statistics Canada (2020)⁸⁷	type. A weighted average of 48% was calculated from the information in this study. - Government data showed that the average value of support received was approximately \$11,300 for the CPP, \$6,700 for the DTC, and \$4,700 for the CCC. - It was assumed that caregivers for people with MS receive support payments at the same rate as all caregivers, reported to be approximately 8%.
Formal home care	Number of people with MS receiving formal home care x unit cost of formal home care	- Data request to the Canadian Institute for Health Information (CIHI) - Zhang and Sun (2020)⁸¹ - Statistics Canada (2019)⁸²	- Data from CIHI showed that approximately 4.7% of people living with MS were receiving formal home care in 2019. - Zhang and Sun (2020) reported that those receiving formal home care received, on average, 774 hours of care in the year.
Long-term care	Number of people in long-term care due to MS x unit cost of long-term care	- Data request to the Canadian Institute for Health Information (CIHI) - Blomqvist and Busby (2014)⁸⁸ - CIHI (2019)⁸⁹	- Data from CIHI showed that approximately 5.3% of people living with MS were in long-term care. - Blomqvist and Busby (2014) reported the average annual cost of long-term care to be \$64,909. - Data from CIHI showed that residents of long-term care had, on average, 5.8 diagnosed conditions in 2019. - Cost of care attributable to MS was adjusted by the average number of diagnoses per person to a final value of approximately \$11,200 per year.

A.9. Loss of wellbeing

Table A.19: Calculation method and data sources for loss of wellbeing

Component	Calculation	Source	Assumptions
YLDs	YLD rate per case of MS x number of people diagnosed with MS x VSLY	- Salomon et al. (2015)⁹⁰ - Government of Canada (2022)⁹¹	- Disability weights for mild, moderate, and severe MS reported to be 0.183, 0.463, and 0.719, respectively. - This means that a person living for one year in each of these levels of MS disability would lose the equivalent of 18%, 46% and 72% of a healthy life year relative to a person in perfect health.
YLLs	Number of premature deaths x expected years of life remaining x VSLY	- Canadian Chronic Disease Surveillance System (CCDSS)⁵ - Government of Canada (2022)	Age at death is the midpoint of the five-year age group within which the death occurred (e.g., 67 for the 65-69 age group)

A.10. Estimating cost components

The cost of MS comprises four broad components:

- Health system costs that represent the cost of providing health services, including costs of hospitalizations, visits to general practitioners and specialists (e.g., neurologists, urologists, ophthalmologists), the cost of pharmaceuticals, and other health system expenditures such as allowances for capital and administration costs
- Productivity costs associated with reduced workforce participation, reduced productivity at work (presenteeism), increased days taken off work (absenteeism), loss of future earnings due to premature mortality, and the value of time that families and friends spend on caring for a person with MS

- Other economic and financial costs associated with other out of pocket expenses made by people with MS and their families and efficiency losses arise from government transfers
- Loss of wellbeing that reflects the reduction in quality of life due to disability and premature mortality among people with MS. The loss of wellbeing from disability is described by a disability weight representing the proportional reduction in a healthy year of life relative to someone in perfect health, while premature mortality measures the number of healthy life years lost for people with MS who died in the base year (2019) instead of when they would otherwise be expected to die (life expectancy).

Costs have been estimated for the 2019 calendar year, which represents the last full year of data for many available datasets, but more importantly this allowed for an estimate of costs in a typical year in the absence of the impacts of the COVID-19 pandemic. Where costs were only available for previous years, they have been updated using appropriate inflators (e.g., a health inflation index, or wage price index) and further adjusted for demographic changes.

To the extent allowed by data availability, cost estimates were stratified by age, sex, province/territory, and level of disease progression.

Further details about these cost components are provided in Table A.20.

Table A.20: Summary of approaches to estimating cost components

Cost component and type of cost	Subgroups	Key bearers of cost	Overview of approach
Health system costs	- Hospital services (including falls) - Pharmaceuticals	- Individuals - Government	Bottom-up approach using data from Canadian Institute for Health Information (CIHI), PHAC, and other literature.
Financial cost	- General practitioners and neurologists - Capital and administrative costs	- Health insurance providers - Employers	
Productivity costs	- Reduced employment participation - Temporary absenteeism	- Individuals - Government	A human capital approach was adopted to estimate productivity losses. This involves the calculation of the difference in employment or productivity of people with MS compared to that of the general population, multiplied by average weekly earnings (AWE).
Economic cost	- Presenteeism - Premature death - Increased need for informal care	Employers	Productivity losses from premature mortality are estimated in terms of the net present value (NPV) of future income streams lost.
Other economic and financial costs	- Aids, equipment, and home modifications - Formal care and long-term care - Rehabilitation services	- Individuals - Government - Society	Financial costs are measured using a bottom-up approach with data gathered from the Canadian Institute for Health Information (CIHI) where available, claims data from MS Canada and literature
Financial and economic cost	Efficiency losses associated with government transfers		Efficiency losses are measured by the increased taxation to provide welfare support payments, health services and replace lost employment taxes
Loss of wellbeing	- Years of life lost due to disability (YLD) - Years of life lost due to premature death (YLL)	Individuals	A burden of disease approach was adopted. This approach involves multiplying disability adjusted life years (DALYs) by the value of a statistical life year (VSLY). DALYs reflect the number of years of healthy life lost due to morbidity and mortality. VSLY is the value society places on reducing the risk of dying or avoiding certain health states.
Non-financial cost			

Source: Deloitte Access Economics.

Note: Financial costs refer to costs that are “paid for”, economic costs are the value of an alternative option.

Appendix C: Technical COVID-19 impacts appendix

A.11. Estimating prevalence and incidence in affected and unaffected years

Consistent with the cost of illness model, the incremental costs of MS associated with COVID-19 in Canada were estimated for years between 2020 and 2024 calendar year using a prevalence approach.

The incidence and prevalence of MS in unaffected years was calculated in line with population growth projections published by Statistics Canada.⁹² For the purpose of this study, an assumption was made that the changes to incidence rate and prevalence of MS in Canada throughout this period was negligible. The authors acknowledged the study conducted by Amankwah et al. (2017) that the number of incident MS cases was projected to rise slightly throughout a 20 year period (i.e., from 4051 cases in 2011 to 4794 cases per 100 000 population in 2031; data not shown in paper), therefore the results of this study should be viewed in this context, that is that the costs are likely to be even higher than estimated.⁴

For COVID-19 affected years, the incidence was calculated by factoring in the per cent reduction in health services (using CIHI clinic outpatient data in relevant years, i.e., 2020-2022) based on projected incidence in unaffected years. The prevalence of MS was calculated in a similar manner where the reduction in incidence was reflected in the prevalence over a 24-month period. It was assumed that the duration of delayed diagnosis was 24 months, supported by evidence shown in CIHI data and stakeholder consultation.

To analyse the impact of COVID-19 in MS disease progression, the incidence and prevalence of MS in unaffected years were segregated by calendar quarter, disease type and disability level by applying the distribution reported in Kobelt (2017)⁹³ and Dahlke (2021).⁹⁴ Estimation of changes to distribution was described below in Section A.13.

In estimating the incidence and prevalence of MS in Canada in 2020-2024, the incidence and prevalence have been considered by the following disaggregation:

- Age: 5-year groupings from 0-5 year to 80+ years
- Sex: Male and female
- Geography: Province / territory
- Disease: MS
- Calendar quarter: Q1, Q2, Q3 and Q4
- MS type: RRMS and progressive
- Disability level: low (EDSS<3), moderate (3≤EDSS<5) and high (EDSS≥5).

A.12. Health system costs in affected and unaffected years

Health system costs in affected years (2020-2024) were calculated in aggregate by applying prevalence and health inflation rate increase to the sum of relevant health system costs in 2019 in the cost of illness model. Health system costs for MS include inpatient and outpatient (i.e., non-admitted) hospitalization, emergency department admissions, primary health care services (e.g., general and rehabilitation practitioners, pharmaceuticals) and referred medical services (e.g., specialists, rehabilitation). Comorbidities were out of scope for the COVID-19 impacts section of this study. Health inflation rate was obtained from Statistics Canada.⁹⁵

Health system costs in affected years were calculated by component using data obtained from CIHI for fiscal years 2019/20 to 2021/22 (i.e., calendar years from 2019 Q3-4 to 2022 Q1-2). Projected health system costs from 2022 Q1-2 to 2024 were estimated by applying the following assumptions:

- health service backlog was/is cleared prior to 2024
- health utilization beyond 2022 Q1-2 increases linearly to address additional health needs
- limitation to health care resources was not considered.

Incremental health system costs were calculated by subtracting the annual cost in projected unaffected years with the annual cost in COVID-19 affected years. A positive figure indicates reductions in health expenditure while a negative figure indicates increases in expenditure to the Canadian health system.

The health system costs described in this report are those borne by the government, individuals (through out-of-pocket costs) and private health insurers. A summary of the estimate approach for each health system cost component is provided in Table A.21.

Table A.21: Calculation method and data sources for health system costs

Component	Calculation	Source	Assumptions
Inpatient care	Utilization rate (2019-2022) = (utilization in Ontario) / (prevalence in Ontario) Costs (2019-2022) = (utilization rate in a given year) x (prevalence in Canada in the same year) x (cost of hospitalization) Costs (2023-2024) = (projected utilization* in a given year) x (cost of hospitalization)	Bottom-up approach using CIHI data on acute inpatient (fiscal year 2019/20 to 2021/22) and CIHI data on average cost of hospitalization	Admission rates in Ontario are generalised to all provinces and territories due to unavailability of data in other jurisdictions.
Outpatient care	Utilization rate (2019-2022) = (utilization in Alberta) / (prevalence in Alberta) Costs (2019-2022) = (utilization rate in a given year) x (prevalence in Canada in the same year) x (weighted average cost of outpatient care) Costs (2023-2024) = (projected utilization* in a given year) x (weighted average cost of outpatient care)	Bottom-up approach using CIHI data on outpatient care (fiscal year 2019/20 to 2021/22) and CIHI data on outpatient costs	Rates of service use in Alberta are generalised to all provinces and territories due to unavailability of data in other jurisdictions.
Emergency department	Utilization rate (2019-2022) = weighted average of [(utilization in Alberta) / (prevalence in Alberta)] and [(utilization in Ontario) / (prevalence in Ontario)] Costs (2019-2022) = (utilization rate in a given year) x (prevalence in Canada in the same year) x (weighted average cost of emergency department visit) Costs (2023-2024) = (projected utilization* in a given year) x (weighted average cost of emergency department visit)	Bottom-up approach using CIHI data on emergency visits (fiscal year 2019/20 to 2021/22) and CIHI data on outpatient costs	Presentation rates in Alberta are generalised to all provinces and territories due to unavailability of data in other jurisdictions.
Specialists (including neurologist and urologist visits)	Utilization rate (2019) = sum of utilization rate of neurologists and other specialists (e.g., urologists) Utilization rate (2020-2022) = (per cent change in outpatient data in a given year compared to 2019) x utilization rate (2019) Costs (2019-2022) = (utilization rate in a given year) x (prevalence in Canada in the same year) x (weighted average cost of specialist visit)	Roux et al. (2022) ⁹⁶	Disruption on specialist visit during COVID-19 mirrors that of outpatient data

	Costs (2023-2024) = (projected utilization* in a given year) x (weighted average cost of specialist visit)		
General practitioners	Utilization rate (2019) is obtained from literature Utilization rate (2020-2022) = (per cent change in outpatient data in a given year compared to 2019) x utilization rate (2019) Costs (2019-2022) = (utilization rate in a given year) x (prevalence in Canada in the same year) x (average cost of GP visit) Costs (2023-2024) = (projected utilization* in a given year) x (average cost of GP visit)	Roux et al. (2022) ⁹⁶	Disruption on GP visit during COVID-19 mirrors that of outpatient data
Rehabilitation (including physical medicine and rehabilitation specialists)	Utilization rate (2019) is obtained from literature Utilization rate (2020-2022) = (per cent change in outpatient data in a given year compared to 2019) x utilization rate (2019) Costs (2019-2022) = (utilization rate in a given year) x (prevalence in Canada in the same year) x (average cost of physical pharmaceuticals) Costs (2023-2024) = (projected utilization* in a given year) x (average cost of physical pharmaceuticals)	Roux et al. (2022) ⁹⁶	Disruption on rehabilitation during COVID-19 mirrors that of outpatient data
Pharmaceuticals	Costs of prescription in BC, MB and SK in a given year = (cost data from CIHI in a given year by age disaggregation) x (expected cohort size informed by Statistics Canada data / number of active beneficiaries in pharmaceutical claim by age disaggregation in the same year) Weighted average cost of prescription per person in a given year = (total cost of prescription by age disaggregation in BC, MB and SK) / (sum of prevalence in BC, MB and SK) Cost of prescription in provinces other than BC, MB and SK = (weighted average cost of prescription per person in a given year) x (prevalence of MS in a province in a given year)	Bottom-up approach using CIHI NPDUIS data Per cent reduction in DMT use was informed by literature⁵⁸	Size of cohort using DMT was estimated based on the assumption that 70% of people with RRMS early in the disease course in recent years use DMT⁹⁷⁹⁸ Reduction in DMT use was assumed to impact 2020 and 2021 Cost of prescription per person in British Columbia, Manitoba and Saskatchewan (weighted average) was generalised for the entire country

Source: Deloitte Access Economics.

A.13. Impacts of treatment change and delayed diagnosis

This study also explored a range of financial and non-financial costs that resulted from disruptions on DMT use and diagnosis by accelerating disease progression. Financial costs include health system costs and productivity loss. Non-financial costs measure the loss of wellbeing. Health system costs incurred by treatment change and delayed diagnosis were assumed to form a part of the total health system costs estimated in Section A.12, however due to data limitation, it was not possible to untangle the costs by health system component in this analysis.

Incremental costs in this section were calculated through the costs associated with increased relapses (health system costs only) and permanent disease/disability progression (health system costs, productivity loss and loss of wellbeing) as shown in Table A.22. The magnitude of increased relapses was calculated using population attributable fraction (PAF) using the formula below where prevalence of DMT delay was calculated using NPDUIS data and prevalence estimates, and odds ratio of relapse rate between nonadherent and adherent DMT users was informed by literature review:⁹⁹

$$PAF = \frac{\text{Prevalence of DMT change/delay} \times \text{odds ratio of relapse rate between nonadherent and adherent DMT users}}{(\text{Prevalence of DMT change/delay} \times \text{odds ratio of relapse rate between nonadherent and adherent DMT users}) + 1}$$

Table A.22: Calculation method and data sources for health system costs

Component	Sub-component	Calculation	Source	Assumptions
DMT change	Delay in DMT schedule	Cohort size per quarter = (prevalence of RRMS) x (rate of reduction in pharmaceutical claims in the quarter compared to average level in 2019) Costs associated with disease progression = costs* x [cohort size x risk of disease progression from RRMS to SPMS during DMT delay x (disability level distribution of SPMS – disability level distribution of RRMS)] Health system costs associated with increased relapse = (PAF of relapses) x (prevalence of RRMS) x (average per person health system cost) x (odds ratio of health care utilization in people with relapse vs people without relapse – 1)	CIHI NPDUIS Brown et al. (2019) ¹⁰⁰ Nicholas et al. (2021) ¹⁰¹	Over a 12-month period
	Switching to a lower efficacy DMT	Cohort size per quarter = (prevalence of RRMS) x (rate of DMT switching) Costs associated with disease progression = costs* x [cohort size x risk of disease progression from RRMS to SPMS during DMT switching x (disability level distribution of SPMS – disability level distribution of RRMS)]	Mateen et al. (2020) ⁵⁸ Brown et al. (2019) ¹⁰⁰	Across 2020 and 2021 Used data from U.S. (Note: it is acknowledged that patterns of MS care in Canada are different than that in the U.S., however in the absence of suitable comparable data that is specific to Canada, data from the U.S. is used)
Delayed diagnosis	-	Cohort size per quarter = (prevalence of MS disaggregated by types) x (reduction in CIHI outpatient data compared to average level in 2019) x proportion of people living with RRMS using DMT Costs associated with disease progression = costs* x [cohort size x risk of disease	CIHI NACRS – outpatient clinic Statistics Canada ¹⁰²	Assumed that there is normally a 12 month delay between diagnosis and start of DMT course

progression from RRMS to SPMS during
DMT delay x (disability level distribution of
SPMS – disability level distribution of
RRMS)]

Health system costs associated with
increased relapse = (PAF of relapses) x
(prevalence of RRMS) x (average per
person health system cost) x (odds ratio of
health care utilization in people with
relapse vs people without relapse – 1)

Source: Deloitte Access Economics.

Note: *Costs were calculated for health system costs, productivity loss and loss of wellbeing using the value generated from the cost of illness model. They were disaggregated by disability level and applied accordingly.

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