

Mortality Impact of COVID-19: Ontario, Canada

© 2021 Hawkins Consulting Corporation

Contact: Michael Hawkins, mh@hawconsult.com

Michael Hawkins is president of Hawkins Consulting Corporation. Previously, he was a consultant to the life insurance industry at a large international consulting company and a senior analyst at a multi-national life insurance company. Mr. Hawkins is an actuary who is enrolled as a Fellow of the Society of Actuaries (FSA) and holds the designation of Fellow of the Canadian Institute of Actuaries (FCIA). Mr. Hawkins is trained as a mathematician. A graduate of the University of Waterloo, Mr. Hawkins was granted a Bachelor of Mathematics degree in Honours Actuarial Science (BMath), graduating With Distinction, Dean's Honour List. Mr. Hawkins has been qualified by the Tax Court of Canada as an expert on individual life insurance, individual annuities and reinsurance at the request of the Department of Justice, Canada.

In 2020 and 2021 much attention has been devoted to infections with severe acute respiratory syndrome coronavirus 2 virus strain (SARS-CoV-2), commonly referred to as the COVID-19 virus, with governments in Canada, and elsewhere, implementing dramatic societal and economic changes. This document summarizes and analyzes the mortality impact of this virus on the population of the Province of Ontario with emphasis on variations by age grouping. Ontario is Canada's most populous province with a population of nearly 15 million and 40% of Canada's population.

Summary

The data of the Government of Ontario contains biases that may materially overstate the impact of the COVID-19 virus on mortality. Data available has been used. The reader is cautioned that the biases in the data result in an overstatement of the severity of outcomes from the COVID-19 virus.

Deaths attributed to the COVID-19 virus have been concentrated at the older age groups. Elderly with pre-existing health conditions have been most affected. COVID-19 may be taking a "death accelerator" role more than a "death cause" role.

COVID-19 has not been a leading cause of death. Cancer and heart disease remain the leading causes of death, however, for children, youths and young adults it is accidents and suicide that remain the leading causes of death.

Canada has experienced a long period with mortality rates decreasing. For example, for the 65-69 age group, mortality in 2019 was 69% of what it was in 2000. For the 65-69 age group, in 2000, deaths were 1,570 per 100,000. In 2019, deaths were 1,080 per 100,000. Increased mortality due to the COVID-19 virus may take the death up to 1,130 per 100,000. 1,130 deaths is more than 1,080 deaths, however, 1,130 deaths is a lot fewer than 1,570 deaths.

Given the decreases in mortality rates that have occurred in prior years, increased mortality due to the COVID-19 virus is equivalent to putting mortality rates back to the levels experienced in the recent past. Mortality rates for all age groups remain low relative to prior periods. Mortality rates reverting to the levels of several years ago is not a dramatic change in mortality.

A female aged 49, prior to COVID-19, would have been expected to live to age 85.6 years. If COVID-19 persists indefinitely at 2020-2021 impact levels, she would now be expected to live to age 85.2 years, a decrease of about 5 months, from living 36.6 more years to living 36.2 more years. Prior to COVID-19, her probability of living to age 65 was 94.5% and under permanent COVID-19 it would be 94.3%. These are notable changes in longevity but they are not dramatic changes even under the assumption of permanent COVID-19 at 2020-2021 impact levels.

0-29 age group:	no noticeable impact on mortality rates.
30-59 age group:	minor impact on mortality rates.
60-89 age group:	noticeable cause of death, increase in mortality rates.
90+ age group:	noticeable cause of death, increase in mortality rates.

Commentary

The Ontario Medical Association reported in June 2021 that Ontario had a backlog of 16 million of surgeries, diagnostic exams, screenings and other medical procedures out of a population of under 15 million. The OMA expressed concern of harm caused by the Government of Ontario decisions and the distractions to normal health practices that have arisen from COVID-19 prioritization. The OMA highlighted the decrease in cancer screenings and testing to detect heart disease that normally leads to early treatment or illness prevention. The OMA also highlighted an increase in mental health issues.

Cancer and heart disease are the leading causes of death, not the COVID-19 virus. It can be expected that the decreases in screenings and testing that have occurred for these and other diseases will negatively affect quality of life and result in increasing rates of morbidity and mortality. For the younger age groups, mental health and drug abuse are primary concerns for health and mortality, not the COVID-19 virus. Government of Ontario measures relating to the COVID-19 virus have included lockdowns, school closures, forbidding socialization and cancellation of recreation and sport. These government measures can adversely affect mental health and cause increases in suicide and drug abuse in all age groups but there should be particular concern for the younger age groups where these are leading causes of death and where COVID-19 has had no noticeable impact on mortality.

Economic effects of government measures will impact the resources that will be available in the future to provide health services and will diminish the standard of living of Ontarians.

For young Ontarians, impacts today on education, training, mental health and substance abuse will have leave marks that last a lifetime, that is, for decades upon decades to come.

For older Ontarians, with only so many good years left, in an attempt to save several months at the end of life, the trade-off has been a diminished quality of life in their golden years for going on two years. These older Ontarians have also endured compromises to their health care that will impact both quality and quantity of life, now and into the future.

Reducing COVID-19 infection rates and improving outcomes of those who do get infected are worthy goals. The effectiveness of any of the government measures is beyond the scope of this research. However, reducing COVID-19 infection rates should not be blind to the consequences and trade-offs that occur. First do no harm.

Analysis of Ontario Data

Table 1 presents Ontario's experience for the 20-month period of January 15, 2020 to September 15, 2021 as reported by the Government of Ontario. It is normal for mortality to be analyzed on an annual basis, not cumulatively. Table 2 presents these results on an annualized basis (factor of 1.5 is used given that first two months had small exposure).

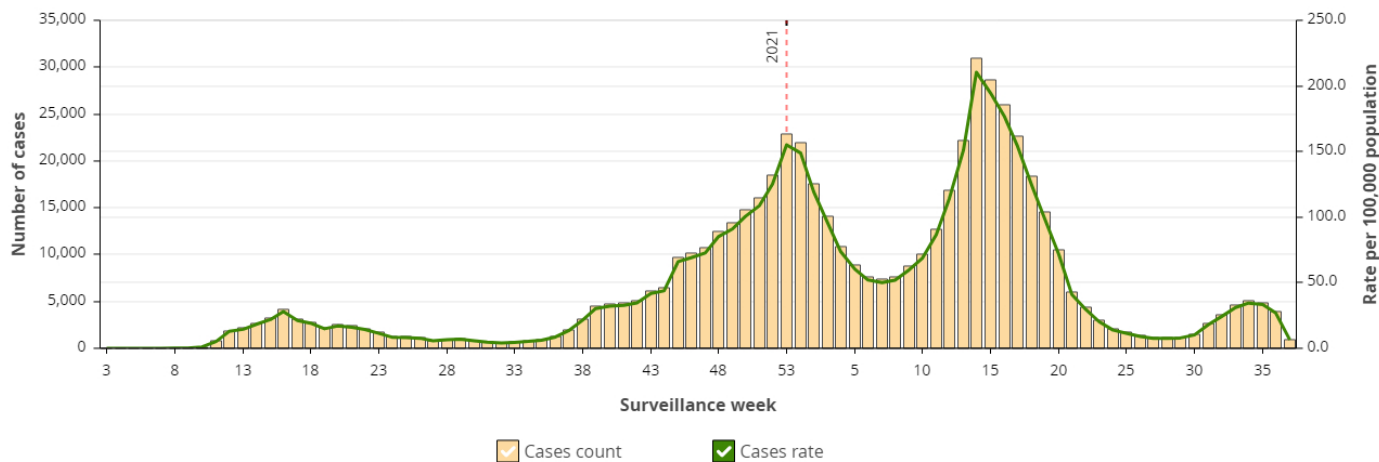
Age Group	Number of Lives	Covid-19		
		Cases	Hospital	Death
0 to 09	1,485,670	35,351	287	2
10 to 19	1,645,352	60,487	259	3
20 to 29	2,117,094	123,225	1114	28
30 to 39	2,034,796	94,706	1,921	66
40 to 49	1,853,436	82,304	2,731	157
50 to 59	2,042,065	80,334	4,641	487
60 to 69	1,765,205	50,178	5,522	1,128
70 to 79	1,134,561	24,916	5,667	1,998
80 to 89	523,775	16,883	5,141	3,260
90+	132,060	8,762	2,224	2,502

Age Group	Number of Lives	Covid-19		
		Cases	Hospital	Death
0 to 09	1,485,670	23,567	191	1
10 to 19	1,645,352	40,325	173	2
20 to 29	2,117,094	82,150	743	19
30 to 39	2,034,796	63,137	1,281	44
40 to 49	1,853,436	54,869	1,821	105
50 to 59	2,042,065	53,556	3,094	325
60 to 69	1,765,205	33,452	3,681	752
70 to 79	1,134,561	16,611	3,778	1,332
80 to 89	523,775	11,255	3,427	2,173
90+	132,060	5,841	1,483	1,668

The period examined represents a broad spectrum of disease prevalence, treatment, societal restrictions, public health orders and preventative treatments. The Graph 1 that follows presents the COVID-19 case counts over these 20 months (source Government of Ontario).

Graph 1

COVID-19 weekly case counts and rates by episode date in Ontario



Outcomes for persons identified as infected with the COVID-19 virus are presented in Table 3. Outcomes have been worse for older persons than for younger persons. For COVID-19 cases, that is, those who were infected with the COVID-19 virus, there has been a low mortality rate of 0.005% for a youth (1 in 20,000) and a high mortality rate of 19.3% for persons in their 80's (1 in 5); put the other way, for a youth that contracts COVID-19 the survival rate is 99.995% (19,999 in 20,000) while for a person in their 80's it is 80.7% (4 in 5).

Age Group	Rate for Covid-19 Cases	
	Hospital	Death
0 to 09	0.8%	0.006%
10 to 19	0.4%	0.005%
20 to 29	0.9%	0.023%
30 to 39	2.0%	0.07%
40 to 49	3.3%	0.19%
50 to 59	5.8%	0.61%
60 to 69	11%	2.2%
70 to 79	23%	8.0%
80 to 89	30%	19.3%
90+	25%	29%

Of course, not everyone becomes infected with the COVID-19 virus, only a small minority have become infected. Analysis of the population risk of hospitalization or death to a disease needs to reflect the rate of infection with the disease. The annual rate of COVID-19 infection has been 2.6% of the population with some variation by age group. Table 4 presents the population rates of hospitalization and death attributed to COVID-19.

Age Group	Annual Covid-19 Rates for Population			Deaths per 100,000
	Cases	Hospital	Death	
0 to 09	1.6%	0.013%	0.00009%	0.09
10 to 19	2.5%	0.010%	0.00012%	0.12
20 to 29	3.9%	0.035%	0.00088%	0.88
30 to 39	3.1%	0.063%	0.0022%	2.2
40 to 49	3.0%	0.098%	0.0056%	5.6
50 to 59	2.6%	0.152%	0.0159%	15.9
60 to 69	1.9%	0.209%	0.043%	43
70 to 79	1.5%	0.333%	0.117%	117
80 to 89	2.1%	0.654%	0.415%	415
90+	4.4%	1.123%	1.26%	1,263

There has been extraordinary variation in hospitalization by age but even more variation in mortality rates by age. For example, for youths aged 10-19 there is a very low COVID-19 mortality rate of 0.00012% (1 in 825,000) whereas for a person in their 80's, COVID-19 mortality rate is 0.415% (1 in 240).

For the 80-89 age group, the COVID-19 mortality rate of 0.415% (1 in 240) may seem high on the surface, and it is 3,400 times the corresponding rate for 10-19 year olds, but it lacks the perspective of both the high mortality rate of this age group (6.47% or 1 in 15 died from all causes of death in 2019) and the historical norm of much higher rates of

death (there has been a 24% decrease in mortality rates for the 80-89 age group from 2000 to 2019, multiples times larger than the present impact of the COVID-19 virus).

Perspective is important and it is discussed further after addressing biases in the data and rates.

Biases in Data and Rates

Rates of hospitalization and death due to COVID-19 infection as reported by the Government of Ontario can be expected to be overstated (rates in Table 3) as not all persons who are infected with the COVID-19 virus are known to the Government of Ontario while hospitalizations and deaths are screened for the COVID-19 virus. However, this bias is removed in the population analysis (rates in Table 4) as number of cases do not enter the determination. The population analysis is the more reliable indicator of the impact of the COVID-19 virus on hospitalization and death.

Another bias in the data is what is considered a hospitalization or death due to COVID-19.

There is bias in the definition of “COVID-19 death” that inflates deaths attributable to the COVID-19 virus. Government of Ontario definition is: “For surveillance purposes, a COVID-19 death is defined as a death resulting from a clinically compatible illness in a confirmed COVID-19 case, unless there is a clear alternative cause of death that cannot be related to COVID-19 (i.e., trauma).” In essence, when the death could be ascribed to COVID-19, it is.

Further, “Number of COVID-19 Hospitalizations” is defined by the Government of Ontario such that it “includes cases that were in hospital prior to acquiring the disease”.

Using these definitions, a person who was hospitalized for heart disease, acquired the COVID-19 virus in the hospital and later succumbed to heart disease would be categorized by the Government of Ontario as both a COVID-19 hospitalization and a COVID-19 death.

The Government of Ontario’s classification method is inconsistent with how Statistics Canada has historically determined cause of death in its reporting. A death that is classified by the Government of Ontario as a “COVID-19 death” is not synonymous with a death caused by COVID-19. From Statistics Canada: “The cause of death tabulated is the underlying cause of death. This is defined as (a) the disease or injury which initiated the train of events leading directly to death, or (b) the circumstances of the accident or violence which produced the fatal injury. The underlying cause is selected from the conditions listed on the medical certificate of cause of death.” In the heart disease example described above, it did not have the COVID-19 virus as being the disease “which initiated the train of events leading directly to death” yet the Government of Ontario would classify it as a COVID-19 death.

The biases in the Government of Ontario’s definitions may be useful from the perspective of a government or its agencies not wanting to underestimate the frequency of infections of an emerging virus or not wanting to underestimate its impact on hospitalizations and death but unfortunately the biases do taint analyses that seek a best estimate of the impact. The Government of Ontario does in fact use the label “surveillance”. This research is to estimate impact, not to surveil the emergence of this virus.

The decision by the Government of Ontario not to follow “the train of events leading directly to death” is especially relevant given that COVID-19 deaths are known to have a very high rates of comorbidities, that is, deceased lives frequently have other diseases, often pre-existing, which could be the cause of death according to the historical Statistics Canada approach. In these cases, the COVID-19 virus may be accelerating death rather than causing death. An alternative approach could have been to follow the historical Statistics Canada method for cause of death or, in the alternative, to ascribe portions of blame to the various diseases in play rather than to give prevalence to COVID-19.

Government of Alberta statistics indicate that 76% of COVID-19 deaths had 3 or more pre-existing health impairments, 14% had 2 pre-existing health impairments, 7% had 1 pre-existing health impairment and 3% had no pre-existing health impairments. The identified pre-existing health impairments would be indicative of higher expected mortality

rates and would make the existence of another disease being the “train” very possible.¹ Table 5 presents the frequency of these pre-existing health impairments.

Condition	Percent of COVID-19 Deaths with Condition
Hypertension	83.8%
Cardio-Vascular Diseases	52.9%
Renal Diseases	50.9%
Diabetes	44.9%
Dementia	44.0%
Respiratory Diseases	40.9%
Cancer	23.8%
Stroke	19.6%
Liver Diseases	4.3%
Immuno-Deficiency Diseases	3.2%

Source: Government of Alberta, data updated to September 14, 2021, one individual can have multiple conditions.

Government of Alberta reported that persons with 2 or more pre-existing health impairments represent:

- 90% of COVID-19 deaths
- 55% of COVID-19 ICUs (but not deaths)
- 55% of COVID-19 hospitalizations (but not ICU or death)
- 11% of COVID-19 non-severe cases (no hospitalization, no ICU, no death)

Lives with 2 or more pre-existing health conditions are 5-times more prevalent in COVID-19 hospitalizations than non-severe cases and 8-times more prevalent in COVID-19 deaths than non-severe cases. Pre-existing health conditions are highly relevant to outcomes for COVID-19 cases.

It was reported in the Toronto Star on September 16, 2021 that Public Health Ontario had determined that 9.2% of COVID-19 deaths, 1 in 11, occurred among people who were infected with the COVID-19 virus while in an Ontario hospital.² Patients are obviously in hospitals for a reason. This large subset of COVID-19 deaths who had their infections occur in hospitals is suggestive of a large number of COVID-19 deaths not having the COVID-19 virus as the “train” that led to death.

It is worthwhile comparing the approach for reporting COVID-19 deaths with the approach for reporting HIV/AIDS deaths. HIV/AIDS victims often die from pneumonia, tuberculosis, cancers and other diseases but the cause of death is HIV/AIDS with the infections and diseases that lead to the death having been opportunistic of the compromised health of the HIV/AIDS victim. Conversely, with the COVID-19 virus, the prevalence of multiple pre-existing health conditions (90% of COVID-19 deaths in Alberta had two or more pre-existing health conditions; 9.2% of COVID-19 deaths in Ontario had the virus infection occurring within hospitals) suggests that COVID-19 may be acting as the opportunistic infection or disease and not the “train” that “leads directly to death”, yet it is reported as if it is the “train”. That is, the role in mortality of COVID-19 (opportunistic infection or disease that follows a primary infection or disease) appears to be the opposite of HIV/AIDS (instigating infection or disease that is followed by an opportunistic infection or disease) but the reporting is not reflective of this different role. Recall the Ontario label of “surveillance”.

There is good reason to believe that there are large biases in the reporting that have resulted in “COVID-19 deaths” being a material overstatement of deaths caused by the COVID-19 virus as cause of death is normally understood.

¹ The pre-existing health impairments recorded by the Government of Alberta include: Diabetes, Hypertension, COPD, Cancer, Dementia, Stroke, Liver cirrhosis, Cardiovascular diseases (including IHD and Congestive heart failure), Chronic kidney disease, and Immuno-deficiency.

² Toronto Star, September 16, 2021 “At least 860 people have died of COVID-19 in Ontario hospital outbreaks. What we now know about the ‘unmitigated tragedy’”, by Ed Tubb and Kenyon Wallace. The article indicates Public Health Ontario reported 860 deaths from COVID-19 hospital outbreaks to July 5, 2021. Government of Ontario data indicates that total COVID-19 deaths were 9,383 as of July 5, 2021.

The incidences in Table 1 and the rates in Tables 2, 3 and 4 above and in Tables 6 and 7 that follow and the survival impacts in Tables 8 and 9 that follow should be considered overestimates of the impact of the COVID-19 virus, that is, the COVID-19 impacts and outcomes are not as severe as presented in the tables herein. That said, this is the data that is available and there are no means presently available to improve the data. The data available is used and the reader is cautioned that the biases in the data result in an overstatement of the severity of impacts and outcomes from the COVID-19 virus.

There could also be cases where deaths that do not meet the definition of COVID-19 death are erroneously reported as a COVID-19 death and conversely a death that does meet the definition not being reported as such. The reporting is taken as given without performing independent audit or analysis of the quality of the reporting.

Increased Mortality put into Perspective

Increased mortality from COVID-19 needs to be considered within the perspective of both all other causes of mortality and historical rates of mortality. That is, perspective should consider whether the increase in mortality ascribed to COVID-19 is significant relative to rates of mortality from other causes, whether COVID-19 is a significant or minor cause of death and whether the increase in mortality stands out from historical rates of mortality.

Table 6 shows the impact of deaths attributed to the COVID-19 virus relative to 2019 Canadian population mortality.³ COVID-19 mortality rates in Table 6 differ from Table 4 by making a correction to reflect that the COVID-19 deaths could have died from other causes had they not died from COVID-19, that is, the rates of mortality in Table 6 present the increase in mortality that has arisen due to COVID-19. The COVID-19 mortality rates in Table 6 were determined presuming that COVID-19 deaths otherwise had average rates of mortality, that is, no adjustment is made for the prevalence of pre-existing health conditions within this population.⁴

Age Group	2019 Canada Population All Causes Mortality Rate	Ontario Covid-19 Mortality Rate	Increase in Mortality: Covid-19 / 2019 All Causes	Stats Canada Annual Mortality Improvement Rate	Increase equated to Number of Years of Improvement
0 to 09	0.01032%	0.00009%	0.9%	4.3%	0.2
10 to 19	0.02206%	0.00012%	0.6%	3.0%	0.2
20 to 29	0.05922%	0.00088%	1.5%	2.1%	0.7
30 to 39	0.0861%	0.0022%	2.5%	1.6%	1.6
40 to 49	0.1497%	0.0056%	3.8%	2.2%	1.7
50 to 59	0.3692%	0.0159%	4.3%	2.2%	2.0
60 to 69	0.870%	0.042%	4.9%	1.8%	2.7
70 to 79	2.146%	0.116%	5.4%	1.4%	3.9
80 to 89	6.470%	0.402%	6.2%	1.0%	6.2
90+	18.84%	1.14%	6.1%	0.5%	12.1

From Table 6, for age group 20-29, mortality is 0.05922% or annual deaths of 59 per 100,000. With COVID-19, mortality for this group goes up 0.00088% or 0.9 extra deaths per 100,000. This represents deaths increasing by 1.5%. This age group is expected to see annual decreases in mortality rates of 2.1%. It will take 0.7 of a year or 9 months for the higher mortality due to COVID-19 to be absorbed by the trending improvement in mortality of this age group.

Another appropriate correction is that those whose death was attributed to the COVID-19 virus may have been more likely to have died than other lives in the same age group. This is the 'underlying health problems' narrative or 'pre-

³ Source of Canadian population mortality is Statistics Canada.

⁴ For example, in 60-69 age group, a person had 0.870% probability of dying from all causes in 2019. If COVID-19 deaths are presumed to occur mid-year, other causes of death cannot occur in second half of the year. Correction is made by multiplying COVID-19 mortality rate by (1 – 50% of All Causes Mortality Rate). This correction impacts older ages where the all causes mortality rate is high (age groups 70-79, 80-89 and 90+) and rounds out at younger ages.

existing health conditions' issue identified in the earlier discussion on biases. All lives are not equally likely to die in a year within the same age group. Further, a person with pre-existing health conditions may be more vulnerable to the COVID-19 virus than another life that is of good health.

There are two aspects of pre-existing health conditions to consider.

First, the likelihood of death for the person with the pre-existing health condition: depending on the severity and nature of the health problem, the extra mortality due to acquiring the COVID-19 virus may be higher on this person than it would be on the general population or it may be that the COVID-19 virus accelerated an inevitable death and "the train of events leading directly to death" indicates that the "train" is the pre-existing health condition(s) and not the COVID-19 virus; see the earlier discussion on biases.

Second, the impact of pre-existing health conditions would reflect on the group experience as a whole, similar to correction made for Table 6, that is, exposure to other causes of death being cut short by a COVID-19 death.

No attempt is made to address the first aspect of pre-existing health conditions and this is left as being a bias that overstates, perhaps materially, COVID-19 mortality. However, a correction for the second aspect was made using the Government of Alberta statistics that indicate that 76% of COVID-19 deaths had 3 or more pre-existing health impairments, 14% had 2 pre-existing health impairments, 7% had 1 pre-existing health impairment and 3% had no pre-existing health impairments. The identified pre-existing health impairments would be indicative of higher expected mortality rates for these lives.^{5 6} This correction for the second aspect was made and is reflected in Table 7.⁷

Table 7 - Increase in Mortality Rate (with adjustment for effect of Pre-Existing Health Conditions): (Ontario Covid-19) / (2019 Canada All Causes)

Age Group	2019 Canada Population All Causes Mortality Rate	Ontario Covid-19 Mortality Rate	Increase in Mortality: Covid-19 / 2019 All Causes	Stats Canada Annual Mortality Improvement Rate	Increase equated to Number of Years of Improvement
0 to 09	0.01032%	0.00009%	0.9%	4.3%	0.2
10 to 19	0.02206%	0.00012%	0.6%	3.0%	0.2
20 to 29	0.05922%	0.00088%	1.5%	2.1%	0.7
30 to 39	0.0861%	0.0022%	2.5%	1.6%	1.6
40 to 49	0.1497%	0.0056%	3.8%	2.2%	1.7
50 to 59	0.3692%	0.0158%	4.3%	2.2%	1.9
60 to 69	0.870%	0.042%	4.8%	1.8%	2.7
70 to 79	2.146%	0.112%	5.2%	1.4%	3.7
80 to 89	6.470%	0.357%	5.5%	1.0%	5.5
90+	18.84%	0.75%	4.0%	0.5%	8.0

2019 is taken as a baseline. 2019 was prior to COVID-19 being monitored in Ontario. Increase in mortality due to COVID-19 is added onto this baseline. The adjustment used to create Table 7 provides the best estimate recognizing that the biases overstate COVID-19 mortality. The findings from Table 7 are reviewed by age grouping in the section that follows.

⁵ The pre-existing health impairments recorded by the Government of Alberta include: Diabetes, Hypertension, COPD, Cancer, Dementia, Stroke, Liver cirrhosis, Cardiovascular diseases (including IHD and Congestive heart failure), Chronic kidney disease, and Immuno-deficiency. Table 5 presents frequency of these pre-existing health impairments.

⁶ Reflecting the frequency, severity and combination of these pre-existing health impairments, a reasonable set of mortality assumptions for COVID-19 deaths could be: 76% had underlying mortality that was 5-times average mortality (3 or more pre-existing conditions); 14% with 3-times average mortality (2 or more pre-existing conditions); and 10% with average mortality (1 or none pre-existing conditions).

⁷ This correction has more impact at older ages where the all causes mortality rate is high (small impact starting with the 50-59 age group and largest impact for 90+ age group) but little impact at the younger ages.

Impact of COVID-19 by Age Group

Ages 0 - 29

For children, youths and young adults (0-29 age grouping), COVID-19 deaths represent a 1% increase in deaths.

As a cause of death, COVID-19 is not a leading cause of death and is not significant to the mortality of this group. For example, the 15-19 age group COVID-19 deaths are 0.12 per 100,000 whereas for 2019 all causes of death were 33.8 per 100,000 with leading causes of death: accidents at 9.7 per 100,000; suicide at 9.5 per 100,000; malignant neoplasms at 3.4 per 100,000; and homicide at 1.5 per 100,000.⁸

COVID-19 deaths would be lost within the variability of some of the leading causes of death, for example, accidental death rate per 100,000 was 11.4, 11.2, 12.8, 10.1 and 9.7 by year in the 2015-2019 period, a range of 3.1 per 100,000 for this cause.⁹ The range of fluctuation for accidental death being 3.1 per 100,000 dwarfs the COVID-19 mortality rate of 0.12 per 100,000; COVID-19 mortality is merely 4% of the range of fluctuation for accidental deaths. In fact, for the 15-19 age group influenza and pneumonia has been more deadly varying within the range of 0.1 to 0.3 per 100,000 over the period 2015-2019 but likewise is also not a leading cause of death.

For the 0-29 age grouping, COVID-19 has been a minor cause of death, has not had a noticeable impact on mortality rates, is well within the year-to-year fluctuation of mortality experience¹⁰ and would not be expected to affect the trending mortality improvement of this age group.

For the 0-29 age group an annual decrease in the mortality rate of 3% is expected and thus a new cause of death increasing mortality by 1%, all else equal, would mean that mortality would still be lower than in the past, without even causing a pause in the trend of decreasing mortality.

Ages 30 - 59

For the 30-59 age grouping, the COVID-19 deaths represent about a 4% increase in deaths.

For this age group COVID-19 is a noticeable cause of death but not a leading cause of death. For example, the 45-49 age group COVID-19 deaths are under 6 per 100,000 whereas for 2019 all causes of death were 179 per 100,000 with leading causes of death: malignant neoplasms at 52 per 100,000; major cardiovascular diseases at 29 per 100,000; accidents at 21 per 100,000; and suicide at 14 per 100,000.

For the 30-59 age grouping, COVID-19 has been a minor cause of death, causing an modest increase in mortality rates but would not be expected to affect the trending mortality improvement of this age group.¹¹

For the 30-59 age group an annual decrease in the mortality rate of 2% is expected and thus a new cause of death increasing mortality by 4% can be absorbed in about two years and may not even be noticeable within the normal year to year fluctuations. If noticeable, COVID-19 may set mortality for this age group back to what it was 1 or 2 years prior, that is, all else equal, it may cause 2021 mortality to be similar to 2019 mortality with the trend of decreasing mortality resuming going forward.

Ages 60 - 89

For the 60-89 age grouping, the COVID-19 deaths represent about a 5% increase in deaths. This age group might normally experience a 1.5% annual decrease in deaths. COVID-19 is a noticeable cause of death for this age group with it being equivalent to perhaps 3-4 years of mortality improvement.

⁸ Source of historical Canadian population mortality and causes of death is Statistics Canada.

⁹ Source of historical Canadian population mortality and causes of death is Statistics Canada.

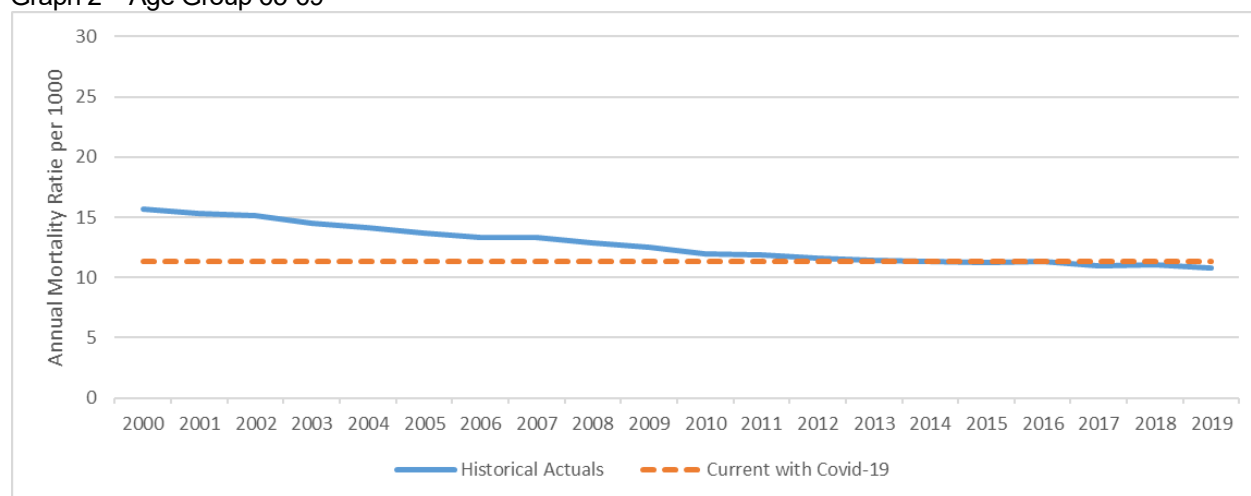
¹⁰ For example, in 2015-2019 mortality rate for 15-19 age group has gone up and down by far more than the 0.12 per 100,000 from COVID-19 deaths with mortality rates per 100,000 in these years being 33.4, 33.2, 35.6, 33.7 and 33.8.

¹¹ For example, in 2015-2019 mortality rate for 45-49 age group has gone up and down by more than the 6 per 100,000 from COVID-19 deaths with mortality rates per 100,000 in these years being 181, 188, 188, 181 and 179.

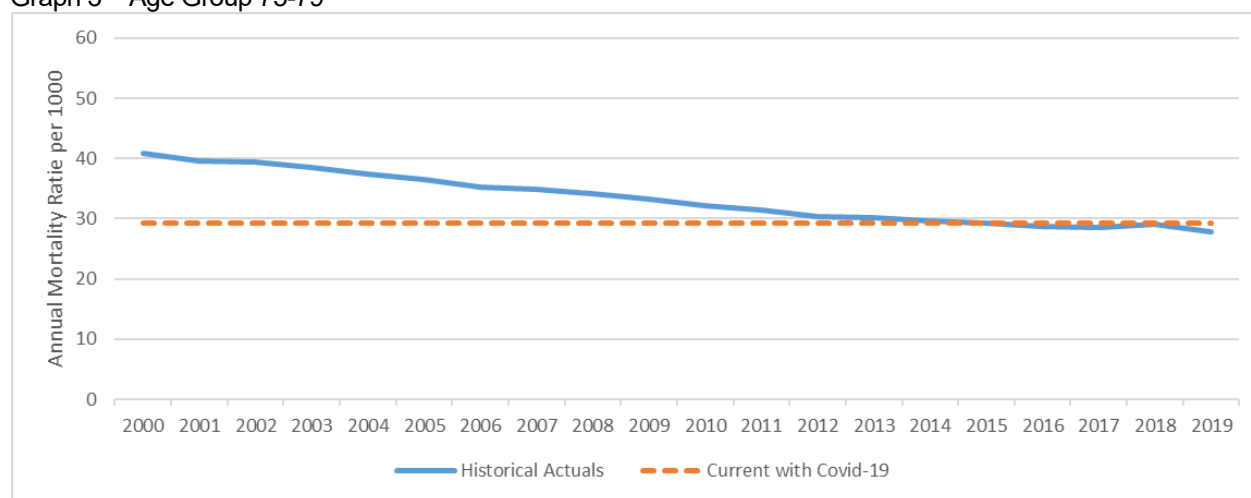
For example, the 75-79 age group COVID-9 deaths are 112 per 100,000 whereas for 2019 all causes of death were 2,790 per 100,000 with leading causes of death: malignant neoplasms at 1,012 per 100,000; major cardiovascular diseases at 661 per 100,000; and chronic lower respiratory diseases at 179 per 100,000. COVID-19 would have come in at 4% of 2019 deaths and would have been the fourth leading cause of death but recognize that the two leading causes of death dwarf it at 60% of deaths. Heart disease and cancer remain the dominant causes of death for the 60-89 age group.

As a new cause of death, COVID-19 could take mortality rates for the 60-89 age group back to the 2014-2018 period which is still a period with historically low mortality. For example, in the 65-69 age group there had been a 31% decline in mortality rates from 2000 to 2019 and thus a 4.8% increase only takes away one sixth of recent mortality decreases. This historical trend is illustrated in Graph 2 for the 65-69 age group and in Graphs 3 and 4 for 75-79 and 85-89 age groups respectively.¹² It is observed that COVID-19 increases mortality modestly above 2019 (orange dashed line) but compared to recent history (blue solid line), mortality is either comparable (similar to 2012-2018) or lower (pre-2010).

Graph 2 – Age Group 65-69

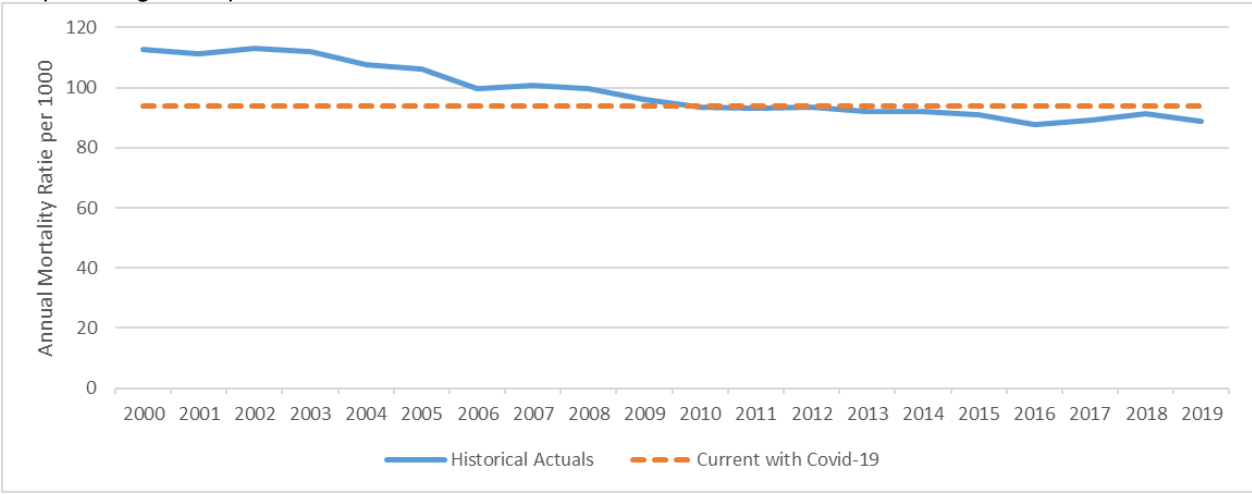


Graph 3 – Age Group 75-79



¹² “Current with Covid-19” is 2019 mortality rates plus the COVID-19 mortality adjustment from Table 7. Note that there are large changes in the vertical scale between graphs due to the large differences in all cause mortality by age group. The vertical scale of the graphs double with each age group presented.

Graph 4 – Age Group 85-89



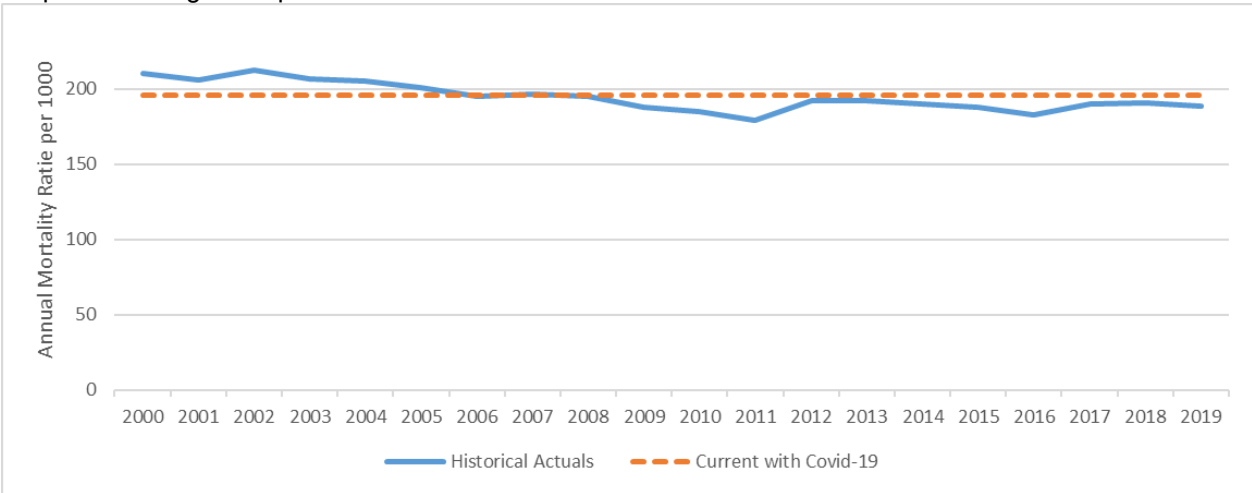
Ages 90 +

For the 90+ age grouping, the COVID-19 deaths represent a 4% increase in deaths.

COVID-19 is a noticeable cause of death for this age group. A difference for this age group is that mortality has not been improving as fast. Also, this age group starts with a high rate of mortality. COVID-19 deaths are 750 per 100,000 for this age group. This is a large number of deaths: more than 2 times the rate for the 80-89 age group and more than 6.5 times the rate for the 70-79 age group. However, 2019 all causes of death were 18,843 per 100,000 with leading causes of death: major cardiovascular disease at 6,126 per 100,000; malignant neoplasms at 2,302 per 100,000; and the catch all for residual deaths not assigned to any other cause of death at 4,857 per 100,000.¹³ The fact that the high rate of COVID-19 deaths in this age group is just 15% of the “other stuff” categorization is indicative that this age group has very high rates of mortality.

With COVID-19 deaths added to 2019 all causes deaths, mortality rates were last this high for the 90+ age group in 2007 but not much higher than the more recent years of 2012, 2013, 2017 and 2018. In 2000, mortality for this age group was 7% higher than the 2019 COVID-19 adjusted mortality rate. At the time, the 2000-2008 period was by no means characterized as being a crisis for elder mortality, yet that period had higher levels of elder mortality than what is now being observed with COVID-19 present. See Graph 5.

Graph 5 – 90+ Age Group



¹³ Four other causes of death were each singularly of similar levels to COVID-19 deaths: Alzheimer’s disease, influenza and pneumonia, chronic lower respiratory diseases and accidents.

Life Expectancies

Mortality rates are annual rates. Life expectancies are statistics derived from mortality rates. Life expectancy represents the average number of additional years that a cohort of similar lives would live. Life expectancy reflects all future mortality and thus compiles the entire remaining lifetime of exposure mortality. Table 8 presents life expectancies using Canadian population mortality rates for the period 2017-2019¹⁴ compared to these rates adjusted for the COVID-19 mortality presented in Table 7 under the assumption of permanent COVID-19 at 2020-2021 impact levels and no future improvement in mortality.¹⁵ Probabilities of survival to various ages are presented in Table 9.

Impact on life expectancy is in 3 to 5-month range. For a female age 49, her entire future lifetime of exposure to COVID-19, assumed to continue at 2020-2021 impact levels, would result in life expectancy decreasing by 5 months, from expecting to live 36.6 more years to expecting to live 36.2 more years. Both before and after adjustment for COVID-19, her life expectancy is age 85 plus a number of months.

There is no noticeable change in the probability of survival to age 55 and little change on surviving to age 65. It is the older ages where COVID-19 mortality is impactful. There are few additional very early deaths, rather, later deaths come marginally sooner. For a female age 49, probability of survival to age 65 (survive 16 years) does not change much, it was 94.5% and is now 94.3%. Her survival probability to age 85 (survive 36 years), changes from being 59.6% to 58.0%, lower yes, but not dramatic.

Table 8 - Change in Female Life Expectancies: 2017-2019 population vs 2017-2019 plus COVID-19

Age	Age Plus Life Expectancy		
	2017-2019	Plus COVID-19	Change
9	84.6	84.1	0.4
19	84.7	84.2	0.4
29	84.9	84.5	0.4
39	85.2	84.8	0.4
49	85.6	85.2	0.4
59	86.4	86.0	0.4
69	87.9	87.5	0.4
79	90.4	90.1	0.3
89	94.8	94.6	0.2

Table 9 - Change in Female Survival Probabilities: 2017-2019 population vs 2017-2019 plus COVID-19

Age	Probability of Living to Age 55		Probability of Living to Age 65		Probability of Living to Age 75		Probability of Living to Age 85	
	2017-2019	Plus COVID-19	2017-2019	Plus COVID-19	2017-2019	Plus COVID-19	2017-2019	Plus COVID-19
9	96.6%	96.5%	92.5%	92.2%	82.3%	81.6%	58.3%	56.7%
19	96.8%	96.7%	92.6%	92.3%	82.5%	81.7%	58.4%	56.8%
29	97.1%	97.0%	93.0%	92.7%	82.8%	82.0%	58.6%	57.0%
39	97.7%	97.6%	93.5%	93.2%	83.2%	82.5%	58.9%	57.3%
49	98.7%	98.7%	94.5%	94.3%	84.1%	83.4%	59.6%	58.0%
59	N/A	N/A	97.0%	96.8%	86.3%	85.7%	61.1%	59.5%
69	N/A	N/A	N/A	N/A	92.0%	91.6%	65.2%	63.7%
79	N/A	N/A	N/A	N/A	N/A	N/A	77.8%	76.7%

Caution with respect to Biases

Please review the section discussing biases. Biases will be most prevalent and relevant to age groups with the highest COVID-19 death rates. Due to biases, the severity of the COVID-19 virus presented herein is overstated.

¹⁴ Source of population mortality rates is Statistics Canada.

¹⁵ There are differences in COVID-19 mortality by sex but no separate analysis of COVID-19 mortality by sex has been performed herein. Female lives were presented in Table 8. Analyzing male and female separately is another project.