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ABSTRACT

Background

Studies have shown that excess all-cause mortality during the COVID-19 pandemic caused declines of life expectancy at birth (LE_0) in most countries around the world, after decades of improvement prior to the pandemic. However, those studies rarely examined the contributions from specific causes of death other than COVID-19.

Methods

This study used the Chiang method to estimate LE_0 for each year in British Columbia from 2000 to 2022 and the changes from 2019 to 2020, 2021, and 2022. Each death case was classified into 1 of 23 categories, including COVID-19, unregulated drug toxicity, cardiovascular diseases, and injuries, according to the International Classification of Diseases, 10th Revision (ICD-10). The changes in LE_0 were decomposed into age and causes of death using the Arriaga method.

Results

Compared with 2019, male LE_0 decreased by 1.16 years in 2020, 1.81 years in 2021, and 1.62 years in 2022; female LE_0 did not change in 2020, but decreased by 0.65 years in 2021, and by 0.56 years in 2022. COVID-19 and unregulated drug toxicity were the top two causes of deaths contributing to the LE_0 declines in males and females, with COVID-19 being the number one contributor in females and unregulated drug toxicity deaths as the number one contributor in males.

Interpretation

The COVID-19 pandemic impacted population health not only through its direct effects but also through indirect impacts on other health outcomes, including the unregulated drug toxicity crisis, the combination of which were driving factors in the decline in life expectancy at birth.

Keywords

life expectancy, COVID-19, unregulated drug toxicity, inequalities

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What is already known on this subject?

- Life expectancy at birth declined in most countries around the world during the COVID 19 pandemic.
- In British Columbia, the mortality rate for unregulated drug toxicity death increased during the pandemic.

What does this study add?

- Life expectancy at birth in British Columbia declined during the first two years of the COVID-19 pandemic but started to recover in 2022.
- While COVID-19 and unregulated drug toxicity deaths were the top two causes contributing to the life expectancy at birth declines in both males and females, COVID-19 was the number one contributor for females and unregulated drug toxicity was the number one contributor for males.
- Future research should further examine the contribution patterns by gender, race, ethnicity, and other socioeconomic factors.

Since COVID-19 was declared a pandemic on March 11, 2020, there have been at least 772 million confirmed cases and 6.9 million confirmed deaths worldwide.[1] In Canada, there were 59,083 COVID-19 deaths[2] as of September 9, 2024, including 6,852 deaths in the province of British Columbia.[3] Globally, the COVID-19 pandemic led to 120.3 excess deaths per 100,000 population (95% confidence interval [95% CI] 113.1 to129.3) in 2020 and 2021 combined.[4] The study estimated that, during the same period, there were 5,260 excess deaths (95% CI 4,350 to 6,250) caused by the pandemic in British Columbia and 43,700 excess deaths (95% CI 39,900 to 47,300) in Canada. Another study using a different statistical method reported an even higher estimate of excess deaths caused by COVID-19 in British Columbia.[5]

Earlier studies demonstrate that these excess deaths led to a decrease in life expectancy at birth (LE_0), a summary measure of population health, around the world for the first two years of the pandemic.[6-8] For instance, Aburto and colleagues[6] reported declines in LE_0 for 27 out of 29 countries in 2020. Islam and colleagues looked at 37 upper-middle and high-income countries worldwide and found similar results.[7] Many of those studies found further disproportional impacts of the pandemic on LE_0. In the United States, the largest LE_0 decline was found in the Hispanic population, followed by the non-Hispanic Black population.[8,9] The population living in lower income communities had a larger LE_0 decline compared with those living in higher-income communities.[9] Analyses by sex also revealed a higher LE_0 decline in males than that in females in many countries.[10,11]

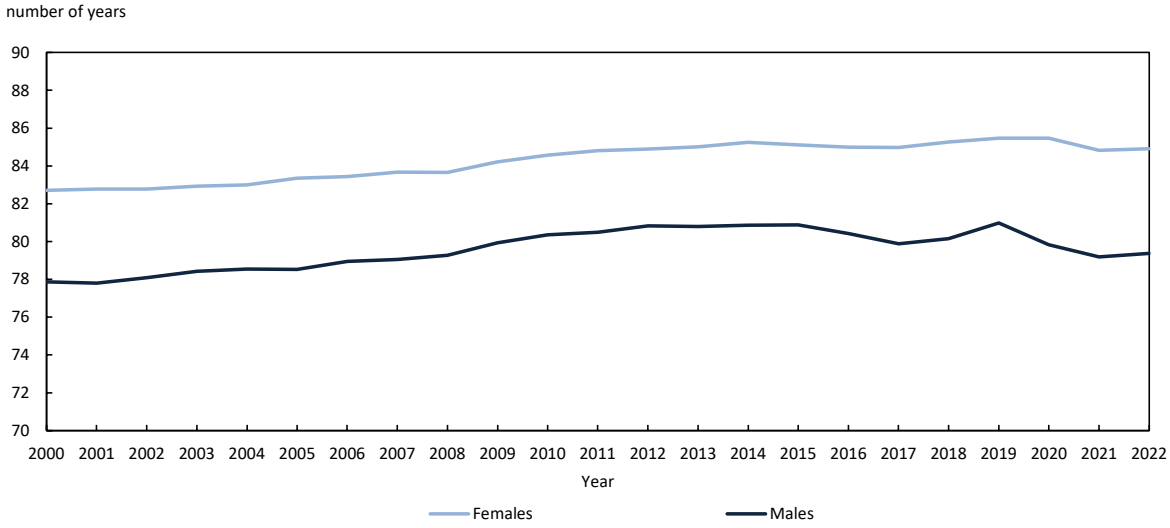
Those studies primarily focused on quantifying the overall impact of the pandemic on LE_0, but little was known about the contributions of COVID-19 deaths and excess deaths because of other causes indirectly related to COVID-19. While most excess deaths were directly attributable to COVID-19, about 17% of these excess deaths were attributable to indirect effects of COVID-19.[12] In British Columbia, opioid use-related deaths have accelerated since the start of the pandemic.[13] Increased opioid toxicity deaths were also observed in other jurisdictions in Canada and the United States.[14,15] Studies have examined the life expectancy changes during the first two years of the pandemic, but little was known on whether the declining trends continued in 2022, given the changing COVID-19 situation. The present study aimed to quantify the changes from 2019 to each year during the pandemic and the contributions from COVID-19, unregulated drug toxicity, and other causes of death in British Columbia, Canada.

Materials and methods

Data sources

The death registry of the British Columbia Vital Statistics Agency (VSA) contains all deaths of British Columbia residents. This study included all deaths recorded in the registry as occurring between 2000 and 2022. A Medical Certification of Death (MCOD) with details about the cause of death is completed by a certifier, i.e., doctor, nurse practitioner, or coroner. The British Columbia Coroners Service (BCCS) is required to determine the cause of death for all unexpected and unnatural deaths in the province. VSA medical coders review the paper MCODs for completeness, internal consistency, obvious errors, and special items of interest and contact certifiers for clarification or additional information. Medical coding staff translate the cause of death information written on the MCOD by the certifier into International Statistical Classification of Diseases and Related Health Problems 10th revision (ICD-10) codes. The ICD-10 codes are classified into one of the causes of death as listed in Appendix Table 1. COVID-19-associated deaths are coded U07.1 or U07.2 in the registry. Cases without a known cause of death are coded as "R99-ill-defined and unknown cause of mortality."

Chart 1
Life expectancy at birth for males and females in British Columbia, Canada 2000 to 2022



Source: British Columbia Vital Statistics Agency Death Registry, 2000 to 2022.

For this study, unregulated drug toxicity deaths (i.e., deaths from controlled drugs such as heroin, cocaine, and illicit fentanyl; and deaths from medications not prescribed to the deceased but obtained or purchased from unknown means or where the origin of the drug is not known) were classified using the death registry data for cases occurring between 2000 and 2017. For deaths occurring from 2018 to 2022, the BCCS list of deaths flagged as suspected unregulated drug toxicity cases was used to identify cases, because of the lagged investigation or confirmation of these cases. Remaining cases with unknown cause of death ("R99") were included in the "Other causes" category. The denominator was derived from the Ministry of Health Client Roster, a provincial database containing information on virtually everyone who lives or has lived in British Columbia over time and has registered with the province's health care system.

Statistical analysis

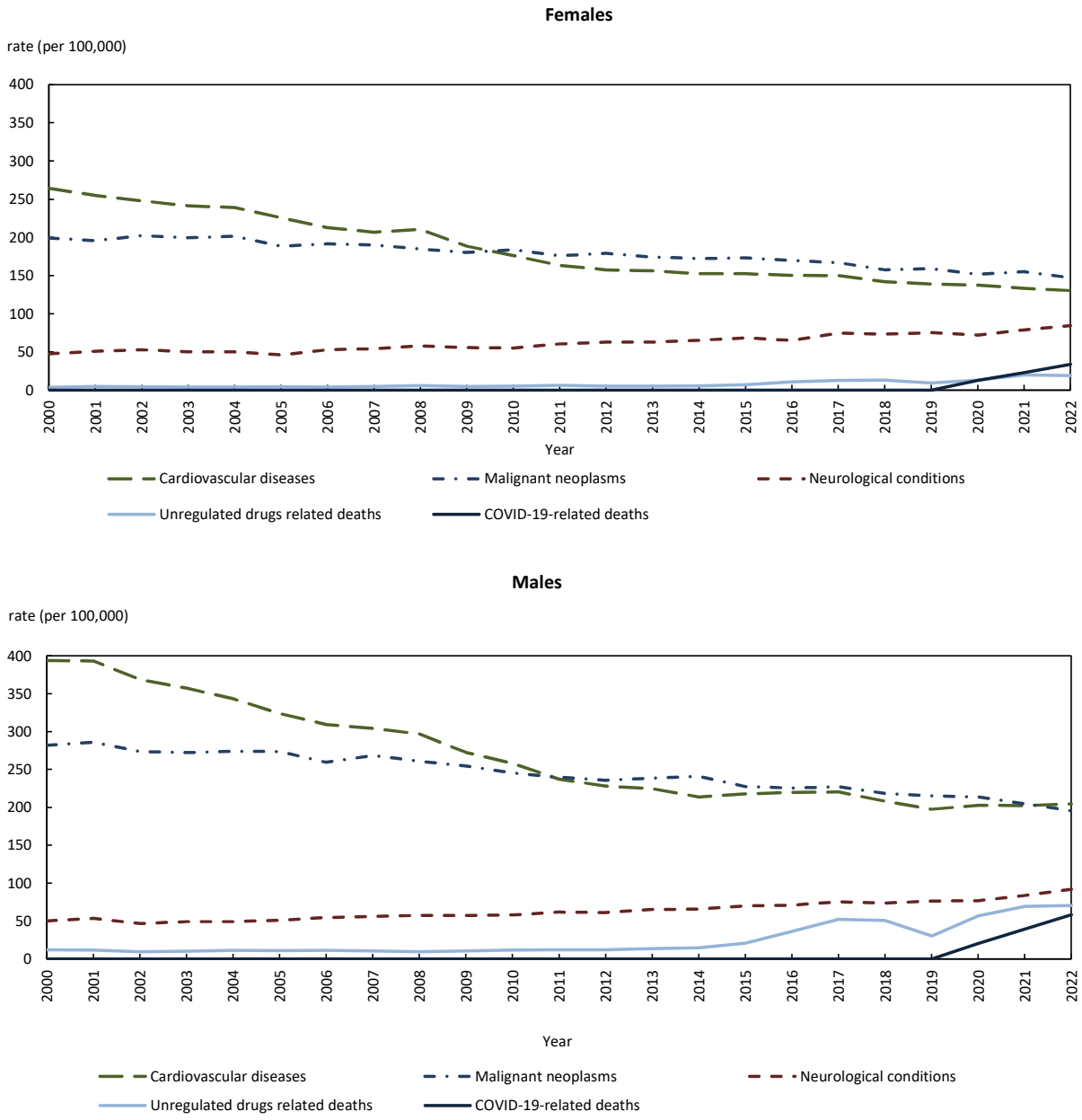
Age-standardized all-cause and cause-specific mortality rates were calculated using the British Columbia population in 2011 as the standard population. The Chiang method was used to construct period life tables and estimate LE_0 for males and females in each year.[16] Changes in LE_0 were estimated between 2019 and each year from 2020 to 2022 for males and females. Each change was then partitioned into age groups and causes of death, including COVID-19 and unregulated drug toxicity, using Arriaga's decomposition method.[17] A sensitivity analysis was conducted by removing all suspected unregulated drug toxicity deaths (i.e., using only the VSA as the source for cause of death from 2018 to 2022). All data and statistical analyses were performed in R. This study was conducted as part of a population health research program approved by the University of British Columbia Research Ethics Board (Ethics REB # H22-01818).

Results

From 2000 to 2014, LE_0 had been increasing at an average rate of 0.18 years per year for females and 0.21 years per year for males (Chart 1) . From 2015 to 2018, LE_0 for both sexes saw a decline and then a recovery, reaching a new high level in 2019 (85.47 years for females, 80.99 years for males). Compared with 2019, LE_0 for females did not change during the first year of the pandemic in 2020 but decreased by 0.65 years in 2021. However, LE_0 for males decreased by 1.16 years in 2020 and the trend continued in 2021, resulting in a cumulative decline of 1.81 years. LE_0 slightly recovered in 2022 in both sexes, with an increase of 0.09 years among females and 0.19 years among males from 2021.

Age-standardized all-cause mortality rates for both males and females steadily decreased during 2000 to 2014, then slightly increased between 2015 and 2017. The rates fell again in 2018 and reached their lowest levels in 2019 (791 deaths per 100,000 population for males and 552 deaths per 100,000 population for females), before starting to increase again during the pandemic (Appendix Chart 1). Age-standardized rates for the top two causes of deaths, cardiovascular diseases and malignant neoplasms, declined during the study period, while the rates for other causes, including unregulated drug toxicity, neurological conditions, and other causes, increased in both males and females (Chart 2). The unregulated drug toxicity mortality rate increased from 2014 to 2017, with a significant decline between 2018 and 2019 but started to substantially increase in 2020. While most COVID-19 death cases were among seniors aged 80 years and older, adults aged between 20 and 69 years accounted for most unregulated toxicity drug deaths in both males and females (Table 1).

Chart 2
Selected age-standardized cause-specific mortality rates, by sex, British Columbia, Canada, 2000 to 2022



Source: British Columbia Vital Statistics Agency Death Registry, 2000 to 2022.

Table 2 shows the contributions of COVID-19, unregulated drug toxicity, and other causes of death to the differences in LE_0 between each year from 2020 to 2022 and the pre-pandemic reference in 2019. COVID-19 was the leading cause of death driving the LE_0 decline in females. Among females, COVID-19-related deaths in 2020 contributed -0.24 years to LE_0 loss, and the contribution increased in 2021 (-0.46 years) and further in 2022 (-0.65 years). COVID-19 deaths caused almost the same LE_0 loss in males in 2020 (-0.25 years), but greater contributions to male LE_0 loss in 2021 (-0.57 years) and 2022 (-0.75 years). However, unregulated drug toxicity was the leading cause of death for the LE_0 loss in males from 2020 to 2022. Deaths from unregulated drug toxicity contributed to the male LE_0 decline by 0.67 years in 2020, 0.94 years in 2021, and 0.96 years in 2022. Among females, contributions from unregulated drug toxicity deaths were half of those from COVID-19. Sensitivity analysis after removing all suspected unregulated drug toxicity deaths under BCCS investigations showed smaller

Table 1
Age-specific mortality rates for unregulated drugs and COVID-19, by sex, British Columbia, Canada, 2020 to 2022

Sex, year and cause of death	Age group (years)								
	0 to 19	20 to 29	30 to 39	40 to 49	50 to 59	60 to 69	70 to 79	80 to 89	90 or older
	rates								
Females									
2020									
Unregulated drugs	2.5	16.3	22.3	22.3	18.7	9.8	0.4	0.0	0.0
COVID-19	0.0	0.0	0.3	0.0	3.3	5.2	25.8	158.4	542.1
2021									
Unregulated drugs	3.7	23.3	33.2	32.7	34.9	8.7	1.7	0.0	0.0
COVID-19	0.4	1.2	3.1	7.7	17.9	27.8	71.0	196.3	463.4
2022									
Unregulated drugs	4.6	25.0	32.0	29.5	30.0	13.7	1.6	0.0	0.0
COVID-19	0.2	0.6	2.0	4.9	11.0	29.4	76.0	357.1	1,294.1
Males									
2020									
Unregulated drugs	3.5	66.3	84.9	100.4	95.1	48.6	7.5	0.0	0.0
COVID-19	0.0	0.0	0.5	1.6	3.1	13.8	59.0	245.6	686.5
2021									
Unregulated drugs	3.9	63.8	103.8	113.3	129.9	71.0	13.5	0.0	0.0
COVID-19	0.0	0.3	5.9	11.5	32.1	61.5	129.5	317.7	658.7
2022									
Unregulated drugs	5.3	60.3	102.0	120.9	132.1	72.6	13.4	0.0	0.0
COVID-19	1.0	1.9	2.2	5.0	19.6	56.0	161.0	619.6	1,870.9

Source: British Columbia Vital Statistics Agency Death Registry, 2020 to 2022.

but still significant contributions, especially in males. The comparisons to 2014 showed similar differences (data not shown).

The contributions from COVID-19 and unregulated drug toxicity deaths were unevenly distributed across different age groups (Chart 3). In 2021, unregulated drug toxicity deaths among men aged between 20 and 59 years contributed -0.81 years to the LE_0 decline from 2019, accounting for 86% of the total loss (-0.94 years) from this cause among males. This proportion was higher for women in the same age group (90%). During the same period, COVID-19-related deaths among both men and women aged 60 years and older accounted for 74% of the total loss.

Increased mortality rates for neurological conditions and other causes had negative contributions (i.e., reducing LE_0) in both sexes. Despite the overall LE_0 decline in both sexes, decreases in mortality rates from some other causes resulted in positive contributions (i.e., increasing LE_0). These include respiratory infections excluding COVID-19 (ranging from 0.1 to 0.2 years in females and ranging from 0.02 to 0.11 years in males from 2020 to 2022), malignant neoplasms (ranging from 0.15 to 0.23 years in females and from 0.05 to 0.32 years in males from 2020 to 2022), and diabetes (ranging from 0.03 to 0.11 years in females and from 0.11 to 0.17 years in males from 2021 to 2022). Cardiovascular disease mortality increased in males (therefore reducing LE_0) but decreased in females (therefore increasing LE_0). Injury mortality rates also decreased, resulting in positive contributions in males (ranging from 0.10 to 0.42 years from 2020 to 2022).

Discussion

The present study found that LE_0 for both females and males declined during the pandemic. From 2019 to 2021, LE_0 for males declined by 1.81 years, a loss equal to almost 9 years of LE_0 gains, based on the average 0.2 years LE_0 increase per year over the past five decades.[18] The loss in females was smaller (equal to four years of gains in the past). This reflected a worldwide trend, although the extent of the decline varied geographically. Globally, LE_0 for both sexes has been increasing since 1950, but the trends reversed starting in 2020, with a total decline of 1.6 years from 2019 to 2021 (-0.9 years in 2020 and -0.7 years in 2021). LE_0 declined in 84% of countries worldwide, with declines ranging from 0.3 years to 3.7 years.[11,19] Despite the decline in 2020 and 2021, LE_0 started to recover in British Columbia in 2022. This trend was found in two other provinces (Saskatchewan and Alberta) but not in the rest of the provinces and territories in Canada.[20] A similar recovery was seen in other countries, such as the United States and the United Kingdom.[10,21] However, LE_0 has not returned to the pre-pandemic level in those areas.

The declines in the present study and those reported elsewhere were due to the excess all-cause mortality during the pandemic.[4,22] Globally, COVID-19 was the largest contributor directly driving the excess mortality and LE_0 decline.[11] However, the pandemic also had indirect impacts on mortality because of non-COVID-19 causes, although these indirect impacts varied both geographically and with different waves of the pandemic. COVID-19 and unregulated drug toxicity deaths were the top two contributors to the LE_0 decline in British Columbia, with their contributions differing between males and

Table 2
Changes (in years) in life expectancy at birth from 2019 to 2022 and contributions by cause of death in British Columbia, Canada

	Males			Females		
Cause of death	**2020**	**2021**	**2022**	**2020**	**2021**	**2022**
	years					
All causes gap	-1.16	-1.81	-1.62	0 .00	-0.65	-0.57
COVID-19-related deaths	-0.25	-0.57	-0.75	-0.24	-0.46	-0.65
Unregulated drug toxicity-related deaths	-0.67	-0.94	-0.96	-0.12	-0.31	-0.32
Infectious and parasitic diseases	0.01	-0.01	0.01	0.01	0.02	0.02
Respiratory infections	0.02	0.11	0.08	0.10	0.20	0.18
Maternal conditions	0.00	0.00	0.00	0.01	0.01	0.00
Neonatal conditions	0.01	0.05	0.06	0.00	-0.01	-0.07
Nutritional deficiencies	0.00	0.00	0.00	0.00	-0.01	0.00
Malignant neoplasms	0.06	0.18	0.32	0.15	0.10	0.23
Other neoplasms	0.00	0.01	0.00	0.00	0.00	0.00
Diabetes mellitus	-0.02	0.11	0.17	0.00	0.04	0.11
Endocrine, blood, immune disorders	-0.02	-0.01	-0.04	-0.02	-0.02	-0.05
Mental and behavioural disorders	-0.06	-0.05	-0.01	0.01	0.01	0.01
Neurological conditions	-0.03	-0.10	-0.20	0.07	-0.07	-0.16
Sense organ diseases	0.00	0.00	0.00	0.00	0.00	0.00
Cardiovascular diseases	-0.08	-0.13	-0.15	0.03	0.09	0.14
Respiratory diseases	0.05	0.12	0.08	0.10	0.15	0.10
Digestive diseases	-0.06	-0.10	-0.03	0.00	-0.04	-0.03
Genitourinary diseases	-0.01	0.01	0.01	0.02	0.02	0.05
Skin diseases	0.00	0.00	0.00	-0.01	-0.01	0.00
Musculoskeletal diseases	-0.01	0.00	-0.01	-0.01	-0.01	-0.02
Congenital anomalies	0.00	-0.02	-0.04	-0.03	-0.02	0.00
Injuries	0.17	0.08	0.33	0.07	-0.08	0.14
Other causes	-0.28	-0.63	-0.61	-0.14	-0.32	-0.32

Source: British Columbia Vital Statistics Agency Death Registry, 2019 to 2022.

females. More specifically, COVID-19 was the number one cause of death for the LE_0 decline among females, but unregulated drug toxicity was the number one contributor to the LE_0 decline among males in British Columbia. The province declared a public health emergency because of the opioid toxicity crisis in April 2016. Previous analysis showed that LE_0 in British Columbia started to level off in 2015 and then declined for the first time in 2016 after three decades of continuous increases, partially because of the opioid toxicity crisis.[23] The province's response measures led to stabilized or even decreased unregulated drug toxicity mortality rates starting in 2018 and continuing in 2019. However, the pandemic accelerated the number of unregulated drug toxicity-related deaths in British Columbia and other jurisdictions,[14,15] especially among males.[15] This increase was the largest contributor (-0.93 years) to the male LE_0 decline from 2019 to 2021 in British Columbia. Early evidence also suggested that alcohol sales, as well as emergency department visits for mental health problems, increased during the pandemic compared with the pre-pandemic period.[24-26] These findings underscore the importance of undisrupted access to harm reduction services, drug addiction treatments, mental health supports, and other risk reduction strategies.

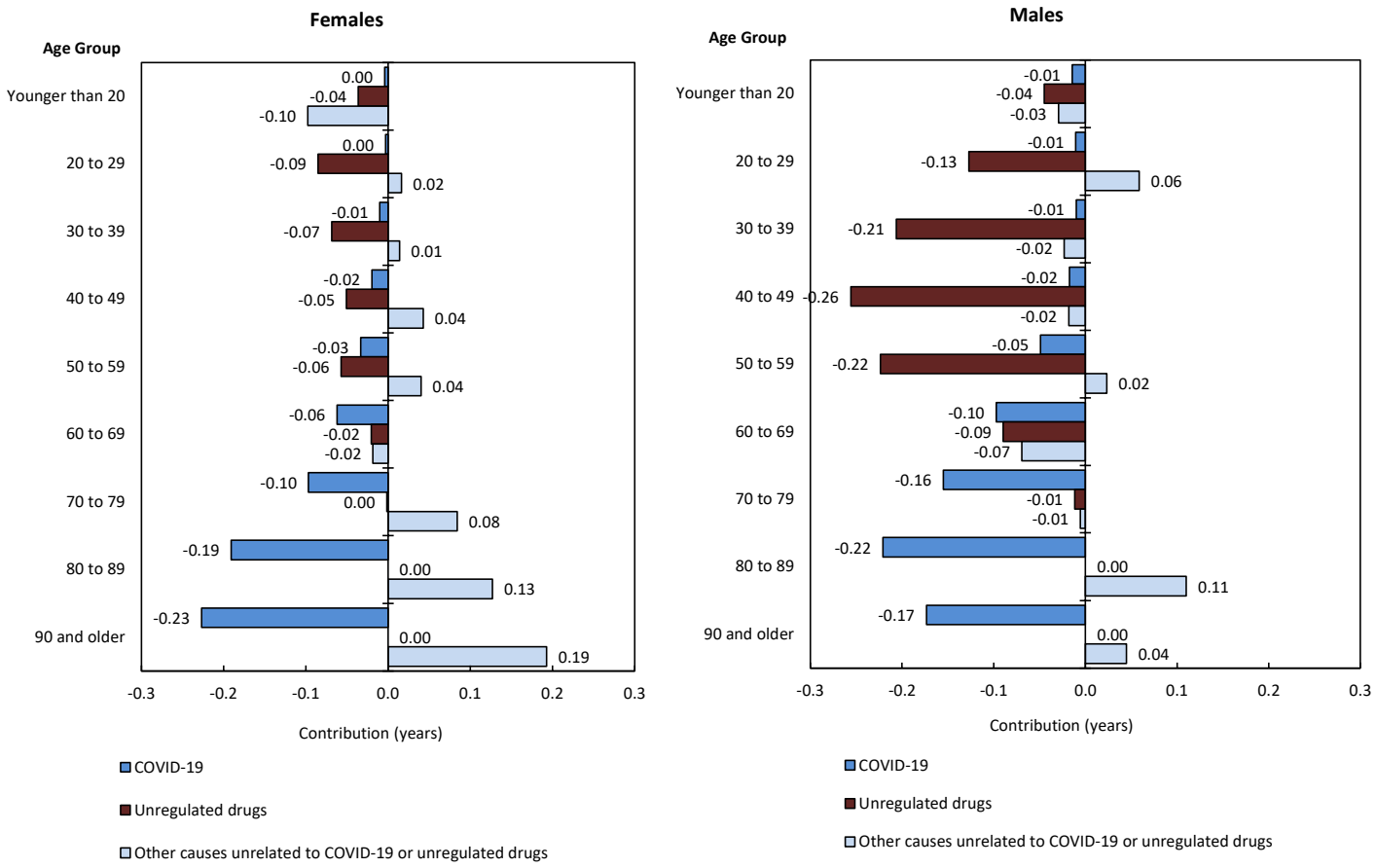
Studies have reported different impacts of the pandemic on other cause-specific excess mortality rates.[27,4] Pandemic response measures including physical distancing, hand hygiene, masking requirements, and vaccination substantially reduced the death rate for respiratory infections.[19] There is early evidence on excess mortality because of other causes during the pandemic, including heart disease, Alzheimer's disease and dementia, and diabetes in Ontario,[28] China,[29] the United States,[30] and European countries,[31] and these non-COVID-19 excess deaths contributed to the LE_0 decline as well. The increased mortality rate for neurological conditions in British Columbia was aligned with the findings in other studies, which found increased mortality risk for parkinsonism, dementia, encephalopathy, and stroke during the pandemic.[32,33] The mechanisms for the increased mortality risk for neurological conditions are not fully understood, but aging, cognitive decline, comorbidities, and immune status may play a role.[33] This study found reduced mortality rates for malignant neoplasms, diabetes, and injuries in both males and females, and cardiovascular diseases among females only. The decreased mortality for injuries might be attributable to less outdoor and indoor physical activities and transportation, as well as delayed death cause investigations by the coroner's service during the pandemic. The investigation delay also partially contributed to the increased mortality in the "other causes" category.

Disproportionate impacts of COVID-19 and unregulated drug toxicity deaths have been reported by sex, race, Indigenous identity, and income. This study showed a larger impact among males than females (and therefore larger LE_0 decline in males and greater LE_0 gap between males and females) in British Columbia, which was also seen in other countries and

regions.[6,10] Males were more likely to develop severe COVID-19 and die from the disease than females.[34] The sex differences may result from sex-related biological factors, such as immune responses and comorbidities, as well as social and behavioural factors such as smoking.[34] The evidence highlights the need to conduct sex- and gender-based analysis and to develop sex- and gender-based COVID-19 clinical and public health intervention strategies. Collaborative work with the First Nations Health Authority in British Columbia also found that First Nations people (-5.8 years) suffered a larger LE_0 decline than other residents (-1.1 years) in the province.[35] This was attributed to higher mortality rates for both COVID-19[36] and unregulated drug toxicity among First Nations people compared with other BC residents.[37] Similarly, American Indian or Alaska Native people had a greater LE_0 decline than other people in the United States.[23] COVID-19 disproportionately impacted certain racialized groups, e.g., the Hispanic population and non-Hispanic Black population in the United States, leading to higher excess all-cause deaths and therefore greater LE_0 declines in those populations.[38] Those living in lower-income neighbourhoods were more heavily hit by the pandemic.[9,39] Patients with cancer, cystic fibrosis, organ transplants, chronic renal disease, and severe developmental disabilities were more likely to experience severe COVID-19 outcomes, including hospitalization and death.[40,41] Many factors, such as systemic racism (e.g., residential segregation), occupational risk (i.e., less likely to work from home or had to work in jobs that required contact with the public), and housing conditions, played a role in generating the disparities.[42-44]

The reversing trends in LE_0 after decades of continuous improvements reflect the significant impacts of public health emergencies, such as the unregulated drug toxicity crisis and the COVID-19 pandemic. These results, along with similar findings from other studies described above, have two public health implications. First, public health emergency response measures should consider unintended consequences that may be directly and indirectly associated with the emergency. The pandemic not only had immediate direct impacts on physical and mental health, but also broader societal consequences on aspects such as income, access to medical and social services, employment,

Chart 3
Age-specific contributions from COVID-19 and unregulated drug toxicity deaths by sex in British Columbia, Canada, between 2019 and 2022

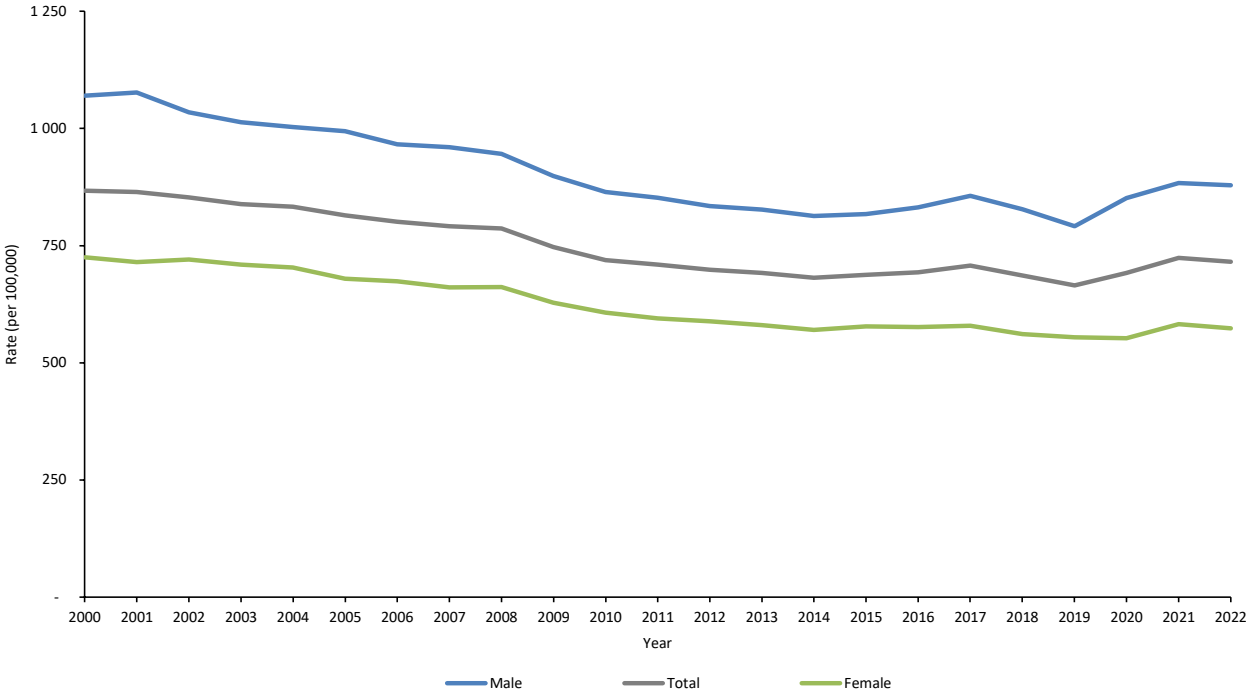


Source: British Columbia Vital Statistics Agency Death Registry, 2019 to 2022.

and education, which determine the health of a population down the road. It is also important to remember that vulnerable populations, including racialized groups, socioeconomically disadvantaged people, and people with disabilities were disproportionately impacted, indicating a requirement to prioritize and target interventions for these groups. In British Columbia, clinically extremely vulnerable patients, Indigenous people who were 55 years of age and older, other people who were 65 years and older, and residents of long-term care and assisted living facilities were prioritized for COVID-19 vaccines and treatment.

This study examined the impacts of dual public health emergencies in British Columbia (i.e., COVID-19 and unregulated drug toxicity crisis), but other Canadian provinces, such as Ontario, and other countries, such as the United States, were experiencing a similar situation (i.e., worsening illicit drug overdoses during the pandemic). Using BCCS data as the source for identifying unregulated drug toxicity-related deaths may overestimate the number of such deaths for the last five years since they include both confirmed and suspected cases, but the issue was mitigated by the sensitivity analysis, which still showed substantial impacts of the deaths on the LE_0 changes. The "Other causes" category includes other inconclusive or pending cause of death investigations by BCCS and deaths coded as R99 (accounting for 4.4% of all death records during the last three years in British Columbia as of September 16, 2024). Often these will eventually resolve to injury-related deaths, including unregulated drug toxicity deaths. In addition, the underlying cause for many deaths may have been misclassified.[45]

Appendix Chart 1
Age-standardized all-cause mortality rates for males and females, British Columbia, Canada, 2000 to 2022



Source: British Columbia Vital Statistics Agency Death Registry, 2000 to 2022

Appendix Table 1
Classification of deaths according to the International Classification of Diseases, 10th Revision

Underlying cause of death classification	ICD-10 code
Unregulated drug toxicity	T36.0-T48.6, T52.8, T53.91*
COVID-19	U07.1, U07.2
Infectious and parasitic diseases	A00-B99, G00, G03-G04, N70-N73
Respiratory Infections	J00-J22, H65-H66, P23, U04
Maternal conditions	O00-O99
Neonatal conditions	P00-P96 (except P23, P37.3, P37.4)
Nutritional deficiencies	E00-E02, E40-E46, E50-E64, D50-D53, D64.9
Malignant neoplasms	C00-C97
Other neoplasms	D00-D48
Diabetes mellitus	E10-E14
Endocrine, blood, immune disorders	D55-D64 (except D64.9), D65-D89, E03-E07, E15-E34, E65-E88
Mental and behavioural disorders	F04-F99, X41-X42, X45
Neurological conditions	F01-F03, G06-G98
Sense organ diseases	H00-H61, H68-H93
Cardiovascular diseases	I00-I99
Respiratory diseases	J30-J98
Digestive diseases	K20-K92
Genitourinary diseases	N00-N64, N75-N76, N80-N98
Skin diseases	L00-L98
Musculoskeletal diseases	M00-M99
Congenital anomalies	Q00-Q99
Injuries	V01-Y89 (except X41-X42, X45)
Other causes	All remaining deaths

Note: * Code presence in any of the causes of deaths found on the medical certification of death. ICD-10 = International Classification of Diseases, 10th Revision.
Source: International Classification of Disease, 10th Revision

References

1. World Health Organization. (2024). *Coronavirus disease (COVID-19)*. Retrieved April 20 from https://www.who.int/emergencies/diseases/novel-coronavirus-2019
2. Public Health Agency of Canada. (2024). *COVID-19 epidemiology update: Current situation*. Retrieved September 20 from https://health-infobase.canada.ca/covid-19/current-situation.html
3. BC Centre for Disease Control. (2024). *Respiratory Surveillance: COVID-19 Situation Report*. Retrieved April 20 from https://bccdc.shinyapps.io/respiratory_outcomes/
4. COVID-19 Excess Mortality Collaborators. (2022). Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020–21. *Lancet*, *399*(10334), 1513-1536. https://doi.org/doi:10.1016/S0140-6736(21)02796-3
5. McGrail, K. (2022). Excess mortality, COVID-19 and health care systems in Canada. *CMAJ*, *194*(21), E741-E745. https://doi.org/10.1503/cmaj.220337
6. Aburto, J. M., Schöley, J., Kashnitsky, I., Zhang, L., Rahal, C., Missov, T. I., Mills, M. C., Dowd, J. B., & Kashyap, R. (2022). Quantifying impacts of the COVID-19 pandemic through life-expectancy losses: A population-level study of 29 countries. *International Journal of Epidemiology*, *51*(1), 63-74. https://doi.org/10.1093/ije/dyab207
7. Islam, N., Jdanov, D. A., Shkolnikov, V. M., Khunti, K., Kawachi, I., White, M., Lewington, S., & Lacey, B. (2021). Effects of covid-19 pandemic on life expectancy and premature mortality in 2020: time series analysis in 37 countries. *BMJ*, *375*, e066768. https://doi.org/10.1136/bmj-2021-066768
8. Woolf, S. H., Masters, R. K., & Aron, L. Y. (2022). Changes in Life Expectancy between 2019 and 2020 in the US and 21 Peer Countries. *JAMA Network Open*, *5*(4), E227067. https://doi.org/10.1001/jamanetworkopen.2022.7067
9. Schwandt, H., Currie, J., Von Wachter, T., Kowarski, J., Chapman, D., & Woolf, S. H. (2022). Changes in the Relationship between Income and Life Expectancy before and during the COVID-19 Pandemic, California, 2015-2021. *JAMA*, *328*(4), 360-366. https://doi.org/10.1001/jama.2022.10952
10. Arias, E., Kochanek, K. D., Xu, J., & Tejada-Vera, B. (2023). *Provisional Life Expectancy Estimates for 2022*. Centers for Disease Control and Prevention (CDC). https://www.cdc.gov/nchs/data/vsrr/vsrr031.pdf
11. Heuveline, P. (2022). Global and National Declines in Life Expectancy: An End-of-2021 Assessment. *Popul Dev Rev*, *48*(1), 31-50. https://doi.org/10.1111/padr.12477
12. Chan, E. Y. S., Cheng, D., & Martin, J. (2021). Impact of COVID-19 on excess mortality, life expectancy, and years of life lost in the United States. *PloS One*, *16*(9), e0256835. https://doi.org/10.1371/journal.pone.0256835
13. Office of the Provincial Health Officer & BC Centre for Disease Control. (2021). *Examining the Societal Consequences of the COVID-19 Pandemic: Increased Overdose Harms and Deaths*. Retrieved April 20 from https://www2.gov.bc.ca/assets/gov/health/about-bc-s-health-care-system/office-of-the-provincial-health-officer/reports-publications/annual-reports/pho-annual-report-examining-societal-consequences-of-covid-19.pdf
14. Gomes, T., Kitchen, S. A., & Murray, R. (2021). Measuring the Burden of Opioid-Related Mortality in Ontario, Canada, during the COVID-19 Pandemic. *JAMA Network Open*, *4*(5), e2112865. https://doi.org/10.1001/jamanetworkopen.2021.12865
15. Imtiaz, S., Nafeh, F., Russell, C., Ali, F., Elton-Marshall, T., & Rehm, J. (2021). The impact of the novel coronavirus disease (COVID-19) pandemic on drug overdose-related deaths in the United States and Canada: a systematic review of observational studies and analysis of public health surveillance data. *Substance Abuse Treatment, Prevention, and Policy*, *16*(1), 1-14. https://doi.org/10.1186/s13011-021-00423-5
16. Chiang, C. L. (1972). On constructing current life tables. *Journal of the American Statistical Association*, *67*, 538-541. https://doi.org/10.1080/01621459.1972.10481245
17. Arriaga, E. E. (1984). Measuring and explaining the change in life expectancies. *Demography*, *21*(1), 83-96.
18. World Bank. (2021). *Life expectancy at birth, total (years) - Canada*. Retrieved April 20 from https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=CA
19. Schumacher, A. E., Hmwe Kyu, H., Aali, A., Abbafati, C., Abbas, J., Abbasgholizadeh, R., Akram Abbasi, M., Abbasian, M., Abd ElHafeez, S., Abdelmasseh, M., Abd-Elsalam, S., Abdelwahab, A., Abdollahi, M., Abdoun, M., Abdullahi, A., Mehadi Abdurehman, A., Abebe, M., Abedi, A., Abedi, A., . . . L Murray, C. J. (2024). Global age-sex-specific mortality, life expectancy, and population estimates in 204 countries and territories and 811 subnational locations, 1950-2021, and the impact of the COVID-19 pandemic: a comprehensive demographic analysis for the Global Burden of Disease Study 2021. *Lancet*, *403*(10440), 1989-2056. https://pubmed.ncbi.nlm.nih.gov/38484753
20. Statistics Canada. (2023). *Deaths, 2022*. Retrieved April 20 from https://www150.statcan.gc.ca/n1/daily-quotidien/231127/dq231127b-eng.htm
21. Vriend, M., & Gazzillo, A. (2024). *Interpreting the latest life expectancy data - The Health Foundation.* Retrieved April 20 from https://www.health.org.uk/publications/long-reads/interpreting-the-latest-life-expectancy-data
22. Msemburi, W., Karlinsky, A., Knutson, V., Aleshin-Guendel, S., Chatterji, S., & Wakefield, J. (2023). The WHO estimates of excess mortality associated with the COVID-19 pandemic. *Nature*, *613*, 130-137. https://doi.org/10.1038/s41586-022-05522-2

23. Ye, X., Sutherland, J., Henry, B., Tyndall, M., & Kendall, P. (2018). Impact of drug overdose-related deaths on life expectancy at birth in British Columbia. *Health Promot Chronic Dis Prev Can*, *38*(6), 248-251. https://doi.org/10.24095/HPCDP.38.6.05

24. Jenkins, E., McAuliffe, C., Hirani, S., Richardson, C., Thomson, K., McGuinness, L., Morris, J., Kousoulis, A., & Gadermann, A. (2021). A portrait of the early and differential mental health impacts of the COVID-19 pandemic in Canada: Findings from the first wave of a nationally representative cross-sectional survey. *Preventive Medicine*, *145*. https://doi.org/10.1016/j.ypmed.2020.106333

25. Lee, B. P., Dodge, J. L., Leventhal, A., & Terrault, N. A. (2021). Retail Alcohol and Tobacco Sales During COVID-19. *Ann Intern Med*, *174*(7), 1027-1029. https://www.acpjournals.org/doi/10.7326/M20-7271

26. Zipursky, J. S., Stall, N. M., Silverstein, W. K., Huang, Q., Chau, J., Hillmer, M. P., & Redelmeier, D. A. (2021). Alcohol Sales and Alcohol-Related Emergencies During the COVID-19 Pandemic. *Ann Intern Med*, *174*(7), 1029-1032. https://www.acpjournals.org/doi/10.7326/M20-7466

27. Alicandro, G., La Vecchia, C., Islam, N., & Pizzato, M. (2023). A comprehensive analysis of all-cause and cause-specific excess deaths in 30 countries during 2020. *European Journal of Epidemiology*, *38*, 1153-1164. https://doi.org/10.1007/s10654-023-01044-x

28. Postill, G., Murray, R., Wilton, A. S., Wells, R. A., Sirbu, R., Daley, M. J., Barrett, K., Born, K., Juni, P., Maltsev, A., Sander, B., Schull, M., & Rosella, L. C. (2021). *Excess Mortality in Ontario During the COVID-19 Pandemic*. https://covid19-sciencetable.ca/sciencebrief/excess-mortality-in-ontario-during-the-covid-19-pandemic

29. Liu, J., Zhang, L., Yan, Y., Zhou, Y., Yin, P., Qi, J., Wang, L., Pan, J., You, J., Yang, J., ... (2021). Excess mortality in Wuhan city and other parts of China during the three months of the covid-19 outbreak: findings from nationwide mortality registries. *BMJ*, *372 (n415)*. https://doi.org/10.1136/BMJ.N415

30. Woolf, S. H., Chapman, D. A., Sabo, R. T., & Zimmerman, E. B. (2021). Excess Deaths From COVID-19 and Other Causes in the US, March 1, 2020, to January 2, 2021. *JAMA Network Open*, *325*(17), 1786-1789. https://doi.org/10.1001/JAMA.2021.5199

31. Docherty, K. F., Butt, J. H., Boer, R. A. d., Dewan, P., Køber, L., Maggioni, A. P., McMurray, J. J. V., Solomon, S. D., & Jhund, P. S. (2020). Excess deaths during the Covid-19 pandemic: An international comparison. *MedRxiv*, *2024*. https://doi.org/10.1101/2020.04.21.20073114

32. Masters, C., Bakal, J., Lam, G., McAlister, F., & Power, C. (2024). Increased frequency and mortality in persons with neurological disorders during COVID-19. *Brain*, *147*(7), 2542-2551. https://academic.oup.com/brain/article-abstract/147/7/2542/7654052

33. Park, J., Woo, W., Lee, S., Park, S., Yon, D., Lee, S., Smith, L., Koyanagi, A., Shin, J., & Kim, Y. (2023). Prevalence and Mortality Risk of Neurological Disorders during the COVID-19 Pandemic: An Umbrella Review of the Current Evidence. *Neuroepidemiology*, *57* (3), 129-147. https://karger.com/ned/article/57/3/129/836671

34. Alwani, M., Yassin, A., Al-Zoubi, R., Aboumarzouk, O., Nettleship, J., Kelly, D., Al-Qudimat, A., & Shabsigh, R. (2021). Sex-based differences in severity and mortality in COVID-19. *Reviews in Medical Virology*, *31*(6), e2223. https://onlinelibrary.wiley.com/doi/epdf/10.1002/rmv.2223

35. First Nations Health Authority. (2024). *First Nations life expectancy in BC drops due to toxic drug poisonings and COVID-19*. Retrieved April 20 from https://www.fnha.ca/about/news-and-events/news/first-nations-life-expectancy-in-bc-drops-due-to-toxic-drug-poisonings-and-covid-19

36. First Nations Health Authority. (2023). *FNHA Statement on the BC Coroners Service Death Review Panel Report*. Retrieved April 20 from https://www.fnha.ca/about/news-and-events/news/fnha-statement-on-the-bc-coroners-service-death-review-panel-report#:~:text=First%20Nations%20people%20died%20at,female%20BC%20residents%20in%202022

37. BC Coroner's Service. (2023). *BC Coroner's Service death review panel: an urgent response to a continuing crisis*. https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/death-review-panel/an_urgent_response_to_a_continuing_crisis_report.pdf

38. Woolf, S. H., Masters, R. K., & Aron, L. Y. (2021). Effect of the covid-19 pandemic in 2020 on life expectancy across populations in the USA and other high income countries: Simulations of provisional mortality data. *BMJ*, *373*(n1343). https://doi.org/10.1136/bmj.n1343

39. Andrasfay, T., & Goldman, N. (2021). Association of the COVID-19 Pandemic with Estimated Life Expectancy by Race/Ethnicity in the United States, 2020. *JAMA Network Open*, *4*(6), e2114520. https://doi.org/10.1001/jamanetworkopen.2021.14520

40. Bahremand, T., Yao, J. A., Mill, C., Piszczek, J., Grant, J. M., & Smolina, K. (2023). COVID-19 hospitalisations in immunocompromised individuals in the Omicron era: a population-based observational study using surveillance data in British Columbia, Canada. *Lancet Reg Health Am*, *20*, 100461. https://doi.org/10.1016/j.lana.2023.100461

41. Ye, X., Ngo, H., Sevcenco, I., Nie, Y., Behn-Smith, D., & Henry, B. (2024). COVID-19 Outcomes among Adults with Severe Developmental Disabilities in British Columbia, Canada. *Unpublished*.

42. Franz, B., Parker, B., Milner, A., & Braddock, J. H., 2nd. (2022). The Relationship between Systemic Racism, Residential Segregation, and Racial/Ethnic Disparities in COVID-19 Deaths in the United States. *Ethn Dis*, *32*(1), 31-38. https://pmc.ncbi.nlm.nih.gov/articles/PMC8785866/

43. Samuel, L. J., Gaskin, D. J., Trujillo, A. J., Szanton, S. L., Samuel, A., & Slade, E. (2021). Race, ethnicity, poverty and the social determinants of the coronavirus divide: U.S. county-level disparities and risk factors. *BMC Public Health*, *21*(1), 1250. https://doi.org/10.1186/s12889-021-11205-w

44. Selden, T. M., & Berdahl, T. A. (2020). COVID-19 And Racial/Ethnic Disparities In Health Risk, Employment, And Household Composition. *Health Aff (Millwood)*, *39*(9), 1624-1632. https://doi.org/10.1377/hlthaff.2020.00897

45. Johnson, S. C., Cunningham, M., Dippenaar, I. N., Sharara, F., Wool, E. E., Agesa, K. M., Han, C., Miller-Petrie, M. K., Wilson, S., Fuller, J. E., Balassyano, S., Bertolacci, G. J., Davis Weaver, N., Arabloo, J., Badawi, A., Bhagavathula, A. S., Burkart, K., Cámera, L. A., Carvalho, F., . . . Naghavi, M. (2021). Public health utility of cause of death data: applying empirical algorithms to improve data quality. *BMC Med Inform Decis Mak, 21*(175), 1-20. https://bmcmedinformdecismak.biomedcentral.com/articles/10.1186/s12911-021-01501-1