Pan-Canadian Health Inequalities Reporting Initiative

Social inequalities in **COVID-19 mortality by area- and individual-level characteristics in Canada**

January 2020 to December 2020/March 2021

Public Health Agency of Canada
Agence de la santé publique du Canada

Canada

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Inégalités sociales des décès liés à COVID-19 au Canada, par caractéristiques individuelles et locales, de janvier 2020 à décembre 2020/mars 2021

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ACRONYM

CIHI	Canadian Institute for Health Information
CMA	Census Metropolitan Area
COVID-19	Coronavirus disease 2019
FNIGC	First Nations Information Governance Centre
HIRI	Health Inequalities Reporting Initiative
PHAC	Public Health Agency of Canada
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
WHO	World Health Organization

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Executive summary

Reporting since the start of the COVID-19 pandemic has demonstrated that the burden of COVID-19 has been distributed unequally across populations and communities in Canada[1, 2, 3, 4, 5, 6, 7, 8, 9].

As with other health conditions, many of the inequalities observed are the result of social, political and economic disadvantages[10] which existed in Canada long before the pandemic was declared.[11, 12] The distribution of social and economic resources (for example, social support, education, income, housing) influences people's capacity to achieve and maintain good health across the life course, shaping persistent inequalities in health-related behaviours, health service access and use, and infectious and chronic disease outcomes. These underlying social and economic conditions affect who is more likely to be exposed to the virus (severe acute respiratory syndrome coronavirus 2 or SARS-CoV-2) through working or living conditions, as well as their access to treatment and their likelihood of severe illness. Underlying inequalities in health are believed to contribute to early reported inequalities in COVID-19 hospitalizations and deaths.[10] However, national reporting on social inequalities in COVID-19 burden remains limited.

In July 2021, the Public Health Agency of Canada (PHAC) began filling this gap in data and evidence. A first report was published, entitled *Social inequalities in COVID-19 mortality by area- and individual-level characteristics in Canada, January to July/August 2020*. The report described the degree and distribution of inequalities in COVID-19 mortality up until July/August 2020, according to several key social determinants of health. As mortality rates and inequalities can change over time, it was important to replicate analyses when more data became available. This present report examines the same factors, using data from the first 12 to 15 months of the pandemic. This update is a critical step in taking action to advance a health equity-focused pandemic response and preparedness for future public health events[13]. Visualizations of the data from this report can be accessed using the online interactive COVID-19 Mortality Data Tool.

BACKGROUND

This report is a product of the Pan-Canadian Health Inequalities Reporting (HIR) Initiative, a collaboration between PHAC, the Pan-Canadian Public Health Network, Statistics Canada, and CIHI. Based on a framework developed by the World Health Organization[14], the HIR Initiative aims to strengthen the measurement, monitoring and reporting of health inequalities in Canada through improved access to data and the development of resources to improve our knowledge of health inequalities. Data from the HIR Initiative representing over 100 indicators of inequalities in health status, health behaviours and health determinants can be accessed using the online interactive Health Inequalities Data Tool.

METHODOLOGY

This report presents results at the national level for age-standardized COVID-19 mortality rates from the first year of the pandemic, according to certain factors known to be important to health equity. Inequalities were measured in relation to sex/gender, residence in large urban centres, income (using neighbourhood after-tax per-person equivalent income quintiles, as well as low-income status according to the after-tax Low Income Measure), dwelling type, and household type and size. A local-area measure was also used. This measure combines the concentration of individuals who recently immigrated to Canada, who were designated as a visible minority, who were born outside of Canada and who have no knowledge of either official language (English, French). The latter represents one dimension of the Canadian Index of Multiple Deprivation, labelled as a measure of "ethno-cultural composition"[15]. The latter composite measure was used to identify sub-groups that may be particularly disadvantaged by structural and systemic factors, namely due to systemic racism and economic inequality[16].

Data for this report come from 2 data integration processes, both led by HIR Initiative core partner, Statistics Canada. All data have been de-identified. One data source was an integration of the 2016 short-form Canadian Census and provisional COVID-19 mortality data from Statistics Canada's Canadian Vital Statistics – Deaths Database. This data linkage allowed an identification of COVID-19 mortality rates between January 1, 2020 and March 31, 2021 across the social and demographic characteristics of individuals living in private dwellings. The other data source was an integration of 2016 Census Area Profile data with preliminary COVID-19 mortality data from the Canadian Vital Statistics – Deaths Database. This data linkage allowed an identification of COVID-19 mortality rates between January 1 and December 31, 2020, across neighbourhood-level social and economic characteristics.

As described above, this report uses updated data compared to the first report on this topic, which was released in July 2021. The present report covers:

- 8 additional months of individual-level integrated data (up until March 31, 2021, instead of July 4, 2020) and
- 4 additional months of area-level integrated data (up until December 31 instead of August 31, 2020)

For more details on the first report, please refer to the Archives tab.

Both data sources are provisional and incomplete. They exclude deaths that occurred in the Yukon, for example. They also likely underestimate the true number of COVID-19 deaths, due to potential reporting delays of deaths to the Vital Statistics Database. Further, the information collected on the 2016 Census might have changed between then and the reported death in 2020 or 2021. However, as used in previous HIR Initiative reporting[11], Canadian Vital Statistics – Deaths data integrated with other sources of socioeconomic information such as the Census represent a useful source of information on general trends and patterns of social inequalities in mortality.

KEY FINDINGS

Significant inequalities in age-standardized COVID-19 mortality rates were observed for those living in large urban centres, in apartments, in areas with lower income, and areas with higher levels of ethno-cultural composition. Inequalities based on measures of area of residence, dwelling type, area-level income and ethno-cultural composition were larger when considering the first 12 to 15 months of the pandemic, as compared to the first 6 to 8 months covered in the first report.

Some of the reasons for these inequalities include increased risk due to poor housing conditions, poverty, and household overcrowding which may limit choices for living arrangements and working conditions that would reduce risk of infection[17]. These risks can be more broadly understood within the context of the social structures and systems of power, such as systemic racism and economic inequality, which contribute to inequitable distribution of health promoting resources and increased health risks[11, 14].

Overall, men experienced higher rates of COVID-19 mortality than women, despite higher rates of COVID-19 cases among women than men in the population during the study period (up to March 2021)[18]. It has been proposed that higher rates of COVID-19 mortality rates among men may be partly due to sex-based immunological factors[19] and to the higher prevalence of COVID-19 mortality risk factors[20] among men in Canada, such as diabetes, cancer and past or current smoking[21].

Past research on sex/gender differences in health indicate the importance that gender-related social norms, behaviours and conditions play in shaping health behaviours and outcomes, above and beyond biological and physiological characteristics. For example, cultural notions of masculinity are believed to explain in part why men are more likely to smoke, report higher levels of alcohol use and not seek health services compared to women[22].

Existing research also indicates that gender norms and experiences can intersect with other sources of discrimination or disadvantage, such as lower socioeconomic status, systemic racism and sexual orientation. This is reflected in the disproportionately higher rates of exposures to occupational risk factors (for example, carcinogens, injury), health-affecting behaviours (for example, smoking, elevated alcohol use) and lower use of health services across the lifecourse in men in lower socioeconomic settings compared to both women overall and men in higher socioeconomic settings[23, 24, 25, 26]. The larger sex/gender inequalities in COVID-19 mortality in areas with lower income and greater ethno-cultural composition concentration are consistent with these previous findings[23, 24, 25, 26, 9].

However, future surveillance and research are needed on the precise mechanisms through which inequalities in COVID-19 mortality are created. This report did not explore, for example, mortality rates across multiple, intersecting identities or groups, nor did it pursue multivariate analyses. This represents an important area of future inquiry.

CONCLUSION

When health inequalities can feasibly be prevented by collective efforts they may be considered unjust and inequitable[27, 28]. The higher number of COVID-19 deaths in some groups and not others suggests that these inequalities could be plausibly avoided and are considered inequitable. A health equity approach seeks to reduce inequities and to increase access to opportunities and conditions that support health for all.

This report provides national evidence of inequalities in COVID-19 mortality burden, a key first step in taking action to advance a health equity-focused pandemic response and preparedness. It builds on previous reporting by HIR Initiative, namely its 2018 *Key Health Inequalities in Canada: A National Portrait* report, which provides key principles for action and practices to advance health equity in Canada, so that all Canadians can experience healthy living and working conditions and environments.

BOX 1. KEY FINDINGS

- Provisional Canadian Vital Statistics - Deaths data suggest that COVID-19 deaths that occurred between January and December 2020/March 2021 were not distributed equally across sub-populations in Canada.
- Absolute inequalities in age-standardized COVID-19 mortality were largest (differences of 24 to 46 deaths per 100,000) for:
  - residents of large urban centres (compared to those outside of urban centres)
  - residents of lowest-income areas (compared to highest-income areas)
  - residents of apartments (compared to those in single-detached homes)
  - residents in areas with the highest concentration of individuals who are visible minorities, recently immigrated to Canada or were born outside of Canada and those who have no knowledge of either official language (compared to areas with lowest-concentration of this composite measure).
- These findings are aligned with public health's understanding of the role of systemic issues such as racism, economic inequality and other social determinants of health, in shaping inequitable distributions of health risk.
- Men experienced higher rates of COVID-19 mortality than women. However the magnitude of this sex/gender gap was even larger in areas with lower income and greater concentration of individuals who recently immigrated or were born outside of Canada, who were designated as visible minorities and were not proficient in either official language.
  - There were 31 and 29 more deaths among men than women per 100,000 population in the lowest-income and highest ethno-cultural areas, respectively, compared to 8 and 9 more male deaths than female deaths per 100,000 population in the highest-income and lowest ethno-cultural areas, respectively.
- The inconsistent size of sex/gender inequalities across sub-populations highlight the importance of risk relating to gendered social experiences, namely relating to living and working conditions, above and beyond purely biological inequalities in risk.
- Additional data and analyses are required to better assess the factors driving these health inequalities.

Introduction

Early provincial[3, 2, 1, 8] and national[5, 6, 7, 9] reporting has highlighted the importance of social determinants of health in shaping inequitable risks of SARS-CoV-2 infection and COVID-19 morbidity and mortality[4].

Variability in distributions of COVID-19 mortality rates across social groups can be due to several factors. As explained in Canada's Chief Public Health Officer's 2020 report From risk to resilience: An equity approach to COVID-19, COVID-19 mortality rates can be a function of several determinants. These can include:

1. differential exposure to SARS-CoV-2 and COVID-19 incidence across social strata
2. systemic differences in distributions of underlying risk factors of COVID-19 morbidity, such as older age, heart disease, diabetes, stress, smoking and nutritional status
3. potential inequalities in access, use and quality of treatment[4]

The Chief Public Health Officer's 2021 report, *A Vision to Transform Canada's Public Health System*, also highlighted the risk that inequitable allocation of COVID-19 vaccines, as well inequalities in vaccine confidence and uptake, would worsen existing pandemic-related health inequities[29]. Public health research has demonstrated how inequalities in risk are often a function of systemic issues such as racism, economic inequality and other social determinants of health[14, 11].

This report aims to contribute to the growing state of knowledge of social inequalities in COVID-19 outcomes, by describing the distribution of COVID-19 mortality rates in the first 12 to 15 months of the pandemic, and absolute and relative differences in COVID-19 mortality between social groups in Canada. Two Statistics Canada datasets were used:

- one allowing for disaggregation of provisional COVID-19 deaths occurring between January 1, 2020, and March 31, 2021 among residents of private dwellings, by individual-level characteristics
- the other allowing for disaggregation of preliminary COVID-19 deaths overall, between January 1 and December 31, 2020, by area-level characteristics (Box 2)

The report discusses the limitations of these data sets (Box 2). Namely, this report presents age-standardized mortality rates across individual- and area-level measures, but does not explore multivariate analyses, nor mortality risk across joint social strata. The latter represents important areas for future inquiry.

Full detailed data disaggregation tables and data visualizations can be found on the COVID-19 Mortality Data Tool tab.

BOX 2. METHODOLOGY AND LIMITATIONS

Data sources

Data for this report come from 2 data integration processes. All data were de-identified. Social inequalities in age-standardized COVID-19 mortality according to individual-level characteristics were explored using Statistics Canada's provisional COVID-19 mortality data between January 1, 2020 and March 31, 2021[30], from the Canadian Vital Statistics – Deaths Database linked to individual-level data from the 2016 Canadian Census of population (short-form). The linked short-form Census was restricted to residents of private dwellings. Thus the deaths recorded in this linkage were restricted to those occurring among individuals living in private dwellings, which represent 98% of the Canadian population[6, 31]. Deaths occurring in collective dwellings, including long-term care and other institutions were excluded. As of March 2021, it was estimated that approximately 50% of COVID-19 deaths in Canada had occurred in long-term care settings[32]. A rounded total of 10,845 COVID-19 deaths (4,820 among females, 6,025 among males) were recorded in the dataset used in this report. For reference, overall in Canada, 22,758 COVID-19 deaths had been reported to the PHAC as of March 31, 2021[18].

For area-level inequality estimates, Statistics Canada's preliminary COVID-19 mortality data from January 1 and December 31, 2020[30] recorded in the Canadian Vital Statistics-Death Database were linked to dissemination area-level[33] data from the 2016 Canadian Census of population via the Postal Code Conversion File plus (PCCF+). These data included all deaths with a residential postal code, regardless of place of death, and therefore included those that had occurred among long-term care residents. A rounded total of 16,120 COVID-19 deaths (8,340 among females and 7,780 among males) were recorded in the dataset used in this report. For reference, overall in Canada, 15,498 COVID-19 deaths had been reported to the PHAC as of December 31, 2020[18].

The Canadian Vital Statistics – Deaths dataset is distinct from COVID-19 surveillance-based case datasets. The provisional death counts and estimates presented in this report may not match counts and estimates from provincial or territorial health authorities and other agencies. Nonetheless, as used in previous HIR reporting[11], Canadian Vital Statistics – Deaths data represent a useful source of information on general trends and social inequalities in mortality for Canada overall.

It should be acknowledged that the Canada Post Corporation source data used to create the PCCF+ contains some large postal codes from rural areas that have links to multiple dissemination areas. Observed inequalities across social measures described herein may be less generalizable to rural areas, given that the majority of COVID-19 deaths (more than 95%) occurred in urban areas and that rural dissemination area characteristics can be vulnerable to measurement error. Further, it was not possible to distinguish which of the deaths recorded in this data source occurred among residents of long-term care institutions and which occurred in private dwellings.

Measures

Two ICD-10 codes were used to identify when COVID-19 was reported as a cause of death: U071 for COVID-19 specified as confirmed by a positive test result and U072 for COVID-19 described as "possible," "probable," or "pending a (positive) test result". For both data sources, age-standardized mortality rates per 100,000 population were estimated using the direct method for Canada overall and by sex, based on the 2011 standard Canadian population, using 5-year age groups.

All mortality data were disaggregated by sex. The 2016 Census asked respondents to report on their sex (presumed at birth: male or female). The data source only collected information on sex, and not gender. However, as in past HIR Initiative reporting[11], this report refers to sex/gender inequalities based on the assumption that the inequalities in COVID-19 mortality between males and females are driven by determinants tied to both constructs of biological sex and gender[11]. To acknowledge this interplay between sex and gender, this report refers to COVID-19 mortality rates among "men" and "women" in the Findings sections instead of among "males" and "females". An exception is the use of the expression "male-to-female ratio", which is consistent with epidemiologic reporting.

Data presented have an associated 95% confidence interval (CI). The CI illustrates the degree of variability associated with a rate. As wide CIs indicate high variability, these rates should be interpreted and compared with due caution.

Using individual-level short-form 2016 Census linked data, the individual stratification measures were:

- Household after-tax low-income status based on Statistics Canada's Low Income Measure (LIM) (low-income status versus not in low-income). This measure is not applicable to individuals living in the Territories or in First Nations communities (reserves), as Statistics Canada does not develop low-income measures for the latter sub-populations[34].
- Structural dwelling type (apartment in building with <5 storeys, apartment in building with ≥5 storeys, flat or apartment in a duplex, row house, semi-detached house, single-detached house)
- Household type (1-person household, couple with children, couple without children, lone-parent family, multigenerational household, ≥2-person non-Census family household (excluding multigenerational) and other Census family household). Individuals not processed for family characteristics were excluded.
- Household size (1, 2, 3, 4, ≥ 5 persons)

Using area-level 2016 Census Profile linked data, the area-level stratification measures were:

- Area-level national ethno-cultural composition (quintiles) dimension of the Canadian Index of Multiple Deprivation (CIMD). The ethno-cultural composition dimension takes into account the ethno-cultural variables from the Census of population 2016. It is a dissemination area-level composite indicator that is made up of the proportion of the population who had recently immigrated to Canada (in the 5 years prior to the Census), were designated as a visible minority, were born outside of Canada or have no knowledge of either official language of Canada.
- After-tax national income per-person-equivalent neighbourhood quintiles
- Census Metropolitan Area (CMA) urban residence versus non-CMA residence. Non-CMA areas include all other area categories.

Observations at the area-level may not apply to all individuals within the measured area, which may represent a source of measurement misclassification bias. Nonetheless, area-based measures are beneficial, and used in HIR Initiative past reporting for several reasons. Namely, inequalities identified by area-based socioeconomic status measures are valid, consistent, and reliable and can be tracked through time for different geographical settings[11, 35]. They can also help capture constructs such as area-level health-promoting resource availability[36].

Limitations

The data used are provisional and incomplete. Neither dataset includes mortality data from the Yukon. They also likely underestimate deaths due to potential reporting delays. Further, the provisional Vital Statistics - Death dataset and the 2016 short-form Census were probabilistically linked to the Derived Record Depository (DRD) in the Social Data Linkage Environment (SDLE) at Statistics Canada. A small portion of the deaths attributable to COVID-19 were not linked to the 2016 short-form Census and were excluded from these tables. As a result, the cumulative total of COVID-19 deaths based on the integrated dataset is lower than the true total of COVID-19 deaths.

For the 2016 Census, respondents are asked to report on their social and demographic data as of May 10, 2016 (Census day). It is possible that individuals' Census information reported in 2016, such as their dwelling type or household size, might have changed by the time deaths occurred between January 1, 2020 and March 31, 2021. This represents a possible source of measurement error.

Variability in distributions of COVID-19 mortality rates across social groups can be due to several factors. As explained in Canada's Chief Public Health Officer's 2020 report *From risk to resilience: An equity approach to COVID-19*, COVID-19 mortality rates are hypothesized to be a function of 3 broad determinants:

1. differential exposure to SARS-CoV-2 and COVID-19 incidence across regions and social groups
2. differences in distributions of underlying risk factors of COVID-19 morbidity, such as older age (a majority of COVID-19 deaths in Canada have occurred among those 70 years and older[18]), heart disease, diabetes, stress, smoking and nutritional status
3. potential inequalities in access, use and quality of treatment[4]

The Chief Public Health Officer's 2021 report, *A Vision to Transform Canada's Public Health System*, also highlighted the risk that inequitable allocation of COVID-19 vaccines, as well inequalities in vaccine confidence and uptake, would worsen existing pandemic-related health inequities[29]. The inequalities presented here indicate sub-populations that face systemic vulnerability to COVID-19 mortality. However, due to the limited scope of the analyses, future research is needed to determine the precise pathways through which these inequalities are created. Unlike surveillance-based case data, Vital Statistics – Deaths data do not contain information on the number and distribution of cases, nor on their characteristics such as chronic condition prevalence. These gaps make it impossible to assess whether higher rates of mortality in some sub-groups may primarily be due to their experience of higher rates of infections or to underlying morbidity risk factors. Future analyses of surveillance-based data that explore the age-standardized rate of deaths over a denominator of cases per sub-group, accounting for morbidity risk factor prevalence, will be needed to fill these gaps.

Further, though mortality rates were explored at the intersection of sex/gender and individual- and area-level measures, these findings did not include an exploration of rates across joint stratum of individual- and area-level characteristics. Future assessment of social inequalities in COVID-19 mortality is needed to address these data gaps.

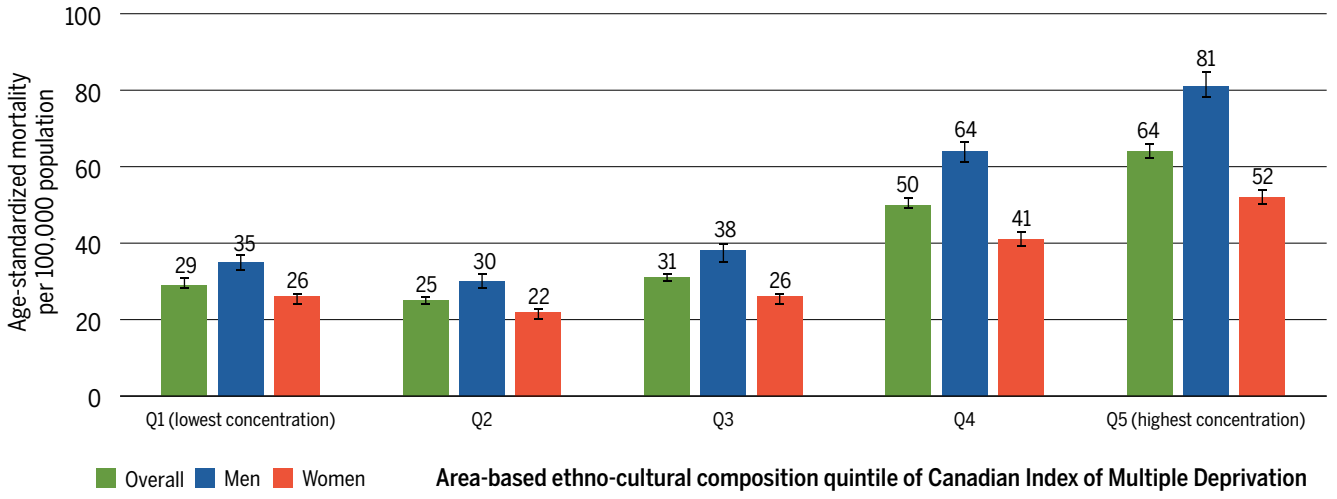
Results

COVID-19 MORTALITY BY AREA-LEVEL ETHNO-CULTURAL COMPOSITION

Statistics Canada's measure of area-level "ethno-cultural composition" captures the relative area-level concentration of individuals who were designated as a visible minority, who recently immigrated to Canada or were born outside of Canada or who have no knowledge of either official language of Canada (English, French). Composition concentration quintiles (1 – lowest to 5 – highest concentration) were used. This measure has been used in population health research and surveillance to identify sub-populations that may be particularly disadvantaged by structural and systemic factors, namely due to systemic racism and economic inequality[16].

Between January 1 and December 31, 2020, age-standardized COVID-19 mortality rates were higher in areas with higher ethno-cultural composition concentration (Figure 1). In Canada overall, the gap in COVID-19 mortality rates between areas with lowest (quintile 1) and highest (quintile 5) ethno-cultural composition concentration was of 35 deaths/100,000 population (rate difference (RD) 95% CI: 33, 37) (2.2 times higher in highest versus lowest concentration quintiles; 64 versus 29 deaths/100,000 population).

FIGURE 1. Age-standardized COVID-19 mortality per 100,000 population by ethno-cultural composition quintile and sex/gender, Canada (January 1 to December 31, 2020)



Sex/ gender groups	Age-standardized COVID-19 mortality per 100,000 population (95% CI)				
	Quintile 1 (lowest concentration)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (highest concentration)
Overall	29 (28, 31)	25 (24, 26)	31 (30, 32)	50 (49, 52)	64 (62, 66)
Men	35 (33, 37)	30 (28, 32)	38 (35, 40)	64 (61, 67)	81 (78, 85)
Women	26 (24, 27)	22 (20, 23)	26 (24, 27)	41 (39, 43)	52 (50, 54)

Sex/gender-based inequalities across ethno-cultural composition

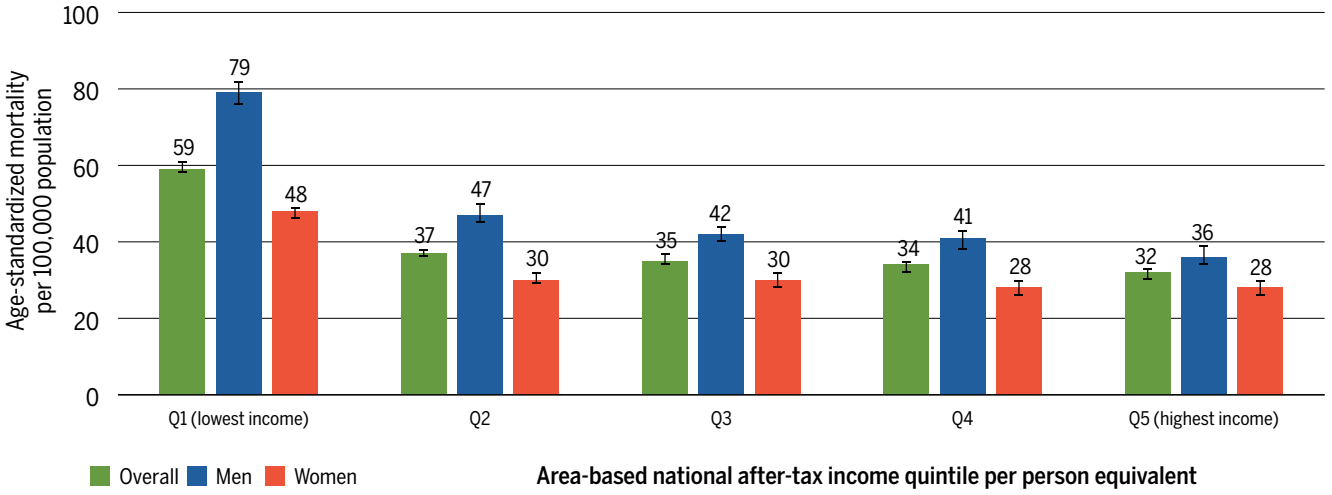
Overall in Canada, between January 1 and December 31, 2020, the age-standardized COVID-19 mortality rate was higher among men than it was for women. The relative male-to-female ratio of COVID-19 deaths was similar across levels of ethno-cultural composition (ranging from 1.4 to 1.6 deaths among men to 1 among women). However, the absolute difference in mortality rates between men and women was approximately 3 times larger in areas with highest ethno-cultural composition concentration (quintile 5) (81 deaths among men to 52 among women per 100,000 population; difference of 29 deaths/100,000 population), compared to lowest concentration areas (quintile 1) (35 deaths among men, 26 among women per 100,000 population; difference of 9 deaths/100,000 population).

COVID-19 MORTALITY BY NEIGHBOURHOOD INCOME

Statistics Canada produces a quintile measure of national after-tax neighbourhood income per single-person equivalent. These quintiles are constructed based on the distribution of dissemination area income values for the entire country.

Between January 1 and December 31, 2020, there was a prominent gap in age-standardized COVID-19 mortality between areas with the lowest-income (quintile 1) and other areas (quintiles 2 to 5) (Figure 2). In Canada overall, the difference in COVID-19 mortality rates between areas with lowest (quintile 1) and highest (quintile 5) income was 28 deaths/100,000 population (RD 95% CI: 26, 30) (1.9 times higher in quintile 1 than quintile 5 areas) (Figure 2).

FIGURE 2. Age-standardized COVID-19 mortality per 100,000 population by neighbourhood income and sex/gender, Canada (January 1 to December 31, 2020)



Sex/ gender groups	Age-standardized COVID-19 mortality per 100,000 population (95% CI)				
	Quintile 1 (lowest)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (highest)
Overall	59 (58, 61)	37 (36, 38)	35 (34, 37)	34 (32, 35)	32 (30, 33)
Men	79 (76, 82)	47 (45, 50)	42 (40, 44)	41 (38, 43)	36 (34, 39)
Women	48 (46, 49)	30 (29, 32)	30 (28, 32)	28 (26, 30)	28 (26, 30)

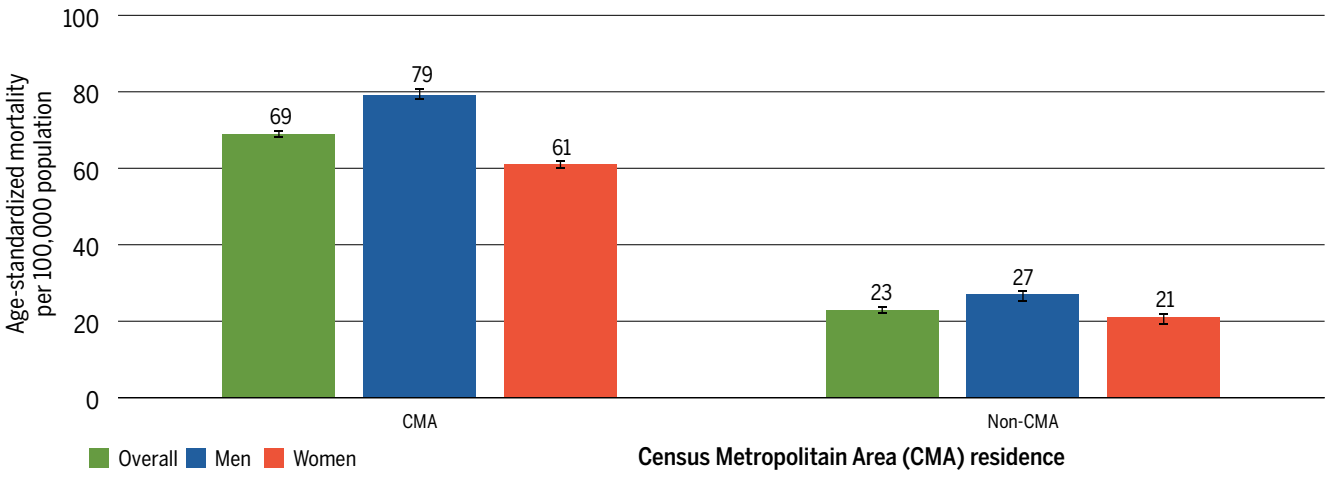
Sex/gender-based inequalities across neighbourhood income

On both a relative and absolute scale, the sex/gender gap in COVID-19 mortality was higher in lowest-income areas. In lowest-income areas, the male-to-female ratio of deaths was 1.7 and the absolute difference in mortality rates between men and women was 31 deaths/100,000 population. In contrast, this ratio and absolute difference were 1.3 and 8 deaths/100,000 population, respectively in highest income areas (quintile 5). This finding is consistent with previous research on sex/gender inequalities in morbidity and mortality in relation to socioeconomic status, which observed greater sex/gender inequalities among lower socioeconomic groups[23, 37, 38]. Researchers have suggested that above and beyond biological risk factors, higher mortality trends among men in lower socioeconomic contexts may relate to gendered material, social and environmental conditions, including higher rates of exposures to occupational risk factors, associated health-affecting behaviours (for example, smoking, elevated alcohol use) and lower use of health services across the life course[23, 24, 25, 26].

COVID-19 MORTALITY IN AND OUTSIDE CENSUS METROPOLITAN AREAS (CMAs)

Age-standardized COVID-19 mortality rates were estimated for individuals dwelling in Census Metropolitan Areas (CMAs) and those living outside of CMAs. CMAs are large urban centres with a minimum population of 100,000 residents[39]. Between January 1 and December 31, 2020, age-standardized COVID-19 mortality rates were systematically higher in urban CMAs than in non-CMA areas overall (3 times higher; 46 more deaths per 100,000 population [RD 95% CI: 44, 48]) and for both men and women separately (Figure 3).

FIGURE 3. Age-standardized COVID-19 mortality per 100,000 population by Census Metropolitan Area (CMA) residence and sex/gender, Canada (January 1 to December 31, 2020)



Sex/gender groups	Age-standardized COVID-19 mortality per 100,000 population (95% CI)	
	CMA	Non-CMA
Overall	69 (68, 70)	23 (22, 24)
Men	79 (78, 81)	27 (25, 28)
Women	61 (60, 62)	21 (19, 22)

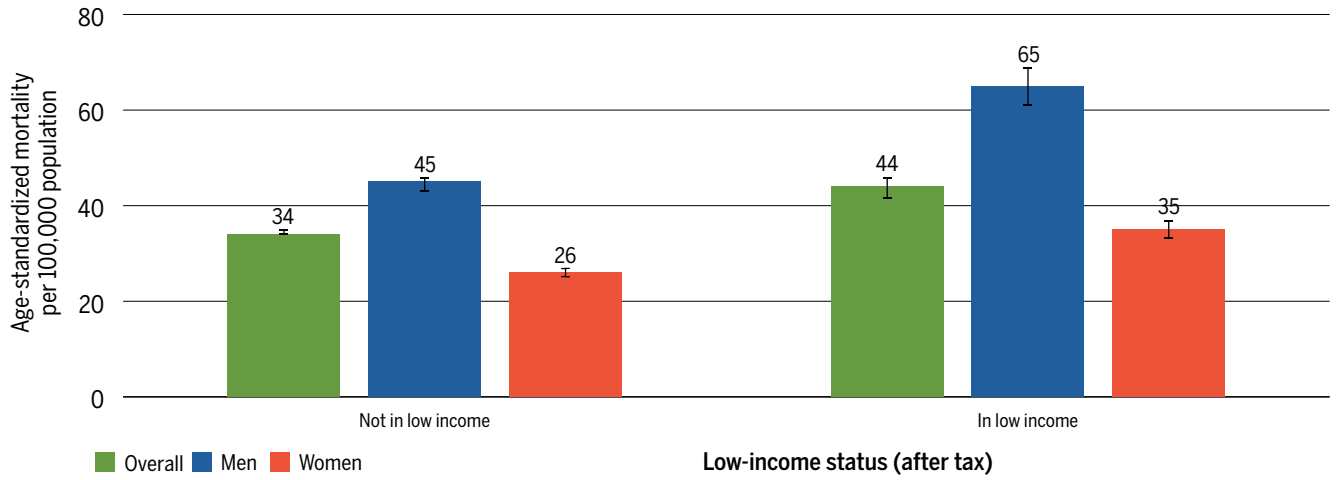
Sex/gender-based inequalities across areas of residence

The absolute difference in COVID-19 mortality between men and women was 18 deaths/100,000 population in CMAs (79 deaths among men versus 61 among women per 100,000 population). This was about 3 times larger than the difference of 6 deaths/100,000 observed in non-CMAs (27 deaths among men versus 21 among women per 100,000 population). However, on a relative scale, the male-to-female mortality ratio was the same for non-CMAs and CMAs (1.3).

COVID-19 MORTALITY BY INDIVIDUAL LEVEL AFTER-TAX LOW-INCOME STATUS

Statistics Canada's Low Income Measure (LIM) identifies households whose household-size adjusted after-tax income is lower than half of the Canadian median adjusted income[34, 40]. It captures 2 groups: those living in low-income and those not living in low-income. Between January 1, 2020, and March 31, 2021, mirroring findings at the area level, private-dwelling populations in low-income experienced higher age-standardized COVID-19 mortality, overall and for both men and women (Figure 4). The gap in COVID-19 mortality rates between those in and not in low-income was 10 deaths/100,000 population in Canada (RD 95% CI: 8, 12) (1.3 times higher for those in low-income than those not in low-income; 44 versus 34 deaths/100,000, respectively) (Figure 4).

FIGURE 4. Age-standardized COVID-19 mortality per 100,000 population by individual low-income status (after-tax) and sex/gender, Canada (January 1, 2020 to March 31, 2021)



Sex/gender groups	Age-standardized COVID-19 mortality per 100,000 population (95% CI)	
	Not low income	In low income
Overall	34 (34, 35)	44 (42, 46)
Men	45 (43, 46)	65 (61, 69)
Women	26 (25, 27)	35 (33, 37)

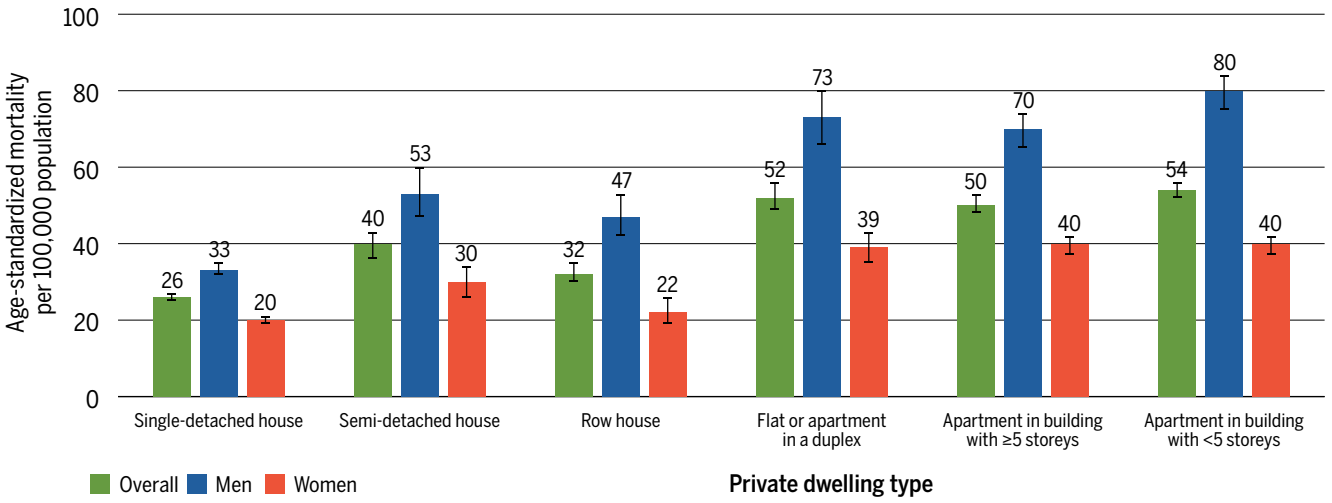
Inequalities across low-income status by sex/gender

For deaths occurring between January 1, 2020 and March 31, 2021 among private dwellings, age-standardized COVID-19 mortality was higher among men than it was for women, in both the low- and not in low-income groups (Figure 4). Mortality rate inequalities between populations in low-income and those not in low-income were larger among men than women. For example, the gap was 20 deaths/100,000 population among men and 9 deaths/100,000 among women in Canada.

COVID-19 MORTALITY BY PRIVATE DWELLING TYPE

In the short-form Census, 6 types of private dwellings are identified: single-detached house, semi-detached house, row house, apartment or flat in a duplex, apartment in a building with 5 or more storeys and apartment in a building with fewer than 5 storeys. In this analysis, deaths occurring in congregate settings, including long-term care homes, were excluded. Private dwelling type captures many social and economic differences. For example, residents of single-detached homes tend to have higher reported median after-tax income compared to residents of apartments in multi-storey buildings[41]. Further, residents of detached homes also tend to report higher satisfaction with the size and number of rooms of their dwelling compared to apartment-dwellers, indicating a potential elevated risk of unsatisfactory housing conditions among apartment-dwellers in the context of the COVID-19 pandemic[42]. Higher mortality rates in apartments may be influenced by the fact that this type of dwelling is more concentrated in larger urban areas, where COVID-19 mortality burden is high (as shown above in results by CMA residence). However, these inequalities were shown to persist when restricted to CMAs in Quebec and Ontario[6].

FIGURE 5. Age-standardized COVID-19 mortality per 100,000 population by dwelling type and sex/gender, Canada (January 1, 2020 to March 31, 2021)



Sex/ gender groups	Age-standardized COVID-19 mortality per 100,000 population (95% CI)					
	Single-detached home	Semi-detached home	Row house	Apartment in a duplex	Apartment in building ≥5 storeys	Apartment in building <5 storeys
Overall	26 (25, 27)	40 (36, 43)	32 (30, 35)	52 (49, 56)	50 (48, 53)	54 (52, 56)
Men	33 (32, 35)	53 (47, 60)	47 (42, 53)	73 (66, 80)	70 (65, 74)	80 (75, 84)
Women	20 (19, 21)	30 (26, 34)	22 (19, 26)	39 (35, 43)	40 (37, 42)	40 (37, 42)

Between January 1, 2020 and March 31, 2021, age-standardized COVID-19 mortality rates in the private-dwelling population were highest for individuals living in apartments (in buildings <5 storeys or ≥5 storeys, flats or duplexes) (Figure 5). Rates were not statistically significantly different across the types of buildings in which these apartments were found, as indicated by overlapping 95% confidence intervals (Figure 5).

Compared to apartment-dwelling residents, rates were lower for those living in semi-detached or row houses. The lowest COVID-19 mortality rate was observed among those living in single-detached houses (26 deaths/100,000 population). Overall, mortality rates were 1.9 to 2.0 times higher in apartment-dwelling populations than those living in single-detached homes. There were 24 (95% CI: 22, 26) to 28

(95% CI: 26, 30) more deaths per 100,000 population in apartment-dwelling populations compared to populations living in single-detached houses (between 50 and 54 deaths compared to 26 deaths/100,000 population, respectively).

The magnitude of the inequality in mortality between row and semi-detached house residents and those living in single-detached houses was smaller. Rates were 1.2 to 1.5 times higher for row and semi-detached house residents. Approximately 6 (95% CI: 3, 9) to 14 (95% CI: 10, 18) more deaths per 100,000 populations occurred among populations living in row and semi-detached homes versus single detached homes (32 to 40 deaths versus 26 deaths/100,000, respectively).

Sex/gender-based inequalities across private dwelling type

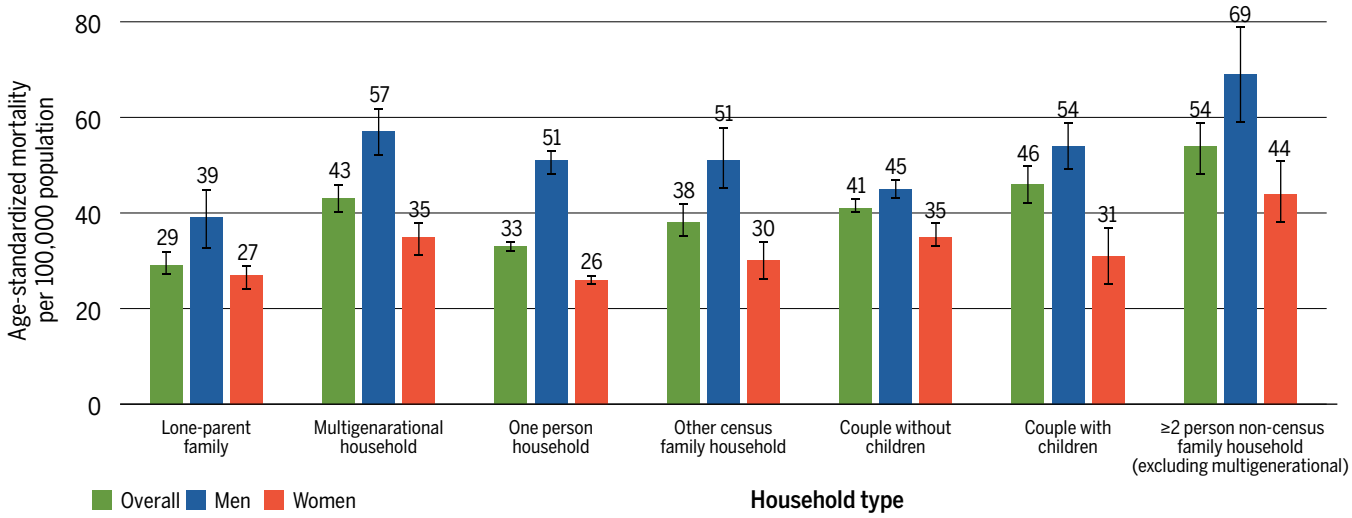
The magnitude of absolute sex/gender-based inequalities varied according to dwelling type. The absolute difference in rates between men and women ranged from 30 to 40 deaths/100,000 population in apartment-dwellers, compared to 13 to 25 deaths/100,000 population in single-, semi-detached or row houses. On the relative scale, however, the male-to-female ratio of deaths were similar across groups (1.7 to 2.1).

COVID-19 MORTALITY BY HOUSEHOLD TYPE

The short-form Census identifies several types of households. These include: 1-person households, Census family household types (that is, couples without children, couples with children, lone-parent families, multi-generational household), "other" Census family households and 2-or-more person non-Census family households. "Other" Census family households include all households where there is 1 Census family with additional persons or more than 1 Census family. Two-or-more person "non-Census family households" include those who do not constitute a Census family, based on marital or parental status[43]. The average household in Canada comprises 2.5 residents[44]. Household size varies by household type, with average 2-or-more person non-Census family households made up of 3 residents and multigenerational households including 5 residents[45]. Certain sub-populations such as immigrants to Canada are more likely to live in multigenerational households compared to non-immigrants (11% of immigrants versus 5% in non-immigrants)[46].

Between January 1, 2020, and March 31, 2021, the portrait of age-standardized COVID-19 mortality across private dwelling household type was heterogeneous (Figure 6). Overall mortality rates were highest among 2-or-more-person non-Census family households (54 deaths/100,000 population; 24 more deaths per 100,000 [95% CI 18, 30] than for lone-parent households). Two-or-more person non-Census family households are those that did not consist of a married or common-law couple with or without children, or of a single parent with one or more children. High rates were also observed for those living in households of couples with children (46 deaths/100,000 population; 17 more deaths per 100,000 [95% CI 12, 22] than for lone-parent households) (Figure 6).

FIGURE 6. Age-standardized COVID-19 mortality per 100,000 population by household type and sex/gender, Canada (January 1, 2020 to March 31, 2021)



Sex/ gender groups	Age-standardized COVID-19 mortality per 100,000 population (95% CI)						
	Lone-parent family	Multi-generational household	One person household	Other census family household	Couple without children	Couple with children	≥2 person non-census family household
Overall	29 (27, 32)	43 (40, 46)	33 (32, 34)	38 (35, 42)	41 (40, 43)	46 (42, 50)	54 (48, 59)
Men	39 (33, 45)	57 (52, 62)	51 (48, 53)	51 (45, 58)	45 (43, 47)	54 (49, 59)	69 (59, 79)
Women	27 (24, 29)	35 (31, 38)	26 (25, 27)	30 (26, 34)	35 (33, 38)	31 (25, 37)	44 (38, 51)

Sex/gender-based inequalities across household type

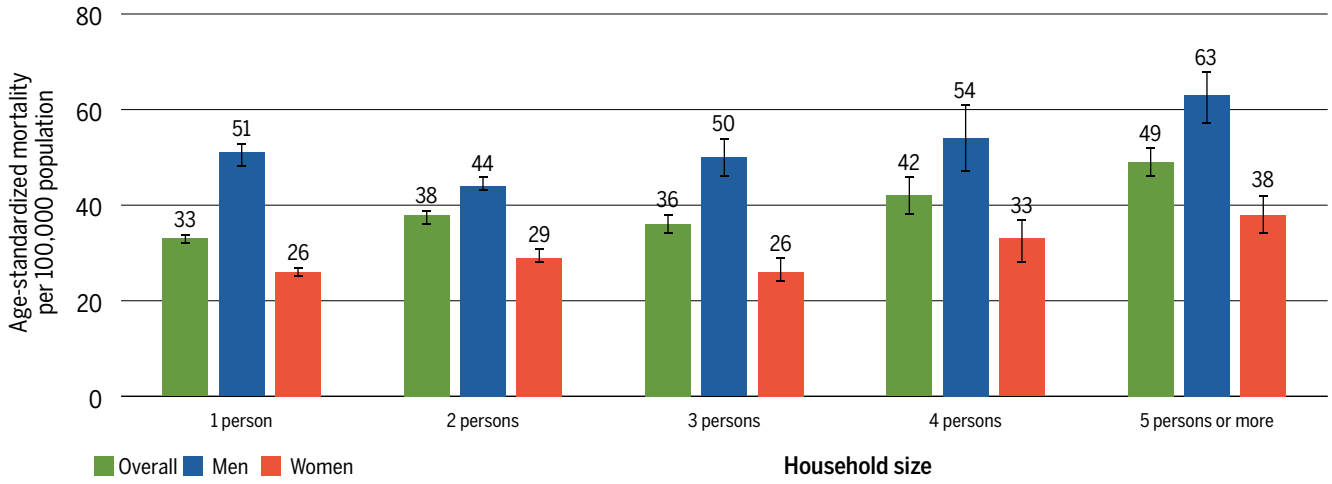
The magnitude of sex/gender-based inequalities varied according to household type. The absolute difference in rates between men and women ranged from 21 to 25 deaths/100,000 population in 1-person households (1.9 male-to-female ratio), households of couples with children (1.7 male-to-female ratio), "other Census family" households (1.7 male-to-female ratio), 2-or-more-person non-Census family household (1.6 male-to-female ratio) and multigenerational households (1.6 male-to-female ratio). In lone-parent families and households of couples without children, the difference in rates between men and women was more modest: between 13 and 10 deaths/100,000 population, respectively (male-to-female ratios of 1.5 and 1.3, respectively). Evidence on the distribution of COVID-19 mortality risk factors between men and women across household types is very limited, and therefore the etiology of these patterns is difficult to explain. It is possible, for example, that the larger sex/gender gap within households of couples with children may be capturing the lower risk of SARS-CoV-2 transmission among women who took leave from work to care for children at home[47]. However, future research on this subject is needed.

COVID-19 MORTALITY BY HOUSEHOLD SIZE

In the 2016 short-form Census, 5 household sizes were recorded: 1-, 2-, 3-, 4- or 5- or more person households. Between January 1, 2020, and March 31, 2021, age-standardized COVID-19 mortality rates were highest in households with either 4 or more, or 5 or more persons (42 and 49 deaths/100,000 population for households with 4 and with 5 or more persons, respectively, versus 33 deaths/100,000 population in households with 1 person) (Figure 7). As such, there were 16 more deaths (95% CI 12, 20) per 100,000 among individuals living in 5- or more person households, compared to single-person households.

The magnitude of sex/gender-based inequalities in COVID-19 mortality varied according to household size, although these differences did not increase with household size. The difference in rates between men and women was highest for 1- and 5-person or more households (25 deaths/100,000 population in each, respectively).

FIGURE 7. Age-standardized COVID-19 mortality per 100,000 population by household size and sex/gender, Canada (January 1, 2020 to March 31, 2021)



Sex/ gender groups	Age-standardized COVID-19 mortality per 100,000 population (95% CI)				
	1 person	2 persons	3 persons	4 persons	5 persons or more
Overall	33 (32, 34)	38 (36, 39)	36 (34, 38)	42 (38, 46)	49 (46, 52)
Men	51 (48, 53)	44 (43, 46)	50 (46, 54)	54 (47, 61)	63 (57, 68)
Women	26 (25, 27)	29 (28, 31)	26 (24, 129)	33 (28, 37)	38 (34, 42)

Conclusion

These provisional data suggest that COVID-19 deaths that occurred between January 2020 and March 2021 were not distributed equally across sub-populations in Canada.

The largest inequalities in COVID-19 mortality were observed between 4 groups:

- residents of large urban centers (CMAs) (versus non-CMA residents)
- residents of areas with highest ethno-cultural composition concentration (quintiles 4 and 5 versus quintile 1 areas)
- residents of areas with lowest income (quintile 1 versus quintile 5 areas) and
- apartment-dwellers (versus residents of single-detached homes)

Age-standardized mortality rates were higher among men than women and sex/gender inequalities were larger in these 4 groups compared to their respective reference populations.

The inequalities presented in this report indicate sub-populations that have faced systemic vulnerability to COVID-19 mortality. These findings are aligned with those from previous provincial, national and international reporting[1, 2, 3, 4, 5, 6, 7, 48, 49, 50, 8, 9, 17]. They are also as aligned with public health's understanding that structural determinants, such as systemic racism, economic inequality and other social determinants of health, shape inequitable distributions of infections[51, 52, 53, 54] and morbidity risk[14, 11, 55, 56]. Public health measures such as closures of non-essential workplaces had differential impacts on SARS-CoV-2 transmission rates across community socioeconomic profiles, given differences in local area-level prevalence of workers who could work from home[57].

Further, COVID-19 vaccination efforts began in Canada in December 2020 and may have contributed to mortality reductions during a portion of the period covered by this report, as individuals at highest risk were prioritized for vaccination, particularly older Canadian adults[29]. By January 2, 2021, less than 1% of Canadians aged 70 years or older had received at least 1 dose of the vaccine. However, by April 3, 2021, 79% of adults aged 80 years and older and 51% of adults aged 70 to 79 years had received at least 1 dose of the vaccine[58]. On average, documented vaccine effectiveness at preventing severe disease and death after 3 to 4 weeks following a first dose of the Pfizer, Moderna or AstraZeneca vaccine ranges from 70% to 90%[59]. Vaccine coverage is of particular importance for COVID-19 mortality inequalities, as lower effectiveness of COVID-19 vaccines has been observed among populations with certain chronic comorbidities[60]. These comorbidities have, in turn, been found to be more prevalent among populations with lower socioeconomic status[61, 11].

Evidence of inequalities in allocation and uptake of COVID-19 vaccines was seen in Canada during this period. An analysis from Ontario showed individuals living in areas with higher levels of both neighbourhood diversity (based on proportion of racialized and recent immigrant residents) and material deprivation (based on indicators of income, education, housing quality and family structure) had lower levels of coverage from at least 1 dose of the vaccine by the end of March 2021[62]. The Canadian Community Health Survey (CCHS) showed that people with a high school education or less had a prevalence of self-reported vaccination that was significantly lower than that of university graduates[63]. Further analysis of CCHS data showed that vaccination coverage varied by racialized identity. Black and Arab Canadians reported significantly lower coverage and South Asian Canadians reported significantly higher coverage than that of non-racialized Canadians[64].

In terms of vaccination intent, the COVID-19 Vaccination Coverage Survey found that intent to get vaccinated increased with household income and individual education level but was also higher among racialized respondents and did not differ by immigrant status[65]. These same patterns were also seen in the CCHS data for education level and racialized respondents[63]. Similar to Canada, inequalities in vaccine coverage during the initial months of vaccination efforts were documented in the United States and United Kingdom. In these countries, lower levels of vaccination coverage occurred for individuals living in poverty[66], as well

as in neighbourhoods with high social vulnerability (an index including factors such as income, racialized identity and housing characteristics)[67]. Inequalities in coverage were also observed among racialized populations in both countries[68, 66], with experiences varying by population group and by age in the U.K. study[66]. This has been attributed in part to lower trust in vaccines and public institutions[69], as well as to experiences of systemic racism[68]. These factors may have contributed to the observed persistent or growing inequalities in COVID-19 mortality in Canada. However, studies exploring these relationships have been limited, and vaccination roll-out was relatively new in the period studied in this report.

Future research is needed to better understand the contribution of inequalities in COVID-19 vaccination coverage to inequalities in COVID-19 mortality in Canada.

Overall, men experienced higher rates of COVID-19 mortality than women, despite similar rates of COVID-19 cases among women and men in the population at that time[18]. Surveillance data indicate that as of March 31, 2021, there were approximately 84,116 COVID-19 cases among women and 79,034 cases among men (male-to-female ratio of 1.06)[18]. Further, as of March 31, 2021, 88% of COVID-19 deaths in Canada occurred among those aged 70 years and above. In that age group, as well, cases among women (approximately 64,315 cases) outnumbered those among men (approximately 44,267 cases) (male-to-female ratio of 0.69)[18]. Among working-age adults, the sex/gender difference in case counts has been attributed, at least in part, to the over-representation of women in certain settings and occupations that may be at greater risk of exposure to the virus, such as teaching, health and care work, as well as elevated testing rates in the latter settings[70,4 7].

It has been proposed that higher rates of COVID-19 mortality among men, despite their lower case counts, may be partly due to sex-based immunological factors[19], as well as to the higher prevalence of COVID-19 mortality risk factors among men compared to women. COVID-19 mortality risk factors include current or former tobacco use and chronic health conditions[20]. Past HIR Initiative reporting indicates that among older adults in Canada, men have higher rates of diabetes, cancer and chronic obstructive pulmonary disease and report higher smoking prevalence compared to women[21].

Further, past research on sex/gender differences in health and mortality indicate the importance of gender-related social norms, behaviours and conditions in shaping health behaviours and outcomes, above and beyond biological and physiological characteristics, and in connection with other key social determinants such as socioeconomic status. For example, cultural notions of masculinity are believed to explain in part why boys and men are more likely to smoke, report higher levels of alcohol use and not seek health services compared to women and girls[22].

Intersections between gender norms and other sources of discrimination or disadvantage, such as lower socioeconomic status and systemic racism, have been reflected in the disproportionately higher rates of exposures to occupational risk factors (for example, carcinogens, injury), health-affecting behaviours (for example, smoking, elevated alcohol use) and lower use of health services among men in lower socioeconomic settings compared to women overall and men in higher socioeconomic settings[23, 24, 25, 26]. The larger sex/gender inequalities in COVID-19 mortality in areas with lower income and greater concentration of individuals who recently immigrated or were born outside of Canada, were designated as visible minorities and were not proficient in either official language (compared to areas with higher income and lower ethno-cultural composition concentration) are consistent with these previous findings of larger sex/gender inequalities in overall mortality in lower socioeconomic settings[23, 24, 25, 26].

However, due to the limited scope of the analyses, future research is needed to determine the precise pathways through which the observed inequalities manifest. They may be due to differential exposure to SARS-CoV-2 infection, differences in distributions of chronic conditions and other underlying risk factors of COVID-19 morbidity[71, 72], and/or potential inequalities in access, use and quality of treatment[4]. Future research and surveillance are required to fill these knowledge gaps. Further, this report did not explore, for example, mortality rates across multiple, intersecting identities or groups.

These types of analyses can help identify sources of confounding bias as well as of mediation or effect modification. For example, an analysis based on the same data integration used in this report found that COVID-19 mortality

rates differed significantly by low-income status for those living in an apartment or a multi-storey building, but not for those who lived in other types of dwellings[73]. In particular, those living in apartments in buildings of 5 or more storeys who were not in low-income had significantly lower COVID-19 mortality rates (45/100,000) than those who were in low-income (65/100,000). These findings of heterogeneity across income groups suggests that income level is likely a source of confounding bias between dwelling type and COVID-19 mortality. It is possible that adjusting for income would reduce or eliminate the observed inequalities by dwelling type.

Similarly, a study that explored inequalities in COVID-19 mortality risk according to neighbourhood-level density of immigrant and racialized populations found that inequalities in the latter population persisted even after adjusting for housing characteristics such as crowding[74]. This may suggest that crowding plays a mediating role between the latter neighbourhood characteristics and COVID-19 mortality risk.

Additionally, this report was also unable to explore COVID-19 burden across a full range of social determinants of health, due to absence of measures in the 2016 short-form Census data source. Missing were measures of individual-level gender and sexual orientation, as proxy measures of various forms of sexism; Indigeneity measures, to identify distinction-based differences in the experience of the pandemic and the effects of anti-Indigenous racism and colonialism; or race/ethnicity, as a proxy measure of racism[56]. Certain regions of Canada have begun disaggregating COVID-19 data using these measures[73, 74, 2]. These represent important areas of future inquiry, as do future assessment of inequalities at later time points during the pandemic, including following the advent of variants of concern[75], and immunization campaigns.

Compared to results reported from the first wave of the pandemic (covering January to July/August 2020, see archived report), this updated report (covering January 2020 to December 2020/March 2021) found that the populations experiencing the largest inequalities have not changed. However, for most populations, the absolute size of the inequalities have grown and in many cases are double those seen in the initial period (see Annex). This may in part be due to the overall increase in the Canadian COVID-19 mortality rate in the latter half of 2020 and early 2021 [26], as well as additional COVID-19 deaths captured due to revisions of provisional numbers from the initial reporting period.

When health inequalities can plausibly be avoided or redressed by collective action, they may be deemed unjust and inequitable[27, 28]. The observed elevated burden of COVID-19 mortality between January and December 2020 to March 2021 in some groups and not others, as well as the persistence of these inequalities across multiple waves of the pandemic, suggests that COVID-19 mortality inequalities can be avoided, and are therefore inequitable. This report provides national evidence of inequalities in COVID-19 mortality burden, a key first step in taking action to advance a health equity-focused pandemic response and preparedness for future events. It builds on previous reporting by HIRI, namely its 2018 *Key Health Inequalities in Canada: A National Portrait report*, which provides key principles for action and practices to advance health equity in Canada, so that all Canadians can experience healthy living and working conditions and environments.

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Annex: Key differences in inequalities between the present and previous report

Overall, compared to the study period for the first report (January to July/August 2020, see archived report), the present report (January 2020, to December 2020/March 2021) found that many of the absolute inequalities (expressed as rate differences, RD) increased while relative inequalities (expressed as rate ratios, RR) persisted (figures 8 and 9).

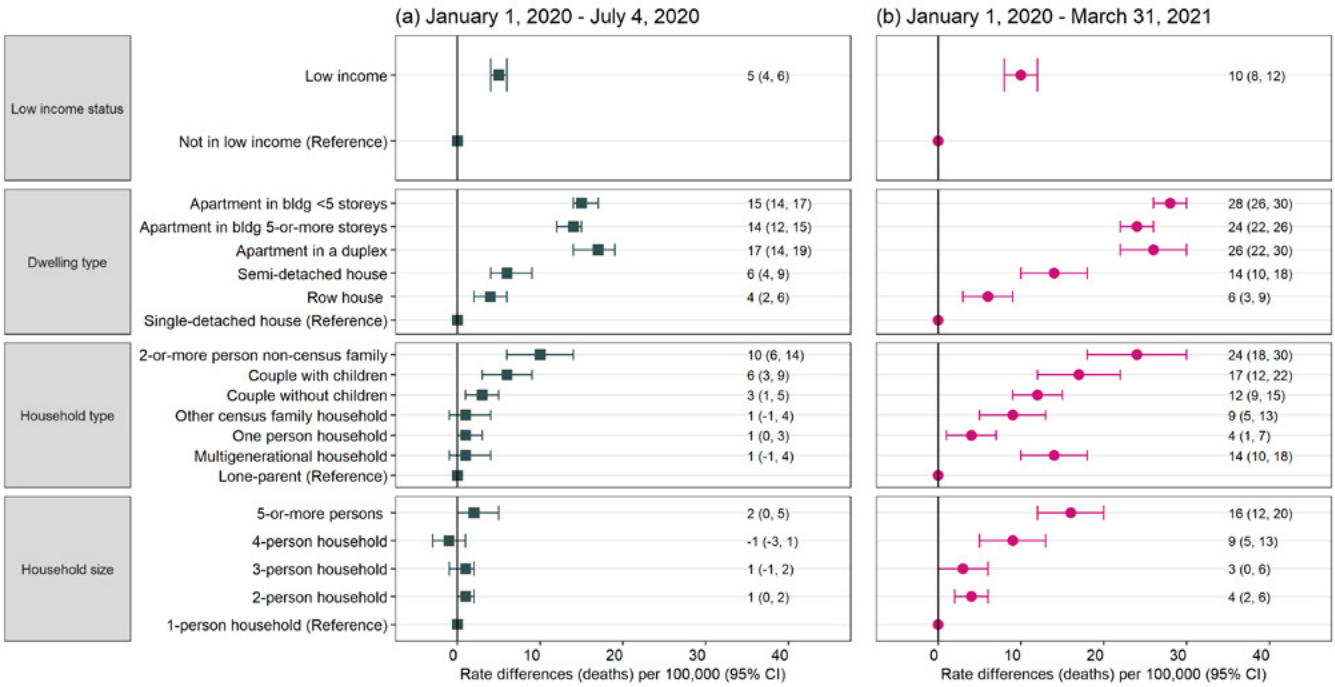
For the individual-level measures, in the periods covered in this report, the absolute inequality between those in and not in low-income doubled (from RD=5 deaths/100,000 to RD=10 deaths/100,000) (Figure 8A). The absolute inequalities according to dwelling type increased by approximately 10 additional deaths per 100,000 for apartment-dwellers (from 15 to 17 more deaths/100,000 to 24 to 28 more deaths/100,000) compared to those living in single-detached homes (Figure 8A). A similar pattern was observed for those living in 2-or-more person non-Census family homes and in households of couples with children (Figure 8A). Further, whereas differences in mortality between other Census family households, 1-person households, multi-generational households and the reference group of lone-parent households were not statistically significant in the first part of the pandemic (Figure 8A), inequalities emerged between these groups by the end of the first year (Figure 8A). For example, the inequality between multigenerational households and lone-parent households rose from RD=1 deaths/100,000 to RD=14 deaths/100,000 (Figure 8A).

For the area-level measures, the absolute inequality according to area of residence rose by approximately 16 additional deaths per 100,000 for those living in a large urban centre (from 30 more deaths/100,000 to 46 more deaths/100,000) (Figure 9A). On a relative scale, the latter inequality was reduced but remained large (from RR=9.5 to RR=3) (Figure 9B).

The absolute inequality between areas with the highest and lowest ethno-cultural composition concentration rose by an additional 14 deaths per 100,000 (from RD=21/100,000 to RD=35/100,000) (Figure 9A). Lastly, the absolute inequality between the lowest- and highest-income neighbourhoods increased between periods of the initial study and the present report (from RD=20/100,000 to RD=28/100,000) (Figure 9A).

FIGURE 8. Differences and ratios of age-standardized COVID-19 mortality per 100,000 population by individual-level measures across 2 periods, January 1 to July 4, 2020 and January 1, 2020 to March 31, 2021

A. Absolute inequalities (rate differences) in individual-level measures across periods



B. Relative inequalities (rate ratios) in individual-level measures across periods

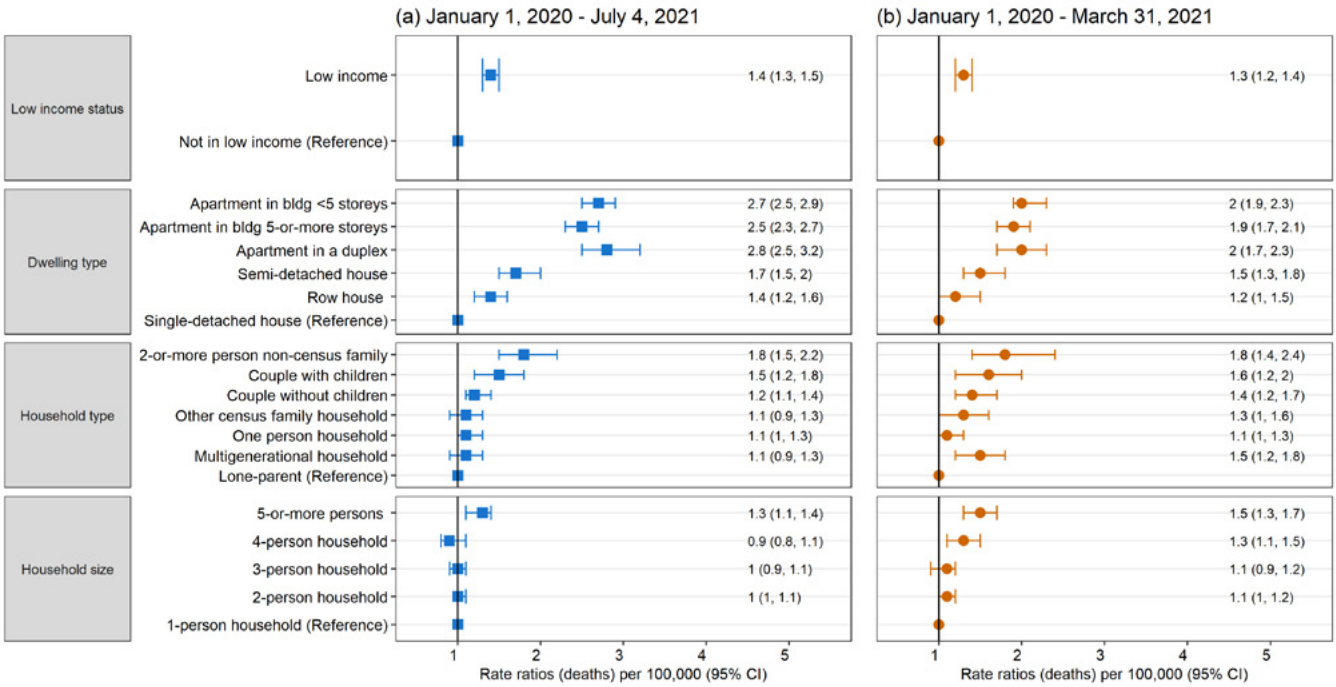
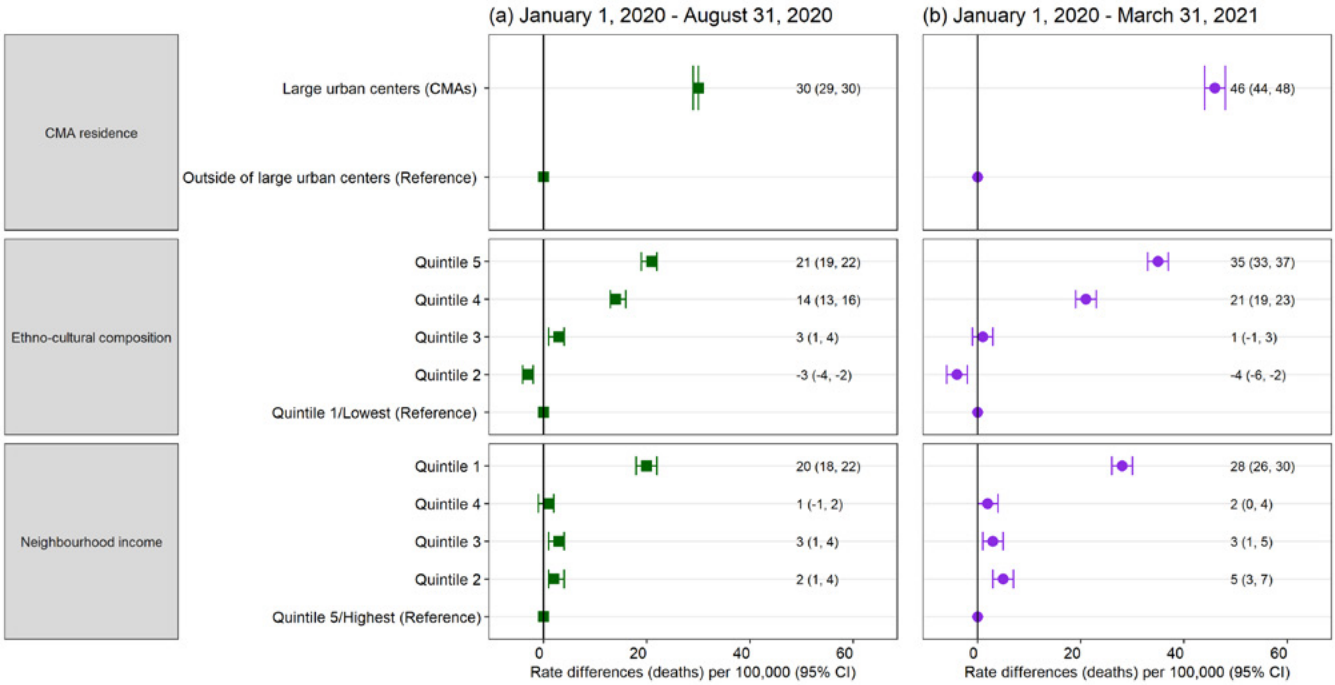


FIGURE 9. Differences and ratios of age-standardized COVID-19 mortality per 100,000 population by area-level measures across 2 periods, January 1 to August 31, 2020 and January 1, 2020 to December 31, 2021

A. Absolute inequalities (rate differences) in area-level measures across periods



B. Relative inequalities (rate ratios) in area-level measures across periods