

Excess mortality and mortality due to COVID-19 in Québec for the period 2020–2023

SURVEILLANCE

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FOREWORD

The Institut national de santé publique du Québec (INSPQ) is Québec's authority and reference point for public health. Its mission is to support the Ministère de la Santé et des Services sociaux du Québec (MSSS), regional public health authorities, as well as local, regional, and national institutions in the exercise of their functions and responsibilities.

The Surveillance collection brings together a variety of scientific output aimed at characterizing population health and its determinants, as well as analyzing threats and risks to health and well-being.

This surveillance report is the result of a mandate given to the INSPQ by the MSSS on September 26, 2023, pursuant to [Article 3.8](#) of the *Act respecting Institut national de santé publique du Québec*. It was developed by science professionals at the INSPQ, in collaboration with the Institut de la statistique du Québec.

This report documents the evolution of excess mortality in Québec, now that COVID-19 is considered to have become endemic, and proposes potential determinants of this excess mortality since the beginning of the COVID-19 pandemic. These determinants will be explored in greater depth in future studies.

Although the concept of excess mortality has been known for several years, the methodology used to produce the expected mortality estimates, which are needed to calculate excess mortality, continues to evolve. To date, there is no established standard in the scientific community on how best to calculate or assess the uncertainty associated with these estimates. The excess mortality estimates presented in this report therefore depend on methodological choices and parameter settings, based on the knowledge available at the time of their development. These results should be interpreted with caution, as estimates and not as exact numbers of excess deaths in Québec during the periods studied.

At the time of writing, knowledge has already evolved, and new data to refine the estimates produced are expected to be available in winter 2024. In particular, the new age-specific population estimates could modulate the excess mortality results obtained in this report for people aged 0–49.

Excess mortality is one of the most recognized approaches for assessing and comparing the health and social consequences of the pandemic. Monitoring the work that will be carried out over the next few years to refine the models used to estimate excess mortality could prove very interesting for the future.

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ABBREVIATIONS AND ACRONYMS

CDC	Centers for Disease Control and Prevention
CHSLD	Centre d'hébergement et de soins de longue durée (Residential and long-term care centres)
COVID-19	Coronavirus disease 2019
INSPQ	Institut national de santé publique du Québec
ISQ	Institut de la statistique du Québec
MSSS	Ministère de la Santé et des Services sociaux du Québec
OECD	Organization for Economic Co-operation and Development
RED	Registre des événements démographiques du Québec
RPA	Résidence privée pour aînés (Private seniors' residences)
RSV	Respiratory syncytial virus
SARS-CoV2	Severe acute respiratory syndrome coronavirus 2
WHO	World Health Organization

KEY MESSAGES

This report documents the evolution of excess mortality in Québec since the beginning of the pandemic, and the extent to which excess mortality can be attributed to COVID-19. Excess mortality is defined as the number of deaths that exceeds the number normally expected for a given period. This expected number takes into account past mortality trends, the seasonality of deaths, and demographic changes. It is one of the most recognized approaches for assessing and comparing the health and social consequences of the pandemic.

- There has been excess mortality in Québec since the beginning of the pandemic. Between February 23, 2020, and August 26, 2023, excess deaths are estimated at 12,551, or 5% more than expected. The greatest peaks in excess deaths are observed during the first (February 23 to July 11, 2020) and fifth (December 5, 2021, to March 12, 2022) waves of the pandemic (following the arrival of the Omicron variant), a considerable proportion of which are due to COVID-19.
- The period from September 2022 to August 2023 (high endemicity of COVID-19) is characterized by excess mortality that reached lower peaks, but was more sustained over time, compared to the period of pandemic waves. However, the proportion of deaths due to COVID-19 is lower among excess deaths. This coincides with the return of certain respiratory viruses in the fall of 2022, after low circulation during the pandemic due to public health measures.
- Since 2020, no age group has been spared excess mortality. In particular, the oldest age groups were the hardest hit given their small populations.
- The results for excess mortality by sex show a similar trend between 2020 and 2023.
- According to Statistics Canada, between March 2020 and December 2022, excess mortality in Québec differs favourably from that of other Canadian provinces. Results from the *World Mortality Dataset* show that the same is true on an international scale.
- The COVID-19 pandemic has upset the historically observed mortality trend in Québec. This report identifies some possible determinants of the excess mortality observed since the beginning of the COVID-19 pandemic. These determinants will be the subject of further work.

SUMMARY

On September 26, 2023, the ministère de la Santé et des Services sociaux (MSSS) mandated the Institut national de santé publique du Québec (INSPQ) to document the evolution of excess mortality in Québec since the beginning of the pandemic, and to propose possible determinants for future examination. The objectives of this report are therefore to estimate excess mortality in the Québec population since the emergence of COVID-19, overall and by age and sex, and to assess the extent to which this excess mortality may be attributable to deaths for which COVID-19 was identified as the underlying cause.

Excess mortality is one of the most recognized approaches for assessing and comparing the health and social consequences of the pandemic. It is defined as the number of deaths that exceeds the number normally expected for a given period. This expected number considers the secular trend in mortality rates, the seasonality of deaths, and demographic changes. This approach is the preferred one, as it avoids the issues associated with the variability of screening practices and reporting of COVID-19 on certificates of death. By measuring the direct and indirect impact of the pandemic on mortality, the analysis of excess mortality provides a clear picture of how mortality evolved during the pandemic.

A first report entitled *Surmortalité et mortalité par COVID-19 au Québec en 2020* was published by the INSPQ to study the impact of the COVID-19 pandemic on mortality in Québec by estimating excess mortality between February 23, 2020, and January 2, 2021. In this report, results based on estimates from the Institut de la statistique du Québec (ISQ) are presented for the entire period (December 29, 2019, to September 23, 2023), the periods of pandemic waves and high endemicity (February 23, 2020, to August 26, 2023), and the CDC years from 2020 to 2023.

Between February 23, 2020, and August 26, 2023, 261,661 deaths occurred in Québec, whereas 249,110 deaths were expected during this period. This represents 12,551 excess deaths and a relative excess mortality of 5% (relative magnitude of excess deaths compared with what was expected), including 4% in women and 6% in men.

Several fluctuations occurred, but it was during the first and fifth waves (following the arrival of the Omicron variant) that we saw the biggest peaks in excess deaths. It was also during these waves that COVID-19 appears to have made a significant contribution to excess deaths. This result should be interpreted with caution, as excess mortality may be influenced by factors other than COVID-19, including variations in other causes of death.

During the waves of the pandemic (February 23, 2020, to September 3, 2022), 185,106 deaths occurred in Québec, 7,564 more than expected, for a relative excess mortality of 4%. In comparison, the period of high endemicity (September 4, 2022, to August 26, 2023) counts 76,555 deaths, corresponding to an excess of 4,987 deaths and a relative excess mortality of 7%. This latter period is notable for an excess mortality rate that reached lower peaks but was more sustained over time. However, the relative importance of deaths with COVID-19 as the

underlying cause, compared to excess deaths, is less notable than during the waves of the pandemic. This coincides with the return of certain respiratory viruses (e.g., influenza and RSV) in the fall of 2022, after low circulation during the pandemic due to public health measures. The higher mortality during periods of high endemicity is also observed in all age groups, apart from the 80–89 age group, and for both sexes. However, it is concentrated in the fall of 2022 and has been weaker since.

Except for 2021, excess mortality was present in every CDC year studied. No age group was unaffected, but nuances can be observed depending on the indicator. In terms of the burden associated with their population size (excess mortality rate per 100,000), the oldest people—those aged 80–89 and particularly those aged 90 years and older—were most affected. In terms of gross burden, i.e., the excess number of deaths, the 70–79 age group has been the hardest hit since 2021, which is not surprising given this group's considerable demographic weight. However, people aged under 50 stand out with the highest relative excess mortality (number of excess deaths compared with the expected number of deaths) of all age groups, with an upward trend between 2020 and 2023. This result should be interpreted with caution, however, for several methodological reasons. This age group also has the lowest relative contribution to excess mortality from COVID-19.

Relative excess mortality has evolved similarly between 2020 and 2023 for each sex, with a maximum reached in 2022 (8% for women and 10% for men) and a minimum in 2021 (–3% and 1%, respectively).

According to results from Statistics Canada but compiled by the ISQ covering the period from March 2020 to December 2022, Québec compares favourably with other provinces, with an excess mortality rate of 6% (estimated by the ISQ) compared to the rest of Canada (11%). According to the World Mortality Dataset, Québec's relative excess mortality for the same period is similar to that of Australia (5%), Norway (6%), and Sweden (6%) when using comparable methods. It is higher than in Japan and Denmark (3%) but significantly lower than in the United States (16%).

Although it is still too early to identify the factors that may have played a role in the recent evolution of excess mortality in Québec, certain lines of explanation have been identified in the literature and classified into three conjectures: the demographic and epidemiological conjecture, the public health measures conjecture, and the Québec social conjecture.

The demographic and epidemiological conjecture

The presence of comorbidities, the age distribution of the population, and the risk of dying according to age are factors that may have influenced excess mortality. Genomic variants of SARS-CoV-2, particularly the arrival of Omicron just before the fifth wave, are among the epidemiological factors that may explain the excess mortality linked to COVID-19.

The public health measures conjecture

The implementation of public health measures and compliance with them are cited in the literature as potentially influencing a range of variables, including the transmission of infectious agents, the demand for care, and access to health services. These effects can be favourable, such as limiting transmission in high-risk groups, or unfavourable, such as affecting lifestyle habits, behaviours, and mental health.

In any case, this literature needs to be treated with caution and critical thinking, as several conditions must be met before conclusions can be drawn about the impact of population-level public health interventions on health outcomes.

The Québec social conjecture

Another phenomenon observed during the pandemic is the uneven effect of its impacts on health, based on the socioeconomic vulnerability of population groups. Conversely, the social safety net of Québec (and its impact on people's health status) may have acted as a protector. A more comprehensive look at the social determinants of health would provide a basis for understanding their effects on mortality in the Québec population, during and after the pandemic.

In conclusion, the onset of the COVID-19 pandemic has shaken the historically observed trend in mortality, which usually does not vary much. Surges in mortality, generally coinciding with the waves of COVID-19, have been observed since 2020. Since the end of the period of pandemic waves, i.e., September 2022, a lower but sustained excess mortality rate has persisted. More work needs to be done to understand past and recent trends in excess mortality, and to refine estimation models. Among other things, it would be interesting to draw up a more detailed portrait of mortality trends in Québec, including an examination of excess mortality by cause of death and regional analyses. Further work, inspired by the various conjectures, will also be needed to better understand the impact of the events of recent years on the present and future health of Québécois.

1 CONTEXT

Excess mortality is defined as the number of deaths that exceeds the number normally expected for a given period. This expected number considers past mortality trends, the seasonality of deaths, and demographic changes. The number of deaths may also be lower than expected, in which case the situation is referred to as a mortality deficit.

At the height of the COVID-19 pandemic, the analysis of excess mortality emerged as the approach providing the best temporal (1) and spatial (2–5) comparison of health and social consequences of the pandemic. This approach makes it possible to circumvent the issues associated with the variability of screening practices and reporting of COVID-19 on certificates of death, provided that all deaths are registered, which is the case in the majority of developed countries (6).

An analysis of excess mortality provides a clear picture of how mortality evolved during the pandemic. It captures the direct impacts (e.g., deaths with COVID-19 as the underlying cause) and indirect impacts (e.g., deaths following postponement of procedures or reduced screening) of the pandemic on mortality. In addition, this type of analysis considers the complex effects of mortality displacement (e.g., a period of low mortality following a period of high mortality) or the replacement of one cause of death by another (e.g., competing risks across multiple causes). Besides, certain phenomena unrelated to the pandemic (e.g., deaths due to heatwaves) can also influence results.

An initial report on excess mortality and mortality due to COVID-19 in Québec was published by the INSPQ in 2021 (7). The purpose of this document was to study the impact of the COVID-19 pandemic on total mortality in Québec by estimating the excess mortality observed between February 23, 2020, and January 2, 2021. For this period, an excess mortality of 5,400 deaths was observed, representing a 9% deviation from the expected number of deaths. The week from April 26 to May 2, 2020, saw the highest excess mortality (57%).^{1,2}

More than two years have passed since the first report on excess mortality, and five further pandemic waves have occurred, as well as a so-called period of high endemicity from September 4, 2022, to August 26, 2023. It is now recommended that COVID-19 be included in Québec's annual surveillance of respiratory viruses.

This updated data will provide a more complete picture of the consequences of the pandemic in Québec, through an analysis of excess mortality and mortality due to COVID-19 over the combined periods of the waves of the pandemic and of high endemicity.

¹ The first case of COVID-19 in Québec was reported on February 23, 2020. January 2, 2021, corresponds to the date on which deaths were available for analysis in the 2021 excess mortality report.

² Analyses were carried out using data from the Registre d'événements démographiques (RED) and the Trajectoire de santé publique (TSP) files.

2 OBJECTIVES

The first objective of this study is to estimate excess mortality in the Québec population since the emergence of COVID-19, overall and according to age group and sex. The excess mortality is then compared with mortality due to COVID-19 in order to assess the extent of excess mortality that could be explained by these deaths.³

³ In this report, the term “Mortality due to COVID-19” refers to mortality for which the underlying cause is COVID-19.

3 METHODOLOGY

3.1 Study periods

In Québec, all-cause and COVID-19 mortality data are presented for the period December 29, 2019, to September 23, 2023. The date of December 29, 2019, was chosen because it corresponds to the beginning of CDC Week 1⁴ of 2020. This means that all of 2020 is available, making it easier to compare one year with another. As for September 23, 2023, this date coincides with the end of CDC Week 38, which corresponds to the most recent data available at the time of analysis.

Data are also presented according to the different periods associated with the spread of the SARS-CoV2 virus (Table 1). These periods correspond to the different waves of the pandemic, as well as the period of high endemicity (February 23, 2020, to August 26, 2023). They have been established by the MSSS, following the INSPQ's recommendations, to facilitate communications and for statistical analysis purposes. The waves and periods were identified following the observation of a sustained increase in the percentage of COVID-19 positivity in different age groups and regions. The end of the pandemic waves and the transition to the period of high endemicity coincide with less marked fluctuations in the percentage of positive cases, but persistent active transmission. It should be noted that data are also presented by CDC year (covering CDC Weeks 1 to 52 or 53, depending on the year).

Table 1 Calendar of COVID-19 surveillance periods in Québec

Period of pandemic waves (February 23, 2020, to September 3, 2022)							Period of high endemicity	2023–2024 Season ^a
Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7		
Feb. 23, 2020	August 23, 2020	March 21, 2021	July 18, 2021	December 5, 2021	March 13, 2022	May 29, 2022	September 4, 2022	August 27, 2023
–	–	–	–	–	–	–	–	–
July 11, 2020	March 20, 2021	July 17, 2021	December 4, 2021	March 12, 2022	May 28, 2022	September 3, 2022	August 26, 2023	Ongoing

Notes: The information presented in this table comes from the Institut national de santé publique du Québec (Données COVID-19 au Québec, page Âge et sexe par vague [Online]. Québec: Institut national de santé publique du Québec. 2023 [Accessed November 6, 2023]. Available from: <https://www.inspq.qc.ca/covid-19/donnees/age-sexe>).

The period between Wave 1 and Wave 2 (July 12, 2020, to August 22, 2020) is referred to as the inter-wave period.

^a The 2023–2024 season corresponds to the new COVID-19 seasonal surveillance schedule. The gradual stabilization of the circulation of SARS-CoV-2, accompanied by fluctuations of lesser magnitude than in previous waves and during the period of high endemicity, indicates that COVID-19 has evolved towards endemic transmission.

⁴ The week numbering proposed by the CDC in the United States is used in several epidemiological studies to ensure comparability of weeks between years. CDC weeks begin on a Sunday and end on a Saturday.

3.2 Data sources

The data used in this report (observed deaths, expected deaths, and excess mortality) were produced by the ISQ from the death file of the RED of the MSSS. These data were published on the ISQ website on October 5, 2023.⁵ They are updated quarterly.⁶

Total observed deaths by age group (0–49, 50–59, 60–69, 70–79, 80–89, ≥ 90 years) and sex were extracted from the RED on September 29, 2023. It is considered definitive until 2020, while the total number of deaths observed between 2021 and 2023 is provisional. The ISQ has produced provisional data by including missing coroner's cases (using administrative data from the Bureau du coroner) and by imputing around 200 deaths outside Québec (based on previous years). The ISQ has rounded up provisional numbers to the nearest multiple of five.

As for deaths with COVID-19 as the underlying cause, they are coded by software according to the rules established by the WHO (8) and then validated by nosologists. The transmission process for certificates of death with COVID-19 as the underlying cause is now computerized, and these are available very quickly. They were extracted from the RED on October 23, 2023. Deaths in which COVID-19 was identified only as a secondary cause were not included in the analyses.

Population estimates by age group and sex for the years 2012–2022 come from Statistics Canada population estimates, and population projections for 2023 and 2024⁷ are produced by the ISQ. These data are used to calculate mortality rates and expected numbers of deaths. These estimates take account of population growth and aging.

3.3 Statistical analyses

3.3.1 Expected number of deaths

To estimate expected all-cause deaths over the period 2020–2023, the ISQ used a quasi-Poisson regression model whose parameters are specified on its [website](#) (9). This modelling takes three components into consideration:

- The secular trend in mortality rates: the reference period for adjusting expected mortality is just over seven years, from 2013 to 2019 and the first two months of 2020, in order to capture the pre-pandemic trend in mortality rates.

⁵ Estimations de surmortalité hebdomadaire selon le groupe d'âge, Québec, 2020-2023 (statistique.quebec.ca/fr/produit/tableau/4201) and Estimations de surmortalité hebdomadaire selon le sexe, Québec, 2020-2023 (statistique.quebec.ca/fr/produit/tableau/4193).

⁶ In the first report, COVID-19 deaths were taken from the *Trajectoire de santé publique* file. Since then, a revision of COVID-19-coded deaths has been carried out, and the RED has become the official source.

⁷ It is necessary to use a projection to July 1, 2024, in order to interpolate the population between July 1, 2023, and the end of 2023.

- Seasonality: normally expected deaths are estimated by taking into account seasonal fluctuations in mortality (seasonal profile for the years 2013–2019, including the first two months of 2020).
- Demographic changes: populations by age and sex are estimated for each week by interpolating population estimates as of July 1 between the years 2012 and 2024,⁸ to take account of demographic change, and more particularly the aging of the population, which tends to increase the number of deaths from one year to the next.

Note that the model excludes exceptional variations in mortality caused by exogenous variables, such as major flu epidemics, extreme heat, or other unusual events.

Regression models were fitted to weekly death data independently for each age group and sex. For each CDC week, expected numbers of deaths were obtained by age group and sex by multiplying the weekly mortality rate predicted by the model by the number of people in the corresponding population in the weeks from 2020 to 2023. For each CDC week, the expected number of deaths is presented with a 95% prediction interval. All analyses were performed using *Rstudio v4.0.2* statistical software (Rstudio Team, 2020).

For more information on the technical aspects and parameter options that have been developed for the ISQ's estimation of expected mortality, consult the [Méthodologie du modèle d'estimation de la surmortalité](#) (available in French only).

3.3.2 Calculating excess mortality

Excess mortality (or a mortality deficit) results from the difference between the observed number of deaths and the expected number. This is the excess mortality rate for all causes of death combined. This calculation was carried out for each CDC week in the study period (December 29, 2019, to September 23, 2023), for the combined period of the waves of the pandemic and of high endemicity (February 23, 2020, to August 26, 2023), the period of pandemic waves (February 23, 2020, to September 3, 2022), the period of high endemicity (September 4, 2022, to August 26, 2023), and by CDC year (2020 to 2023). Data by wave are also available in Appendix 1. Analyses were carried out for the total population, by age group, and by sex. Finally, in order to examine the relative importance of deaths with COVID-19 as the underlying cause of excess mortality, the ratio⁹ between the number of deaths with COVID-19 as the underlying cause and excess mortality was calculated.

⁸ The population for 2023 and 2024 is taken from ISQ population projections.

⁹ The ratio should be interpreted with caution: it is calculated based on data aggregated at the population level and cannot be used to establish a causal relationship between the observation of excess mortality and deaths caused by COVID-19. See the section on limitations for more details.

4 RESULTS

In this chapter, results are presented according to the following three periods of interest:

- The entire period for which data is available (between December 29, 2019, and September 23, 2023).
- Specific periods of pandemic waves and high endemicity (between February 23, 2020, and August 26, 2023).
- CDC years cover the period for which data are available (2020 to 2023).

4.1 The entire period

Figure 1 shows the number of deaths per CDC week in Québec between December 29, 2019 (CDC Week 1 of the year 2020), and September 23, 2023 (CDC Week 38 of the year 2023, the latest date for which data are available), for the entire Québec population.

The figure shows:

- Deaths with COVID-19 as underlying cause (turquoise);
- Deaths with another underlying cause (orange);
- Observed all-cause mortality (solid line);
- Expected all-cause mortality (long dotted line);
- The 95% prediction interval for expected all-cause mortality (short dotted line).

The waves that occurred in Québec during the pandemic were also identified, as was the period of high endemicity that ended in August 2023. As a complement to Figure 1, Figure 2 shows the difference between observed and expected deaths per CDC week since the beginning of the pandemic (green line), deaths with COVID-19 as the underlying cause (grey line), as well as a few isolated events that may have influenced short-term mortality.

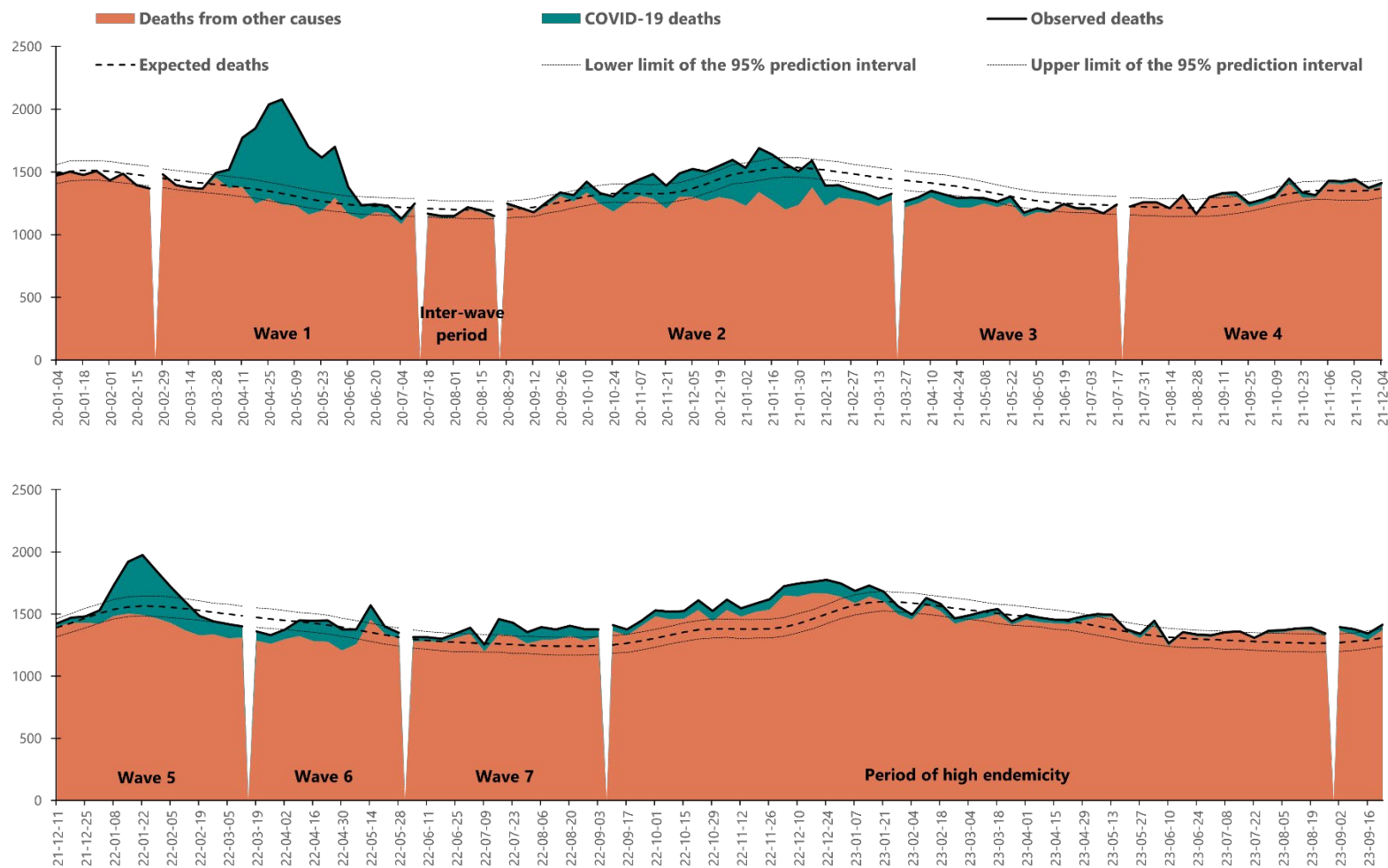
Figure 1 shows the fluctuations in deaths since January 2020. More specifically, there was a significant excess of deaths in spring 2020, coinciding with the first wave of COVID-19. This wave began rapidly after the first death having COVID-19 as the underlying cause, on March 14, 2020 (Figure 2). Figure 2 also shows a peak in excess mortality at the end of May 2020, corresponding to a heatwave from May 17 to 24, 2020, combined with high COVID-19 mortality.

A second clearly visible episode of excess mortality occurred in Wave 5. Similar to the first wave, COVID-19 appears to be the cause of a significant proportion of excess deaths. It should be noted that the excess mortality observed during this wave began approximately one month after the detection of the first case linked to the Omicron variant in Québec, on November 29, 2021.

Wave 2, which lasted seven months between August 2020 and March 2021, and Wave 6, which took place in the spring of 2022, were notable for having more deaths with COVID-19 as the underlying cause than excess deaths. Notably, these waves did not observe a significant number of excess deaths (see Table A1.1 in Appendix 1 for exact data). There is also a peak during Wave 6, from May 11 to 14, 2022, which corresponds to an early heatwave, as shown in Figure 2. Waves 3 and 4 showed little or no excess mortality. Moreover, episodes of mortality deficit were observed on several occasions, particularly at the crossroads of Waves 2–3 and 5–6. Mortality displacement may be a contributing factor: during periods marked by unusually high mortality, such as waves 1 and 5, some deaths may occur earlier than they would have in the absence of such events. This phenomenon can subsequently lead to a compensatory decline in mortality, wherein the observed death rate temporarily falls below the expected mortality threshold. The absence of circulating respiratory viruses other than SARS-CoV-2, such as influenza and RSV, in the fall and winter of 2020 and 2021, which are major contributors to deaths normally observed in fall and winter (10), could also explain the mortality deficit observed during Wave 2 and at the beginning of Wave 3.

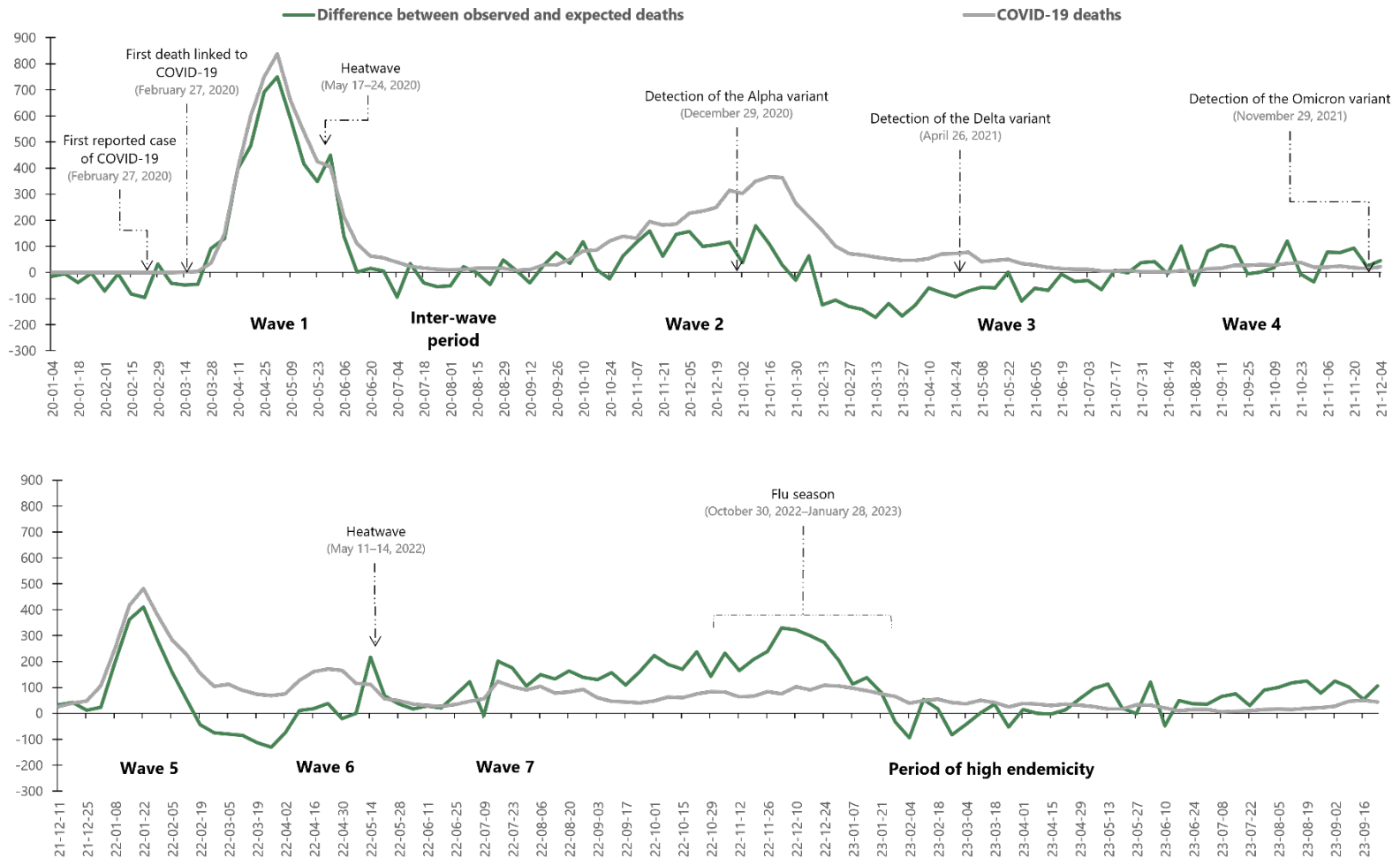
Finally, the period of high endemicity began with excess mortality and continued until the end of January 2023, but the number of deaths with COVID-19 as the underlying cause no longer seems to account for all the excess deaths. This period coincides with the return of certain respiratory viruses, including influenza and RSV, after a long period of limited circulation, which may have contributed to excess mortality.

Figure 1 Number of deaths per CDC week in Québec between December 29, 2019, and September 23, 2023



Note: The dates shown in the figure indicate the last day of each CDC week. Data for 2021 to 2023 are provisional.

Figure 2 Difference between observed and expected deaths, and number of deaths with COVID-19 as underlying cause per CDC week in Québec between December 29, 2019, and September 23, 2023



Note: The dates shown in the figure indicate the last day of each CDC week. Data for 2021 to 2023 are provisional.

4.2 Periods of pandemic waves and high endemicity

4.2.1 Results for the overall population

Between February 23, 2020 (beginning of the pandemic wave period, CDC Week 9 of 2020), and August 26, 2023 (end of the period of high endemicity, CDC Week 34 of 2023), 261,661 deaths occurred in Québec, according to data provided by the ISQ (Table 2). Based on the trend over the previous seven years, 249,110 deaths were expected over the same period.¹⁰ The number of excess deaths, obtained by subtracting the number of expected deaths from the number of observed deaths, is thus estimated at 12,551. This corresponds to a relative excess mortality of 5% and an average annual excess mortality rate of 41 per 100,000 people. For reference purposes, the relative excess mortality rate reflects the extent of the observed mortality in relation to what was expected, while the excess mortality rate, expressed on an annual basis per 100,000 people, reflects the extent of the excess mortality in relation to the Québec population.

4.2.2 Results by age group

For the same period (February 23, 2020, to August 26, 2023), the relative excess mortality varies across different age groups. Rather low in the 50–59 and 80–89 age groups (1% and 2%, respectively), it matches the overall population rate (5%) in the 90 years and older group. This is followed by people aged 60–69 and those aged 70–79, with an estimated excess mortality of 7%. Finally, the relative excess mortality rate for people under 50 is 16%. This result, which appears to be the highest in relative terms, should be interpreted with caution. This is the age group with the lowest baseline mortality, so a small increase in the number of deaths may have a greater impact than in other age groups. Other methodological considerations discussed in the section on the limitations of the analysis and in Appendix 2 may also have influenced this result.

Whereas relative excess mortality reflects the magnitude of deaths more than what was expected, focusing on the excess number of deaths provides an opportunity to consider the gross burden of mortality across different age groups. Unsurprisingly, the number of excess deaths correlates with the number of deaths normally observed by age. As a result, the number of excess deaths is higher among people aged 60 years and older. More specifically, people aged 70–79, 80–89, and 90 years and older had 4,076, 1,781, and 2,663 more deaths, respectively, than would normally be expected in these age groups.

4.2.3 Results by sex

For the period from February 23, 2020, to August 26, 2023, an analysis by sex shows an excess mortality rate of 4% for women and 6% for men. The number of excess deaths is estimated at 5,352 for women and 7,204 for men.

¹⁰ Remember that expected numbers of deaths are estimates obtained by modelling and projection. These results are thus based on an indirect statistical approach that is subject to a certain margin of uncertainty and should be interpreted as such.

4.2.4 Results for deaths with COVID-19 as the underlying cause

Deaths with COVID-19 as the underlying cause are also shown in Table 2. It is possible to estimate the relative importance of these deaths in the context of total all-cause mortality. A total of 18,263 deaths with COVID-19 as the underlying cause occurred over the entire study period, representing 7% of all-cause mortality. In comparison, the number of excess deaths mentioned above was 12,551. The number of deaths with COVID-19 as the underlying cause is highest among the oldest age groups and is similar for women and men (9,167 and 9,096, respectively).

For people aged 50–59 and 80 years and older, and for both sexes, the number of deaths with COVID-19 as the underlying cause exceeded the number of excess deaths (ratio of COVID-19 deaths to excess mortality > 1) over the entire period. This result, which seems to indicate that COVID-19 is mainly responsible for excess mortality, should be interpreted with caution because this measure is influenced by various factors, including fluctuations in other causes of death and estimates of expected deaths. The limitations of this measure are discussed in detail in Section 5.4. For people under the age of 50, the number of deaths with COVID-19 as the underlying cause is much lower than the number of excess deaths (ratio of 0.1). In the 60–69 and 70–79 age groups, this ratio is 0.6 and 0.9, respectively.

Table 2 Observed deaths, expected deaths, and excess mortality by age group and sex, for the period from February 23, 2020, to August 26, 2023, Québec

Characteristics	Observed deaths* (N)	Expected deaths* (N)	Excess mortality* (N)	Relative excess mortality	Excess mortality rate* (per 100,000 people)	Observed deaths COVID-19 (N)	Deaths COVID-19/ Excess mortality* (ratio)
Calculation formulae	A	B	A–B	$((A-B)/B) * 100$	$((A-B)/\text{population}) * 100,000$	C	C/(A–B)
Total population	261,661	249,110	12,551	5.0%	41.2	18,263	1.5
Age group							
< 50 years	11,335	9,813	1,522	15.5%	8.5	160	0.1
50–59 years	13,444	13,266	178	1.3%	4.4	387	2.2
60–69 years	35,995	33,604	2,391	7.1%	57.7	1,310	0.6
70–79 years	62,348	58,272	4,076	7.0%	146.0	3,616	0.9
80–89 years	80,841	79,060	1,781	2.3%	147.5	7,030	4.0
≥ 90 years	57,758	55,095	2,663	4.8%	864.2	5,760	2.2
Sex							
Women	130,497	125,145	5,352	4.3%	35.2	9,167	1.7
Men	131,169	123,965	7,204	5.8%	47.3	9,096	1.3

Notes: Data for 2021–2023 are provisional; *Refers to all-cause mortality.

4.2.5 Comparison of periods of pandemic waves and high endemicity

The period of pandemic waves begins on February 23, 2020, and ends on September 3, 2022, and includes the seven waves of COVID-19 as well as the intervening period between Waves 1 and 2 (Table 1). During this period, 185,106 deaths occurred in Québec, according to data provided by the ISQ (Table A1.1 in Appendix 1). The expected number of deaths calculated for the same period, based on the previous seven years, was 177,542. Excess mortality, obtained by subtracting the number of expected deaths from the number of observed deaths, is estimated at 7,564 deaths, or 4%.

This is followed by the period of high endemicity (September 4, 2022, to August 26, 2023), with a total of 76,555 deaths. The expected number of deaths estimated for the same period, based on the previous seven years, was 71,568, representing an excess mortality of 4,987 deaths, or 7%.

Overall, a higher percentage of all-cause excess mortality is observed for the period of high endemicity, compared with the period of pandemic waves. It is worth noting that the period of high endemicity shows very little mortality deficit compared with the period of pandemic waves. Furthermore, the number of deaths with COVID-19 as the underlying cause was much lower during the period of high endemicity (2,370 deaths, or 3% of all deaths) than during the period of pandemic waves (15,893 deaths, or 9% of all deaths). This means that excess mortality during the period of high endemicity can be explained, among other things, by an increase in other causes of death.

This pattern is also observed within younger age groups. In the under-50 age group, a relative excess mortality of 25% was observed during the period of high endemicity, compared with 12% during the period of pandemic waves. In the 50–59 age group, excess mortality is 5% for the period of high endemicity, while no excess mortality is observed for the period of pandemic waves. In the 60–69 and 70–79 age groups, the percentages are 12% and 11%, respectively, whereas during the pandemic waves, they were approximately 5% and 6%. Thus, it appears that excess mortality is increasing over time in these age groups, even though SARS-CoV-2 transmission has now become endemic in Québec. In the oldest age groups (those aged 80–89 and 90 years and older), excess mortality rates of 2% and 5%, respectively, were observed for the period of high endemicity, compared with 3% and 5% for the period of pandemic waves. Unlike younger age groups, these groups do not show higher relative excess mortality during the period of high endemicity compared with the period of pandemic waves.

4.3 CDC years

4.3.1 Results for the population as a whole

The data presented in Table 3 provide an overview of excess mortality by CDC year.¹¹¹² Looking at the total population, there is greater variability in deaths between 2020 and 2023 than what would have been expected in the absence of a pandemic. It is important to note that the mortality data for 2023 extends only through September 23, 2023; therefore, a lower number of recorded deaths is to be expected. Excess mortality is observed in the years 2020 (7%), 2022 (9%), and 2023 (3%). Only the year 2021 shows no excess mortality (–1%). The years 2020 and 2021 have the distinction of presenting more deaths with COVID-19 as the underlying cause than excess deaths, while the opposite is true for the years 2022 and 2023. As previously indicated, these results, based on the ratio of COVID-19 deaths to excess deaths, should be interpreted with caution, given that this measure is influenced by various factors, including fluctuation in other causes of death and estimates of expected deaths (see Section 5.4 on limitations).

4.3.2 Results by age group

The results by age group, reported in Table 3 and illustrated in Figure 3, show relative excess mortality for each CDC year, and an upward trend in excess mortality in the 0–49 age group, from 8% to 23% between 2020 and 2023.¹³

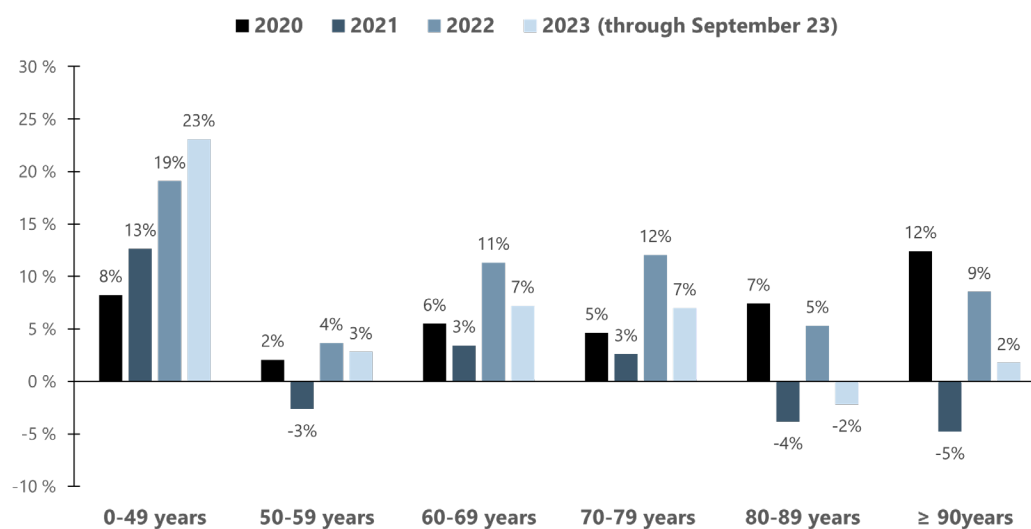
In the 50–59 age group, excess mortality fluctuated between –3% and 4% over the four CDC years considered. The 60–69 and 70–79 age groups show a similar relative excess mortality for the years 2020 to 2023, with a trough in 2021 and a peak of around 12% in 2022. Among people aged 80–89, excess mortality is observed in 2020 (7%) and 2022 (5%), while a mortality deficit is recorded in 2021 (–4%) and 2023 (–2%). Finally, people aged 90 years and older register excess mortality in all years except 2021. Proportionally, it ranges from 12% (2020) to 2% (2023) in this age group.

¹¹ The 2020 CDC year begins on December 29, 2019, and the most recent data available for the 2023 CDC year at the time of ISQ data production ends on September 23, 2023

¹² Aggregated death data for each wave, inter-wave period, period of pandemic wave, and period of high endemicity are also available in Appendix 1.

¹³ As discussed in the text on limitations and in Appendix 2, these results should be interpreted with caution.

Figure 3 Excess mortality as % by age group and CDC year, Québec



Note: Data for 2021 to 2023 are provisional.

Table 3 Observed deaths, expected deaths, and excess mortality by age group and sex, by CDC year, Québec

CDC year	Observed deaths* (N)	Expected deaths* (N)	Excess mortality* (N)	Relative excess mortality	Excess mortality rate* (per 100,000 people)	Observed deaths COVID-19 (N)	Deaths COVID-19/ Excess mortality* (ratio)
Total population							
2020	75,911	70,744	5,167	7.3%	59.1	7,965	1.5
2021	69,725	70,329	-604	-0.9%	-7.0	3,286	-
2022	78,165	71,817	6,348	8.8%	73.0	5,883	0.9
2023 [†]	55,035	53,326	1,709	3.2%	26.7	1,299	0.8
< 50 years							
2020	3,191	2,948	243	8.2%	4.7	42	0.2
2021	3,150	2,796	354	12.6%	7.0	60	0.2
2022	3,275	2,750	525	19.1%	10.3	52	0.1
2023 [†]	2,450	1,991	459	23.1%	12.2	7	0.0
50-59 years							
2020	4,166	4,082	84	2.1%	7.0	128	1.5
2021	3,730	3,831	-101	-2.6%	-8.7	114	-
2022	3,825	3,690	135	3.7%	11.9	135	1.0
2023 [†]	2,675	2,602	73	2.8%	9.0	13	0.2
60-69 years							
2020	10,358	9,817	541	5.5%	46.2	457	0.8
2021	9,905	9,575	330	3.4%	28.2	327	1.0
2022	10,655	9,570	1,085	11.3%	91.2	462	0.4
2023 [†]	7,440	6,940	500	7.2%	56.8	76	0.2
70-79 years							
2020	17,308	16,542	766	4.6%	99.7	1,462	1.9
2021	16,900	16,470	430	2.6%	54.9	733	1.7
2022	18,815	16,790	2,025	12.1%	249.9	1,183	0.6
2023 [†]	13,340	12,469	871	7.0%	143.0	272	0.3
80-89 years							
2020	23,811	22,166	1,645	7.4%	493.7	3,184	1.9
2021	21,320	22,170	-850	-3.8%	-252.0	1,158	-
2022	24,100	22,884	1,216	5.3%	347.8	2,256	1.9
2023 [†]	16,910	17,286	-376	-2.2%	-141.7	507	-
≥ 90 years							
2020	17,077	15,190	1,887	12.4%	2,259.3	2,692	1.4
2021	14,745	15,486	-741	-4.8%	-859.5	894	-
2022	17,510	16,132	1,378	8.5%	1,529.5	1,795	1.3
2023 [†]	12,250	12,038	212	1.8%	312.0	424	2.0
Women							
2020	38,224	35,580	2,644	7.4%	60.5	4,247	1.6
2021	34,425	35,351	-926	-2.6%	-21.5	1,594	-
2022	38,805	36,067	2,738	7.6%	63.1	2,765	1.0
2023 [†]	27,705	26,800	905	3.4%	28.3	635	0.7
Men							
2020	37,687	35,164	2,523	7.2%	57.8	3,718	1.5
2021	35,275	34,977	298	0.9%	6.9	1,692	-
2022	39,370	35,749	3,621	10.1%	83.2	3,118	0.9
2023 [†]	27,360	26,526	834	3.1%	26.0	664	0.8

Notes: Data for 2021 to 2023 are provisional; *Refers to all-cause mortality; †Partial year to September 23, 2023 (CDC Week 38).

Table 3 shows excess mortality rates per 100,000 people per CDC year from 2020 to 2023, by age group. Ratios provide a more standardized picture by relating excess mortality to the population of each age group. Thus, we see that people aged 90 years and older appear to have the highest excess mortality rates in 2020, 2022, and 2023. They are followed by people aged 80–89 for 2020 and 2022. As already shown by the percentage of excess mortality (Figure 3), people aged 70–79 are more affected by excess mortality from 2022 onwards than in previous years. While the 40–49 age group shows one of the highest relative excess mortality rates between 2020 and 2023, accounting for their large population size in the rate calculations reveals that their overall excess mortality rate is among the lowest, comparable to that of the 50–59 age group. Still, the trend appears to be slightly more pronounced in people aged 0–49, with excess mortality rising from 5 to 12 per 100,000 between 2020 and 2023.

Relating deaths with COVID-19 as the underlying cause to excess deaths (Table 3), we observe that the relative importance of COVID-19-related deaths to excess mortality is lowest in the under-50 age group. Deaths with COVID-19 as the underlying cause are also lower than excess deaths for all years except 2022 in the 60–69 age group. However, COVID-19 accounts for a significant proportion of excess mortality in the 50–59 age group in 2020, in the 70–79 age group in 2020 and 2021, in the 80 years and older age groups in 2020 and 2022, and in the 90 years and older age group in 2023. For a detailed view of Figure 1 for each age group, see Figures A1.1 to A1.6 in Appendix 1.

4.3.3 Results by sex

Regarding results by sex, excess mortality has evolved similarly for both men and women between 2020 and 2023. In 2020, it was around 7% for both sexes, increasing to 8% for women and 10% for men in 2022, and declining to 3% for both sexes in 2023. In 2021, women experienced a mortality deficit (–3%), while men experienced excess mortality (1%). Looking at the relative importance of deaths with COVID-19 as the underlying cause in excess mortality, the trend is also similar, with a greater relative importance of COVID-19-related deaths in the first year of the pandemic. For a detailed view of Figure 1 repeated for each sex, see Figures A1.7 to A1.8 in Appendix 1.

5 DISCUSSION

5.1 Excess mortality in Québec from 2020 to 2023

During the pandemic waves and the period of high endemicity studied, 12,551 deaths more than what was normally expected were estimated for Québec, corresponding to a deviation of 5%. As a reminder, 5,400 excess deaths had been estimated, for an excess mortality of 9%, during the period studied in the first report (February 23, 2020, to January 2, 2021) (7). For the main methodological differences between the two reports, see Appendix 3.¹⁴

Excess mortality, which was particularly high during the first wave of the pandemic (16%, Table A.1.1), varied according to age group. As the results of the previous report, the most recent studies have also highlighted a higher mortality rate among people aged 80 years and older at the beginning of the pandemic. However, people under 50 years of age stand out for all periods of pandemic waves and high endemicity, with an upward trend in relative excess mortality emerging between 2020 (8%) and 2023 (23%). According to estimates by sex, the relative excess mortality appears to be slightly lower for women (4%) than for men (6%) and has evolved fairly similarly between 2020 and 2023.¹⁵

Deaths with COVID-19 as the underlying cause account for most of the excess mortality observed from 2020 to 2022, particularly at the height of Waves 1 and 5. However, nuances are observed depending on the year or age group. Thus, the number of deaths with COVID-19 as the underlying cause explains very little of the excess mortality in the 0–49 age group, while the opposite situation is observed in the 80–89 age group. In more recent years, the scale of deaths with COVID-19 as the underlying cause appears to be less significant in relation to excess mortality, particularly in the fall of 2022 (beginning of the period of high endemicity). The same is true for both sexes.

5.2 Excess mortality in Québec, other Canadian provinces, and around the world

According to results from Statistics Canada compiled by the ISQ (11,12), an excess of all-cause mortality was observed from March 2020 to December 2022 in Québec, as in the other Canadian provinces. Excess mortality over this period varies from east to west. Although this excess mortality affected the provinces at different times over the period studied, the Atlantic provinces had a lower excess mortality (5%) than the other provinces. Next in line are Québec, with 6% excess mortality,¹⁶ and Ontario, with 9%. The highest excess mortality is found in the western provinces (Alberta, 14%; Saskatchewan and British Columbia, 15%). It should be noted that the excess mortality rate in Canada, excluding Québec, is 11%.

¹⁴ Between February 23, 2020, and August 26, 2023.

¹⁵ See Section 5.4 on limitations for a better understanding of why these results should be interpreted with caution.

¹⁶ The 6% relative excess mortality for Québec is estimated by the ISQ.

Comparing excess mortality in Québec with that of other countries remains challenging, given the absence of methodological standards for estimating expected deaths, which form the basis for excess mortality calculations. However, according to the ISQ (12,13), it is possible to compare Québec's results with those of a selection of countries that provide estimates using comparable methods. For the period between March 2020 and December 2022, according to the World Mortality Dataset, excess mortality in Québec (6%) compares favourably with most countries in the OECD. It is similar to that of Australia (5%), Norway (6%), and Sweden (6%), considering the margin of uncertainty of around $\pm 1\%$ that surrounds these estimates. Japan and Denmark, on the other hand, had a lower excess mortality rate over the period studied (3%). Meanwhile, New Zealand (-0.3%) showed a slight mortality deficit over the entire period. Conversely, the United States (16%), Italy (14%), and Spain (12%) had the highest excess mortality rates among OECD countries over the period studied.

5.3 What trends emerge from the evolution of excess mortality in Québec?

As mentioned above, excess mortality captures both the direct and indirect effects of the pandemic on mortality. It is still too early to identify all the factors (demographic, epidemiological, political) that may have played a role in the evolution of excess mortality in Québec. Furthermore, certain effects, such as social repercussions (14), can only be reflected over the long term. It is also possible that the multiple factors influencing mortality are too complex and interrelated to be isolated, therefore limiting the ability to provide a comprehensive explanation. However, the emerging literature on the subject, as well as the context, does suggest some conjectures that merit further study.

5.3.1 The demographic and epidemiological conjecture

From the beginning of the pandemic to the end of the sixth wave (May 28, 2022), there were clear periods of high and low mortality. Each long-lasting trend of excess mortality was followed by an episode of mortality deficit, which could be explained in part by a mortality displacement or by the low circulation of respiratory viruses other than SARS-CoV-2. The mortality displacement is observed more quickly when the affected population is vulnerable, and therefore likely to die in the short or medium term from other causes. This was the case in Québec after the first and second waves, during which most deaths occurred among seniors living in Centres d'hébergement et de soins de longue durée (CHSLD) or Résidences privées pour aînés (RPA). As of May 25, 2020, Québec was among the Canadian provinces—along with Ontario, Alberta, and Nova Scotia—where long-term care residents accounted for over 70% of all deaths with COVID-19 as the underlying cause (15). Québec is also the province with the highest proportion of people aged 65 and over in long-term care (15). In addition, more women live in these settings, which probably explains the slightly higher excess mortality observed among women (18% versus 15% among men; see Appendix 1) in the first wave (16).

After the first wave, men generally show a slightly higher excess mortality than women. The fact that they suffer from more comorbidities than women could be an avenue worth exploring (17).

People aged 70–79 also stand out with the highest number of excess deaths since 2021. This result is not surprising, given that the first cohorts of the baby-boomer generation are to be found in this age group, which to this day remains the largest in the Québec population (2). We can therefore expect the number of deaths to be higher in this age group. The fact remains, however, that if we look at excess mortality rates by age, it is the oldest people—those aged 90 years and older—who have been most affected over the whole period.

One of the epidemiological factors that may support the contribution of COVID-19 to excess mortality during the pandemic is the frequent mutations in the SARS-CoV2 virus genome, more commonly known as variants, leading to changes in the virus' characteristics. Certain variants that emerged during the pandemic are associated with an increased transmissibility, virulence, or even COVID-19 vaccine or treatment escape. The Alpha (B.1.1.7) and Delta (B.1.617.2) variants, which reached Québec in December 2020 and April 2021, respectively, appear to have had little impact on excess mortality across Québec (Figure 2). However, the arrival of the Omicron variant (B.1.1.529) at the end of November 2021 was followed by the fifth wave, during which excess mortality peaked at 26%. The unprecedented transmissibility of this variant resulted in an explosion in the number of cases and, consequently, in deaths with COVID-19 as the underlying cause.

Up until Wave 6, periods of excess mortality in Québec were often characterized by numbers of deaths with COVID-19 as the underlying cause exceeding the number of excess deaths, particularly among people aged 80 years and older. It is possible that the introduction of measures to curb transmission of COVID-19 may have halted the circulation of influenza and other respiratory viruses other than SARS-CoV-2, which had been virtually absent in 2020 and 2021. In addition, the implementation of these measures may have contributed to lower mortality for other reasons, such as traffic accidents due to reduced road traffic (18–20) and reduced air pollution following the closure of factories, schools, and shops (21). Finally, the strict application of the criteria for selecting the underlying cause of death, as established by the WHO (8) at the beginning of the pandemic, may have resulted in some deaths being classified "COVID-19 as the underlying cause" when the virus was only involved as a contributory (secondary) cause. These reasons, as well as the harvesting effect discussed in the first paragraph, may explain why excess mortality is often lower for deaths with COVID-19 as the underlying cause.

At the beginning of the period of high endemicity (from September to December 2022), observed deaths were much higher than expected. This season was characterized by persistent excess mortality, which peaked at 24% during the week of December 3, 2022. Several respiratory viruses may have contributed to this phenomenon, in particular: SARS-CoV-2 (22), influenza (23,24), and RSV (23).

After the fall of 2022, mortality returned to the level expected in the winter of 2023. However, from the end of July 2023 to the end of the study period (September 23, 2023), excess mortality was around 8%. Based on the underlying cause of death data for this period, COVID-19 would explain only a small part of this excess mortality, as in the fall of 2022. A closer look by cause of death for each age group and sex would certainly reveal more.

5.3.2 The public health measures conjecture

In the context of the pandemic, numerous measures have been implemented to limit transmission and the demand for care, as well as to reduce pressure on health services. These measures range from health advice and information (hand hygiene, disinfection, distancing) to public health actions (vaccination), regulatory or legislative measures (ban on gatherings, confinement, school closures, curfews), and economic measures (income support, emergency loans). A growing body of work is now attempting to determine and evaluate the effects of these different measures.

For example, it is possible that lockdown measures and reduced access to services have amplified the sense of isolation among some Québécois, with negative effects on mental health, as various studies have concluded (25–27). Other studies point to the postponement of services, such as delayed surgeries (28) or delayed diagnoses, as collateral impacts of the pandemic that could have an adverse effect on population mortality (29). An overburdened healthcare system, including fatigued and sick staff, and a lack of availability of resources and equipment, may also have had an adverse indirect impact on mortality (18,29). Finally, any consequences on lifestyle habits, behaviours, and mental health that could lead to increased mortality in the longer term will also need to be further investigated.

However, caution must be exercised regarding this literature. Several of these studies use the “interrupted time series” approach, whose methodological limitations are well documented (30,31). Although these series can be used to evaluate public health interventions at a population level (32,33), several conditions are necessary in order to measure their impact on health outcomes. Additional constraints are also present when assessing effects on infectious diseases (34). The fact that excess mortality is the product of the interaction of several components, each affected differently by interventions, adds another layer to this complex picture. Further work, necessary to better understand the long-term impacts of the events of recent years on the present and future health of the people of Québec, will need to take these factors into account.

5.3.3 The Québec social conjecture

Another repercussion observed during the pandemic was the uneven effect of its impact on the health and mortality of the most vulnerable groups, compared with the general population (35,36) and the amplification of social inequalities in health. In a summary of evidence to support COVID-19 public health measures, the Government of Canada mentioned that socioeconomic determinants have an impact on SARS-CoV-2 transmission, particularly in

vulnerable populations and those facing inequalities (37). As early as March 2020, the Canadian Human Rights Commission, along with the Observatoire québécois des inégalités, reported on the additional difficulties that could affect people in vulnerable situations¹⁷ during the pandemic (access to services, social support, overcrowding and housing conditions, poverty, violence, etc.) (38.39). In addition, a report by the Public Health Agency of Canada (40) found higher COVID-19 mortality rates among socially and economically disadvantaged Canadians (for the period January 1, 2020, to March 31, 2021).¹⁸

As of May 16, 2020, in Montreal, the number of people with COVID-19 was higher in the island's disadvantaged areas, and the gap with the more affluent areas was widening (41). Among the reasons for the differences observed in Montreal, cramped housing and building population density, unfavourable living conditions, limited access to outdoor areas, and a high presence of exposed essential workers (41) were mentioned.

These few observations, which are in line with a number of international studies (42–46), seem to indicate that the pandemic has exacerbated the existing vulnerabilities impacting people's health. Conversely, the effect of the social safety net on people's health and resilience is also well documented, including during health and social crises (47–52). A more comprehensive look at the social determinants of health would provide a basis for understanding their effects on mortality in the Québec population, during and after the pandemic.

5.4 Study limitations

As the timeframe for this study was very tight, compromises were made to produce the most comprehensive report possible based on data available in October 2023.

For instance, only prediction intervals per CDC week could be calculated; aggregated prediction intervals for periods (e.g., whole period, years, waves) are not available. This measure of uncertainty would have made it possible to assess the temporal evolution of excess mortality and to compare groups more objectively. It should be noted, however, that there is as yet no standard method for estimating the variability associated with estimates produced by excess mortality models (53).

¹⁷ The groups in vulnerable situations mentioned by the Commission are people with disabilities, Indigenous people, children, people with housing needs or experiencing food insecurity, women and children fleeing violence, single-parent families, the LGBTQ2I community, people needing medical treatment in Canada, the elderly, and people held in correctional facilities.

¹⁸ The variables examined are sex, residency in a large city, income, dwelling type, household type, and household size. Neighbourhoods that may be disadvantaged by systemic racism and inequality (a combination of four variables) were also examined.

Care must also be taken when interpreting the ratio of deaths with COVID-19 as the underlying cause to excess deaths. A high ratio does not necessarily mean that COVID-19 alone explains the observed excess mortality. This measure is influenced by several factors. These include the number of deaths with COVID-19 as the underlying cause, which may have varied according to changes in screening practices and reporting on certificates of death. The measure of the ratio is also influenced by fluctuations in other causes of death and estimates of excess mortality. An analysis of the distribution of the various causes of death, including COVID-19, among all deaths would provide a more accurate picture of how mortality evolved during the pandemic and a better understanding of the role played by each cause.

The choice of period for calculating excess mortality influences its level. The first death occurred on March 14, 2020. Excess mortality, estimated at 7% for the whole of 2020, is in fact 9% if we begin the analysis on February 23, 2020, which is the start date of the first wave. It is even higher if we begin the period on March 8, 2020, the CDC week in which the first death occurred (10%). This demonstrates the importance of making the most objective choices possible when carrying out analyses and of clearly indicating the periods selected. Finally, the number of deaths is only known up to September 23, 2023, so the excess mortality estimates presented for the year 2023 are obtained using the period from January 1 to September 23, 2023. Moreover, the further away we are from the pre-pandemic reference period, the more sensitive the estimates of excess mortality are to the hypotheses made and the choice of model parameters. The estimate of excess mortality should therefore be more accurate for 2020 than for 2023.

As previously mentioned, the estimates produced for people under 50 should be interpreted with caution. The current parameters of the excess mortality model and the uncertainty surrounding the evolution of the 0–49 age group could underestimate expected mortality and, consequently, amplify excess mortality in this age group. In addition, the pre-pandemic mortality trend in this age group could be influenced by a stabilization of mortality observed at the end of the reference period used (2016–2019), making the modelling of the expected number of deaths more sensitive to the underlying hypotheses of the model. The various issues affecting data interpretation in this age group are detailed in Appendix 2.

COVID-19 has rekindled interest in analyzing excess mortality to measure the direct and indirect consequences of certain public health phenomena. However, there are no methodological standards for calculating expected deaths. Model development, parameter settings choices, and the data entered into the model can all have an impact on the estimates produced, making comparisons between territories difficult (53). Thus, caution should be exercised when comparing excess mortality estimates between different entities that have used different models, and systematic comparisons based on a uniform method should be sought instead. In other words, it must be understood that the data produced are estimates obtained using an indirect approach and must be interpreted as such.

6 CONCLUSION

The arrival of the COVID-19 pandemic, in Québec and elsewhere, has shaken the historically observed trend in mortality, a trend usually considered predictable since it varies relatively little. As initially noted in the results of the 2021 report, this study confirms that excess mortality has been observed in Québec since the beginning of the pandemic. It is noted that this excess mortality resurges cyclically, peaking during the first and fifth waves, which appear to be primarily explained by deaths due to COVID-19. We also note that, since the beginning of the period of high endemicity in August 2022, excess mortality has persisted, but the role of COVID-19 is more uncertain.

The limitations identified in this report demonstrate the work that remains to be done to perfect the models used to produce estimates of excess mortality, as well as the value of considering different approaches, including the examination of excess mortality by cause of death and regional analysis, which would provide a complete and more in-depth picture of mortality trends in Québec.

Various conjectures have also been mentioned, and it is only over time, through further work and in light of the emerging literature, that an understanding of what happened in Québec during this atypical period will gradually emerge.

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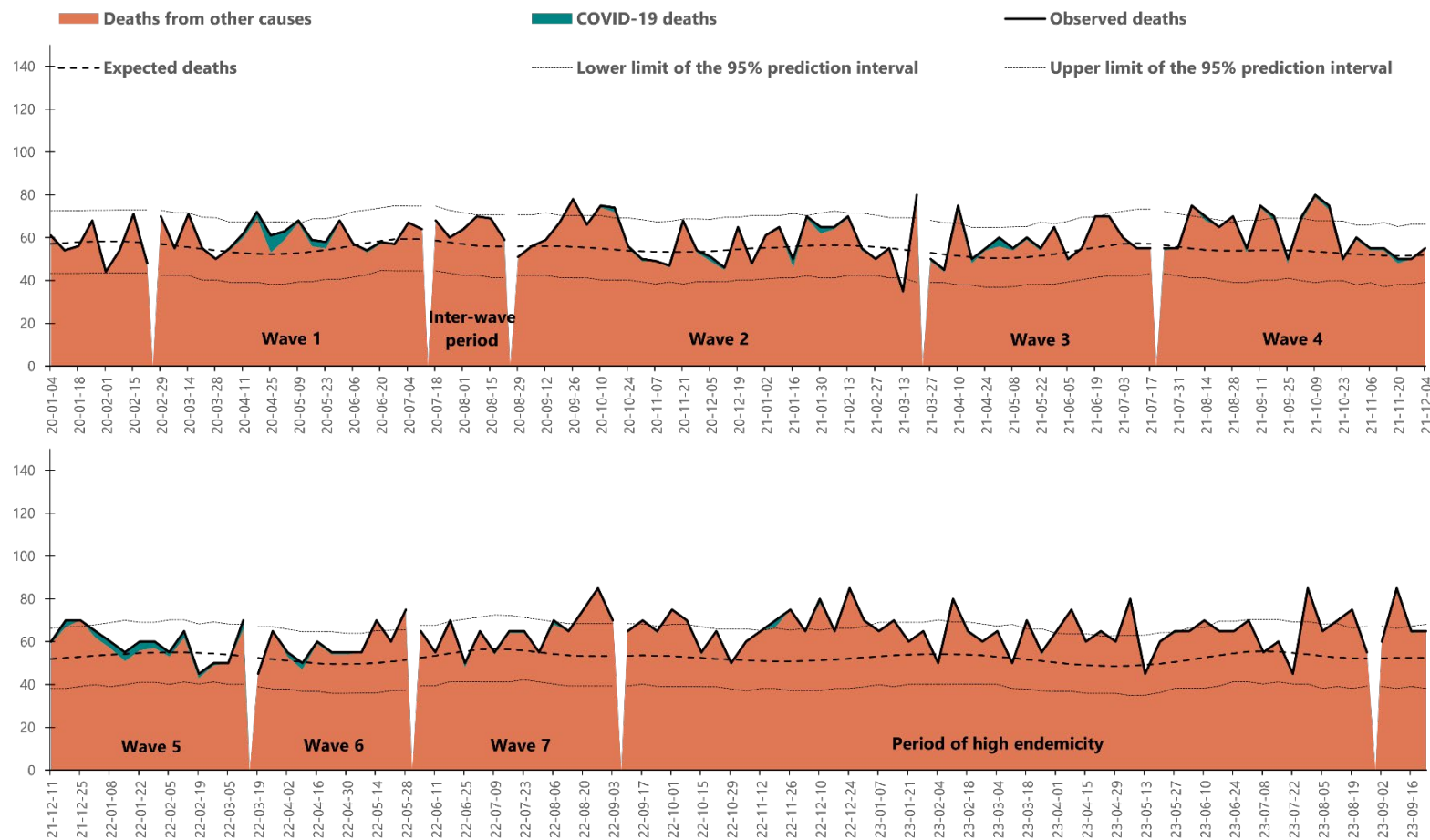
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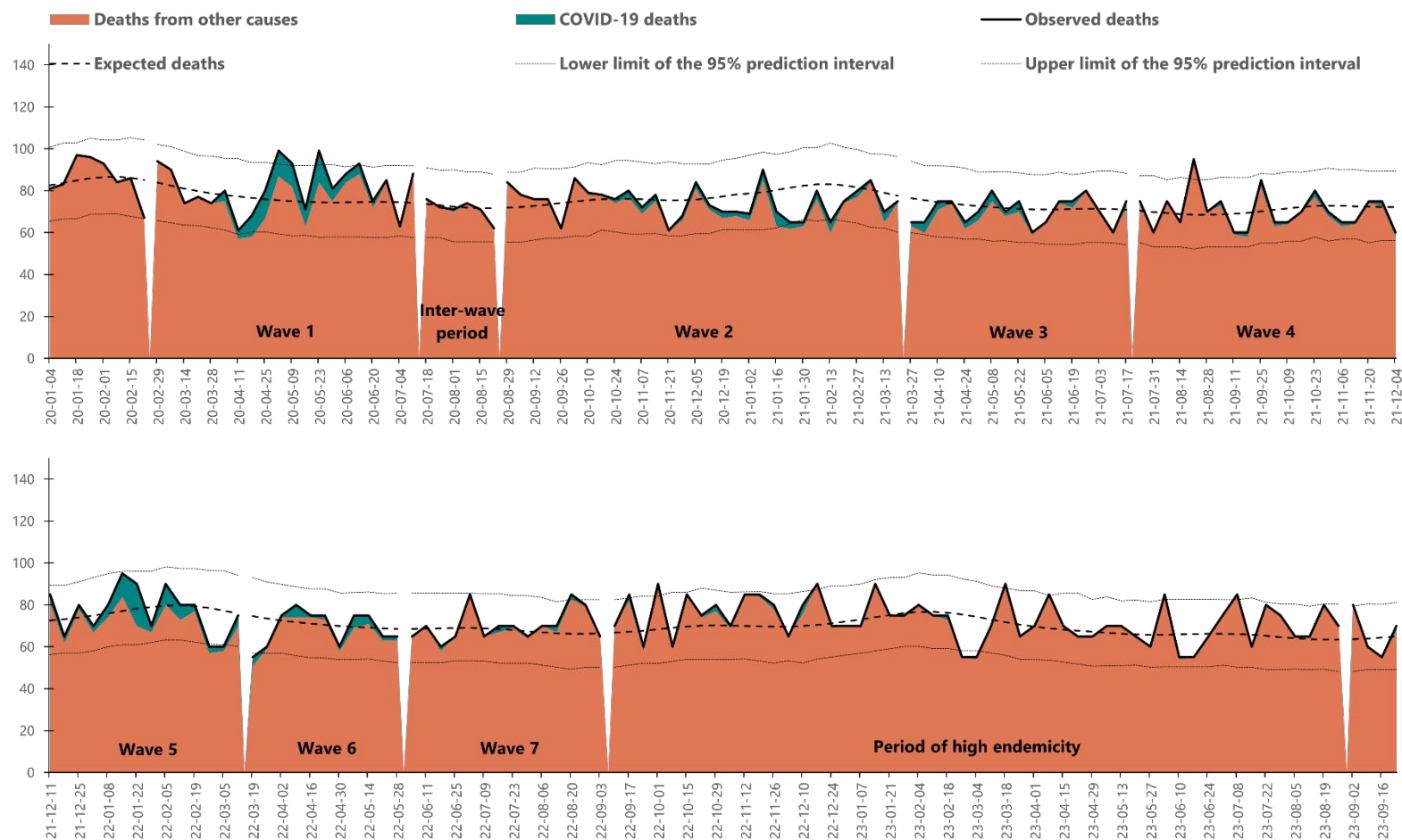
APPENDIX 1 SUPPLEMENTARY RESULTS

Figure A1.1 Number of deaths per CDC week in the 0-49 age group in Québec between December 29, 2019, and September 23, 2023



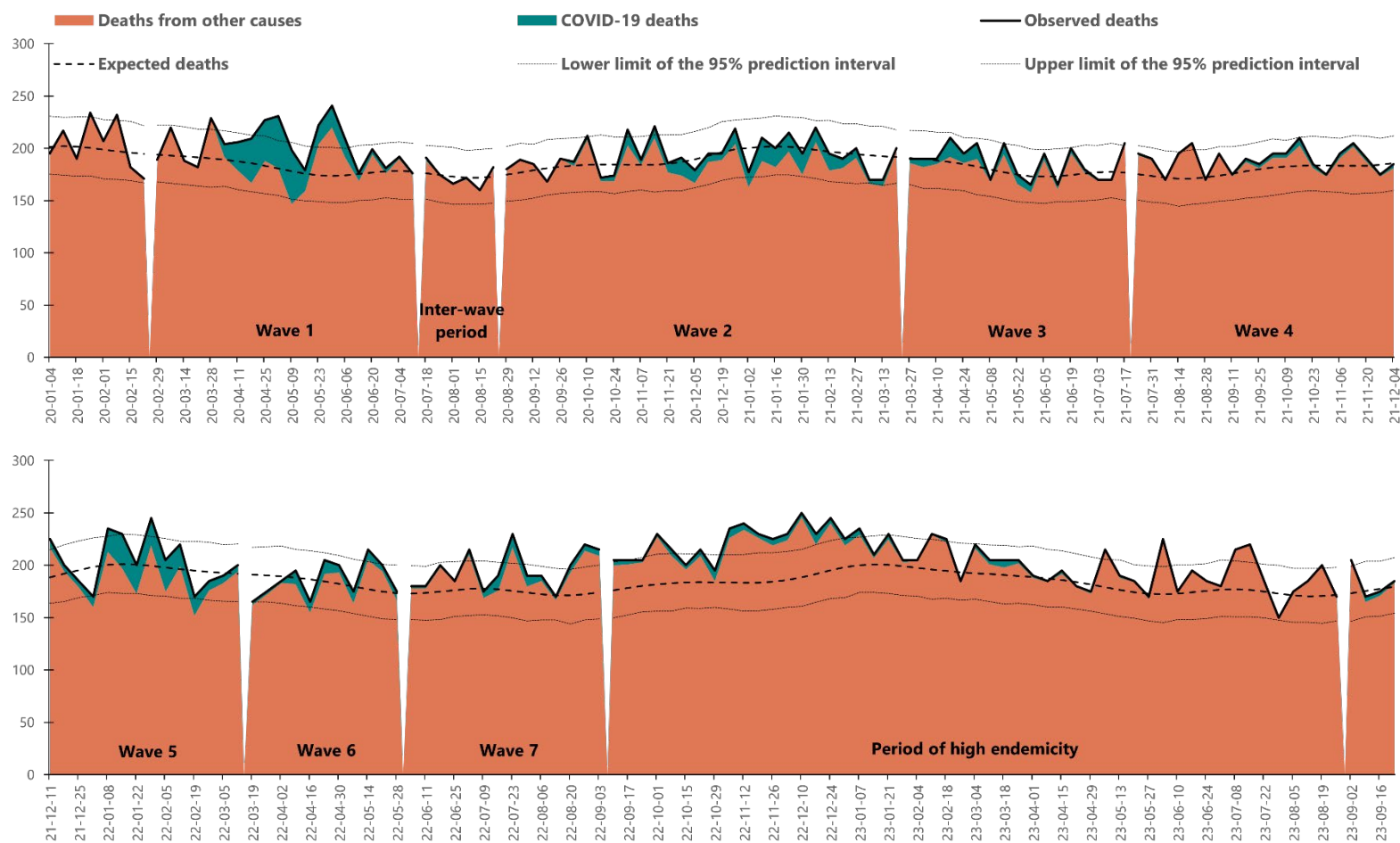
Notes: The dates shown in the figure indicate the last day of each CDC week. Data for 2021 to 2023 are provisional.

Figure A1.2 Number of deaths per CDC week in the 50-59 age group in Québec between December 29, 2019, and September 23, 2023



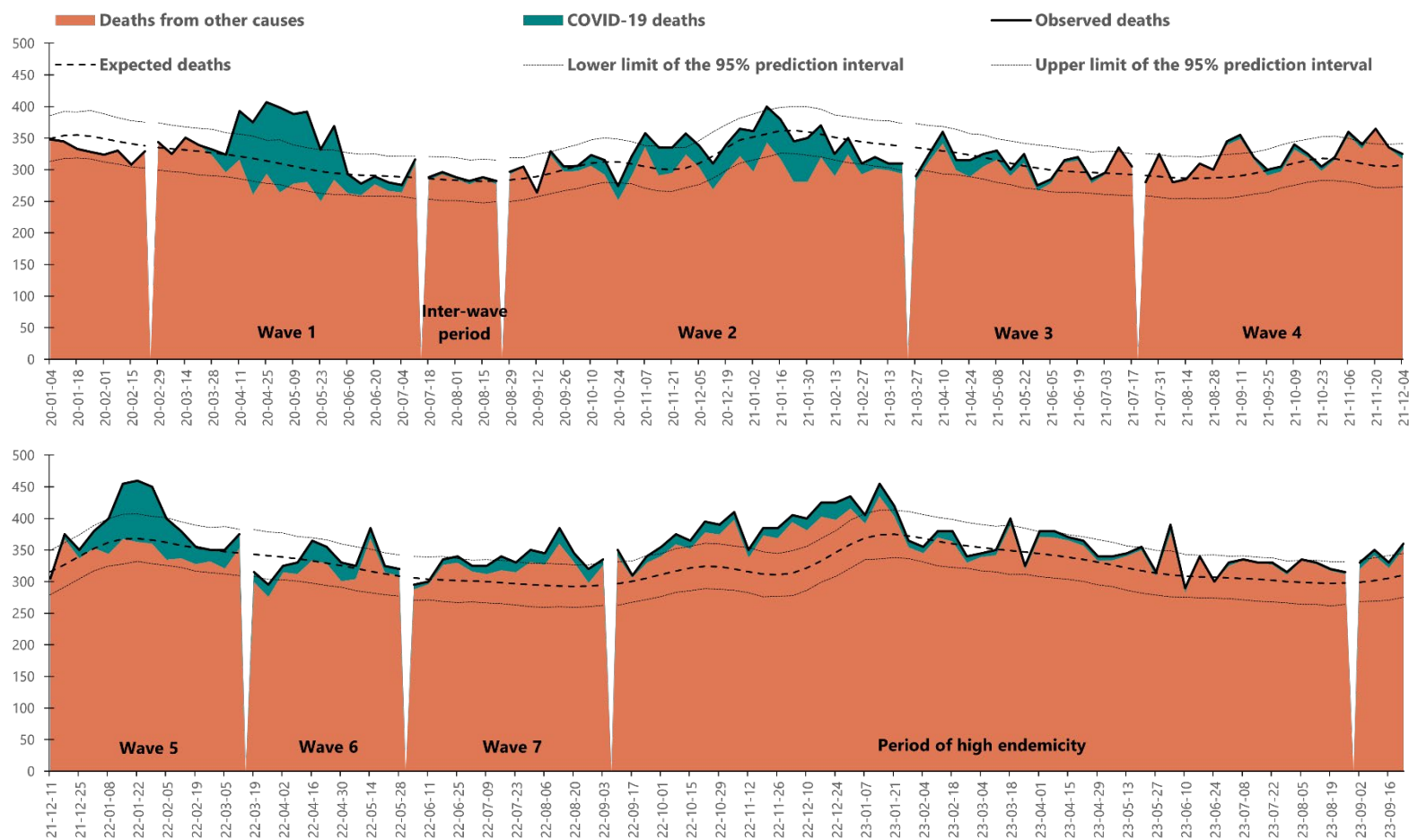
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Figure A1.3 Number of deaths per CDC week in the 60-69 age group in Québec between December 29, 2019, and September 23, 2023



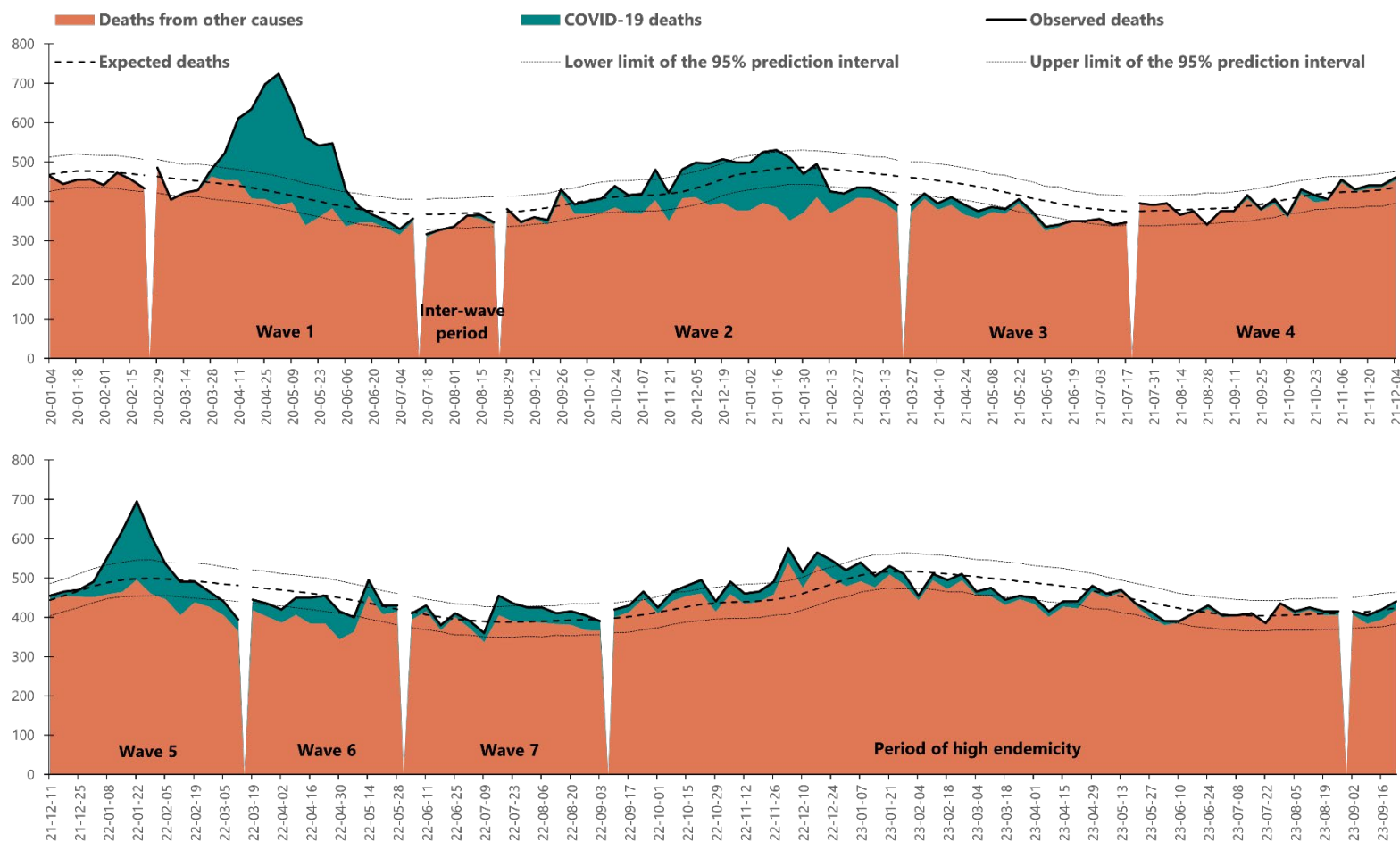
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Figure A1.4 Number of deaths per CDC week in the 70-79 age group in Québec between December 29, 2019, and September 23, 2023



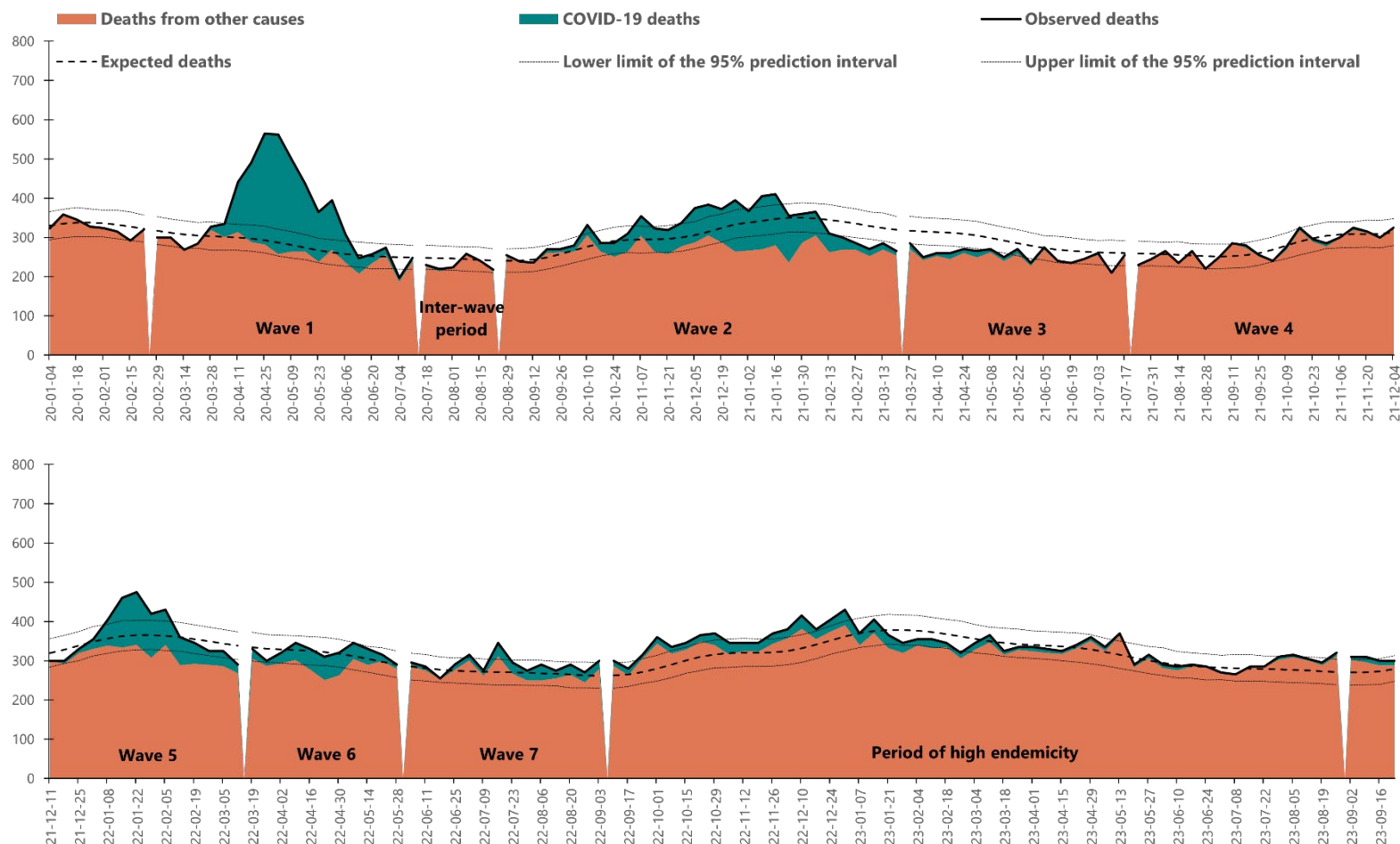
Notes: The dates shown in the figure indicate the last day of each CDC week. Data for 2021 to 2023 are provisional.

Figure A1.5 Number of deaths per CDC week in the 80-89 age group in Québec between December 29, 2019, and September 23, 2023



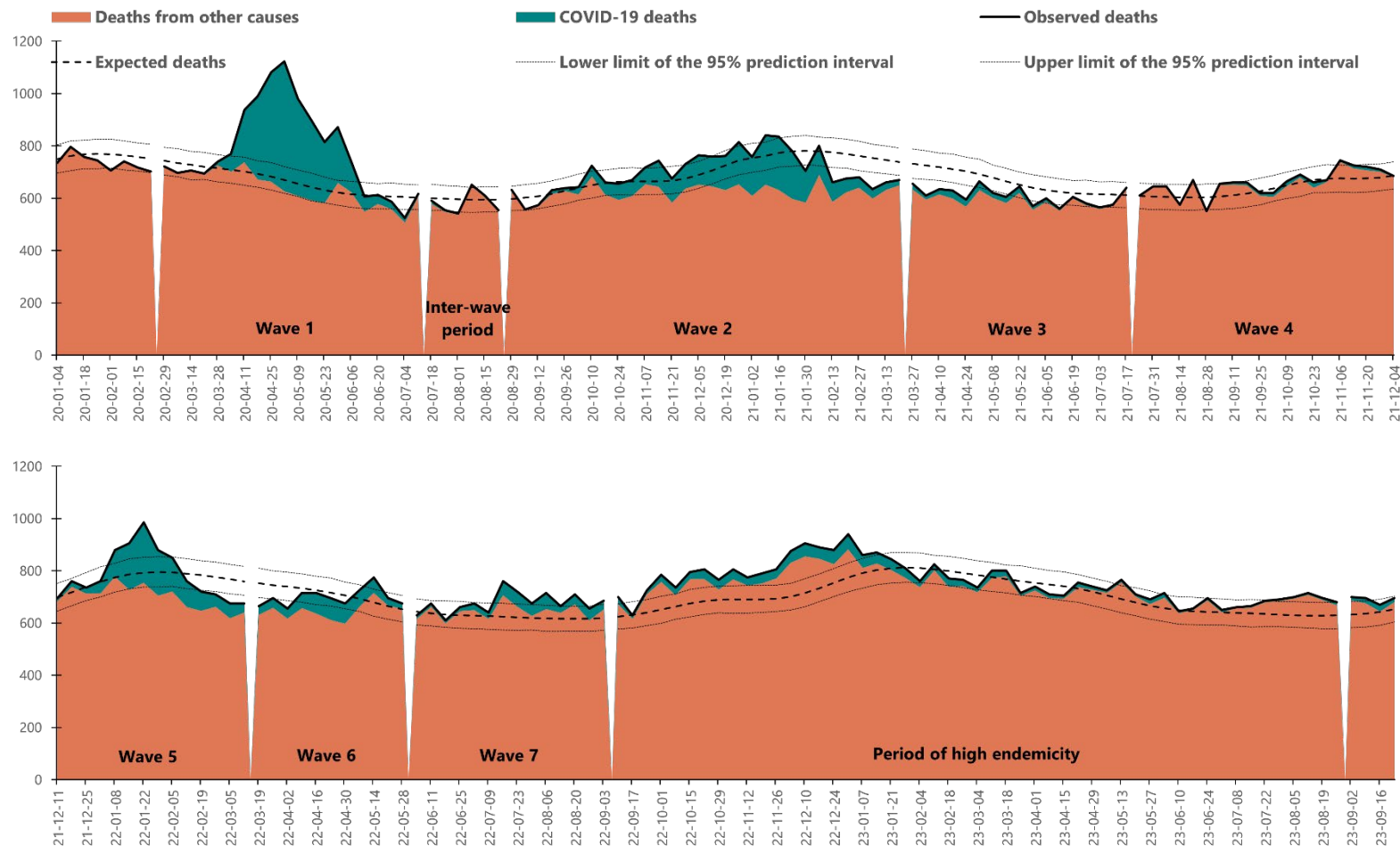
Notes: The dates shown in the figure indicate the last day of each CDC week. Data for 2021 to 2023 are provisional.

Figure A1.6 Number of deaths per CDC week in the 90 years and older age group in Québec between December 29, 2019, and September 23, 2023



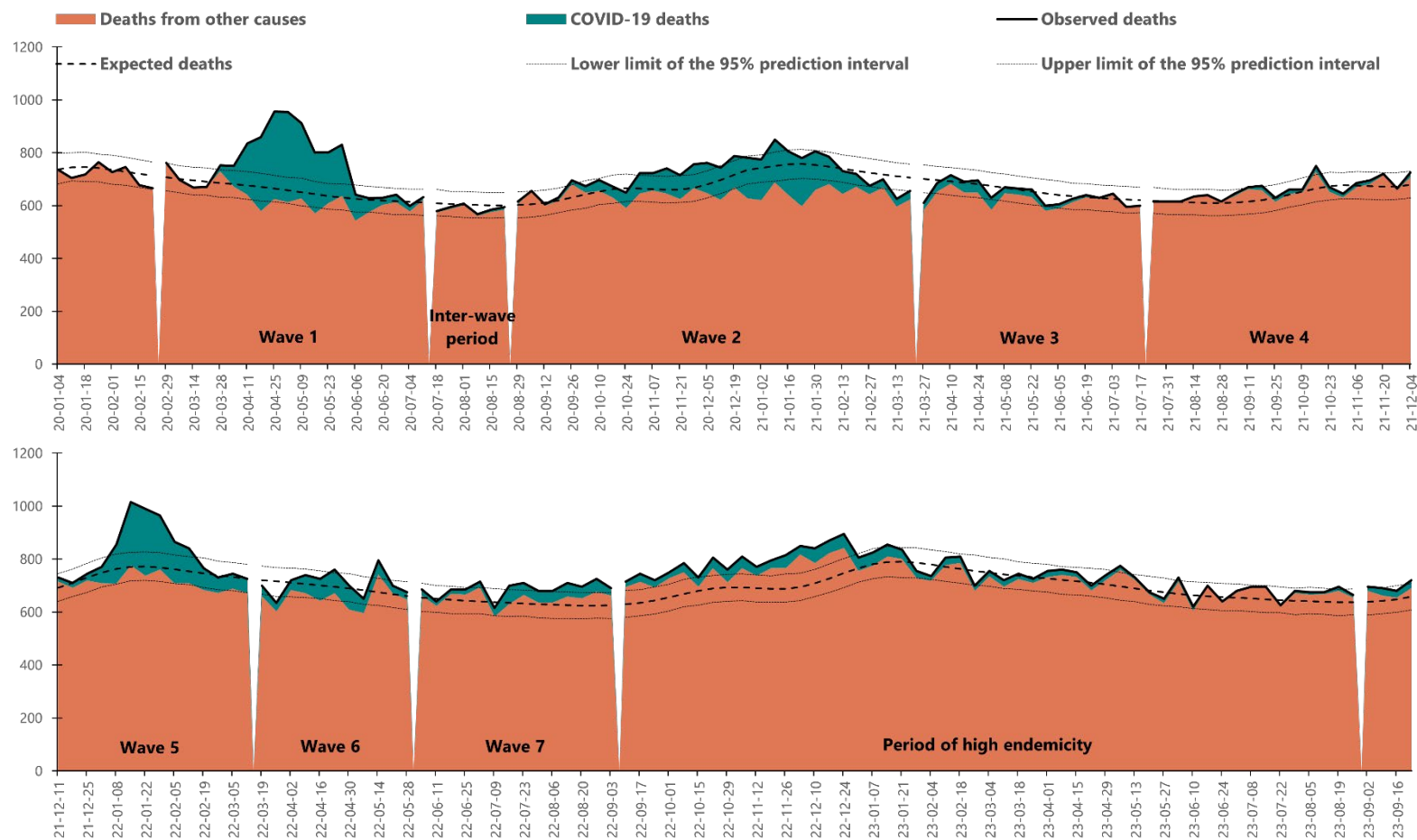
Notes: The dates shown in the figure indicate the last day of each CDC week. Data for 2021 to 2023 are provisional.

Figure A1.7 Number of deaths per CDC week among women in Québec between December 29, 2019, and September 23, 2023



Notes: The dates shown in the figure indicate the last day of each CDC week. Data for 2021 to 2023 are provisional.

Figure A1.8 Number of deaths per CDC week among men in Québec between December 29, 2019, and September 23, 2023



Notes: The dates shown in the figure indicate the last day of each CDC week. Data for 2021 to 2023 are provisional.

Table A1.1 Observed deaths, expected deaths, and excess mortality by age group and sex, by pandemic period, Québec

Characteristics	Observed deaths* (N)	Expected deaths* (N)	Excess mortality* (N)	Relative excess mortality	Excess mortality rate* (per 100,000 people)	Observed deaths COVID-19 (N)	Deaths COVID-19/ Excess mortality* (ratio)
Total population							
Period of pandemic waves	185,106	177,542	7,564	4.3%	34.6	15,893	2.1
Wave 1	30,731	26,391	4,340	16.4%	131.7	5,296	1.2
Inter-wave period	7,028	7,201	-173	-2.4%	-17.5	82	-
Wave 2	42,582	41,710	872	2.1%	17.6	4,656	5.3
Wave 3	21,325	22,410	-1,085	-4.8%	-38.6	637	-
Wave 4	26,425	25,610	815	3.2%	24.6	360	0.4
Wave 5	22,440	21,147	1,293	6.1%	55.5	2,721	2.1
Wave 6	15,480	15,429	51	0.3%	2.8	1,177	23.0
Wave 7	19,095	17,645	1,450	8.2%	123.7	964	0.7
Period of high endemicity	76,555	71,568	4,987	7.0%	58.1	2,370	0.5
< 50 years							
Period of pandemic waves	8,010	7,146	864	12.1%	6.7	146	0.2
Wave 1	1,224	1,107	117	10.6%	6.0	28	0.2
Inter-wave period	390	341	49	14.3%	8.4	2	0.0
Wave 2	1,781	1,649	132	8.0%	4.5	28	0.2
Wave 3	985	905	80	8.9%	4.8	16	0.2
Wave 4	1,240	1,069	171	16.0%	8.8	21	0.1
Wave 5	835	755	80	10.6%	5.8	33	0.4
Wave 6	645	557	88	15.9%	8.1	10	0.1
Wave 7	910	764	146	19.1%	10.6	8	0.1
Period of high endemicity	3,325	2,667	658	24.7%	13.0	14	0.0
50-59 years							
Period of pandemic waves	9,734	9,738	-5	-0.1%	-0.2	358	-
Wave 1	1,633	1,534	99	6.4%	21.7	98	1.0
Inter-wave period	426	434	-8	-1.9%	-5.9	2	-
Wave 2	2,240	2,322	-82	-3.5%	-12.1	65	-
Wave 3	1,200	1,231	-31	-2.5%	-8.2	39	-
Wave 4	1,410	1,415	-5	-0.4%	-1.1	26	-
Wave 5	1,080	1,075	5	0.4%	1.6	82	17.1
Wave 6	760	780	-20	-2.5%	-8.3	31	-
Wave 7	985	948	37	3.9%	12.1	15	0.4
Period of high endemicity	3,710	3,527	183	5.3%	16.7	29	0.2

Characteristics	Observed deaths* (N)	Expected deaths* (N)	Excess mortality* (N)	Relative excess mortality	Excess mortality rate* (per 100,000 people)	Observed deaths COVID-19 (N)	Deaths COVID-19/ Excess mortality* (ratio)
60–69 years							
Period of pandemic waves	25,510	24,225	1,285	5.3%	43.4	1,150	0.9
Wave 1	4,057	3,650	407	11.2%	92.5	319	0.8
Inter-wave period	1,046	1,040	6	0.5%	4.5	7	1.2
Wave 2	5,792	5,702	90	1.6%	13.5	270	3.00
Wave 3	3,180	3,056	124	4.1%	32.5	107	0.9
Wave 4	3,780	3,577	203	5.7%	44.9	51	0.3
Wave 5	2,860	2,743	117	4.3%	36.8	229	2.0
Wave 6	2,055	2,017	38	1.9%	15.1	86	2.3
Wave 7	2,740	2,440	300	12.3%	93.6	81	0.3
Period of high endemicity	10,485	9,379	1,106	11.8%	93.9	160	0.1
70–79 years							
Period of pandemic waves	43,878	41,587	2,291	5.5%	115.7	3,130	1.4
Wave 1	6,801	6,183	618	10.0%	214.6	955	1.6
Inter-wave period	1,724	1,700	24	1.4%	27.5	21	0.9
Wave 2	9,908	9,734	174	1.8%	39.4	912	5.3
Wave 3	5,300	5,271	29	0.6%	11.4	172	5.9
Wave 4	6,420	6,006	414	6.9%	136.4	84	0.2
Wave 5	5,385	4,915	470	9.6%	218.6	585	1.2
Wave 6	3,670	3,605	65	1.8%	38.2	206	3.2
Wave 7	4,670	4,173	497	11.9%	227.5	195	0.4
Period of high endemicity	18,470	16,685	1,785	10.7%	219.7	486	0.3
80–89 years							
Period of pandemic waves	57,366	55,980	1,386	2.5%	162.2	6,113	4.4
Wave 1	9,919	8,300	1,619	19.5%	1,293.4	2,109	1.3
Inter-wave period	2,052	2,215	-163	-7.3%	-431.5	29	–
Wave 2	13,270	13,127	143	1.1%	74.9	1,840	12.9
Wave 3	6,340	7,067	-727	-10.3%	-662.0	178	–
Wave 4	8,050	8,002	48	0.6%	36.7	110	2.3
Wave 5	7,170	6,764	406	6.0%	438.6	1,001	2.5
Wave 6	4,825	4,980	-155	-3.1%	-211.3	461	–
Wave 7	5,740	5,524	216	3.9%	229.2	385	1.8
Period of high endemicity	23,475	23,080	395	1.7%	111.9	917	2.3

Characteristics	Observed deaths* (N)	Expected deaths* (N)	Excess mortality* (N)	Relative excess mortality	Excess mortality rate* (per 100,000 people)	Observed deaths COVID-19 (N)	Deaths COVID-19/ Excess mortality* (ratio)
≥ 90 years							
Period of pandemic waves	40,643	38,864	1,779	4.6%	817.6	4,996	2.8
Wave 1	7,097	5,618	1,479	26.3%	4,728.7	1,787	1.2
Inter-wave period	1,390	1,470	-80	-5.4%	-844.3	21	-
Wave 2	9,596	9,176	420	4.6%	871.0	1,541	3.7
Wave 3	4,335	4,880	-545	-11.2%	-1,945.5	125	-
Wave 4	5,515	5,540	-25	-0.4%	-74.5	68	-
Wave 5	5,120	4,894	226	4.6%	948.3	791	3.5
Wave 6	3,535	3,491	44	1.3%	232.7	383	8.6
Wave 7	4,055	3,796	259	6.8%	1,066.1	280	1.1
Period of high endemicity	17,115	16,231	884	5.4%	976.2	764	0.9
Women							
Period of pandemic waves	91,947	89,212	2,735	3.1%	25.0	8,008	2.9
Wave 1	15,712	13,293	2,419	18.2%	146.8	2,912	1.2
Inter-wave period	3,501	3,578	-77	-2.2%	-15.6	40	-
Wave 2	21,049	21,037	12	0.1%	0.5	2,352	193.2
Wave 3	10,355	11,246	-891	-7.9%	-63.4	274	-
Wave 4	13,180	12,773	407	3.2%	24.6	162	0.4
Wave 5	10,990	10,732	258	2.4%	22.2	1,225	4.7
Wave 6	7,685	7,805	-120	-1.5%	-13.1	577	-
Wave 7	9,475	8,748	727	8.3%	62.2	466	0.6
Period of high endemicity	38,550	35,933	2,617	7.3%	61.1	1,159	0.4
Men							
Period of pandemic waves	93,134	88,330	4,804	5.4%	43.9	7,885	1.6
Wave 1	15,019	13,098	1,921	14.7%	116.6	2,384	1.2
Inter-wave period	3,527	3,623	-96	-2.6%	-19.4	42	-
Wave 2	21,533	20,673	860	4.2%	34.7	2,304	2.7
Wave 3	10,960	11,163	-203	-1.8%	-14.4	363	-
Wave 4	13,230	12,837	393	3.1%	23.7	198	0.5
Wave 5	11,450	10,415	1,035	9.9%	88.8	1,496	1.5
Wave 6	7,800	7,624	176	2.3%	19.2	600	3.4
Wave 7	9,615	8,896	719	8.1%	61.3	498	0.7
Period of high endemicity	38,035	35,635	2,400	6.7%	55.8	1,211	0.5

Notes: Period of pandemic waves from Feb. 23, 2020, to Sept. 3, 2022; Wave 1 from Feb. 23 to Jul. 11, 2020; inter-wave period from Jul. 12 to Aug. 22, 2020; Wave 2 from Aug. 23, 2020, to Mar. 20, 2021; Wave 3 from Mar. 21 to Jul. 17, 2021; Wave 4 from Jul. 18 to Dec. 4, 2021; Wave 5 from Dec. 5, 2021, to Mar. 12, 2022; Wave 6 from Mar. 13, 2022, to May 28, 2022; Wave 7 from May 29, 2022, to May 28, 2022. 2021; Wave 4 from July 18 to Dec. 4, 2021; Wave 5 from Dec. 5, 2021, to March 12, 2022; Wave 6 from March 13, 2022, to May 28, 2022; Wave 7 from May 29, 2022, to Sept. 3, 2022; period of high endemicity from Sept. 4, 2022, to Aug. 26, 2023.

Data for 2021 to 2023 are provisional.

*Refers to all-cause mortality.

APPENDIX 2 SENSITIVITY ANALYSIS OF THE RESULTS: THE CASE OF THE 0-49 AGE GROUP

According to preliminary estimates, since mid-2022 the number of deaths in the 0–49 age group has frequently exceeded the number normally expected according to the ISQ excess mortality model. Although this result reflects a real increase in mortality at these ages, it should be interpreted with caution, taking several factors into account. It should be remembered that estimates of excess mortality are based on an assumption of “normal” trends in deaths from 2020 onwards, in the absence of pandemics, major influenza epidemics, heatwaves, or any other event significantly altering mortality. In the case of the 0–49 age group, this hypothesis is more complex to formulate.

Before the pandemic, mortality from overdose was on the rise

It is important to note that, even before the pandemic, mortality was trending upwards at certain ages within the 0–49 age group. In Québec, according to causes of death attributable to drug overdose, including overdose from psychoactive substances, an overall increase is observed from 2016 to 2020 (54). Canadian data suggest that these increases are linked to unintentional overdoses, particularly opioid-related ones, which were on the rise before the pandemic and seem to have been accentuated by it (55). Québec is not as affected by this issue as British Columbia, for example, but an overall upward trend in deaths attributable to unintentional opioid overdose is visible in Québec data from 2000 to 2017 (56,57), followed by a decrease in 2018–2019 (58), and then an increase in 2020 (59). Data on unintentional deaths linked to suspected drug or opioid overdose suggest that the rise linked to psychoactive substances continued in 2022 (58).

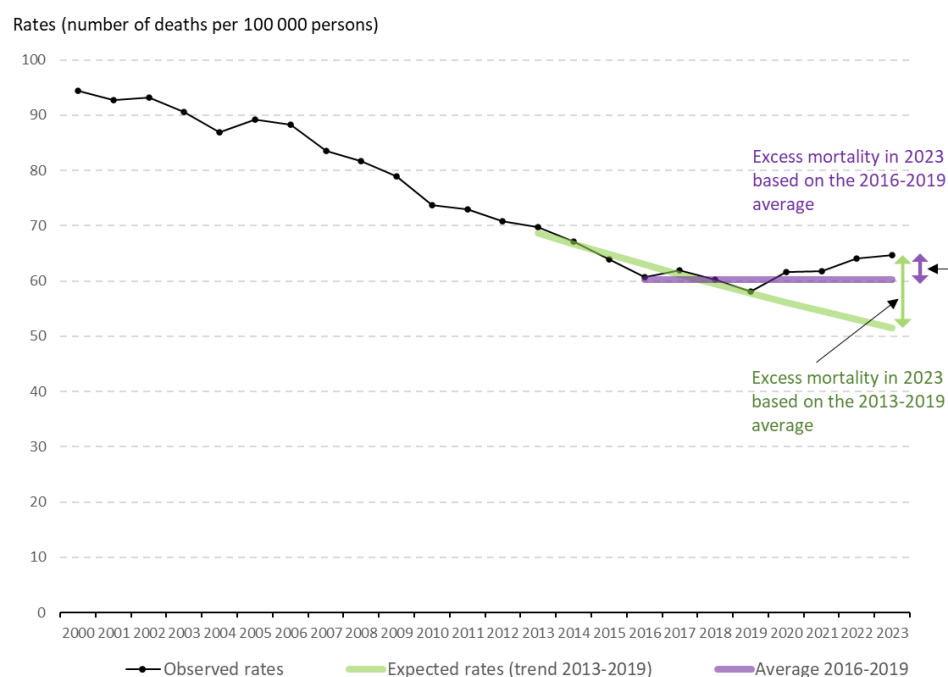
The challenge of projecting a changing trend

The estimation of expected deaths using the ISQ model is based on the assumption of an uninterrupted continuation of the 2013–2019 trend in mortality rates. This assumes a moderate but steady decline in mortality after 2019, as illustrated by the green line in Figure A2.1. This approach is most appropriate for mortality in the elderly but is potentially less conclusive for the 0–49 age group, where trends are less closely linked to the aging process. As shown in Figure A2.1, the mortality rate for the 0–49 age group has fallen very steadily since 2000, but it may be relevant to test the effect of an alternative hypothesis based on a stagnation of the rate after 2019. Thus, if we were to measure excess mortality in relation to the average for the 2016-2019 period, as illustrated by the purple line, excess mortality for this age group in 2022 and 2023 would still be present, but much lower.

Uncertainty related to the population at risk of dying

The number of expected deaths estimated by the model depends not only on projected mortality rates, but also on the size and age structure of the population at risk of dying. For the years prior to 2023, the model is based on population estimates that will be revised in the near future (February 2024), based on the results of the most recent Canadian census (2021). As the population in 2023 is still unknown, the model is based on a demographic projection. The uncertainty surrounding these estimates and projections is minimal for the total population and the elderly population, but greater for the 0–49 age group. On the other hand, the most recent partial data (without age details) suggest that this population is higher than previously estimated due to the very sharp rise in immigration since 2022 (considering that immigration is usually concentrated in the 0–49 age group).

Figure A2.1 Observed and modelled mortality rates for 0–49 year-olds according to two hypotheses, Québec, 2000–2023



Note: Raw data; not standardized to control the internal age structure of the 0–49 age group. The 2023 rate refers to the first 38 CDC weeks of the year. Data for 2021 to 2023 are provisional.

Source: Special compilation (2023), Institut de la statistique du Québec.

Summary

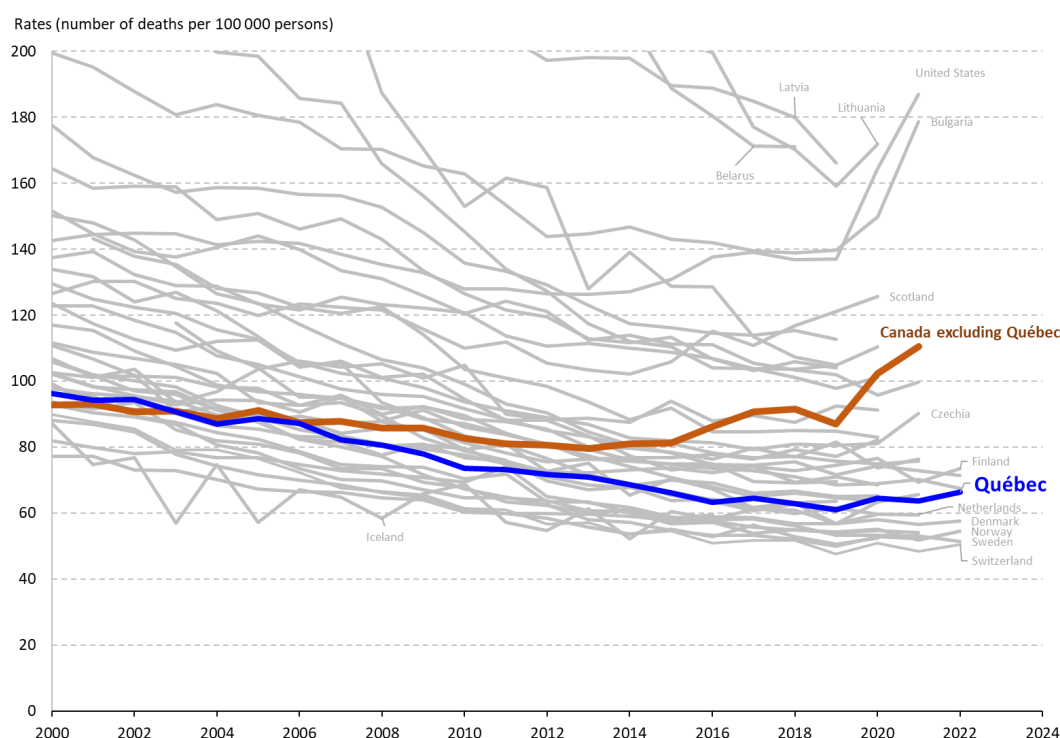
The excess mortality among people aged 0–49 since the beginning of the pandemic could be explained, in part, by the upward trend in deaths from unintentional overdose observed in 2020, and which is likely to have continued since. Data for more recent years will be available when the coroner's reports are finalized.¹⁹ In addition, the current parameters of the ISQ excess mortality

¹⁹ Final data for 2021 will be available in a few months, and those for 2022 in late 2024.

model and the uncertainty surrounding people aged 0–49 influence the estimate of excess mortality in this age group. The exact magnitude of these factors cannot yet be calculated.

Although mortality at these ages is a trend that should be monitored, it is important to emphasize that Québec has some of the lowest mortality levels in the world among young people, as illustrated by Figure A2.2, which shows standardized mortality rates for 0–49 age group, by year, for most countries or nations available in the Human Mortality Database.²⁰ This puts into perspective the slight increase (from 61 to 66 per 100,000) of mortality for the 0-49 group observed in Québec from 2019 to 2022 (latest annual data available), which is also observed elsewhere.

Figure A2.2 Standardized mortality rates for the 0-49 age group, Québec and selected countries, 2000-2022



Source: Human Mortality Database.

Compilation and calculations: Institut de la statistique du Québec (2023).

²⁰ This source brings together mortality statistics from 46 countries or nations with high-quality data. The curves for Russia (320 per 100,000 in 2014, latest data available) and Ukraine (267 per 100,000 in 2013, latest data available) extend beyond the y-axis and are not shown.

APPENDIX 3 METHODOLOGICAL COMPARISONS OF THE TWO REPORTS ON EXCESS MORTALITY

For the period common to both reports, i.e., from February 23, 2020, to January 2, 2021, the first report produced on excess mortality in Québec presented the same crossover variables, except for estimates of excess mortality by sex, which were newly introduced in the 2023 report. In addition to the more recent data available since the first report was written, there are also a few differences in terms of data sources and modelling of expected deaths. These elements are presented in Table A3.1. Finally, it should be noted that the analysis of data by CDC year, by waves, and by period of pandemic waves and period of high endemicity has been prioritized in this report, whereas episodes of sustained excess mortality had been prioritized for analysis in the previous report.²¹

Table A3.1 Methodological differences between the two reports on excess mortality in Québec

	First report (2021)	Present report (2023)
Final and provisional death data	- Final: 2012 to 2018 - Provisional: 2019 and 2020	- Final: 2013 to 2020 - Provisional: 2021, 2022, and CDC Weeks 1 to 38 of 2023
Data sources	- All-cause mortality: Registre des événements démographiques (RED) - COVID deaths: Trajectoire de santé publique (TSP)	- All-cause mortality: RED - COVID deaths: RED
Base periods for calculating expected deaths	2012 to 2020 (January 1, 2012, to February 22, 2020)	2013 to 2020 (December 30, 2012, to February 29, 2020)
Prediction intervals	- CDC weeks - Aggregated for different periods of excess mortality and the entire study period	CDC weeks

Given the differences in Table A3.1, a verification was carried out to compare the estimates of expected deaths released in the first report with the estimates used in this report for the dates included in the period common to both documents (February 23, 2020, to January 2, 2021). This verification confirms that the estimates are very similar and do not change the main conclusions of the first report. As for deaths due to COVID-19, they are lower by 524 deaths in this report, compared with the 2021 report for the same period. This can be explained by the fact that all deaths to which COVID-19 had contributed, whether as underlying or secondary cause, were counted in the TSP data source used in the 2021 report, whereas only deaths with COVID-19 as the underlying cause are presented in this report via the RED.

²¹ Guertin MH, Vandal N, Gilca R. Surmortalité et mortalité par COVID-19 au Québec en 2020. *Inst. Natl. Santé Publique Qué.*, June 2021. Accessed: November 9, 2023. [Online]. Available from: <https://www.inspq.qc.ca/publications/3143>.

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