How COVID-19 has Affected Mortality in 2020 to 2023

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July 2024

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How COVID-19 has Affected Mortality in 2020 to 2023

July 2024

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Executive Summary

Australian experience

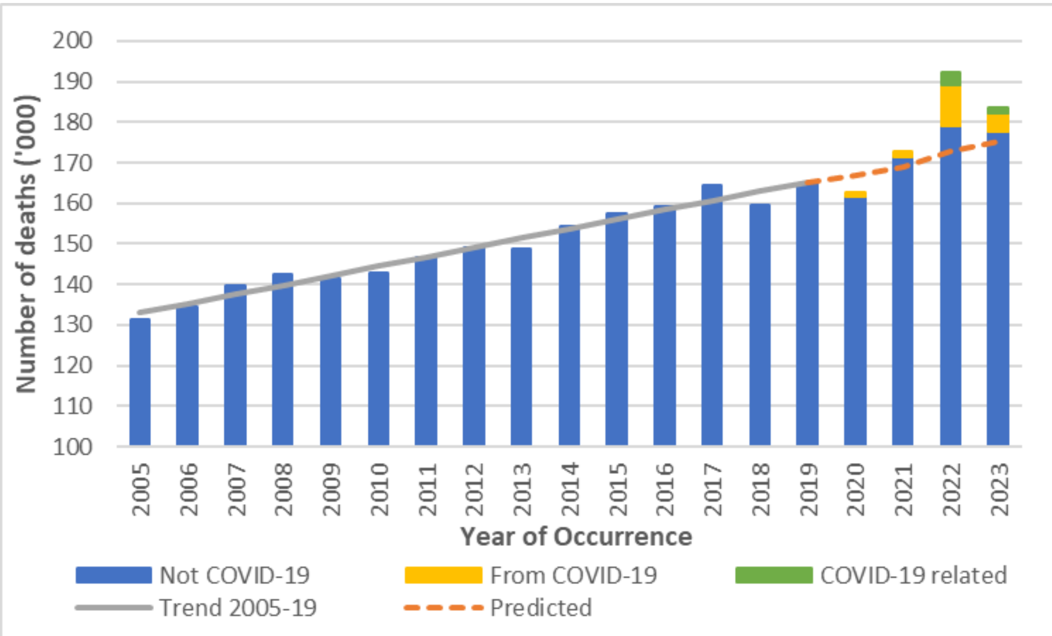
We estimate that there were around 8,400 (5%; 95% confidence interval of 3%-7%) more deaths in Australia in 2023 than we would have expected if there had been no pandemic. While still high, this is significantly lower than the almost 20,000 (11%) excess deaths estimated for 2022. For comparison, the equivalent figures for 2020 and 2021 were -4,300 (-3%) and 3,800 (2%), giving an overall total of 27,200 (4%) excess deaths over the four years. Excess mortality is widely regarded as the best measure of the overall impact of a pandemic, since it includes deaths both directly and indirectly due to the disease.

Of the 8,400 excess deaths in 2023, we estimate that:

- 4,600 deaths (55%) were *from* COVID-19;
- 1,500 deaths (18%) were COVID-19 *related*, meaning that COVID-19 contributed to the death; and
- 2,300 deaths (27%) had no mention of COVID-19 on the death certificate, but it is likely that many of these are due to second-order impacts of the pandemic.

Figure 1 shows the number of deaths in Australia in each year since 2005, with deaths *from* COVID-19 and COVID-19 *related* deaths shown separately. We have also shown a simple trend line fitted through deaths in 2005 to 2019[1], plus our predicted numbers of deaths for 2020 to 2023.

Figure 1 – Annual deaths In Australia

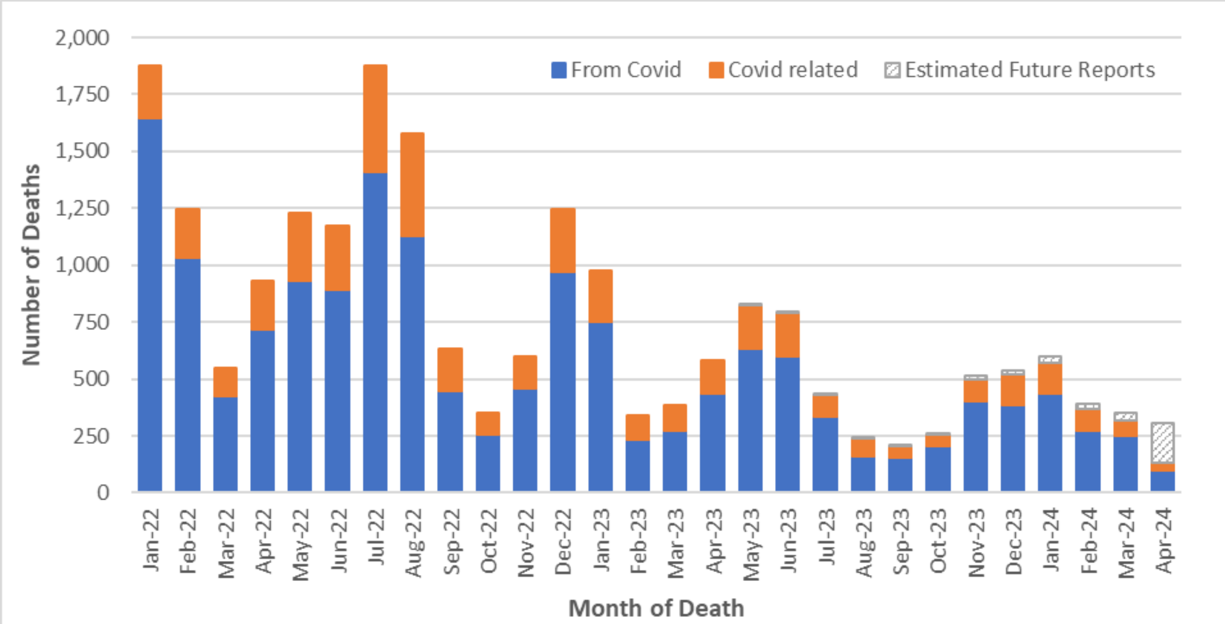


Deaths *from* COVID-19 are those where COVID-19 is given as the underlying cause of death on the death certificate. We estimate that deaths *from* COVID-19 were the ninth leading cause of death in Australia in 2023, down from third in 2022. COVID-19 *related* deaths are those where COVID-19 was a contributing factor mentioned on the death certificate.

It is unclear how close we are to reaching an endemic state, when the impact of COVID-19 on mortality will become (more) predictable. Figure 2 shows that the summer 2023/24 wave of COVID-19 deaths reduced over the months of February, March and April 2024, however the number of COVID-19 deaths was not as low as the former low levels of August 2023 to October 2023.

[1] The trend line included here shows the linear trend of total deaths for illustrative purposes only. Our predicted values are derived from a more complex approach taking demographic changes into account, as discussed in Section 2.2

Figure 2 – COVID-19 deaths in 2022, 2023 and the first four months of 2024[2]



Just over one-quarter of excess deaths in 2023 had no mention of COVID-19 on the death certificate. These non-COVID-19 deaths represent excess mortality of 1.3%, which is high in itself, but lower than the 4% for 2022. We note that both the 2022 and 2023 influenza seasons were "average" years and that the severity (or not) of the flu season has, in prior years, dictated any significant variation from trend.

Non-COVID-19 excess deaths are particularly apparent in those aged over 75 for both genders, and those aged under 45 for females only. We consider that the most likely reasons for these excess deaths are:

- the impact of COVID-19 on subsequent mortality risk, particularly heart disease, stroke, diabetes and dementia, which have all been identified in studies[3];
- delays in emergency care, particularly at times of high prevalence of COVID-19 and/or influenza;
- delays in routine care, which refer to missed opportunities to diagnose or treat non-COVID-19 diseases and the likelihood of consequent higher mortality from those conditions in future. From discussions with medical professionals, we understand that disrupted prescription of medications may be particularly likely to be a major risk factor for those with chronic heart disease; and
- (negative) mortality displacement from continued lower rates of mortality from non-COVID-19 respiratory disease (compared with pre-pandemic trends), although it is possible that this has been largely offset by mortality displacement from the high overall excess mortality in 2022.

Other possible reasons, which (in our opinion) have had less impact in 2023, include:

- undiagnosed COVID-19 as testing becomes less widespread, although the numbers involved, so far, are likely to be small[4];

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[2] This data comes from the latest ABS COVID-19 article, based on death certificates.
[3] A small selection of numerous research studies includes:
Davis, H.E., McCorkell, L., Vogel, J.M. et al. Long COVID: major findings, mechanisms and recommendations. Nat Rev Microbiol 21, 133–146 (2023).
Xie Y, Xu E, Bowe B, Al-Aly Z. Long-term cardiovascular outcomes of COVID-19. Nature Medicine. 2022;28(3):583-590.
Douaud G, Lee S, Alfaro-Almagro F, et al. SARS-CoV-2 is associated with changes in brain structure in UK Biobank. Nature. 2022;604(7907):697-707.
Xu E, Xie Y, Al-Aly Z. Long-term neurologic outcomes of COVID-19. Nature Medicine. 2022;28(11):2406-2415.
[4] For example, there were higher-than-expected influenza deaths in the latter part of 2023, despite low prevalence of influenza

- mental health issues, widely understood to have arisen from stress associated with the pandemic, but have not (or not yet) shown up in any significant way in suicide mortality data; and
- alcohol-induced deaths and road deaths, which were up a little in 2022 and 2023 but are not of the magnitude required to significantly impact excess mortality.

In this context, we note that vaccination is **highly unlikely** to be a cause of excess mortality. While it is not conclusive proof, the overwhelming weight of the available evidence does not point to COVID-19 vaccines as a cause of significant numbers of additional deaths. Of our estimate of 27,200 excess deaths across 2020-2023, just over 17,000 have been identified as being deaths *from* COVID-19, while fewer than 20 deaths have been identified as being caused by COVID-19 vaccination. If the number of COVID-19 vaccine deaths is very small in relation to COVID-19 deaths, it is an even smaller fraction when compared to the number of COVID-19 deaths that the vaccines have prevented in Australia – a conservative minimum of 50,000[5].

Our considered view is that, while there could be COVID-19 vaccine-related deaths that have not been identified as such, the number of such deaths is likely to be small, especially in the context of the estimated numbers of excess deaths and the lives saved by vaccination. There are other, more plausible, reasons that explain excess mortality in Australia.

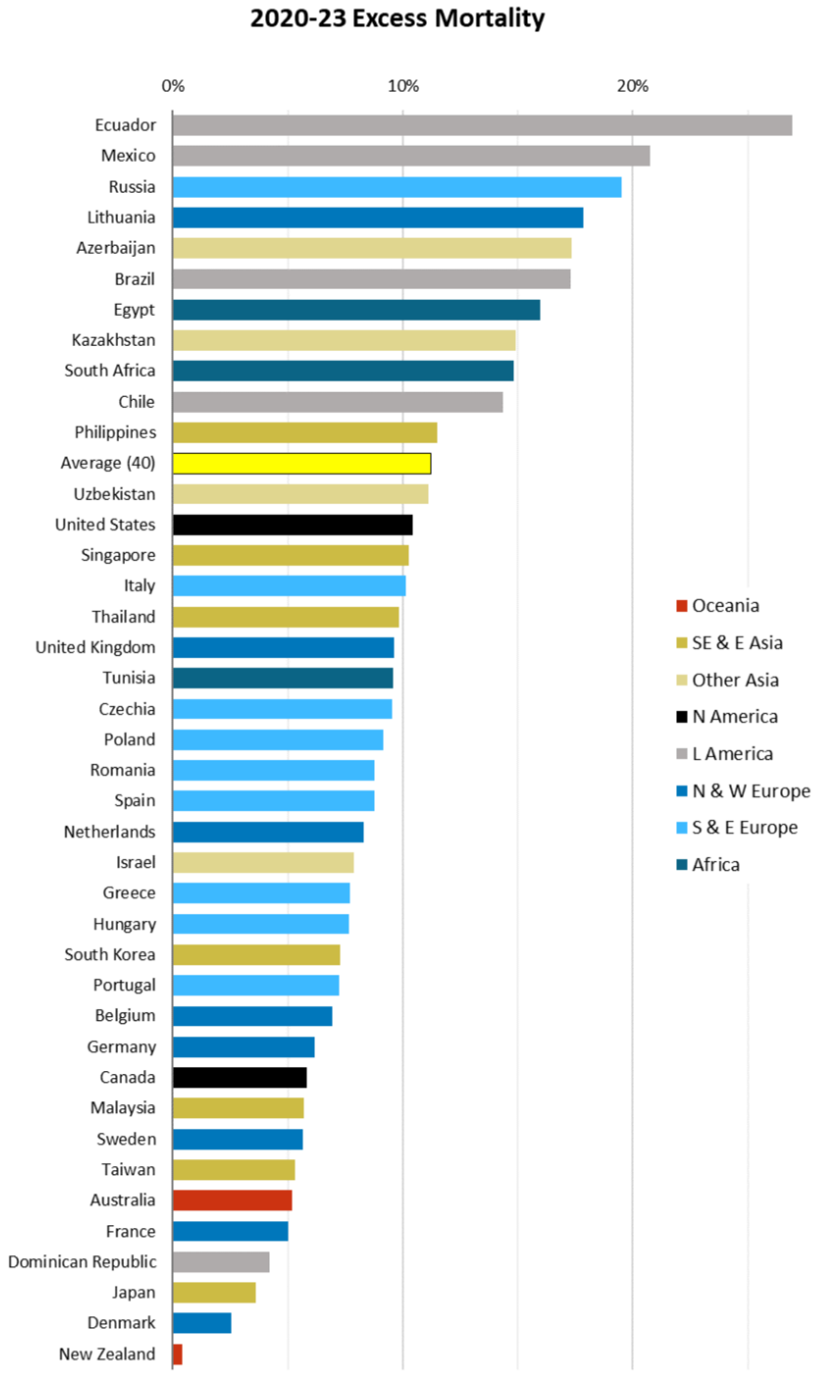
World-wide experience

Countries for which data is available generally had positive total excess mortality[6] across the four years 2020-23. Figure 3 sets Australia in the global context, noting that (as discussed in Section 4) the excess mortality baseline is slightly different in this global comparison than in our detailed Australian analysis.

[5] Based on a NSW study: Assessing the impact of Australia's mass vaccination campaigns over the Delta and Omicron outbreaks | PLOS ONE

[6] In the Our World in Data (OWID) database, only Greenland (-7%) and Luxembourg (-2%) had negative total excess mortality over the period, but note that there are gaps in the OWID coverage

Figure 3 – Excess mortality for 40 countries over four years ending 31/12/23, as a percentage of expected deaths



Source: Our World in Data (OWID) and analysis. Excess mortality relative to projected deaths.

All 40 countries[7] shown here had positive total excess mortality, with a weighted average[8] of 11%.

Excess mortality has been very high in Latin America, averaging about 20% over the four years.

South-East and East Asia (7%) have generally fared much better than Other Asia (19%). Similarly, Northern and Western Europe (7%) has generally had lower excess mortality than Southern and Eastern Europe (14%).

[7] See Section 4 and Appendix H for a discussion of the selection of the 40 countries in Figure 3, including the unavailability of data for four of the five largest countries by population (China, India, Indonesia and Pakistan)
[8] The average shown is (total actual) / (total expected) – 1 for the 40 selected countries; the unweighted average is 10%

The United States has experienced 10% excess mortality across the four years, substantially higher than Canada (6%). The difference is mostly due to reported COVID-19, with excess mortality from other causes at 1% in both countries.

Despite high excess mortality in 2022 and 2023, Australian excess mortality over the four years (5%) is among the lowest of the countries included in our selection – at 35th out of 40.

In general, we note that those countries with higher excess mortality in 2020 and 2021 appear to have lower excess mortality in 2022 and 2023. At the same time, those with low excess mortality in 2020 and 2021 generally have had higher excess mortality in 2022 and 2023. The latter countries have generally had lower overall excess mortality; this appears to be because their populations were less exposed to COVID-19 prior to a high proportion having been vaccinated.

Looking at the monthly mortality experience in each region (see Figure 4), we can see that excess mortality was driven by COVID-19 waves – and not by vaccination rates. The timing of peaks and troughs shows some common ground and some differences between regions. After allowing for the first Omicron wave in early 2022, most regions have experienced lower excess mortality in 2022 and 2023, suggesting that a degree of "herd immunity[9]" has been achieved, through a combination of infection and vaccination. Sadly, it is clear that some regions have paid a high price in lives lost.

Figure 4 – Monthly excess mortality compared with COVID-19 mortality and vaccination rates, by region

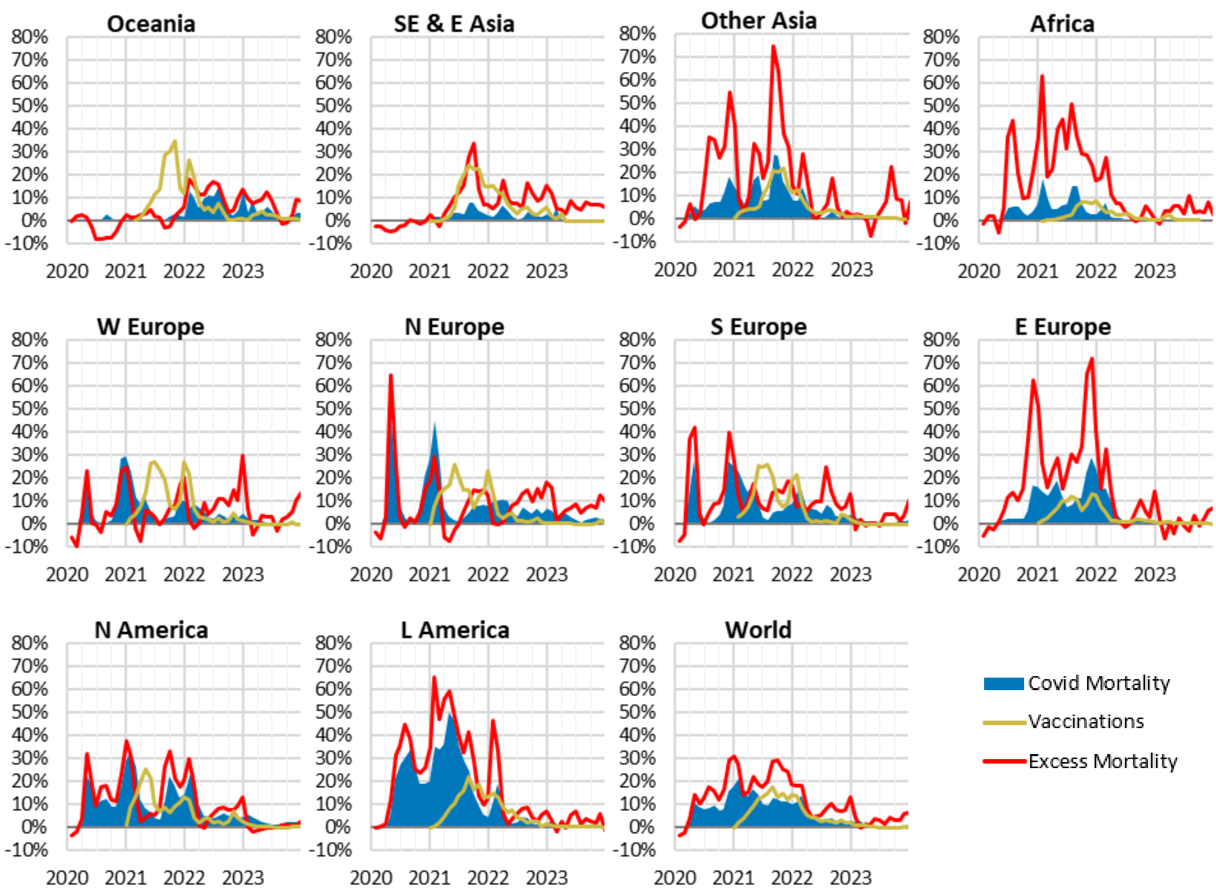
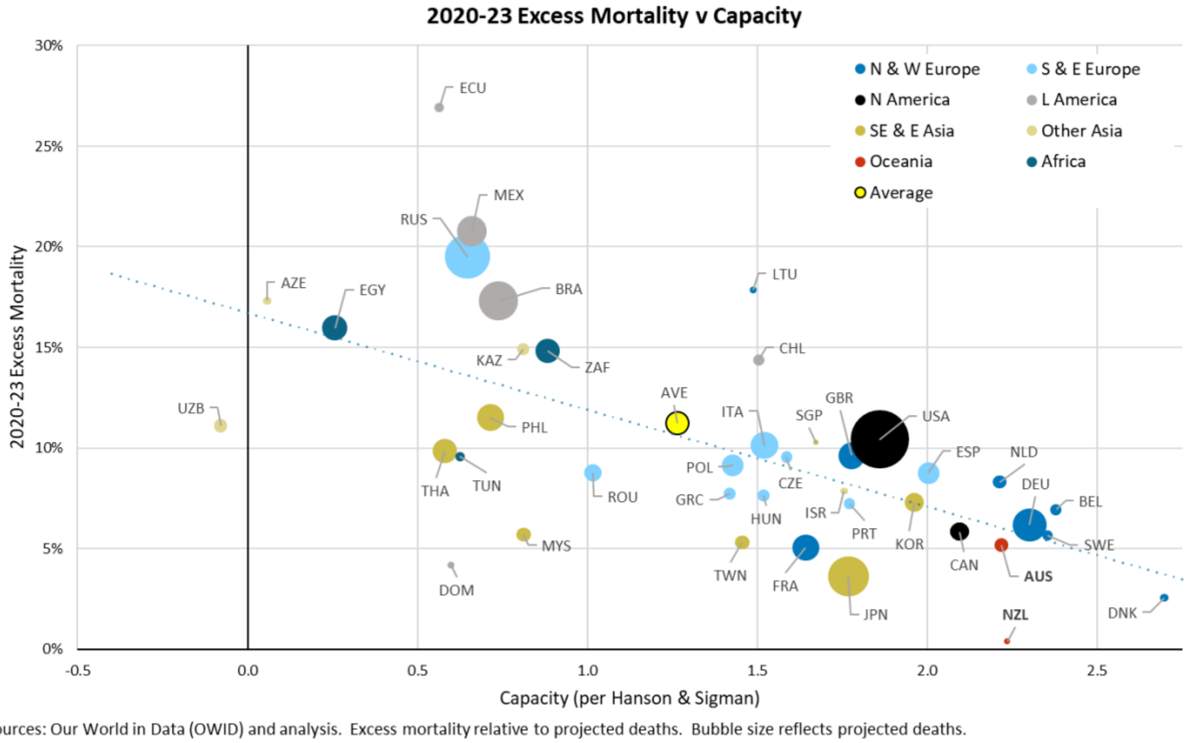


Figure 5 shows that there appears to be an overall negative correlation between the measured capacity of a state to manage a crisis[10] and its excess mortality – wealthier countries (which tend to have higher capacity) generally had lower excess mortality than less wealthy countries.

[9] We use the term "herd immunity" loosely here, to indicate that the net impact of the pandemic on current national mortality rates is low. We do not suggest that there is vastly reduced spread of COVID-19 or that it has become "safe" or "like flu".
[10] Refer to Section 4.8 for discussion of state capacity, which is highly correlated to per-capita GDP

Figure 5 – Comparison of 2020-23 excess mortality of 40 countries with state capacity, showing a clear, if weak, inverse relationship



The information available for the world also enables a high-level look at the differences in excess mortality by age.

Table 1 – Simple unweighted average of excess mortality (as a percentage of expected) of 24 countries by age group and year

Age Group	2020	2021	2022	2023	All Years
0-14	-5.5%	-0.9%	2.4%	2.4%	**-0.4%**
15-64	5.4%	13.5%	7.0%	3.3%	**7.3%**
65-74	8.4%	15.0%	7.3%	0.5%	**7.8%**
75-84	11.5%	16.2%	15.6%	11.3%	**13.7%**
85+	7.9%	7.1%	8.7%	-0.1%	**5.9%**

Table 1 shows a simple, unweighted average of excess mortality by age group across 24 countries where relevant data was available. It confirms the observation that excess mortality (as a percentage) has been highest in the 75-84 age group, but that excess mortality appears to have been material in all but the youngest age group (0-14) for the last four years. Note, however, that the second-youngest age group (15-64) covers a wide range of ages, and its overall mortality experience is likely to be dominated by the older end of that range, where expected mortality rates are more than 30 times higher than for the younger end of the range[11].

Mortality outlook

We have considered the factors influencing mortality in Australia in 2023 and how those factors may change in the near future.

In our view, the "new normal" level of mortality is likely to be higher than it would have been in the absence of the pandemic. 2022 had 11% higher than predicted mortality while 2023 had 5% higher

[11] See, for example, the Australian Life Tables 2015-17

than predicted mortality. Looking ahead, we think that excess mortality (relative to pre- pandemic expectations) will probably reduce from the level in 2023.

While we think that the level of excess mortality will decline, COVID-19 is likely to continue to cause **some** excess mortality for some years to come, directly as a cause of death and less directly, as a contributor to other causes such as heart disease. There will also be an indirect impact, with the largest contributor likely to be the ongoing consequences of disruption to usual healthcare practices in the earlier years of the pandemic. Counter to this, to the extent that mask-wearing and other defence measures (such as isolation when sick), persist in vulnerable settings, this will likely lead to lower deaths from respiratory disease.

There has been a long-term underlying trend of mortality improvement in Australia (i.e. over decades). Although the rate of improvement has gradually been slowing, we do not think that it will cease. The underlying drivers of mortality improvement, such as medical advances, reduction in smoking rates, and other societal improvements are continuing (noting that improvements in many causes of death are "baked in" from population-wide changes years, or even decades, beforehand). The question remains as to whether mortality will eventually return to the pre-pandemic trajectory, or whether there may be a permanent loss of a few years of mortality improvement.

1 Introduction

This section discusses why we measure excess mortality and introduces terminology used throughout the Research Paper.

1.1 Defining Excess Mortality

Excess mortality is defined as the difference between the actual number of deaths in a period and the predicted number.

The predicted number of deaths is an **estimate** based on certain assumptions, and therefore the calculated excess mortality is also an estimate. Excess mortality can only ever be an estimate – it is not, and cannot be, a known quantity.

The starting point for any estimate of predicted deaths for a population will be the number of deaths that have occurred in recent years (five years has become the accepted norm, but there are no established rules around this). Any reasonable estimate of the predicted number of deaths in a period should also take into account:

1. changes in the size of the population over time: the larger the population, the greater the predicted number of deaths (all else being equal);
2. changes in the demographics of the population over time, the most important of which is changes in the age structure of the population: the older the population, the greater the predicted number of deaths (all else being equal); and
3. trends in mortality rates over time: in Australia, mortality rates had improved for decades prior to the pandemic, and it is reasonable to assume that they will continue to do so in future.

Further, any estimate of predicted deaths needs to be supported by a clear explanation of what the predicted number represents. In this Research Paper (and in our work over the course of the pandemic), the predicted number of deaths is **the predicted number had there been no pandemic**. The resulting estimate of excess deaths represents the additional number of deaths due to both direct and indirect impacts of the pandemic.[12]

1.2 Why measure excess mortality?

It is generally accepted[13] that excess mortality is a key measure of the mortality impact of a pandemic. In the context of COVID-19, it captures:

- direct COVID-19 deaths, including those not reported as such;
- reduced deaths from defence measures, such as in Australia when border closures and lockdowns reduced the incidence of respiratory diseases; and
- increases in other deaths that may be indirectly caused by the pandemic, such as those due to delayed medical attention.

While the official global death toll from COVID-19 is now (June 2024) about 7.1 million, estimates of the actual impact of COVID-19 are far higher. For example, The Economist estimates that there have been 27.2 million excess deaths, with a 95% confidence interval of 19.2 million to 36.2 million[14].

In some countries and/or at certain high-stress times during the pandemic, many COVID-19 deaths will not have been recorded as such, simply because the infrastructure did not cope. Even under more "normal" conditions, COVID-19 deaths may be misclassified where the deceased has not experienced noticeable symptoms. As "living with COVID-19" becomes the norm, we might also

[12] The estimate of excess deaths would also include any excess (positive or negative) that is not related to the pandemic at all. However, in the absence of any reason to suppose otherwise, this is taken to be zero.
[13] See, for example, Measuring Australia's excess mortality during the COVID-19 pandemic | Australian Bureau of Statistics (abs.gov.au) and Excess mortality during the Coronavirus pandemic (COVID-19) - Our World in Data
[14] The pandemic's true death toll | The Economist (extracted 16 June 2024)

expect some missed COVID-19 deaths as complacency sets in and less testing for COVID-19 occurs compared with earlier in the pandemic.

On the other hand, necessary differences in criteria between surveillance reporting (which sacrifices accuracy for speed) and official death certificates mean that there may be systemic over- or under-reporting of COVID-19 deaths in the surveillance reports. This is the "death with-not-from COVID" issue.

The impact of COVID-19 on mortality from other causes may have been positive or negative. For example, lockdowns, border closures and other measures appear to have reduced the spread of respiratory disease, with several countries benefiting from milder flu seasons[15]. But the same behavioural changes have led to a reduction in the rate of screenings and diagnostic tests and to mental stress – which, in turn, could lead to higher mortality, albeit potentially with a time lag.

1.3 Terminology for COVID-19 deaths

Throughout this Research Paper we separate COVID-19 deaths into:

- deaths "from COVID-19", namely deaths where COVID-19 is listed as the primary/underlying cause of death; and
- deaths that were "COVID-19 related", namely deaths where the underlying cause of death has been determined as something other than COVID-19, but COVID-19 was a contributing factor mentioned on the death certificate.

The above COVID-19 deaths are distinct from "incidental COVID-19" deaths, namely deaths where the person was COVID-19 positive at the time of death, but COVID-19 was not recorded on the death certificate. These deaths are sometimes included in surveillance reporting where identified (other than where there is a clear alternative cause of death, such as trauma) but are not separately identified in the ABS statistics.

We have used the same definition of a week/year as the ABS, namely that weeks are based on the ISO (International Organization for Standardisation) week date system.

1.4 Mortality displacement

Mortality displacement is an important concept in the discussion of excess mortality over a period of time. Excess mortality, by its nature, represents the deaths of a number of people sooner than would have been expected. To the extent that this excess mortality has occurred among the frail (including, but not limited to, the elderly), there will be correspondingly fewer deaths in the next year or two (all else being equal).

Likewise, to the extent that frail lives have been saved by reduced exposure to a pathogen (negative mortality displacement), there will be correspondingly more deaths in the next year or two (all else being equal).

1.5 Content warning

This Research Paper includes discussion of suicide deaths in several places, notably in Section 3.6.

[15] This is a common shorthand for the seasonal impact of respiratory disease on mortality, whether directly from conditions such as pneumonia or flu or indirectly from other conditions (such as dementia) that leave the sufferer more vulnerable

2 Excess deaths in Australia

This section includes analysis of excess deaths in Australia since the start of the pandemic. Our previous Research Papers[16] included detailed analysis of mortality experience in 2020, 2021 and 2022. This paper concentrates on 2023, although information is also shown for 2020 to 2022. This section covers:

- the available data;
- our approach;
- excess deaths in total; and
- excess deaths broken down by cause of death, by age band/gender and by state/territory.

Section 3 discusses the possible causes of excess mortality in Australia, concentrating on 2022 and 2023.

2.1 Available data

There have traditionally been significant delays in releasing information on deaths in Australia given the sometimes lengthy delays between the time of death and the time the death is registered, with these delays further exacerbated if a death is referred to the coroner. Given the heightened interest in death statistics due to the pandemic, the ABS has been releasing a subset of the death statistics each month since June 2020[17] in order to provide more timely information to the public.

The information used in this section in respect of Australian deaths is predominantly based on the ABS *Provisional Mortality Statistics*[18] publication, including:

- Deaths occurring in each week from the start of 2015 until the end of 2023, provided that the death had been registered by 29 February 2024. Due to delays in registration of deaths, most weeks of 2023 will be missing a small number of deaths (around 0.5% for the earliest weeks of 2023 increasing to around 3.7% for the last week of the year). Deaths are broken down by:
  - cause of death for doctor-certified deaths, for eleven selected causes (including COVID-19), plus coroner-referred deaths for all causes combined. The ABS has worked around the significant delays introduced by coronial investigations by including deaths once they have been reported to the coroner, but not waiting for the outcome of cause of death. As such, the coroner-referred deaths are not broken down by cause;
  - age band and gender, summarised into five age bands for each gender; and
  - state/territory.

  Note that, due to confidentiality restrictions placed on the data the ABS is able to release, combinations of cause/age band/state are not available, so for example, we are unable to examine cancer mortality for older females in NSW only.
- Standardised death rates; weekly figures are available for all-cause mortality and broken down by cause of death (but not by age band/gender or state/territory).
- The number of deaths registered and received by the ABS by 29 February 2024 that included COVID-19 on the death certificate. Monthly data is supplied on whether deaths were *from* COVID-19 or were COVID-19 *related* deaths.

We were also supplied with additional data by the ABS in a customised report in relation to COVID-19 deaths registered by 29 February 2024, namely the total number of deaths each week (doctor-certified and coroner-referred) both *from* COVID-19 and COVID-19 *related*. Breakdowns were provided by age band/gender and by state/territory (where confidentiality provisions allowed it).

[16] *Impact of COVID-19 on Mortality and Morbidity in 2020, Impact of COVID-19 on Mortality and Morbidity in 2020 and 2021,* and *How COVID-19 has affected Mortality in 2020 to 2022*
[17] The first release covered mortality from January to March 2020
[18] https://www.abs.gov.au/statistics/health/causes-death/provisional-mortality-statistics/latest-release

The analysis by state/territory included in this Research Paper relies on analysis included in the most recent ABS excess mortality article *Measuring Australia's excess mortality during the COVID-19 pandemic until December 2023*[19] ("the ABS excess mortality calculations").

2.2 Measuring excess deaths – approach

Measuring excess deaths is not straightforward. In its simplest form, excess deaths are calculated as the difference between actual deaths occurring in a particular period less a "baseline" level of deaths. But what to use for the baseline?

Early in the pandemic, most measures of excess deaths compared 2020 actual deaths to a simple average of deaths in 2015 to 2019. However, this approach does not allow for changes in either the size or the age structure of the population, or for the continuation of any trends in mortality that may have been expected in the absence of the pandemic.

In their June 2021 paper[20], Karlinsky and Kobak took a different approach, fitting a trend to the 2015 to 2019 years to get their baseline. This approach, while allowing for past changes in size of population, age structure of the population and mortality trends, intermingles these three effects and assumes that their aggregate impact will continue on the same trend into 2020 to 2022.

Unlike Karlinsky and Kobak, who were projecting a baseline for each of 84 countries, we are focusing on Australia only, so we have taken the opportunity to apply a more detailed approach. We have explicitly allowed for changes in population size and age structure. Any modelled trends are the residual, being the improvement in the overall mortality rate over time[21].

As we do not have the data in three-way breakdowns (i.e. cause x age band/gender x state) we have built separate models for each of the breakdowns that are available. We have the most information for the breakdown by cause of death, due to the ABS provision of standardised death rates (SDRs) by cause. We have necessarily used a more approximate approach to allow for changes in population size and age demographic for the model by age band/gender. As a result, our models of excess deaths broken down by cause of death are our primary models. For the analysis by state/territory, we have adopted the ABS excess mortality calculations. Our approach for each model is discussed further below.

2.2.1 Deaths broken down by cause

As discussed in our July 2023 Research Paper, we have used different sets of years as the basis for our projections, depending on the projection year in question (the 2020 and 2021 years are estimated differently to 2022 and 2023) and whether the pandemic had a significant impact on 2020 and 2021 mortality (some causes are treated differently to others).

Specifically, for our cause of death model we:

- fitted linear regression models to the SDRs. We trained the regression models on different years of data, depending on the cause of death:
  - For the 2020 and 2021 projection years, we have used the 2015-19 experience to train the model for all causes.
  - For the 2022 and 2023 projection years, we have:
    - used 2015-19 experience to train the model for deaths from respiratory disease, dementia, diabetes and other cardiac conditions, on the basis that 2020 and 2021 experience for these causes was materially affected by the pandemic; and
    - used 2015-21 experience to train the model for deaths from all other causes and for coroner-referred deaths, on the basis that it is likely that 2020 and 2021 experience more

[19] https://www.abs.gov.au/articles/measuring-australias-excess-mortality-during-covid-19-pandemic-until-december-2023
[20] Karlinsky & Kobak, 2021, *Tracking excess mortality across countries during the COVID-19 pandemic with the World Mortality Dataset*
[21] We identified this trend for each separate cause of death, age/gender and state/territory combination for which we have data

closely reflects a slow-down in underlying mortality improvement than the impacts of the pandemic.

- extrapolated the linear regression model to arrive at predicted SDRs for each week in 2020 to 2023;
- converted predicted SDRs to predicted numbers of deaths for ease of communication;
- compared predicted deaths to the actual deaths in 2020 to 2023 (after including a small allowance in the actual numbers for late-reported deaths).

The baselines for our estimates of excess deaths are "predicted deaths in the absence of the pandemic, allowing for a continuation of pre-pandemic mortality improvement" for each of the years 2020 to 2023. We have not included any COVID-19 deaths in the baselines, as these would not exist in the absence of the pandemic.

It is important to note that predicted death *numbers* are increasing faster from demographic changes (ageing and population size) than they are reducing due to mortality improvement, even though age-standardised death *rates* are reducing. Therefore, our model predicts higher baseline numbers of deaths in each successive year.

2.2.2 Deaths broken down by age/gender

Our models of excess deaths broken down by age band/gender are supplementary to our cause of death models. As SDRs are not available by age band/gender, we use a modified version of the above approach by cause of death. For each age band/gender combination we:

- scaled actual weekly deaths from 2015 to 2022 so that they are representative of the number of deaths in those years if they had the 2023 population size and age mix;
- fitted a linear regression model to the scaled deaths from 2015 to 2019. As we know that some causes of death were more impacted by the pandemic than others, but have no information by cause and age/gender, we are unable to use any data other than the 2015-19 years to obtain baselines representative of pre-pandemic expectations;
- extrapolated the linear regression model to arrive at a predicted number of deaths for each week in 2020 to 2023 (implicitly assuming that the same per annum mortality improvement over 2015-19 continues, and ignoring the impact of the pandemic); and
- compared predicted deaths to the actual deaths in 2020 to 2023 (after a small allowance for late-reported deaths).

Details of our approach and the adjustments made are included in Appendix A .

2.2.3 Deaths broken down by state/territory

In our July 2023 Research Paper, we included estimates of excess mortality by state/territory, using the same approach as outlined above for the models by age/gender. However, since that time, the ABS has performed its own analysis of excess mortality, including estimates of the excess by state/territory (but not by cause of death or age/gender).

Our view is that the ABS's predictions of deaths by state/territory are superior to ours as:

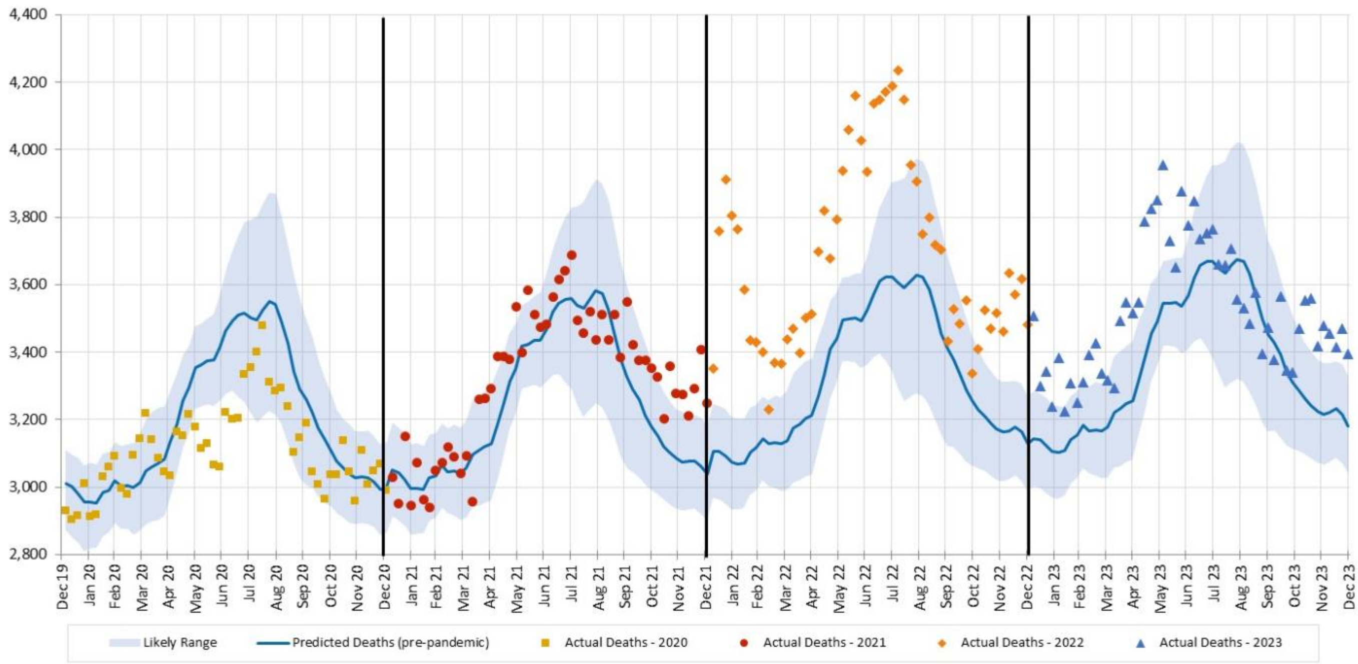
- the ABS has access to the detailed information that allows age-specific mortality by state/territory to be modelled, whereas our approach approximates this level of detail; and
- the ABS has access to a longer weekly time series than what is publicly available, and use the 2013-2019 years in setting their baseline. We believe that this results in more robust estimates of predicted deaths, particularly for the smaller states where year-to-year and week-to-week volatility is greater.

As such, in this Research Paper we have adopted the ABS's predicted deaths rather than producing our own estimates by state/territory. We note that our measured excess mortality is slightly different to what is shown in the ABS publication as we have allowed for late-registered deaths in our count of "actual" deaths while the ABS makes no such allowance.

2.3 Excess deaths in total

Figure 6 shows the results of our analysis, comparing actual deaths each week to our predicted values and the 95% prediction interval.

Figure 6 – Weekly actual and predicted deaths – All Causes



2020-2022 actuals include allowance for late reporting
Predicted deaths and ranges come from the fitted trend in each week's standardised death rate

In 2020, the main feature of note is that, during winter, there was significant negative excess mortality. This was due to Australia's success in containing COVID-19 that also resulted in a lack of flu in the country that year (a situation that persisted until borders re-opened in early 2022). Overall, we estimate a negative excess of 3% for that year.

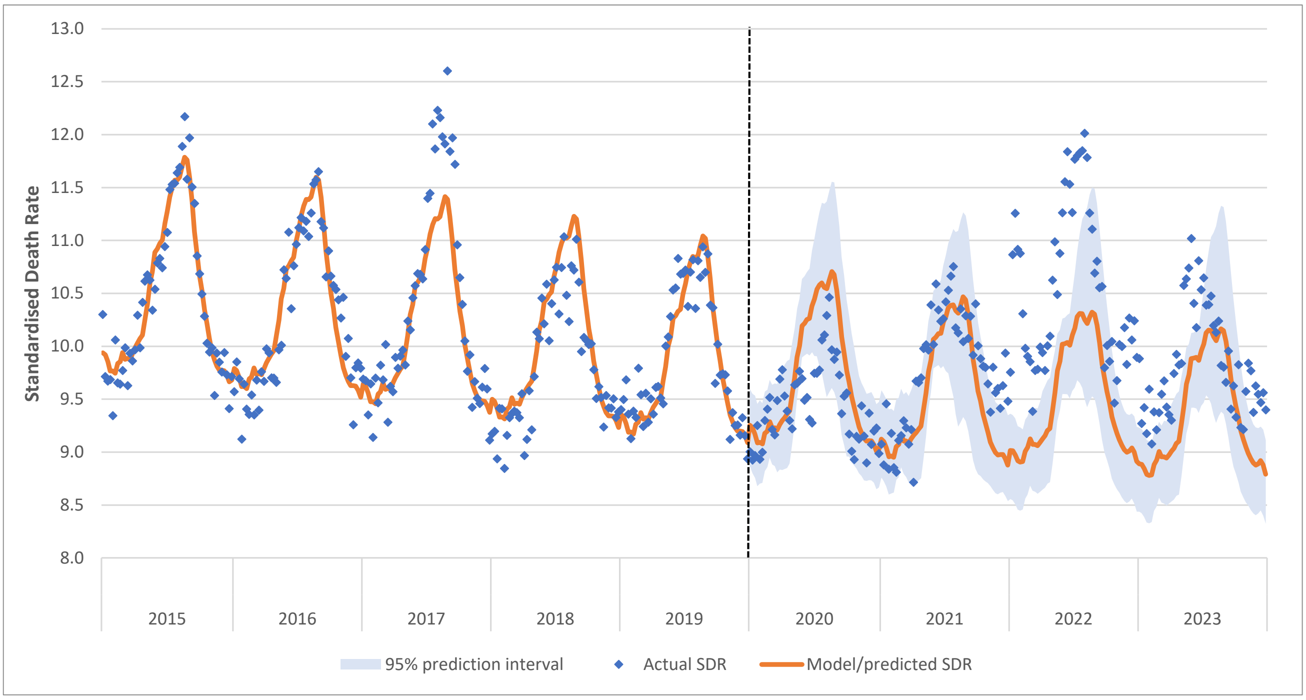
In 2021, most weeks are within the 95% prediction interval until we get closer to the end of the year; the overall excess for that year is estimated at 2%.

In 2022, our model predicted 173,000 deaths but actual deaths were almost 20,000 higher than this. We can see this excess throughout the year, with very few weeks within the prediction interval. The only period where deaths were not outside the prediction interval was from around mid-August to end-October, when COVID-19 prevalence in Australia was relatively low. Excess mortality across that year is estimated at 11%.

In 2023, we again see many weeks above the upper end of the prediction interval, although the experience is not as high as in 2022. The only period where actual deaths were close to the predicted level was again from around mid-August to end-October, when COVID-19 prevalence was relatively low. Excess mortality for 2023 is estimated at 5%, about half the level of 2022.

Figure 7 includes a longer time series, showing the weekly standardised death rates (SDRs) compared with the modelled SDRs (from 2015 to 2019) and predicted SDRs (from 2020 to 2023).

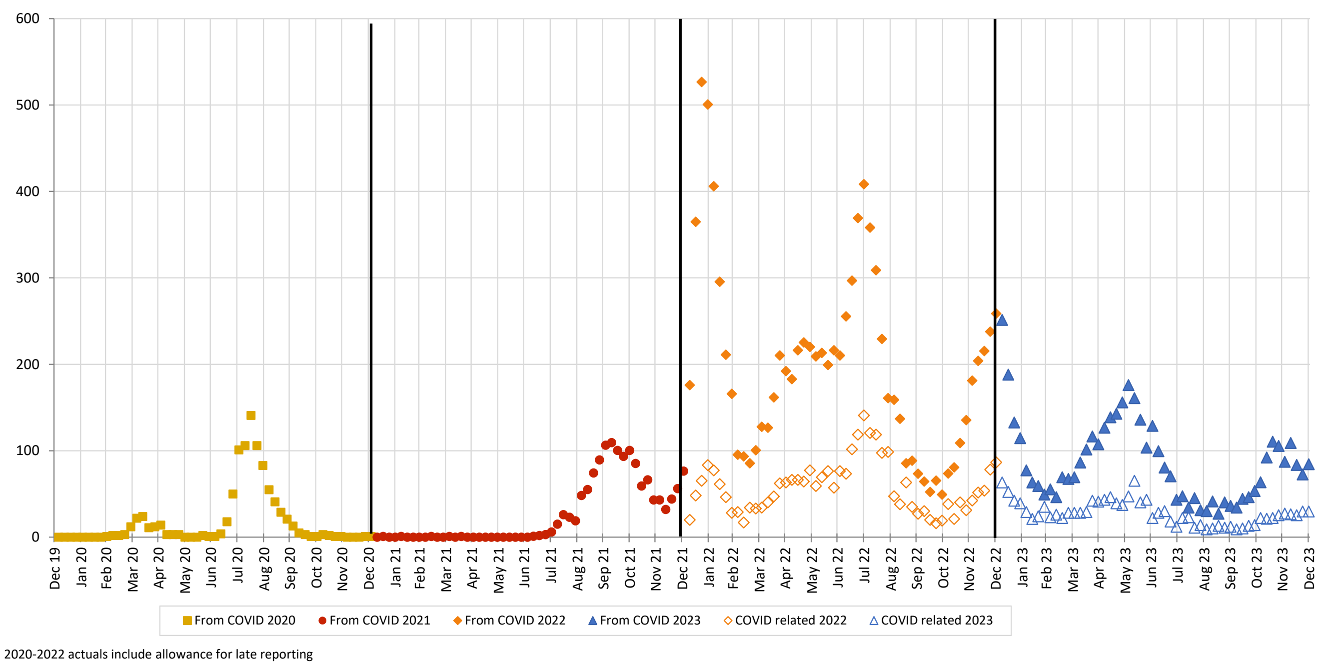
Figure 7– Weekly actual, modelled and predicted standardised death rates – All Causes from 2015 to 2023



As well as showing the improving trend in mortality rates, the chart shows that the level of excess mortality in 2022 and 2023 was much higher than even the worst recent pre-pandemic year (2017).

Figure 8 shows deaths *from* COVID-19 and COVID-19 *related* deaths, noting that, given small numbers, weekly data for COVID-19 *related* deaths is not available for 2020 or 2021.

*Figure 8 – Weekly deaths – from COVID-19 and COVID-19 related**



* *COVID-19 data from ABS customised report 2023. Predicted COVID-19 deaths are zero as our baseline is intended to represent predicted deaths in the absence of the pandemic.*

Unsurprisingly, deaths *from* COVID-19 have been the major contributor to excess mortality, particularly in 2022 and 2023.

In 2022 there were around 10,300 deaths *from* COVID-19, accounting for a little more than half of the excess deaths. There were another 3,000 deaths where COVID-19 was a contributory factor in the death. By comparison, there were 900 COVID-19 deaths in 2020 and 1,400 in and 2021.

In 2023, after inclusion of estimated late-reported deaths, we estimate there were around 4,600 deaths *from* COVID-19, again accounting for just over half of the excess deaths in the year, and around 1,500 COVID-19 *related* deaths. This is substantially less than the number of such deaths in 2022.

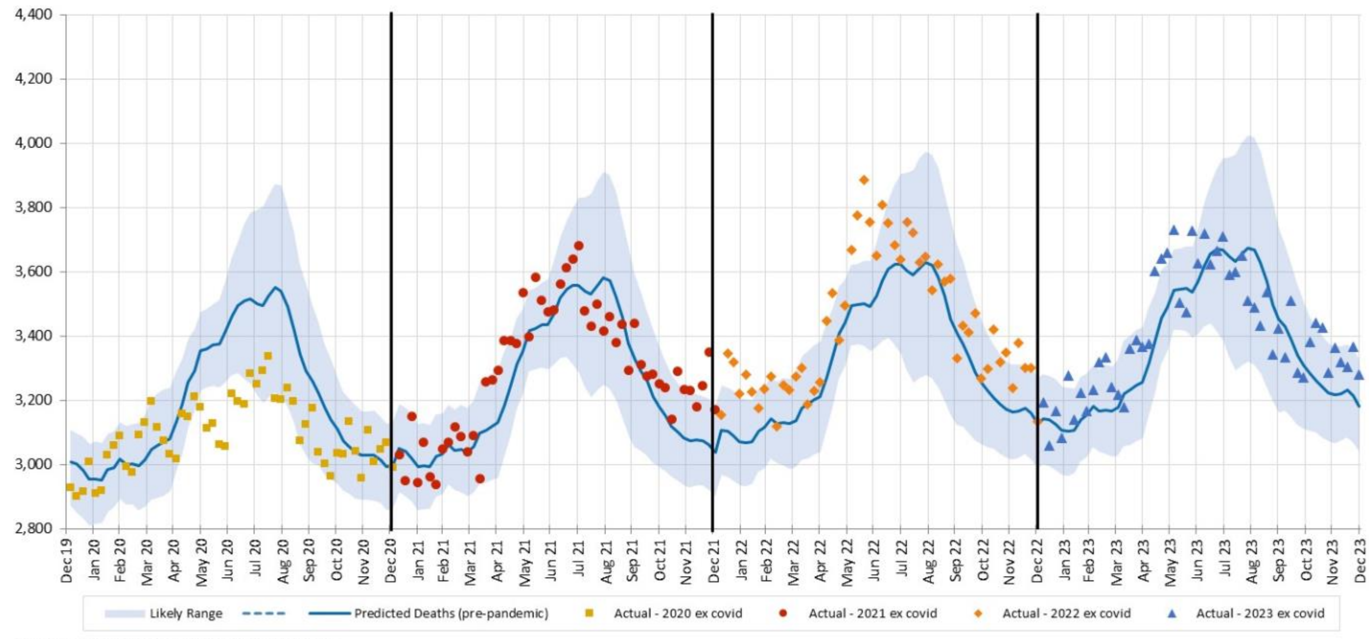
COVID-19 waves are very clear, showing an encouraging trend of reducing mortality impact since early 2022, with each successive wave resulting in fewer deaths than the previous wave. Deaths *from* COVID-19 and COVID-19 *related* deaths are strongly correlated, following the same pattern of peak and troughs.

It is unclear how many people whose deaths were COVID-19 *related* would have died during this period anyway, and how many may have had their death hastened by COVID-19. Given that COVID-19 is considered to have contributed to the death, and that these deaths follow the same peaks and troughs as *from* COVID-19 deaths, it seems that COVID-19 is a catalyst in these deaths, rather than being merely coincidental. We note that the same has traditionally happened with the winter peak of respiratory disease deaths.

There may be instances where it is difficult to determine whether a death is due to COVID-19 versus COVID-19 being a contributing cause, and an element of professional judgment by the certifier will necessarily need to be exercised. It is unclear to us how often such decisions may need to be made, and how much "blurring" there may be between deaths *from* COVID-19 and COVID-19 *related* deaths.

Figure 9 shows the comparison of actual deaths to predicted after removing deaths *from* COVID-19 and COVID-19 *related* deaths.

Figure 9 – Weekly actual and predicted deaths – All Causes excluding deaths from COVID-19 and COVID-19 related deaths



2020-2022 actuals include allowance for late reporting
Predicted deaths and ranges come from the fitted trend in each week's standardised death rate

Even after removing all deaths *from* COVID-19 and those that were COVID-19 *related*, significant excess mortality remains for both 2022 and 2023.

Very few weeks have actual deaths below the prediction in 2022. In 2023, the experience is closer to predicted than in 2022, however actual deaths were only below predicted at times when COVID-19 prevalence was low.

In both 2022 and 2023, the times where non-COVID-19 deaths are above the prediction interval are times of high COVID-19 or influenza prevalence. That is, non-COVID-19 excess has been higher at times of high COVID-19 prevalence.

The next section explores excess mortality by cause of death, providing insights into what is driving this trend in non-COVID-19 excess mortality.

2.4 Excess deaths by cause of death

Table 2 shows our estimate of excess deaths broken down by cause. We have shown the 2023 and 2022 years in detail, plus summary findings for 2020 and 2021 (a full table showing all figures is included in Table 10 in Appendix D).

Note that we have formed an estimate of the number of coroner-referred deaths that were *from* COVID-19 as discussed in Appendix B . We have assumed that coroner-referred deaths *from* COVID-19 will be 4.5% of all deaths *from* COVID-19 for each month of 2023, based on the experience of late 2021 and 2022. We have deducted these estimated coroner-referred deaths *from* COVID-19 from other coroner-referred deaths. If our estimate of coroner-referred COVID-19 deaths is too high (or low), this will not affect the total level of excess deaths measured; it will just mean that our estimate of non-COVID-19 coroner-referred deaths will be too low (or high) by the same amount.

Table 2 – Excess deaths by cause – 2020 to 2023

	2023				2022				2021		2020	
	Actual	Predicted	Excess	% Excess	Actual	Predicted	Excess	% Excess	Excess	% Excess	Excess	% Excess
From COVID-19												
Doctor-certified	4,422	-	4,422	n/a	9,801	-	9,801	n/a	1,230	n/a	855	n/a
Coroner-referred	208	-	208	n/a	463	-	463	n/a	125	n/a	51	n/a
All From COVID-19	**4,630**	**-**	**4,630**	**n/a**	**10,264**	**-**	**10,264**	**n/a**	**1,355**	**n/a**	**906**	**n/a**
Doctor-certified other respiratory disease												
Influenza	405	700	(290)	-42%	289	680	(390)	-57%	(660)	-100%	(590)	-93%
Pneumonia	2,330	2,840	(510)	-18%	2,340	2,770	(430)	-15%	(780)	-28%	(750)	-28%
Lower respiratory	7,830	8,490	(660)	-8%	8,080	8,370	(290)	-3%	(820)	-10%	(1,280)	-16%
Other respiratory	3,840	3,850	-	0%	3,780	3,720	70	2%	(10)	0%	(440)	-13%
All doctor-certified respiratory	**14,410**	**15,880**	**(1,470)**	**-9%**	**14,490**	**15,530**	**(1,040)**	**-7%**	**(2,260)**	**-15%**	**(3,070)**	**-21%**
Doctor-certified other diseases												
Cancer	51,470	50,770	700	1%	50,720	50,160	560	1%	110	0%	(640)	-1%
Ischaemic heart disease	13,320	12,670	660	5%	15,060	13,190	1,860	14%	830	6%	(110)	-1%
Other cardiac conditions	10,250	9,340	910	10%	10,350	9,350	1,000	11%	440	5%	(480)	-5%
Cerebrovascular disease	8,880	8,620	260	3%	9,370	8,890	480	5%	360	4%	(90)	-1%
Diabetes	5,450	4,790	660	14%	5,650	4,810	840	17%	360	8%	330	7%
Dementia	17,060	18,720	(1,670)	-9%	17,740	17,860	(120)	-1%	(550)	-3%	(980)	-6%
Other unspecified diseases	35,560	33,260	2,300	7%	35,640	32,280	3,360	10%	2,360	8%	(120)	0%
All other doctor-certified disease	**141,980**	**138,170**	**3,810**	**3%**	**144,530**	**136,540**	**7,990**	**6%**	**3,900**	**3%**	**(2,080)**	**-2%**
Coroner-referred excl. From COVID-19	**22,660**	**21,230**	**1,430**	**7%**	**22,870**	**20,820**	**2,050**	**10%**	**740**	**4%**	**(140)**	**-1%**
Total	**183,700**	**175,300**	**8,400**	**5%**	**192,200**	**172,900**	**19,300**	**11%**	**3,800**	**2%**	**(4,300)**	**-3%**

* Figures shaded green indicate that the observed values are below the 95% prediction interval while figures shaded red are above the 95% prediction interval. COVID-19 data from ABS customised report 2023 and analysis

When broken down by cause of death, in 2023:

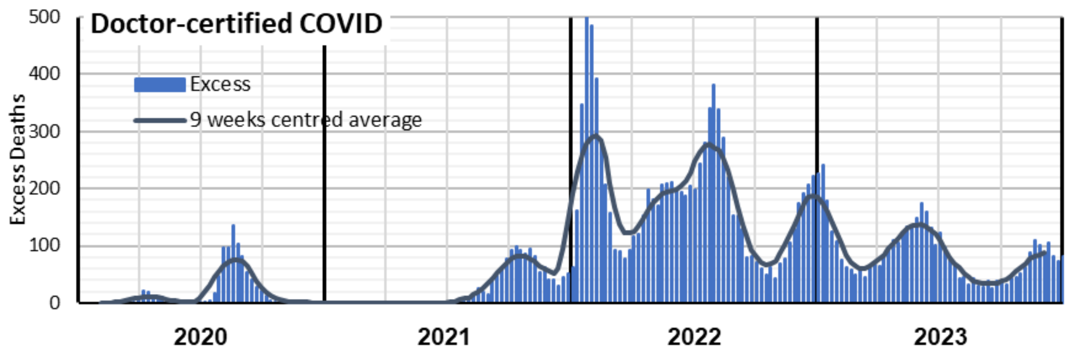
- total deaths were 5% (95% confidence interval: 3% to 7%) or +8,400 higher than predicted (compares with an 11% excess for 2022 or +19,300 deaths);
- there were 4,630 deaths *from* COVID-19, representing 55% of the excess deaths (compared with almost 10,300 for 2022, representing 53% of the excess);
- the remaining 3,800 excess deaths had other underlying causes on the death certificate and are shown in the table according to the relevant underlying cause:
    - there were 1,478 COVID-19 *related* deaths included among these other causes of death, representing 18% of the total excess deaths (compared with almost 3,000 for 2022, representing 15% of the excess); and
    - the remaining 27% of excess deaths, or around 2,300 deaths, have no mention of COVID-19 on the death certificate (compared with around 6,000 for 2022, representing 31% of the excess);

- despite influenza circulating in Australia again in 2022 and 2023, doctor-certified deaths from respiratory disease were again lower than expected (9% lower) although not as low as we saw earlier in the pandemic;
- while doctor-certified deaths from cancer were close to predicted in percentage terms (1% higher), this difference is statistically significant. Of the 700 excess cancer deaths, around 380 are deaths where COVID-19 was a contributing cause. When these COVID-19 *related* deaths are excluded, deaths from cancer are not statistically significantly different from predicted;
- doctor-certified deaths from ischaemic heart disease, other cardiac conditions, cerebrovascular disease and diabetes were all significantly higher than predicted (by between 3% and 14%) and remain so after COVID-19 *related* deaths are excluded;
- doctor-certified deaths from dementia were significantly lower than predicted, suggesting that defensive measures are still providing some protection to aged care residents against both COVID-19 and influenza;
- doctor-certified deaths from other unspecified diseases were significantly higher than predicted (by 7%), continuing a trend observed since April 2021. Note that this is a large "catch-all" category and it is difficult to infer the reason for this large increase; and
- coroner-referred deaths excluding those *from* COVID-19 were 7% higher than predicted. Note that in the years immediately preceding the pandemic, around 11,500 coroner-referred deaths were those from "external causes" (being accidents, assaults, suicides, poisonings, etc) with the remaining approximately 9,000 deaths being deaths from disease that are referred to the coroner for various reasons. Of these disease deaths, around 4,500 (about half) are from ischaemic heart disease and other cardiac conditions and are thus likely to be a significant contributor to the excess mortality for this cohort.

For almost all causes of death, excess mortality was lower in 2023 compared with 2022.

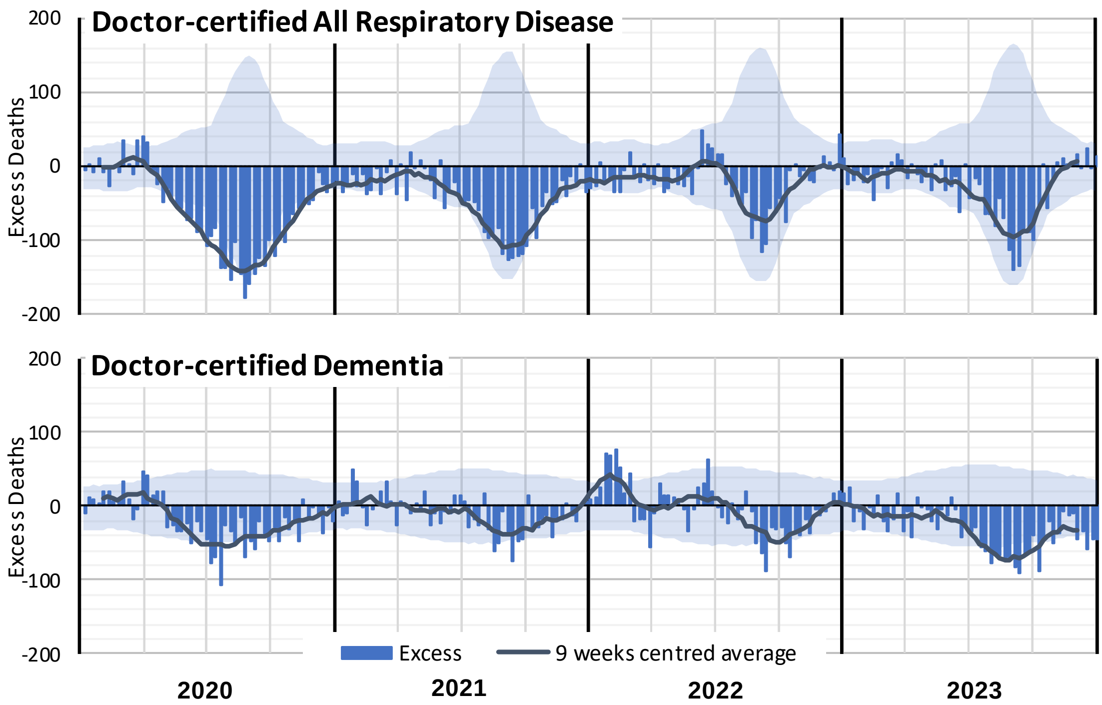
The following series of figures show weekly excess deaths by underlying cause (thus including COVID-19 *related* deaths) since the start of the pandemic, compared with the 95% prediction interval. All graphs are shown using the same y-axis to give a sense of the contribution of each cause. The 9-week centred average is also shown, to highlight any trends.

Figure 10 – Weekly excess deaths in 2020-2023 for doctor-certified deaths from COVID-19



Unsurprisingly, deaths *from* COVID-19 have been the major contributor to excess mortality, particularly in 2022 and 2023, once the vast majority of the population was vaccinated and Australia was no longer pursuing a suppression/elimination strategy. Across the four years shown, we estimate that the total deaths *from* COVID-19 of 17,200 make up almost two-thirds of the total estimated excess mortality of 27,200. COVID-19 waves have shown a trend of reducing mortality impact since early 2022, with each successive wave resulting in fewer deaths than the previous wave.

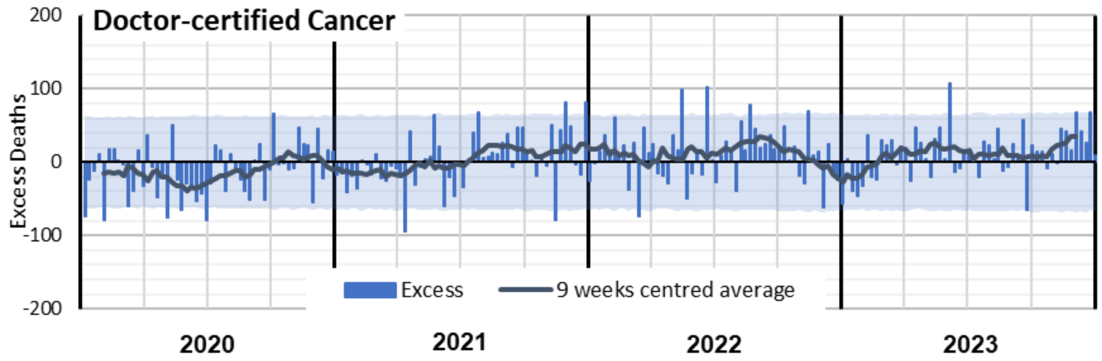
Figure 11 – Weekly excess deaths in 2020-2023 for doctor-certified deaths from respiratory disease and dementia



Deaths from respiratory disease have been significantly lower than predicted throughout the pandemic except for the short (and early) flu season which peaked in late June 2022. This coincides with the second 2022 peak in excess non-COVID-19 deaths that we saw in Figure 9. The much lower than predicted respiratory deaths in 2020 and 2021 are driven by the absence of influenza in Australia in those two years, which has a direct impact on deaths "from flu", but also secondary impacts where influenza would normally be a contributory cause in other respiratory deaths. The return of the circulation of influenza in early 2022 has resulted in an increase in respiratory deaths, but they have not returned to pre-pandemic levels, suggesting that non-pharmaceutical interventions (such as isolation, increased sanitisation measures and mask wearing) in hospitals and aged care facilities continue to reduce mortality (relative to pre-pandemic levels).

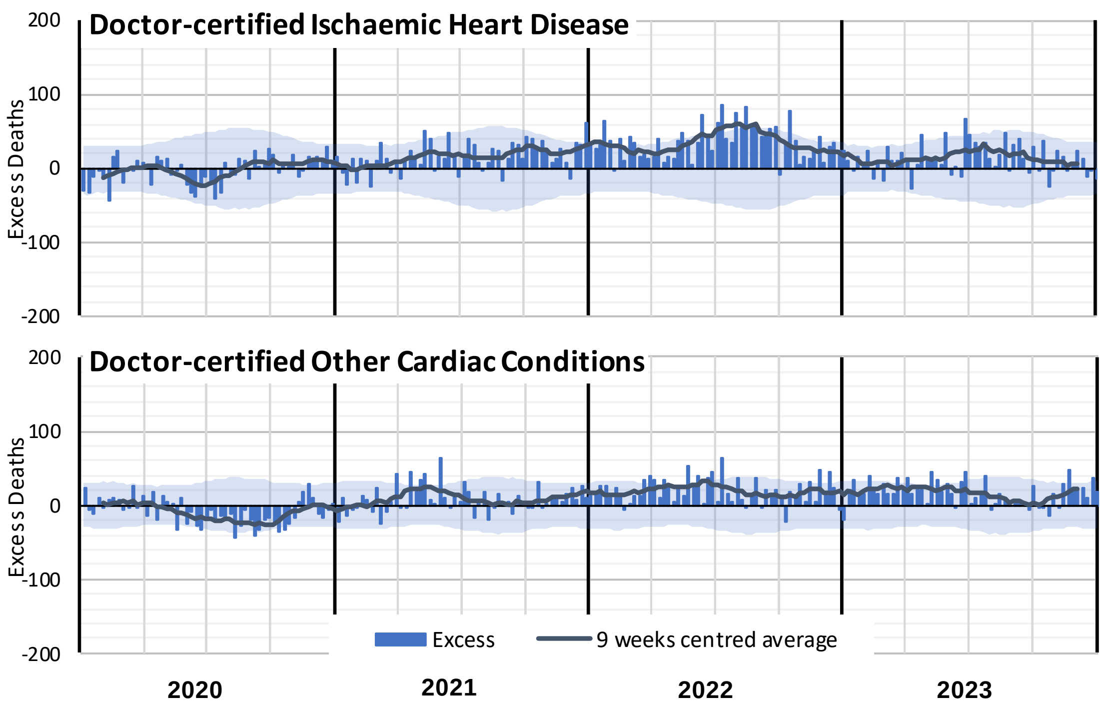
Excess deaths from dementia follow a similar pattern to excess deaths from respiratory disease, with the timing of lower than predicted mortality in the two series being closely linked. This is because flu is a contributory cause in a large proportion of dementia deaths. We also see the impact of COVID-19 as a contributory cause as dementia deaths have tended to be higher at times of high COVID-19 prevalence. The negative excess deaths for dementia in 2020, 2021, 2022 and 2023 were closely aligned with lower prevalence of respiratory disease. The higher excess deaths in the first half of 2022 and in December 2022/January 2023 were closely aligned with COVID-19 and flu waves.

Figure 12 – Weekly excess deaths in 2020-2023 for doctor-certified deaths from cancer



Cancer deaths account for about 30% of Australian deaths each year. Across the pandemic, cancer deaths have been within 1% of predicted. There were concerns in 2020 and 2021 about the impact of lockdowns on cancer deaths, with people being less able to access medical care. Section 3.4 shows that, while there does appear to have been a reduction in cancer screenings via the three national cancer screening programs (for bowel, breast and cervical cancer) during lockdown periods, this was quite short lived and does not seem likely to be a material driver of excess mortality. In both 2022 and 2023, excess cancer mortality was significant, but this can be explained by deaths where COVID-19 was a contributory cause.

Figure 13 – Weekly excess deaths in 2020-2023 for doctor-certified deaths from ischemic heart disease and other cardiac conditions



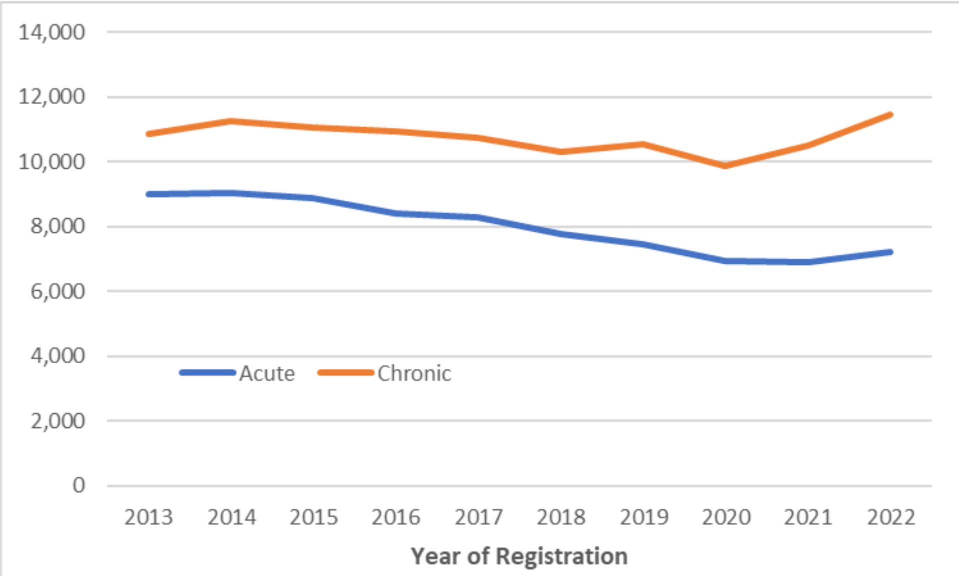
Both ischaemic heart disease and other cardiac conditions had lower than predicted deaths in winter 2020, which is also likely to be related to the absence of influenza (it is generally accepted that viral infections affect the mortality of people with heart conditions). But, since then, there has been significant excess mortality in both heart series, with much of the excess coinciding with COVID-19 peaks (noting that each chart includes COVID-19 *related* deaths from that cause). As discussed in Section 3, in our opinion, the most likely explanations for these excesses are:

- the after-effects of COVID-19 infection, with many studies showing a link between COVID-19 and increased subsequent risk from heart disease;
- (negative) mortality displacement from 2020;

- disruptions to routine medical care of people with heart conditions (i.e., missing early detection, no follow-up checks, no interventions such as medications/exercise to improve outcomes and delay deaths); and
- delayed access to emergency medical care, with longer ambulance wait times and slower emergency department treatment times, particularly in 2022.

Deaths from ischaemic heart disease are classified into sub-types based on the duration, complications and consequences of the disease progression. Five major sub-types are included in the International Classification of Diseases, version 10 (ICD-10) codes, being codes I20-I25. We understand that, generally, these sub-types help designate whether the ischaemic heart disease was acute or chronic in nature, with acute manifestations assigned codes I20-I24 and chronic manifestations assigned code I25. Figure 14 shows the number of deaths from ischaemic heart disease split between acute and chronic manifestations. Note this information is only available for deaths registered by 31 December 2022, and the graph is compiled by year of registration rather than year of occurrence.

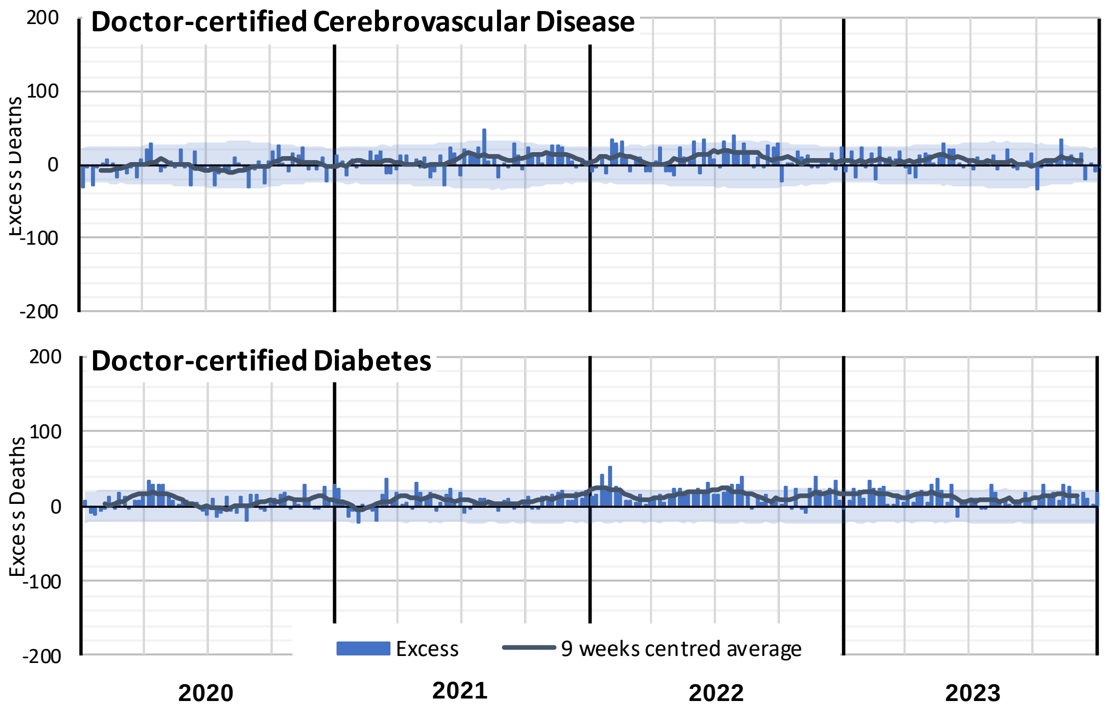
*Figure 14 – Yearly deaths from ischemic heart disease by year of registration – Acute versus Chronic**



** Source: Table 1.2 of the ABS publication Causes of Death, Australia, 2022*

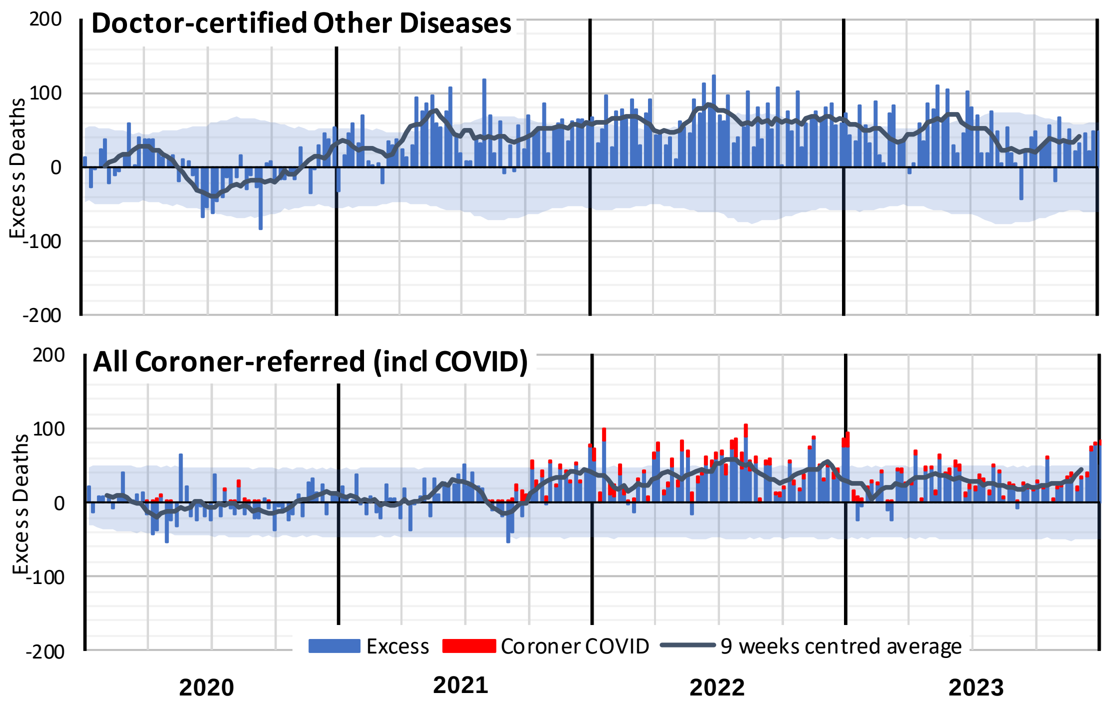
This shows that the vast majority of the **increase** in deaths from ischaemic heart disease has been in those with chronic heart conditions, rather than an acute episode, lending further weight to the hypothesis that after-effects of COVID-19, mortality displacement and lack of routine medical care, are the main drivers of excess mortality from this cause.

Figure 15 – Weekly excess deaths in 2020-2023 for doctor-certified deaths from cerebrovascular disease and diabetes



There has been a consistent excess since mid-2021 for deaths from cerebrovascular disease (strokes and the like). Deaths from diabetes have been higher than predicted throughout the pandemic, with peaks and troughs following the same patterns as deaths *from* COVID-19. Again, studies have shown that these two causes have a link to COVID-19, and we also expect that deaths from cerebrovascular disease may be impacted by delayed access to emergency care.

Figure 16 – Weekly excess deaths in 2020-2023 for doctor-certified deaths from other diseases and coroner-referred deaths



Deaths from other diseases (where the ABS data does not specify the cause) were also lower than predicted in 2020 (correlated with lower respiratory disease) but have been the largest contributor to non-COVID-19 excess deaths since 2021. This category covers the many different causes of death that are not separately reported on by the ABS in the Provisional Mortality Statistics. Given the wide variety of these causes of death, various factors are likely influencing this outcome. We expect that at least part of the excess will be (negative) mortality displacement. This is supported by ABS data at the detailed cause of death level for 2021 and 2022; that data shows that the excess is spread across a large number of individual causes included in this category, rather than being driven by a handful of causes (which also suggests that COVID-19 vaccines are not a significant contributor). We also expect that there is a contribution from the impacts of interrupted routine care due to lockdowns.

Coroner-referred deaths include those *from* COVID-19 that have been referred. In Figure 16, we have separately shown these (in red), using actual coroner-referred COVID-19 deaths for 2020 to 2022, and estimates for 2023 based on our assumption that 4.5% of all COVID-19 deaths are referred to the coroner. The residual non-COVID-19 coroner-referred deaths are well above predicted levels from the second half of 2021. However, as shown in Section 3.6 and Section 3.7, suicide monitoring reports and road death statistics indicate that deaths from these causes do not account for a material proportion of this excess. A large proportion of deaths from heart-related conditions are generally referred to the coroner, and we expect that this may be the main driver of the excess mortality for this category.

2.5 Excess deaths by age and gender

Table 3 summarises the results of the analysis by age band and gender, for 2022 and 2023 (the results for 2020 and 2021 are included in Appendix E). Note that the totals are not quite the same as the totals in Table 2 due to the more approximate approach to setting our baseline by age/gender, and also because the results are summarised by ISO year (exactly 52 weeks) rather than calendar year. We remind the reader that our models by cause of death are our preferred models, but we provide the age band/gender models here for indicative purposes. In particular, we note that the numbers of deaths in the 0-44 and 45-64 age bands are small and hence subject to considerable natural variation and the results for these younger age bands are less reliable than for older age bands.

We have shown the excess including all deaths, and then again after deducting *from* COVID-19 and COVID-19 *related* deaths.

Table 3 – Excess deaths by age band and gender – 2022 and 2023

Age Band and Gender	2023 (52 weeks)						2022 (52 weeks)					
	Actual	Predicted	Excess	% Excess	COVID-19	% Net	Actual	Predicted	Excess	% Excess	COVID-19	% Net
Males, 0-44	5,050	5,250	-200	**-4%**	25	**-4%**	5,220	5,120	100	2%	138	-1%
Males, 45-64	13,420	13,250	170	1%	169	0%	14,010	13,280	730	**5%**	511	2%
Males, 65-74	17,160	15,810	1,350	**9%**	451	**6%**	17,970	15,970	2,000	**13%**	1,070	**6%**
Males, 75-84	28,540	25,850	2,690	**10%**	1,007	**6%**	29,320	25,350	3,970	**16%**	2,255	**7%**
Males, 85 and over	31,810	29,840	1,970	**7%**	1,515	2%	33,790	29,250	4,540	**16%**	3,339	**4%**
Males, All ages	**96,000**	**90,000**	**6,000**	**7%**	**3,167**	**3%**	**100,300**	**89,000**	**11,300**	**13%**	**7,313**	**5%**
Females, 0-44	2,810	2,640	170	**6%**	20	**6%**	2,870	2,610	260	**10%**	86	**6%**
Females, 45-64	8,390	8,110	280	**3%**	113	2%	8,800	8,140	660	**8%**	331	**4%**
Females, 65-74	11,290	10,690	600	**6%**	246	**3%**	11,660	10,680	980	**9%**	587	**4%**
Females, 75-84	22,220	19,980	2,240	**11%**	721	**8%**	22,330	19,600	2,730	**14%**	1,383	**7%**
Females, 85 and over	42,460	39,020	3,440	**9%**	1,676	**5%**	45,720	39,180	6,540	**17%**	3,615	**7%**
Females, All ages	**87,200**	**80,400**	**6,700**	**8%**	**2,776**	**5%**	**91,400**	**80,200**	**11,200**	**14%**	**6,002**	**6%**
Person, 0-44	7,860	7,880	-20	0%	45	-1%	8,090	7,730	360	**5%**	224	2%
Person, 45-64	21,800	21,370	430	**2%**	282	1%	22,810	21,420	1,390	**7%**	842	**3%**
Person, 65-74	28,460	26,500	1,960	**7%**	697	**5%**	29,630	26,650	2,980	**11%**	1,657	**5%**
Person, 75-84	50,750	45,840	4,910	**11%**	1,728	**7%**	51,660	44,950	6,710	**15%**	3,638	**7%**
Person, 85 and over	74,270	68,860	5,410	**8%**	3,191	**3%**	79,510	68,430	11,080	**16%**	6,954	**6%**
Person, All ages	**183,100**	**170,400**	**12,700**	**7%**	**5,943**	**4%**	**191,700**	**169,200**	**22,500**	**13%**	**13,315**	**5%**

* Figures shaded green indicate that the observed values are below the 95% prediction interval while figures shaded red are above the 95% prediction interval. COVID-19 data from ABS customised report 2023 and analysis

In 2022, all age band/gender combinations show excess deaths, other than the youngest male age group. This is not surprising given the high excess deaths for the whole population. After deducting COVID-19 deaths, the excess remains significant for all but the two youngest male age groups.

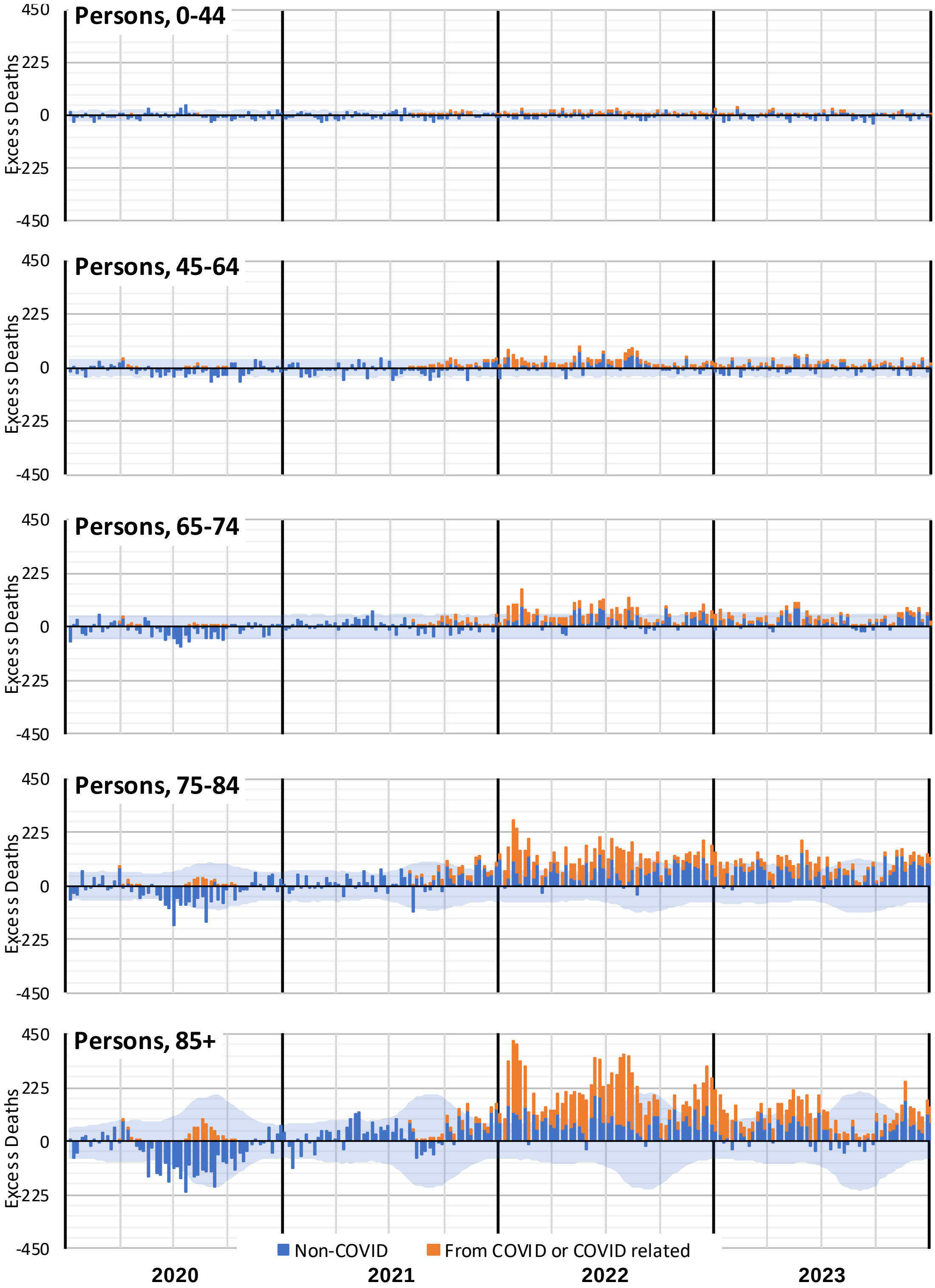
In 2023, the excess in each age band/gender combination is lower than for 2022, but there were statistically significant excess deaths in all but the two youngest male age groups. After deducting COVID-19 deaths, the excess is no longer significant for males aged over 85 and females aged 45-64 i.e. COVID-19 deaths explain all of the excess for these two age band/gender combinations.

In both years, the number and percentage of excess deaths is higher in older age bands. The risk of mortality *from* COVID-19 is steeper than the underlying age mortality curve, so this result is somewhat expected when COVID-19 is included. Excess mortality is also generally higher in older age bands when COVID-19 is excluded, which is consistent with Figure 9, which showed that deaths excluding those with mention of COVID-19 still showed evidence of COVID-19 waves.

The table also indicates that the percentage excess for females is higher than for males in most age groups, both before and after removing COVID-19 deaths.

It is notable that excess deaths in each age band are generally significant in both years, even after removing COVID-19 deaths. To look at this further, we have shown these results similarly to the graphs by cause, showing weekly excess deaths by age band since the start of the pandemic. For these charts, we have been able to show the contribution of deaths *from* COVID-19 and COVID-19 *related* deaths (in orange) separately to non-COVID-19 deaths. The 95% prediction interval is also shown. All age bands are shown using the same y-axis to give a sense of contribution of each age band.

*Figure 17 – Weekly excess deaths in 2020-2023 by age band (all persons)**

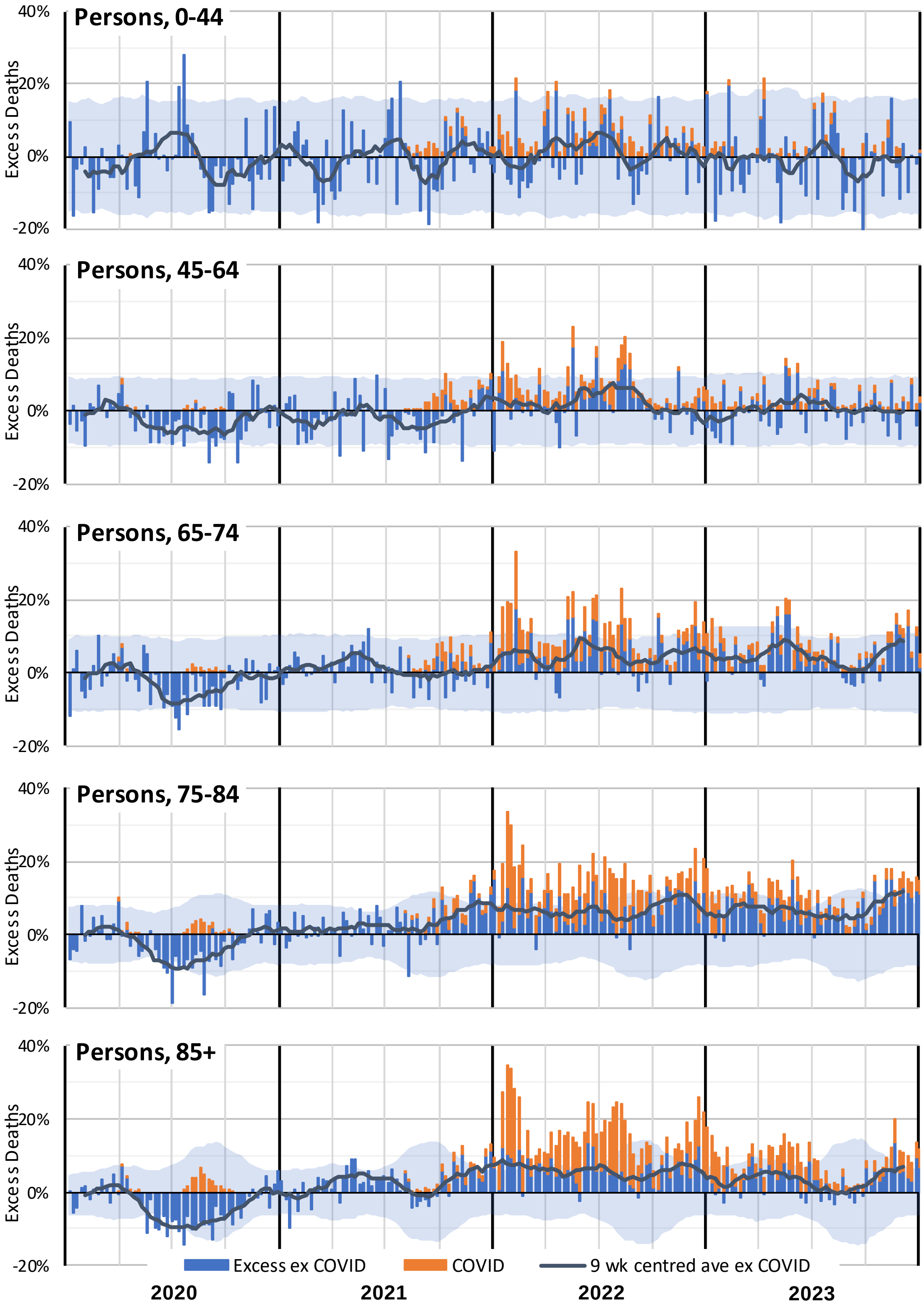


** COVID-19 data from ABS customised report 2023*

Figure 17 shows that the vast majority of the excess is in those over 65 years of age. While we already expect many more deaths in these age groups, the excess is further skewed to older age groups. In 2022 and 2023, 83% of predicted deaths are in those aged over age 65 but 94% of excess mortality is in those over 65. This is not surprising given that the majority of the excess mortality is due to COVID-19 and COVID-19 deaths are more highly skewed to older ages than non-COVID-19 deaths.

It is instructive to consider the same information with the excess deaths expressed as a percentage of predicted deaths as shown in Figure 18.

*Figure 18 – Weekly excess deaths as a percentage of predicted in 2020-23 by age band (all persons)**



** COVID-19 data from ABS customised report 2023*

The older age groups still experienced the most significant increase in excess deaths when expressed as a percentage of predicted deaths. Indeed, deaths of people over the age of 75 are significantly higher than expected (i.e. above the light blue shaded area) in almost every week of 2022 and 2023, other than the period of low COVID-19 prevalence in August to October of 2023.

2.6 Excess deaths by state/territory

As mentioned in Section 2.2.3, the results shown in this section use the ABS estimates of predicted deaths for each state/territory. Table 4 shows the estimated excess deaths by state/territory for 2022 and 2023, before and after deducting *from* COVID-19 and COVID-19 *related* deaths (where available). Note that, as we have used the ABS predicted deaths, the totals are not the same as the totals in either Table 2 or Table 3. The overall estimates for Australia using the ABS predicted values by state/territory are close to our overall estimates using our (preferred) cause of death models (1% different for each of 2022 and 2023). These differences are not as statistically significant and arise due to the different modelling approaches used.

We have included allowance for late-reported deaths in the "actual" figures shown in Table 4, hence the calculated excesses are a little different from those shown in the ABS publication. This is only materially different for the Northern Territory where there are (proportionally) substantially more late-reported deaths than in other states.

*Table 4 - Excess deaths by State/Territory – 2022 and 2023**

State/Territory	2023 (52 weeks)						2022 (52 weeks)					
	Actual	Predicted	Excess	%Excess	Covid-19	%Net	Actual	Predicted	Excess	%Excess	Covid-19	%Net
NSW	58,600	56,300	2,300	4%	2,078	0%	62,500	55,800	6,700	12%	4,833	3%
Victoria	45,000	42,000	3,000	7%	1,336	4%	47,700	41,600	6,100	14%	3,464	6%
Queensland	37,500	35,600	1,900	5%	1,116	2%	38,600	34,800	3,800	11%	2,345	4%
South Australia	15,400	14,600	800	6%	475	2%	16,000	14,500	1,500	10%	1,062	3%
Western Australia	17,600	16,600	1,000	6%	633	2%	17,500	16,300	1,200	8%	971	2%
Tasmania	5,100	4,600	500	11%	187	7%	5,100	4,700	400	10%	342	3%
Northern Territory	1,220	1,150	70	6%	25	4%	1,350	1,130	220	20%	91	12%
ACT	2,750	2,690	60	2%	93	-1%	2,900	2,600	300	11%	207	3%
Australia	**183,200**	**173,700**	**9,600**	**6%**	**5,900**	**2%**	**191,600**	**171,400**	**20,200**	**12%**	**13,123**	**4%**

** COVID-19 data from ABS customised report 2023*

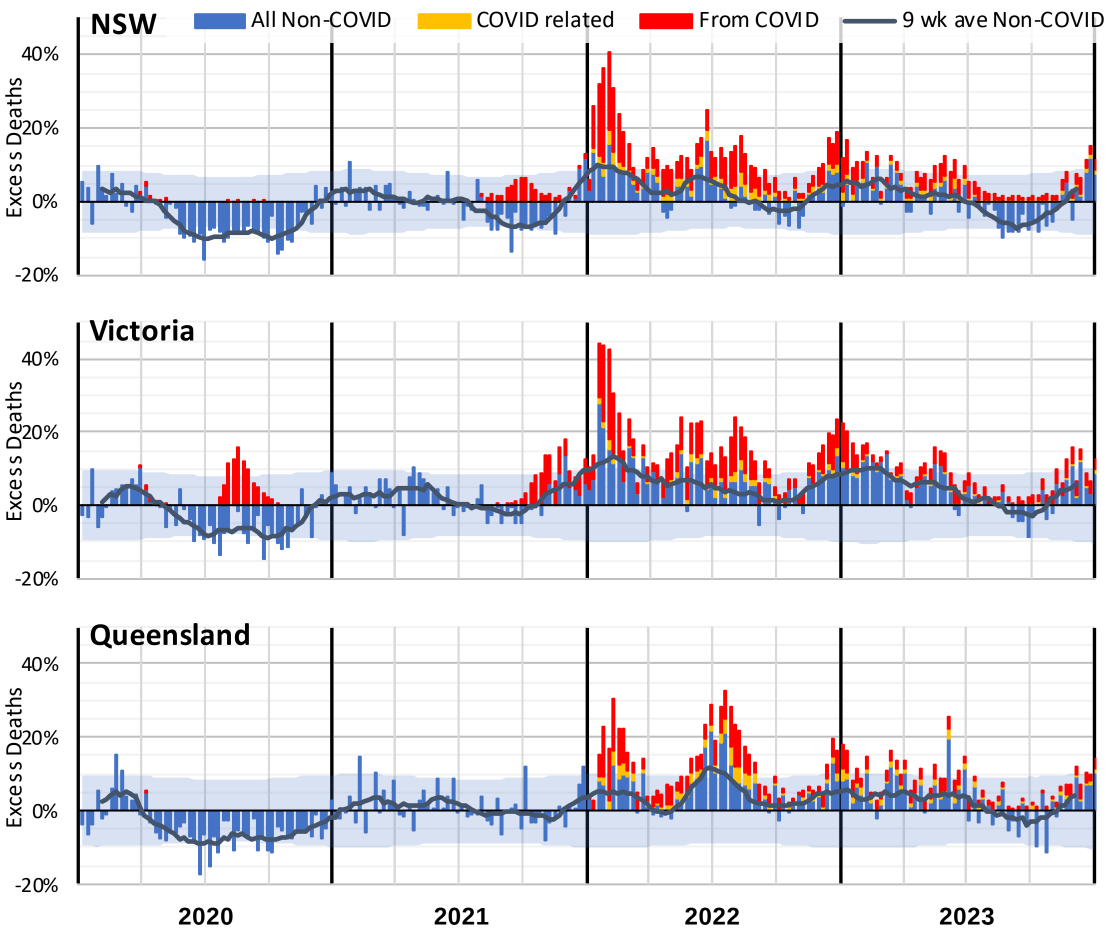
In 2022, all states/territories had excess mortality ranging from 8% to 20% of predicted. After removing COVID-19 deaths, all states/territories had excesses ranging from 2% to 12%. While we do not have yearly confidence intervals for the ABS estimates, we expect that only WA would have statistically significantly lower excess mortality than the other states/territories and that only NT would have statistically significantly higher excess mortality than the other states/territories.

In 2023, most states/territories had excess mortality of 4% to 11%, with the ACT lower at only 2%. The excess for Tasmania is likely to be statistically significantly higher than the other states. After deducting COVID-19 deaths, all states/territories other than NSW and the ACT have excess mortality.

The graphs below show these results week-by-week (with the excess shown as a percentage of the predicted value) for:

a. the three largest states (NSW, Victoria and Queensland) where we have weekly information on both deaths *from* COVID-19 deaths and COVID-19 *related* deaths;
b. SA and WA where we have weekly information on deaths *from* COVID-19 only; and
c. the smaller states/territories (Tasmania, NT and ACT) where weekly information on COVID-19 deaths is not available.

*Figure 19 – Weekly excess deaths as a percentage of predicted in 2020-23 for NSW, Victoria, Queensland**



** COVID-19 data from ABS customised report 2023*

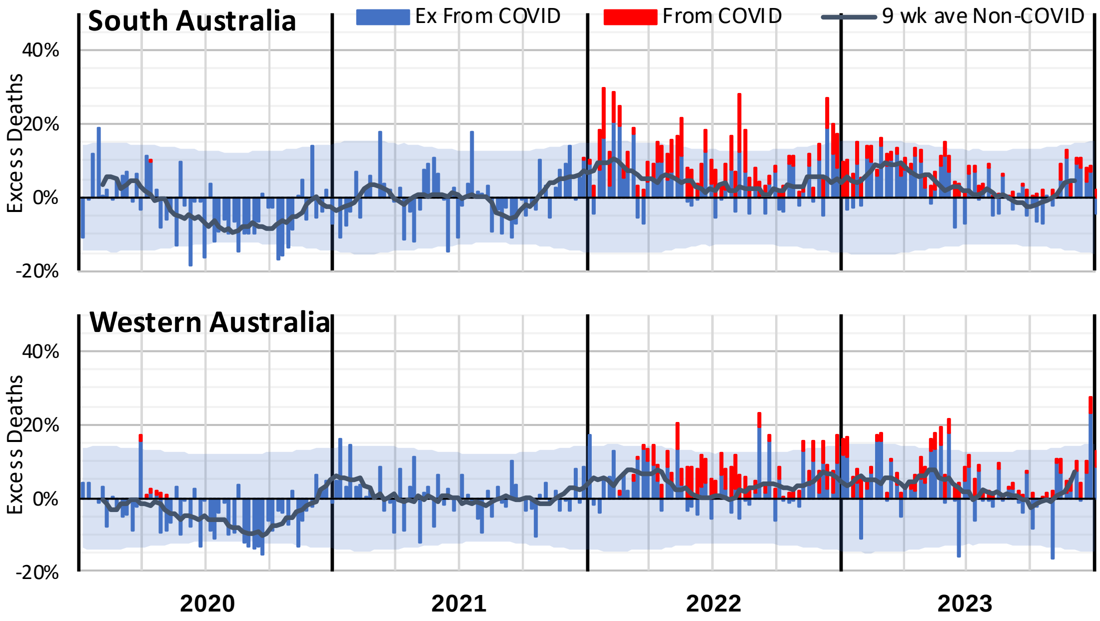
Figure 19 shows that these larger states all had better-than-expected mortality in 2020. It also shows the impact of the second COVID-19 wave in Victoria.

In 2021, Victoria shows a much higher level of excess deaths in the Delta wave – in the last quarter of the year – than either NSW or Queensland.

In 2022, Queensland had a large peak in non-COVID excess deaths in the middle of the year (at the time of flu and COVID-19 waves). NSW had a smaller peak of non-COVID deaths at this time. Victoria tended to have higher levels of non-COVID-19 deaths throughout this year.

In 2023, Victoria had higher levels of non-COVID-19 deaths than NSW and Queensland in the first quarter of the year. NSW had substantial negative non-COVID-19 excess from mid-August until late-October, a time of low COVID-19 prevalence; this negative excess offset the earlier excess, resulting in zero net-of-COVID-19 excess for 2023. Both Victoria and Queensland had negative non-COVID-19 excess at the same time as NSW, although the magnitude was not as large.

*Figure 20 – Weekly excess deaths as a percentage of predicted in 2020-23 for WA and SA**



** COVID-19 data from ABS customised report 2023*

The SA experience is similar to the three largest states, although somewhat more volatile given its smaller size.

Western Australia, while mostly having excess deaths within the 95% prediction interval, had many more weeks with positive excess deaths than with negative excess deaths. There is no large COVID-19 spike in January/February 2022, thanks to the later opening of WA's borders.

Figure 21 – Weekly excess deaths as a percentage of predicted in 2020-23 for Tasmania, ACT and NT

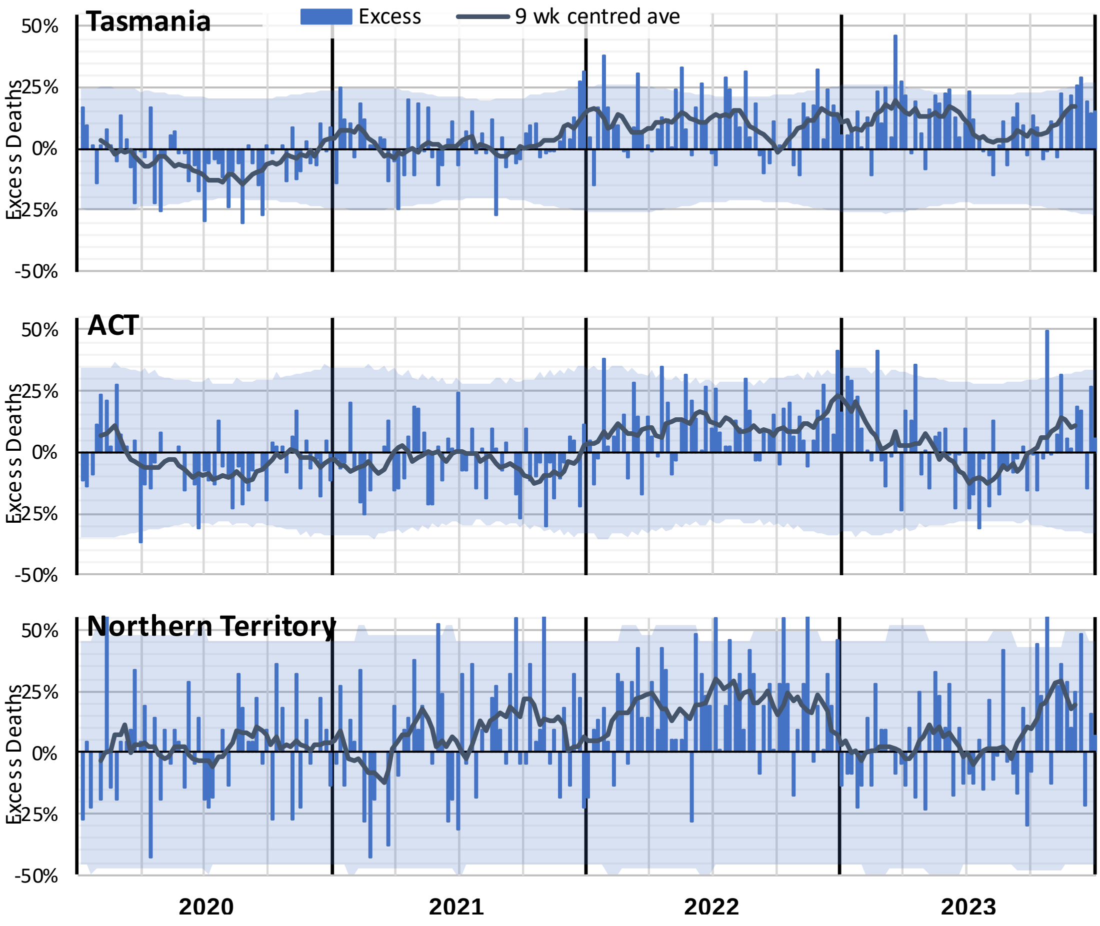


Figure 21 shows the higher volatility of excess mortality experienced by the smallest state and the two territories, however the overall trends are broadly that same as for the larger states.

Tasmania's excess mortality has tended to be higher than for the larger states, particularly in 2023. This may be due to the relatively older population in Tasmania.

With its relatively young and affluent population[22], the ACT has experienced lower excess mortality than the larger states.

The Northern Territory experience is more volatile from week to week than other jurisdictions, caused by a very small weekly expected death count. However, the excess for 2022 appears to be consistently higher than the other states. While weekly data is not available, annual figures show that the excess attributable to COVID-19 is similar to other jurisdictions, implying that the non-COVID-19 excess is higher. Given the remote nature of the Territory, we expect that this may be due to mis-diagnosed COVID-19 deaths, worse outcomes due to interruption of health services, or a combination of both. The excess for 2023 appears lower than for the other jurisdictions in the first half of the year, noting that there is considerable uncertainty around the 2023 figures given the longer registration delays in the NT compared with larger, more populous states.

[22] ABS statistics included in the *COVID-19 Mortality in Australia* article show that those in the lowest SEIFA quintile have had higher COVID-19 mortality than those in the highest SEIFA quintile

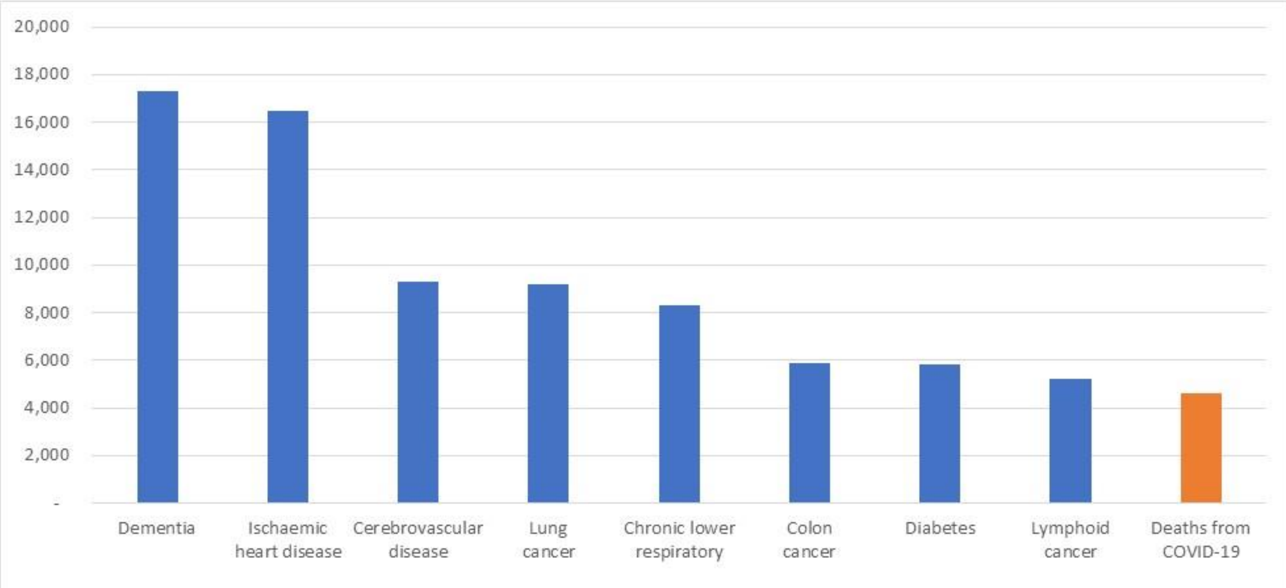
2.7 Leading causes of death

The ABS reports on the top 20 leading causes of death by grouping deaths based on their ICD-10 code. Unlike the *Provisional Mortality Statistics*, cancers are grouped based on the region of the body rather than being classed as a single cause of death. In this section, we assess where COVID-19 sits in terms of leading causes of death in Australia in 2023 and have followed the ABS classification system.

We have estimated deaths for the leading causes for 2023 by:

- taking doctor-certified deaths by cause to 31 December 2023 as shown in Table 2;
- including an allowance for coroner-referred deaths (using the historical ratio of doctor-certified to coroner-referred deaths)[23]; and
- for the leading cancer causes, estimating deaths from all cancers and then assuming that lung, colon and lymphoid cancers make up 18%, 11% and 10% respectively of all cancer deaths, in line with the stable proportions seen over the recent past.

Figure 22 – Estimated leading causes of death – Australia 2023



With around 4,600 deaths *from* COVID-19, we estimate this puts COVID-19 as the ninth leading cause of death in Australia in 2023. This is down from around 10,300 deaths and COVID-19 being the third leading cause in 2022.

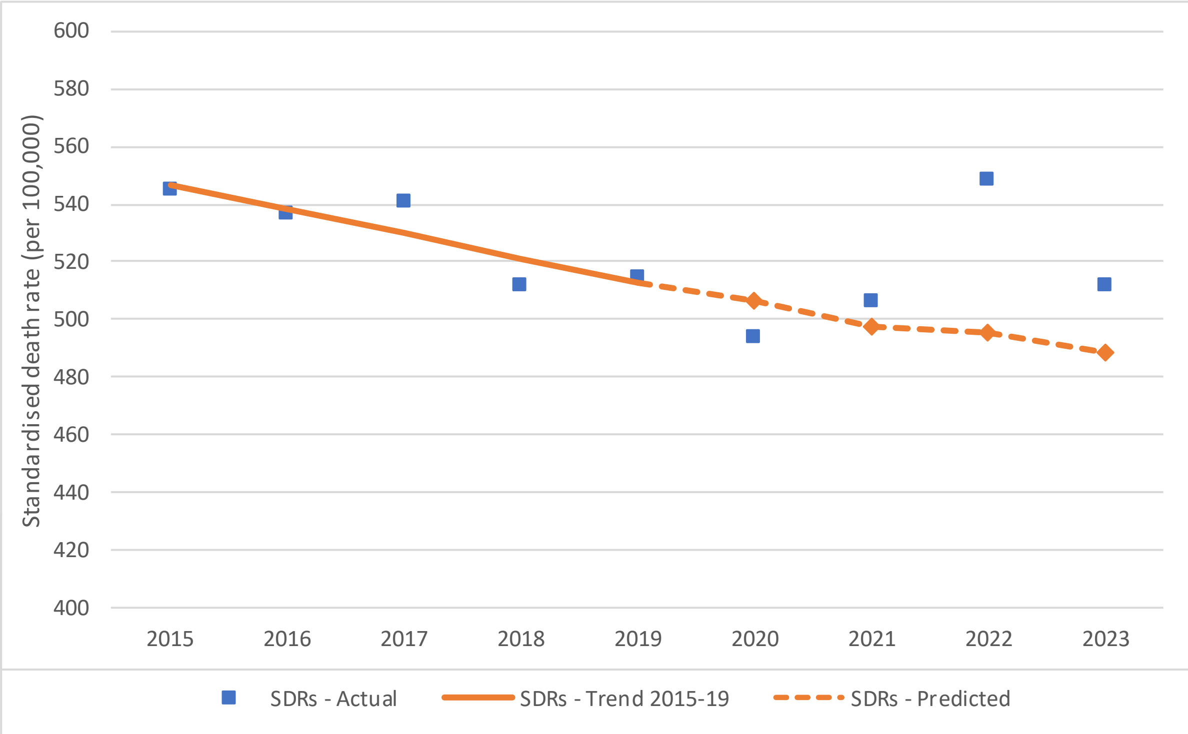
We also estimate that dementia will be the leading cause of death in Australia in 2023, replacing ischemic heart disease. Standardised mortality rates for both of these causes fell in 2023, however the fall was greater for ischemic heart disease compared with dementia.

2.8 Standardised death rates

Figure 23 shows the standardised death rates (SDRs) for 2015 to 2023, taken from the *Provisional Mortality Statistics*, plus allowance for late-reported deaths. We have also shown the trend line for 2015 to 2019, plus our predicted SDRs.

[23] We have taken all deaths from the ABS *Cause of Death*, and doctor-certified deaths from the ABS *Provisional Mortality Statistics*, with the difference assumed to be coroner-referred deaths. For almost all causes of death shown, around 95% or more deaths have historically been doctor-certified. The exception to this is ischaemic heart disease where around 80% of deaths have historically been doctor-certified. With significantly higher numbers of deaths in Australia in 2022, particularly for doctor-certified ischaemic heart disease deaths, there is uncertainty over these assumptions.

Figure 23 - Standardised death rates – 2015 to 2023



Between the 2015 to 2019 pre-pandemic years, mortality rates improved, noting that both 2017 and 2019 were "bad" influenza years, resulting in higher than usual deaths both from and related to influenza.

The 2020 year is considerably lower than 2019 and our predicted value, a result of the lower number of respiratory and respiratory-related deaths in that year due to measures introduced to curb COVID-19.

The 2021 year is higher than 2020 and our predicted value, a combination of both deaths *from* COVID-19 during the Delta wave and excess mortality from other causes of death (other than from respiratory disease).

The 2022 year is higher than any other year shown, and significantly higher than our predicted value, due to significant numbers of deaths *from* COVID-19, COVID-19 *related* deaths and higher than predicted deaths from non-COVID-19 causes.

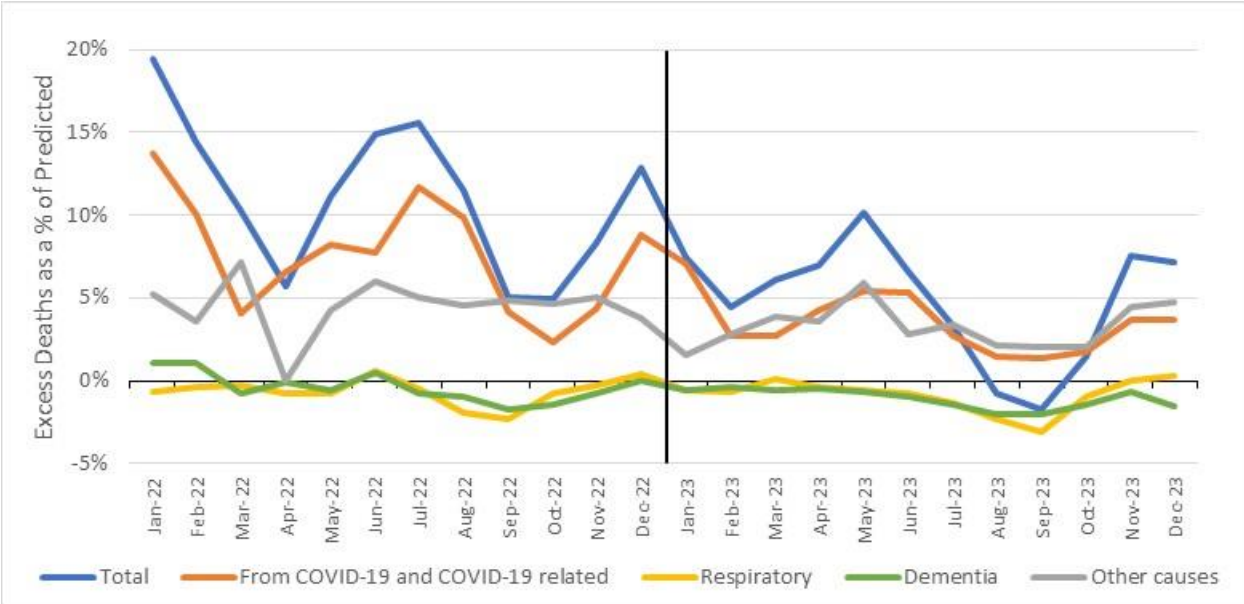
The 2023 year is lower than the very high 2022 year, but still higher than our predicted value. The SDR for 2023 is similar to that for 2018 and 2019.

3 Possible causes of non-COVID-19 excess deaths in 2022 and 2023

Taking the figures from Section 2.2.1, Figure 24 shows excess deaths (as a percentage of predicted) for each month of 2022 and 2023. We have shown the total excess (blue) and the contributions of:

- deaths *from* COVID-19 and COVID-19 *related* deaths (orange), noting that Figure 8 showed that deaths from these two sources move in the same pattern;
- doctor-certified deaths from respiratory disease (yellow);
- doctor-certified deaths from dementia (green); and
- deaths from all other causes (grey).

Figure 24 – Excess deaths (percentage of predicted) by month in 2022 and 2023



Deaths *from* COVID-19 and COVID-19 *related* deaths are the clear drivers of the majority of the excess mortality.

Deaths from respiratory disease have mostly been a negative contributor to excess mortality. We can see the impact of the early, lighter than average, influenza season in 2022 with a small contribution to excess mortality in June 2022, more than offset by high negative contributions in August and September 2022 (the months where influenza deaths usually peaked before the pandemic). The 2023 flu season was, like 2022, earlier than pre-pandemic normal.

Deaths from dementia are correlated with COVID-19 and respiratory deaths. As noted in Section 2.4, a high proportion of deaths *from* dementia have either influenza or COVID-19 listed as a contributory cause, so it is no surprise to see the excess dementia deaths move broadly in line with COVID-19 and influenza waves.

Excess deaths from other causes (i.e., non-COVID-19, non-respiratory), somewhat follows the pattern of COVID-19 mortality; it tends to be higher when COVID-19 (and respiratory) deaths are high and tends to be low when COVID-19 deaths are low. However, the relationship is not 100% correlated – e.g., there was substantial non-COVID-19, non-respiratory excess mortality in September and October 2022 when both COVID-19 and respiratory deaths were relatively low. The correlation has been stronger in 2023 than in 2022.

The measurement of higher numbers of deaths than predicted does not tell us why this is occurring. It is not possible to identify from death counts alone what is causing the non-COVID-19 excess deaths. Multiple factors are likely in play, and different factors may be more or less pronounced at various times. There are several reasons hypothesised around the world (where this effect is occurring to a greater or lesser extent) including, but not limited to:

- post-COVID-19 sequelae or interactions with other causes of death;
- mortality displacement;
- delays in emergency care;
- delays in routine care;
- undiagnosed COVID-19;
- mental health issues leading to suicide deaths;
- increases in alcohol-induced deaths;
- increases in road accident deaths; and
- vaccine-related deaths.

In this section, we explore these factors in the Australian context, with a particular focus on the impact on excess mortality in 2022 and 2023. As a reminder, we estimate that non-COVID-19 excess deaths were around 6,000 in 2022 and around 2,300 in 2023 (see Section 2.4).

For clarity, in this section we discuss the impacts on total excess mortality across the whole population (i.e. covering all ages). While some impacts may be immaterial at a population level, they may have a material impact on the mortality of particular (younger) age groups.

Table 5 summarises the key findings of the rest of this Section.

Table 5 – Summary of Possible Causes of Non-COVID-19 Excess Deaths

Possible Cause	Likely impact in 2022	Likely impact in 2023
Post-COVID-19 sequelae	High	High
Mortality displacement	Moderate	Lower than in 2022
Delays in emergency care	High during COVID-19 and influenza peaks	High during COVID-19 and influenza peaks but lower than in 2022
Delays in routine care	Low to Moderate	Lower than in 2022
Undiagnosed COVID-19	Low, perhaps higher during COVID-19 peaks	Higher than in 2022
Suicide deaths	Not numerically significant	Not numerically significant
Alcohol-induced deaths	Low	Low
Road accident deaths	Not numerically significant	Not numerically significant
Vaccine-related deaths	Not numerically significant	Not numerically significant

3.1 Post-COVID-19 sequelae or interactions with other causes of death

Studies have shown that COVID-19 is associated with higher subsequent mortality risk from heart disease and other causes[24], but certifying doctors would generally not be able to medically identify a **causative** link several months after recovery from COVID-19 (for example, we understand that medical science cannot currently distinguish between a heart attack that was caused by the after-effects of

[24] A small selection of numerous research studies includes:
Davis, H.E., McCorkell, L., Vogel, J.M. et al. Long COVID: major findings, mechanisms and recommendations. Nat Rev Microbiol 21, 133–146 (2023).
Xie Y, Xu E, Bowe B, Al-Aly Z. Long-term cardiovascular outcomes of COVID-19. Nature Medicine. 2022;28(3):583-590.
Douaud G, Lee S, Alfaro-Almagro F, et al. SARS-CoV-2 is associated with changes in brain structure in UK Biobank. Nature. 2022;604(7907):697-707.
Xu E, Xie Y, Al-Aly Z. Long-term neurologic outcomes of COVID-19. Nature Medicine. 2022;28(11):2406-2415.

COVID-19 versus any other heart attack). Therefore, it seems likely that there would be more of these deaths than identified.

Likely impact in Australia in 2022 and 2023: High

3.2 Mortality displacement

Australia had fewer deaths than expected in the first year or so of the pandemic. The lower deaths than predicted from respiratory causes and dementia, particularly in 2020 and 2021, have implications for mortality displacement. People who die from influenza tend to be those who are frail, or in a weakened state, and so already would have been more likely to die from another cause within no more than a few years. Excess mortality in 2021 from non-respiratory causes was likely higher than otherwise due to negative respiratory excess mortality in 2020 (i.e., a transfer of deaths from 2020 to 2021, compared with the expected pre-pandemic pattern of mortality). Similarly, part of the non-respiratory excess in 2022 is likely due to (negative) mortality displacement from 2020 and 2021.

Likely impact in Australia in 2022 and 2023: Moderate in 2022, of lesser impact in 2023

3.3 Delays in emergency care

Pressure on the health, hospital and aged care systems, including ambulance ramping[25] and bed block[26], could lead to people not getting the care they require, either as they avoid seeking help, or their care is not as timely as it might have been in pre-pandemic times. The peaks in non-COVID-19 excess deaths at times of high COVID-19 and/or influenza deaths supports this hypothesis.

Note that the following sections show statistics for certain states that are readily publicly available. The absence of statistics for a particular state or territory does not imply the absence of similar issues.

Ambulance response times: Figure 25 shows ambulance response times for NSW[27], and Victoria[28], noting that the metrics shown are not directly comparable due to different definitions used. For NSW, we have shown the percentage of highest priority (P1A) responses reached within 10 minutes and the percentage of emergency priority (P1) responses reached within 15 minutes. For Victoria, we have shown the percentage of Code 1 responses that were reached within 15 minutes (Code 1 patients are those that require urgent paramedic and hospital care and receive a "lights and sirens" response).

Figure 26 shows the median ambulance response times for Queensland[29] for responses designated 1A (actual time critical), 1B (emergent time critical) and 1C (potential time critical). While for NSW and Victoria a *reduction* in the metric suggests poorer outcomes, for the Queensland statistics, an *increase* in the metric suggest poorer outcomes.

[25] Refers to the inability of ambulances to transfer patients to emergency departments on arrival due to the emergency department itself having reached capacity

[26] Refers to when patients in emergency departments cannot be moved to hospital beds because they are occupied, often by patients who could be discharged from hospital but, for various reasons, are not

[27] Source: Bureau of Health Information, quarterly *Tracking public hospital and ambulance service activity and performance in NSW* reports

[28] Source: Ambulance Victoria, quarterly *Response Times* report

[29] Source: Queensland Ambulance Service, quarterly *Public Performance Indicators.* The reports show year-to-date figures each quarter, and we have derived the quarterly performance figure based on the number of daily emergency incidents also included in the reports.

Figure 25 – Percentage of ambulance responses within time in NSW and Victoria – 2018-223

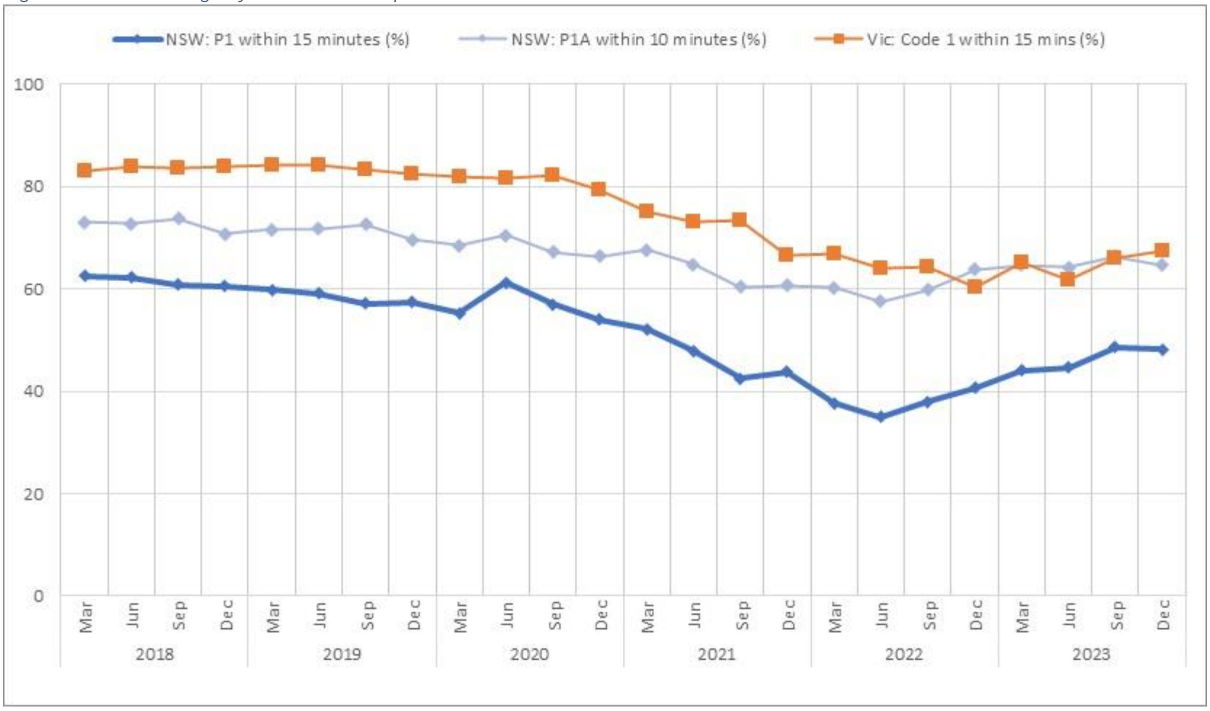
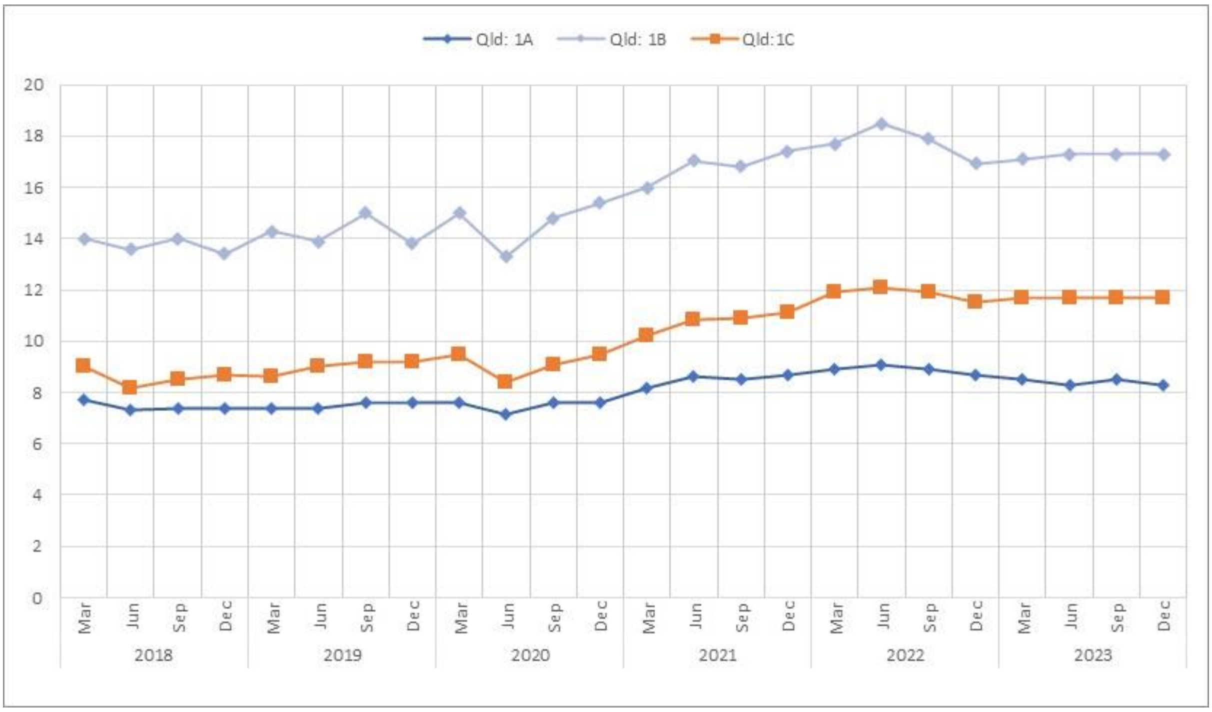


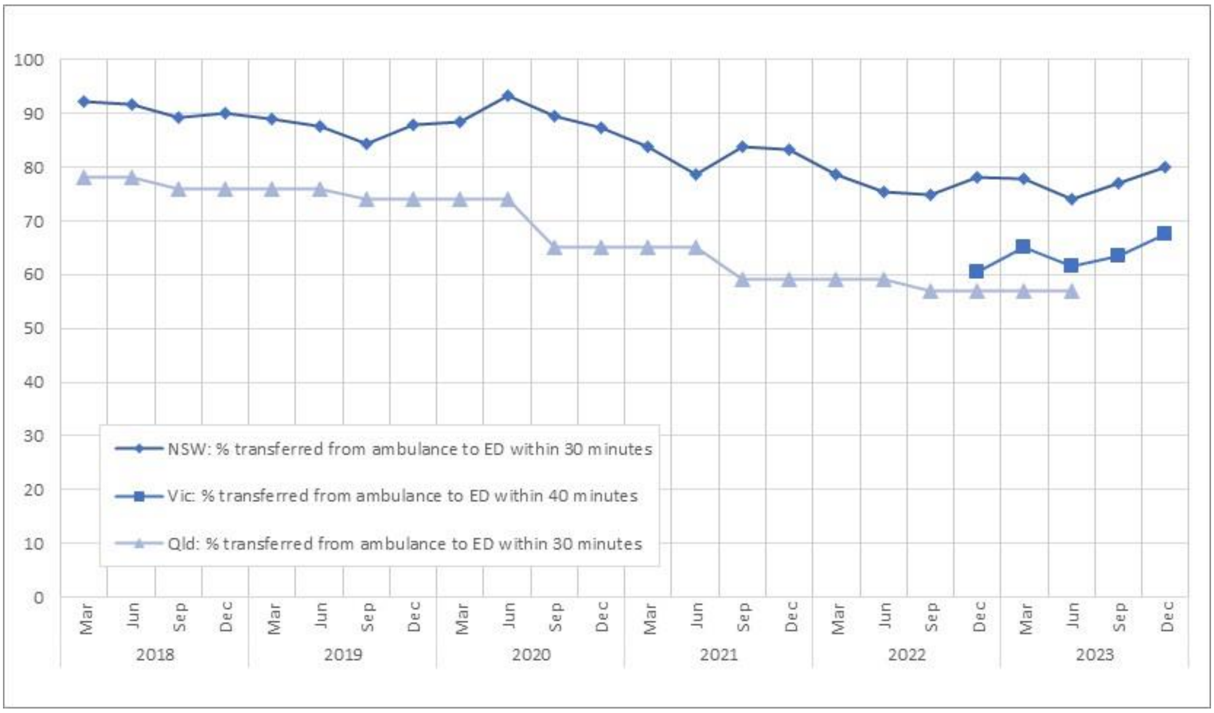
Figure 26 – Median ambulance response time for Queensland – 2018-23



For each of the metrics for each of the states shown, ambulance response times deteriorated from around the start of the pandemic until around mid-2022, before slowly improving. While the response times in 2023 are an improvement on 2022, all continue to be substantially worse than before the pandemic.

Ambulance "ramping": Figure 27 shows the proportion of patients transferred to emergency departments within specified times for NSW[30], Victoria[31] and Queensland[32], noting that the metrics shown are not directly comparable due to different definitions used.

Figure 27 – Proportion of patients transferred from ambulance to ED within specified times – NSW, Victoria and Queensland – 2018-23

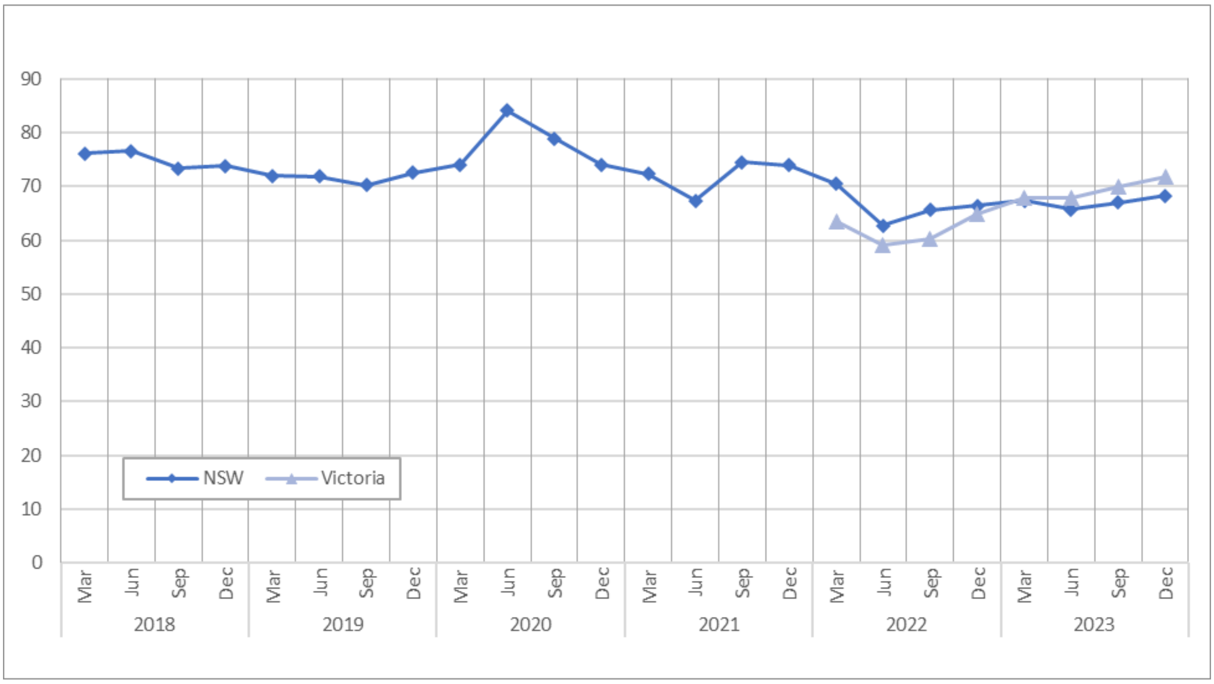


NSW and Queensland statistics show that transfer times from ambulances to emergency departments continue to be substantially worse than before the pandemic. The Victorian statistics show that transfer times are significantly below the target level of 90%, but no pre-pandemic figures are available for comparison.

Emergency Department treatment times: Figure 28 shows the proportion of emergency department patients treated on time in NSW[33] and Victorian[34] public hospitals.

[30] Source: Bureau of Health Information, quarterly *Tracking public hospital and ambulance service activity and performance in NSW* reports
[31] Source: Victorian Agency for Health Information, Victorian Health Services Performance
[32] Source: Queensland Audit Office, Health 2023, Report 6 2023-24
[33] Source: Bureau of Health Information, quarterly *Tracking public hospital and ambulance service activity and performance in NSW* reports
[34] Source: Victorian Agency for Health Information, Victorian Health Services Performance

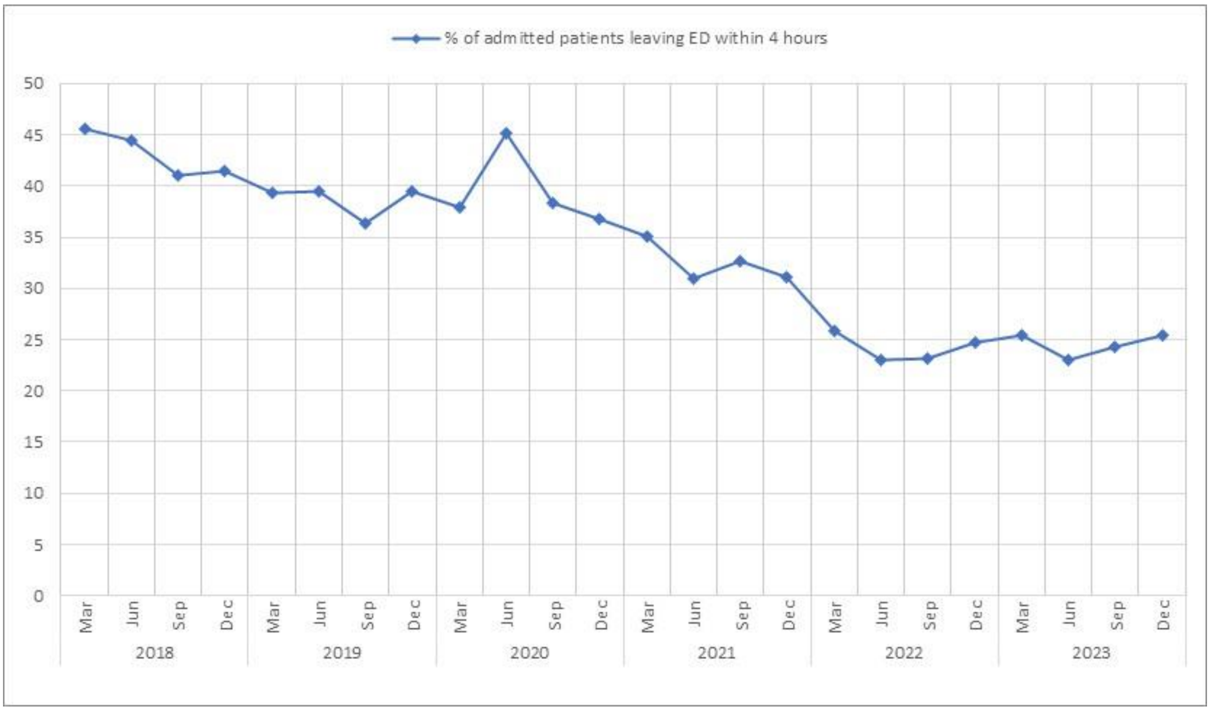
Figure 28 – Proportion of Emergency Department patients whose treatment started on time – NSW and Victoria – 2018-23



The proportion of NSW emergency department patients starting treatment on time has improved relative to 2022 but remains worse than before the pandemic. The Victorian statistics also show improvement on 2022 levels, but again no pre-pandemic figures are available for comparison.

"Bed block": Figure 29 shows the proportion of patients who were subsequently admitted to hospital (rather than going home) who left the emergency department within four hours for NSW[35]. This statistic provides an indication of the level of "bed block" but will also reflect any changes in waiting times before being seen in the emergency department.

Figure 29 – Proportion of admitted patients leaving the ED within 4 hours – NSW – 2018-23



[35] Source: Bureau of Health Information, quarterly *Tracking public hospital and ambulance service activity and performance in NSW* reports

These statistics show that wait times in emergency departments for those who are subsequently admitted to hospital are significantly longer now than before the pandemic.

These statistics on ambulance and emergency department performance for NSW, Victoria and Queensland all suggest that performance now remains substantially worse that for pre-pandemic years, although 2023 has improved compared with 2022. This is consistent with the relative levels of excess mortality for 2023 compared with 2022. Unfortunately, the statistics are only available quarterly (rather than monthly), so it is difficult to compare the figures directly to our excess non-COVID-19 deaths and to be conclusive about their impact on non-COVID-19 mortality.

Likely impact in Australia in 2022 and 2023: High during COVID-19 and influenza peaks, of lesser impact in 2023 compared with 2022

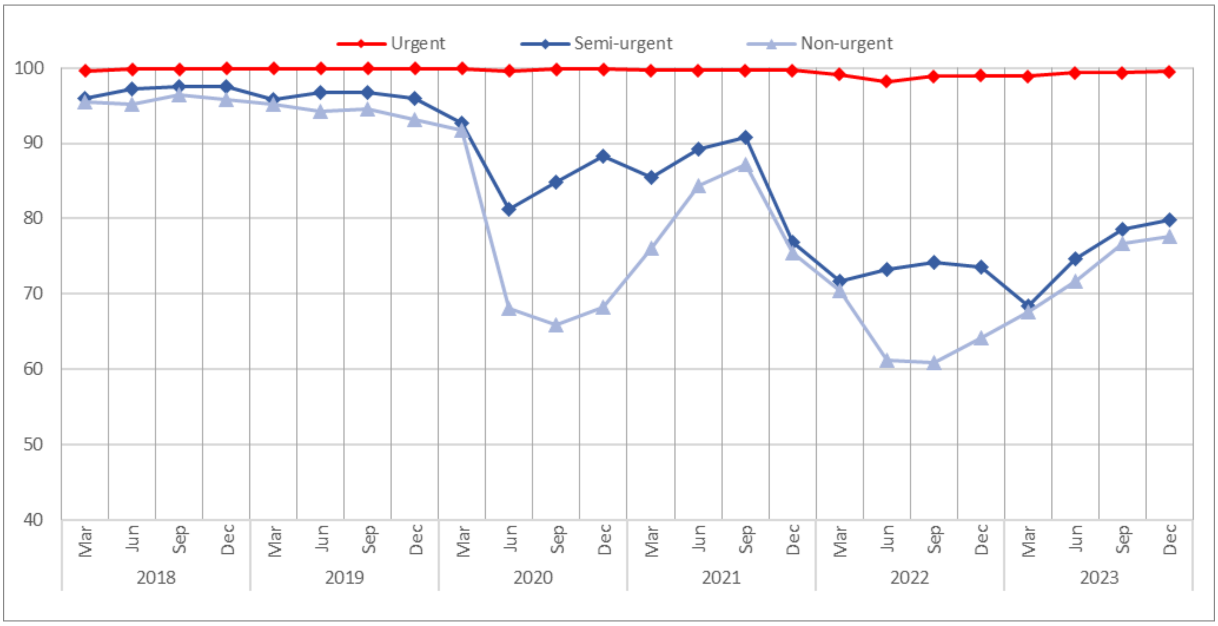
3.4 Delays in routine care

Opportunities to diagnose or treat non-COVID-19 diseases have been missed for various reasons including fear and lack of opportunity. There is some evidence that disruptions to prescribing heart medications may be impacting on chronic ischaemic heart disease deaths. It may also be a factor in higher deaths from other causes, such as diabetes, and the large "other" category.

Screening program statistics: In our July 2023 Research Paper we included statistics on Australia's three national cancer screening programmes for Bowel Cancer, Breast Cancer, and Cervical Cancer. This analysis showed that while there did appear to have been a reduction in cancer screening during the lockdown period, this was quite short lived and is not expected to be a material driver of any non-COVID-19 excess mortality. We refer the reader to that Paper for this analysis.

Elective surgery statistics: during the pandemic, hospitals across Australia experienced suspensions in elective surgeries at various times. Figure 30 shows the percentage of elective surgeries performed on time in NSW[36].

Figure 30 – Percentage of elective surgeries performed on time in NSW – 2018-23

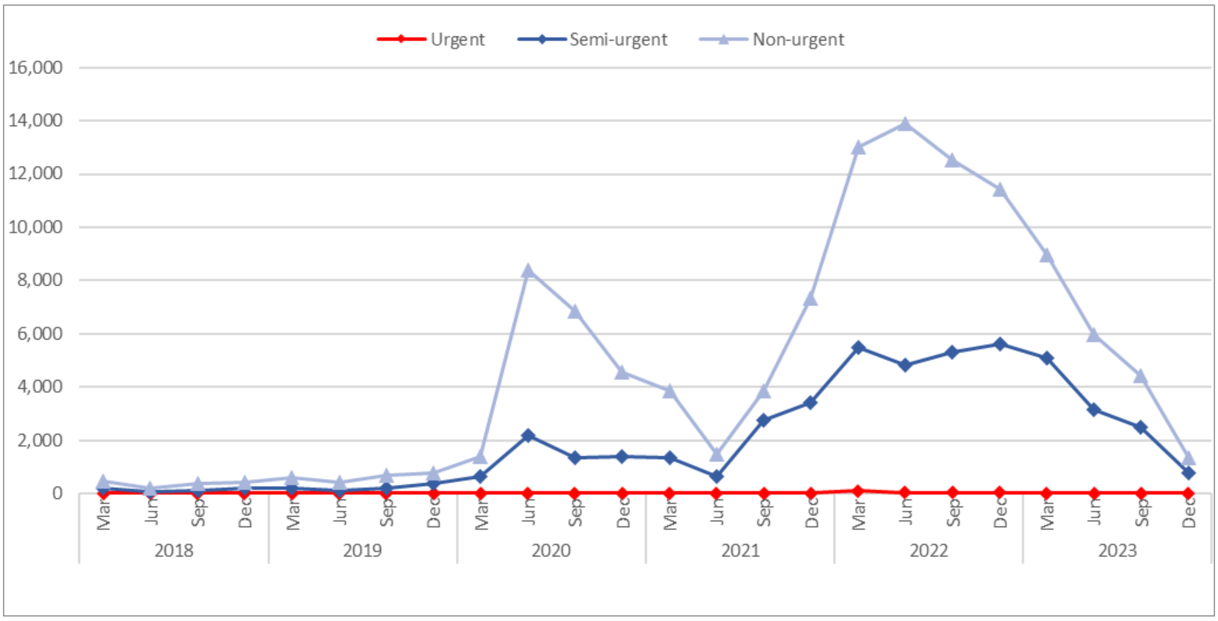


As for the other hospital statistics shown above, the proportion of elective surgeries performed on time has improved in 2023 relative to 2022, but still remains substantially worse than for pre-pandemic years.

[36] Source: Bureau of Health Information, quarterly *Tracking public hospital and ambulance service activity and performance in NSW* reports

Figure 31 shows the number of NSW patients on the waiting list who have waited beyond clinically recommended times.

Figure 31 – Numbers of patients on the waiting list for surgery in NSW beyond clinically recommended times – 2018-23



Pleasingly, the latest NSW statistics show that the backlog of patients who have waited longer than clinically recommended for elective/planned surgery has been mostly cleared over the course of 2023. This should mean that the percentage of elective surgeries performed on time as shown in Figure 30 should improve even further.

These elective surgery statistics represent only one aspect of the impact of delayed access to routine care. Other statistics of relevance would include, for example, trends in the number of prescriptions for heart and/or hypertension medications, the number of "heart health checks" conducted[37], etc. We have been unable to source such statistics and can therefore only speculate about other aspects of delays to routine care.

Likely impact in Australia in 2022 and 2023: Low to Moderate, of lesser impact in 2023 compared with 2022

3.5 Undiagnosed COVID-19

Some excess deaths could be from unidentified COVID-19. This happened early in the pandemic when access to testing was very limited, although, given Australia's low COVID-19 prevalence in 2020 and 2021, the number of such deaths was small.

Unidentified COVID-19 deaths seem less likely to have occurred in 2022, as testing was much more available, particularly for those who were seriously ill.

However, as the pandemic has progressed, the level of testing has reduced, particularly for mild illness. It is unclear to what extent this might now be starting to affect the testing of those with more serious illness. We have noticed that deaths from influenza were higher than usual in the last few months of 2023 and early in 2024, when influenza surveillance showed that prevalence was low. While the numbers involved are small, this suggests that there could be small numbers of COVID-19 deaths being mis-coded as influenza deaths. This situation could arise when a person dies without having the type of their respiratory infection diagnosed; we think that this is most likely to occur when the death

[37] A heart health check is a 20-minute check-up with a GP that assesses the risk of having a heart attack or stroke in the next five years. The GP or nurse will set a plan to lower the risk of heart attack or stroke which may involve: ways to make heart-healthy lifestyle changes; referrals to programs or other health professionals for more support e.g. dietitians; and/or prescribing blood pressure or cholesterol lowering medicines.

happens at home, rather than in a hospital or aged care setting. While post-mortem testing may be occurring in Australia where COVID-19 is suspected, it is likely that this would happen more often when the person is younger. While we have noticed possible miscoding of COVID-19 deaths as influenza deaths, this may not be limited to influenza (due to generally lower levels of COVID-19 testing now compared with earlier in the pandemic).

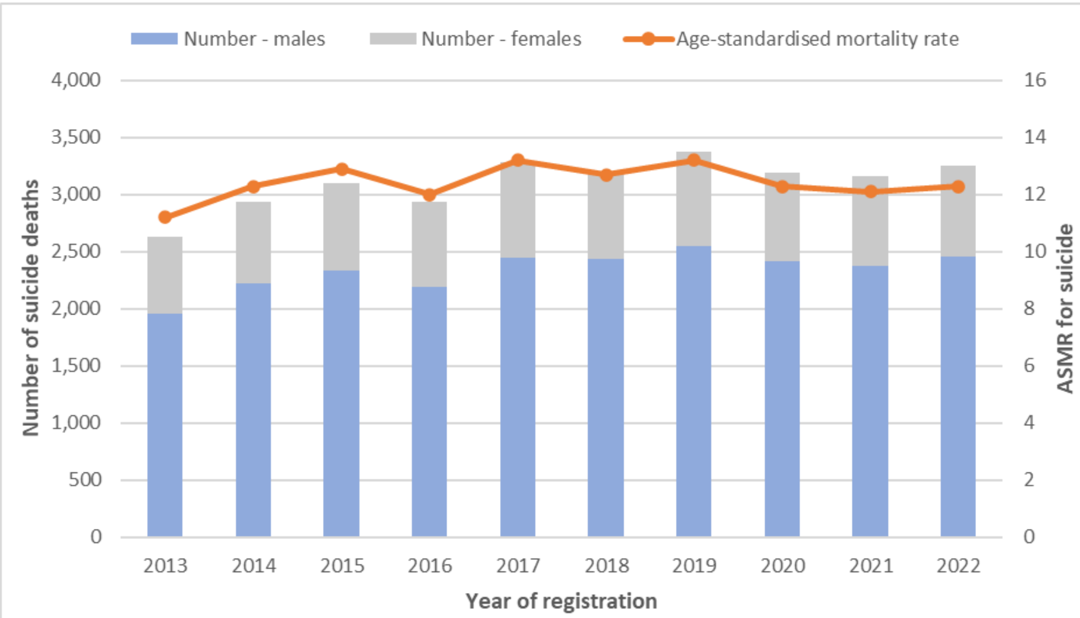
It is also possible that some deaths caused by COVID-19 with unusual symptoms (e.g. some sudden cardiovascular deaths) may not be identified as caused by COVID-19. The timing of the higher levels of non-COVID-19 excess deaths (once COVID-19 *related* deaths are also removed) coinciding with high levels of COVID-19 deaths suggests that there may be some undiagnosed COVID-19 deaths.

Likely impact in Australia in 2022 and 2023: Low, perhaps higher during COVID-19 peaks, of greater impact in 2023 compared with 2022

3.6 Mental health issues

There has been much discussion throughout the pandemic about the impacts on mental health, including commentary that lockdowns and other measures are causing an increase in suicide deaths. Figure 32 uses data from the ABS and shows the number of suicides in Australia for both males and females from 2013 to 2022 by year of registration (rather than year of occurrence). The age-standardised mortality rate is also shown. Note that the figures for 2020 to 2022 are preliminary.

Figure 32 – Suicide deaths and age-standardised mortality rates[38]



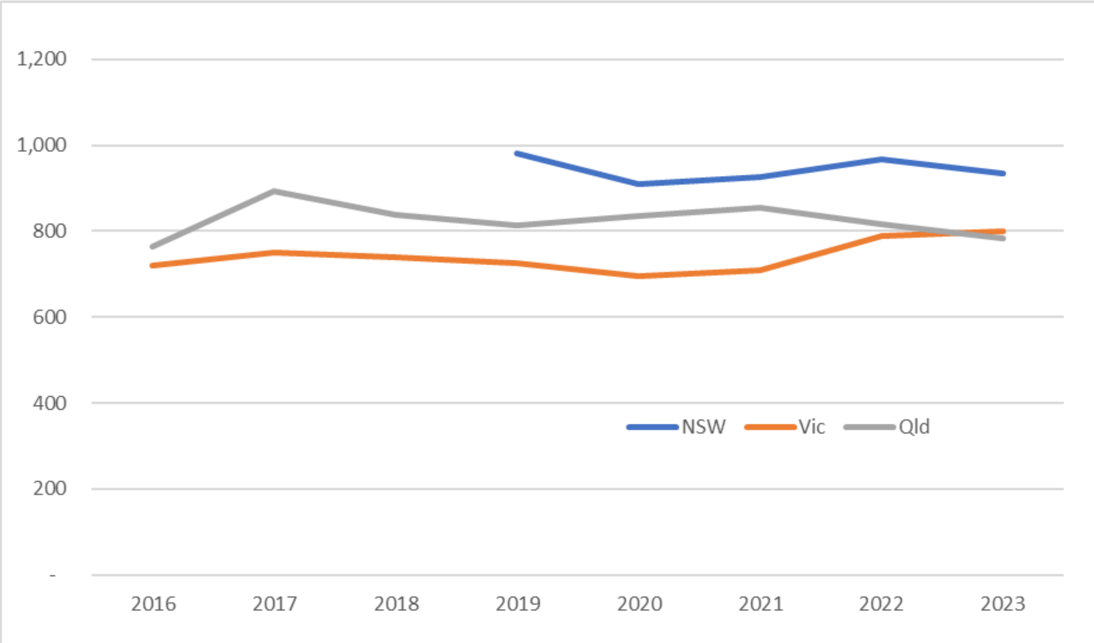
Both the number of suicide deaths and the age-standardised suicides rates for males and females were lower in 2020 to 2022 compared with the preceding three years.

The ABS publication also shows that the pandemic was mentioned as a risk factor in 4.0% of suicide deaths in 2020 (0.08% of all deaths), 2.6% of suicide deaths in 2021 (0.05% of all deaths) and 2.6% of suicide deaths in 2022 (0.04% of all deaths). Even where the pandemic was a risk factor, there were, on average, 6.5 other risk factors for those who died in 2022.

[38] Source: ABS Causes of Death, Australia, 2022

Three states (NSW[39], Victoria[40], and Queensland[41]) publish preliminary suicide statistics, by month of occurrence, and statistics for 2023 are available. Figure 33 shows the number of suicide deaths in each year, after adjustment for changes in population size.

Figure 33 – Yearly suicide deaths, adjusted for 2023 population size – NSW, Victoria and Queensland



After adjusting for changes in the size of the populations in each state:

- in NSW, suicide deaths in 2020 were 7% lower than in 2019, but then increased by 2% in 2021, 4% in 2022, and then fell by 3% in 2023;
- in Victoria, suicide deaths in 2020 were 4% lower than 2019, but then increased by 2% in 2021, 11% in 2022 and 2% in 2023; and
- in Queensland, suicide deaths in 2020 were 3% higher than in 2019, a further 2% higher in 2021, before falling by 4% in each of 2022 and 2023.

While there is a small increase in the number of suicide deaths in Victoria in the last two years shown, in total across the three largest states of Australia, suicide deaths in 2020 to 2023 are largely unchanged from pre-pandemic levels.

We are cognisant of the potential for increases in rates of suicide in the next few years as the longer-term consequences of financial and other distress can take some time to emerge, and we may be seeing some of this impact in the higher 2022 and 2023 figures in Victoria. Note, however, that the absolute numbers of such deaths remain a very small proportion of all deaths and are not a major driver of excess mortality.

If you or anyone you know needs support call Lifeline on 131 114.

Likely impact in Australia in 2022 and 2023: Not numerically significant

3.7 Alcohol-induced deaths

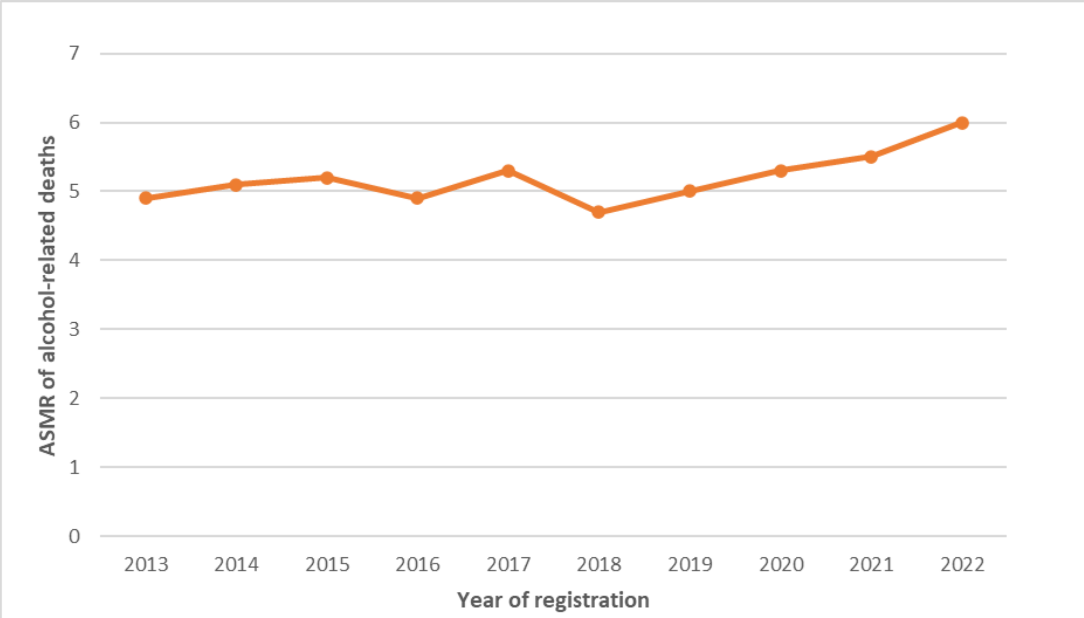
There have also been concerns about the impact of the pandemic on alcohol consumption and a resulting increase in alcohol-induced deaths. The ABS defines alcohol-induced deaths as those where

[39] *NSW Suicide Monitoring System, Data to March 2024*, NSW Health
[40] *Coroners Court Monthly Suicide Data Report*, April 2024 update, Coroners Court of Victoria
[41] 2020-2023 figures from Queensland *Suicide Data – Monthly Report, March 2024, Queensland Mental Health Commission. 2016-2019 figures from Queensland: Annual Reports*, Griffith University

the underlying cause of death can be directly attributed to alcohol use, including acute conditions such as alcohol poisoning or chronic conditions such as alcoholic liver cirrhosis.

Figure 34 uses data from the ABS and shows the age-standardised mortality rate for alcohol-induced deaths from 2013 to 2022 by year of registration (rather than year of occurrence).

Figure 34 – Age-standardised mortality rates (ASMR) for alcohol-induced deaths[42]



The graph shows that the age-standardised mortality rate for alcohol-induced deaths has increased from around 5.0 in pre-pandemic years to 6.0 for 2022. While this is clearly a concern, the absolute number of deaths involved is a very small proportion of all deaths. The actual number of such deaths is not published by the ABS, but we note that the SDR for alcohol-induced deaths is around 45% of the SDR for suicide deaths, implying around 1,500 alcohol-induced deaths per annum. The increase in the rate of alcohol-induced deaths between 2019 and 2022 represents around 250 deaths per annum (compared with total non-COVID-19 excess deaths for 2022 of around 6,000).

Likely impact in Australia in 2022 and 2023: Low

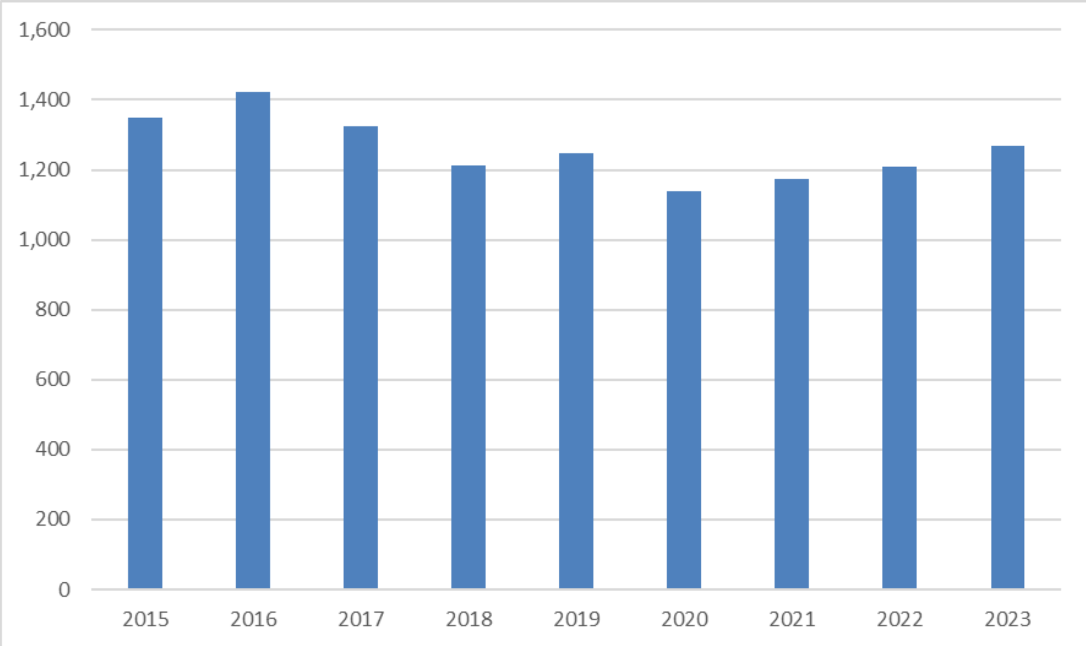
3.8 Road deaths

The Australian Government via the Bureau of Infrastructure and Transport Research Economics (BITRE) publishes statistics on road accident deaths[43], including month of death and breakdowns by state/territory, age, gender, and road user type. Figure 35 shows the number of road deaths in each year, after adjustment for changes in population size.

[42] Source: ABS Causes of Death, Australia, 2022

[43] https://www.bitre.gov.au/publications/ongoing/road_deaths_australia_monthly_bulletins

Figure 35 – Road deaths, adjusted to 2023 population size



For the 2020 year, the number of road deaths (after adjustment for changes in population size) was 9% lower than 2019, with most of the lower road toll occurring during the nation-wide lockdown of late-March 2020 to June 2020.

Road deaths in both 2021 and 2022, while higher than 2020, are lower than all prior years. In 2023, road deaths have increased by 5% and are similar to 2019 levels.

While this increasing trend in road deaths in 2023 is of concern, we again note that the numbers involved are small and are not a key driver of excess mortality.

Likely impact in Australia in 2022 and 2023: Not numerically significant

3.9 Vaccine-related deaths

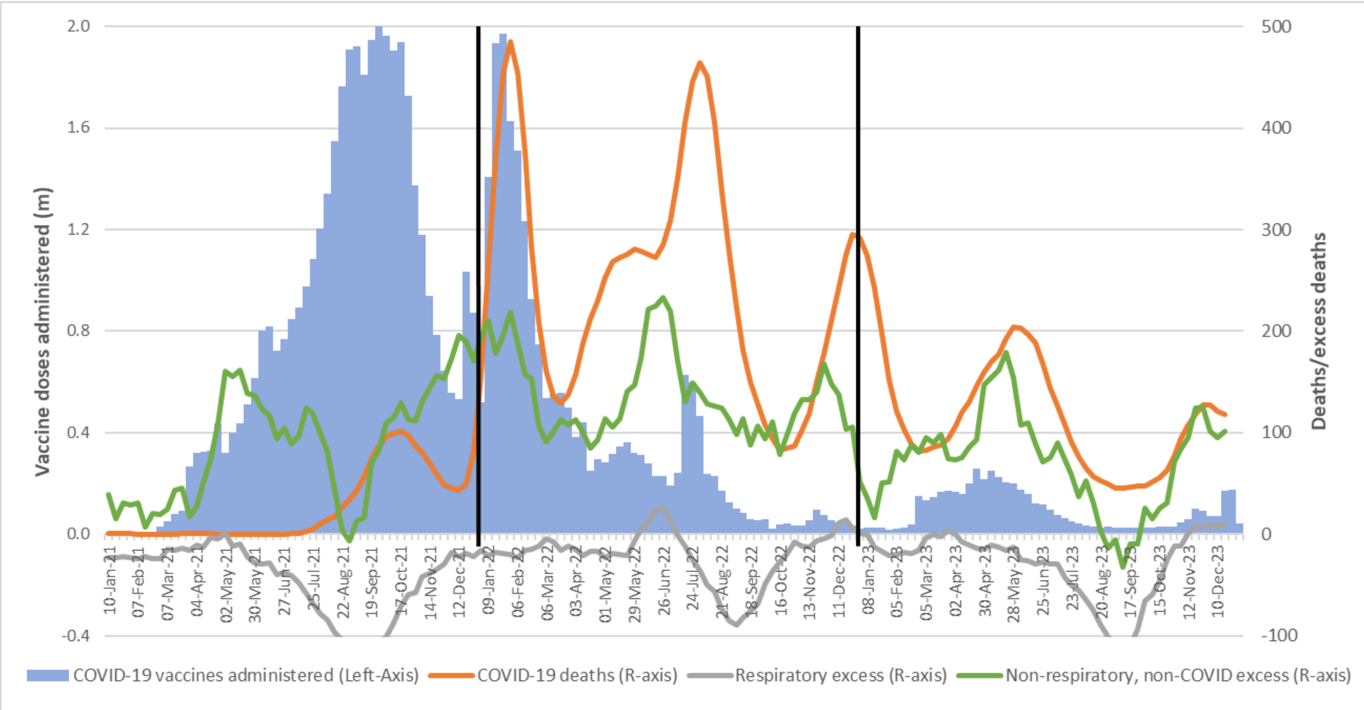
We are aware that excess mortality has been attributed to COVID-19 vaccines by some, but our view is that adverse impacts of COVID-19 vaccines are unlikely to be a significant contributing factor. Our view is quite the reverse: COVID-19 vaccines have significantly reduced excess mortality. We have come to this view based on the weight of statistical evidence as discussed below.

While there have been deaths in Australia known to have been caused by the administration of COVID-19 vaccines, the number of such deaths has been small:

1. Australia's vaccine approval and safety monitoring processes are administered by the Therapeutic Goods Administration (TGA). The latest TGA COVID-19 Vaccine Safety Report issued on 2 November 2023 identified 14 deaths where the cause of death was linked to COVID-19 vaccination (from 1,004 reports received). All but one of these deaths were linked to the AstraZeneca vaccine which is no longer in use in Australia. The TGA has not found a link between vaccination and death for the remaining reports. This may be due to either there being insufficient information to assess any potential link, or that available information indicates that the death was due to other, unrelated causes. There have been no new vaccine-related deaths identified since 2022, even though COVID 19 vaccines have continued to be administered.
2. The TGA is not a de facto coroner. The TGA does not make formal determination of cause of death for individuals; that is the role of treating medical practitioners and coroners. The ABS reporting of death certificate data shows that there have been 16 deaths registered to the end of 2022 where the certified underlying cause of death was the use of COVID-19 vaccines, very similar to the 14 deaths identified by the TGA.

The timing of when COVID-19 vaccinations were administered does not correspond with the timing or shape of excess mortality. Figure 36 shows a comparison of the vaccine rollout in Australia compared with excess deaths. The graph compares the number of COVID-19 vaccines administered (blue columns) to COVID-19 deaths (orange line), excess deaths from respiratory causes (grey line) and excess deaths from non-respiratory, non-COVID-19 causes (green line). Note that the COVID-19 deaths, respiratory excess and non-respiratory, non-COVID-19 excess are all shown as five-week averages to reduce the week-to-week volatility.

Figure 36 – Vaccine rollout versus excess deaths[44]



The vaccine rollout ramped up slowly from February 2021, with high rates of vaccination in August to October 2021 and again in January 2022, but vaccination rates have been low for most of 2022 and 2023. This does not fit with the timing or shape of the excess mortality. The majority of the excess in 2022 and 2023 can be explained either directly by deaths *from* COVID-19 or by the indirect impacts of high prevalence of COVID-19 and influenza (i.e., the timing of excess mortality in these years corresponds more closely to the timing of high COVID-19/influenza prevalence, not vaccinations).

It is widely acknowledged that the mRNA COVID-19 vaccines may result in myocarditis (inflammation of the heart) and/or pericarditis (inflammation of the membrane around the heart) as rare side effects, particularly in young males. ABS statistics show that in 2021 and 2022 combined that there were 31 deaths from myocarditis and 5 deaths from pericarditis. These numbers are small and not any higher than earlier (pre-vaccination) years.

Guillain-Barre syndrome is a known rare side-effect of the AstraZeneca COVID-19 vaccine and the TGA has linked two deaths from Guillain-Barre syndrome in Australia to COVID-19 vaccines. The ICD-10 codes reported on by the ABS do not show Guillain-Barre syndrome in isolation, but it is included with other polyneuropathy causes (code G61). ABS statistics show that in 2021 and 2022 there were 27 and 35 deaths respectively from polyneuropathy causes. As for myocarditis and pericarditis, these numbers are small and no higher than earlier years.

When looking for vaccine-related causality, consideration is given to both timing and the "mechanism of action" (biological plausibility) of any death. Unlike myocarditis and pericarditis, we have been advised by the TGA that neither they, nor any other international medicines regulator, has established a causal link between COVID-19 vaccines and ischaemic heart disease. As stated above, excess

[44] Source: Federal Health Departments statistics on the number of doses administered

deaths seen from this cause are likely related to the after-effects of COVID-19 infection, mortality displacement, a lack of routine medical care earlier in the pandemic, and delayed access to emergency care.

The majority of excess mortality in Australia is in people over the age of 65. However, Australia has very high vaccination rates for those over the age of 16. If COVID-19 vaccines were a significant contributor to excess mortality, we would observe higher excess mortality in those aged between 16 and 65 years. Indeed, excess mortality due to vaccines should be even more obvious among younger people where there is a much lower expected mortality rate. The pattern of excess mortality by age group does not support COVID-19 vaccines as a significant cause.

The COVID-19 vaccines administered in Australia are exactly the same formulation as the vaccines administered in other countries, each of which has their own oversight body equivalent to Australia's TGA. These oversight bodies share information, and it is through this sharing process that the rare thrombosis with thrombocytopenia syndrome (TTS) associated with the AstraZeneca vaccine was identified and confirmed in April 2021. The world-wide response was swift, including in Australia where there was an immediate change to recommendations regarding the AstraZeneca vaccine. It is extremely unlikely that there remains a significant unidentified risk of death from the COVID-19 vaccines currently administered in Australia.

While we have not conducted an exhaustive analysis, we have not been able to find an obvious statistical relationship suggesting that COVID-19 vaccinations caused excess mortality in any other country.

Many studies around the world have shown that COVID-19 vaccines reduce the severity of the disease. For example, a recent study[45] presented a conservative estimate that deaths *from* COVID-19 would have been six times as high with no vaccinations. This meant that almost 18,000 deaths were averted between August 2021 and July 2022 in people aged over 50 by the COVID-19 vaccines in NSW alone. Extrapolating this nationally, more than 50,000 deaths were averted in this 48-week period. In other words, COVID-19 vaccines were found to have significantly reduced excess mortality.

We cannot conclusively disprove that adverse impacts of COVID-19 vaccines are a substantial driver of excess mortality. However, the overwhelming weight of the available evidence does not point to COVID-19 vaccines as a cause of significant numbers of additional deaths. As noted above, of our estimate of 27,200 excess deaths across 2020-2023, just over 17,000 have been identified as being caused by COVID-19, while fewer than 20 deaths have been identified as being caused by COVID-19 vaccination. And if the number of COVID-19 vaccine deaths is very small in relation to COVID-19 deaths, it is an even smaller fraction when compared to the number of COVID-19 deaths that the vaccines have prevented in Australia – a conversative minimum of 50,000 based on the NSW study referenced above.

Our considered view is that, while there could be COVID-19 vaccine-related deaths that have not been identified as such, the number of such deaths is likely to be small, especially in the context of the estimated numbers of excess deaths and the lives saved by vaccination. There are other, more plausible, reasons that explain excess mortality in Australia.

Likely impact in Australia in 2022 and 2023: Not numerically significant.

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[45] Assessing the impact of Australia's mass vaccination campaigns over the Delta and Omicron outbreaks | PLOS ONE

4 Australian excess mortality in context: what happened in the rest of the world?

4.1 Methodology

As discussed earlier, the impact of the pandemic on global and national mortality can best be seen by considering excess mortality. It is, therefore, interesting to consider how excess mortality differs between countries. Fortunately, a rich data repository is available in the form of Our World in Data (OWID: ourworldindata.org). Except where otherwise specified, all data for the charts and tables in this section comes from this source. It is important to note that this data (such as for excess mortality) is, in turn, sourced by OWID from a primary source. We refer to OWID as our source to reflect how we accessed the material, and for convenience.

Our analysis of excess mortality in different countries revolves around two measures of mortality as a percentage of expected deaths:

- **total excess mortality**, which we have taken directly from OWID data, interpolating where required; and
- **COVID-19 mortality**, which we have calculated by dividing COVID-19 deaths by the expected deaths for the relevant period. We understand that the COVID-19 deaths included in OWID are taken from each country's surveillance statistics (rather than being based on death certificates).

This has required us to derive expected deaths for each period, data that is not directly available in the OWID database[46]. We have done so by dividing actual deaths by (1 + excess mortality). Because of rounding, this will have introduced a small error that is unlikely to have a material impact on our analysis.

4.2 Handle with care

We note that the approach used by OWID to calculate excess mortality is to compare reported deaths for each week or month with projected deaths for that period based on the experience in 2015 to 2019. In turn, this generally uses estimates of expected deaths produced by Ariel Karlinsky and Dmitry Kobak as part of their World Mortality Dataset (WMD)[47]. We are very grateful to Karlinsky and Kobak for their work.

This work is subject to general uncertainty, to the extent that there may be reporting delays or errors. Also, there may be issues relating to the interpretation of data in some countries. For example, our own analysis gives slightly different rates of excess mortality in Australia. However, the WMD analysis is objective, and we do not expect any material differences in the context of our analysis.

In relation to COVID-19 deaths from surveillance reports, it is important to understand that the criteria vary between countries, and within countries/jurisdictions the definitions can change over time. Further, since the World Health Organisation declared the emergency phase of the pandemic over in May 2023 the level of reporting of COVID-19 surveillance deaths has reduced and/or ceased in many countries.

The likelihood that a person dying with COVID-19 has had a positive test will also vary across countries and over time, so our assessment of the contribution of COVID-19 to excess mortality in different countries and/or time periods is subject to considerable uncertainty.

[46] Note that OWID clearly uses different expected values for each of 2020, 2021 and 2022, but the data item included in OWID called projected_deaths_2020_2022_all_ages is not a sum of these values hence cannot be used

[47] GitHub - akarlinsky/world_mortality: World Mortality Dataset: international data on all-cause mortality.

4.3 Selected countries[48]

Appendix H contains tables, derived from OWID data, showing COVID-19 deaths and total excess deaths for 40 countries, for the four years 2020 to 2023, individually and combined.

There are 79 countries for which, at the time of collecting our data (1 May 2024), OWID had produced excess death data covering the whole of 2020, 2021 and 2022 and most of 2023. We have selected the largest 30 of these (including Australia) by expected deaths, plus a further ten (Sweden, Tunisia, Ecuador, Azerbaijan, Denmark, Israel, Dominican Republic, Lithuania, New Zealand and Singapore) for their relevance. The reasons for selecting these additional countries are set out in Appendix H .

These 40 countries represent about 93% of the 79 countries by population[49] and by expected and actual deaths. They had 14.3% combined excess mortality across 2020-2022, with reported COVID-19 deaths representing 11.3% of expected deaths.

Adopting the criterion of "most of 2023" enabled us to include (in decreasing order of annual expected deaths):

- Brazil (11 months of data in 2023);
- Mexico (50 weeks of data in 2023);
- The Philippines (8 months);
- South Korea (39 weeks);
- Canada (30 weeks);
- Uzbekistan (9 months);
- Tunisia (8 months); and
- Dominican Republic (10 months).

Nevertheless, notable omissions[50] from the list include:

- four of the top five countries by population (China, India, Indonesia and Pakistan) and parts of Africa[51] – for which OWID has no data on excess mortality; and
- Ukraine, Türkiye, Iran, Argentina, Colombia, Algeria and Peru – which are in the OWID top-30 for expected deaths but for which OWID has little or no excess mortality data for 2023.

The latter seven countries are included in individual country charts in Appendix G .

We have been able to use a larger set of 120 countries for regional analysis. This includes countries that we had excluded from detailed analysis on the grounds of size or the incompleteness of data. They include the seven countries listed above.

Our 40 selected countries represent about 77% of the expanded set of 120 countries by population and 81% by expected annual deaths.

In our analysis, we have generally grouped countries in accordance with the UN geoscheme[52] to provide an objective basis for comparison at a regional level. For this purpose, we have combined some regions to give a total of eight, being:

- Oceania;
- South-East & East Asia;
- Other Asia;
- North America;
- Latin America (including the Caribbean);
- Northern & Western Europe;

[48] We use "country" as a shorthand, given that the list includes Taiwan on the basis that it is in the top 30 territories by expected deaths in the available OWID data
[49] Total population of the 40 countries is over 2.2 billion
[50] Countries that would have made the top 40
[51] Egypt and South Africa are included in our 40 countries, and there are only two others of reasonable size (Algeria and Tunisia) for which OWID has any excess mortality data at all
[52] Found at https://en.wikipedia.org/wiki/List_of_countries_by_United_Nations_geoscheme

- Southern & Eastern Europe; and
- Africa.

4.4 Excess mortality by region in 2020-23

Figure 37 – Excess mortality by region in 2020-23, showing differences in regional trends

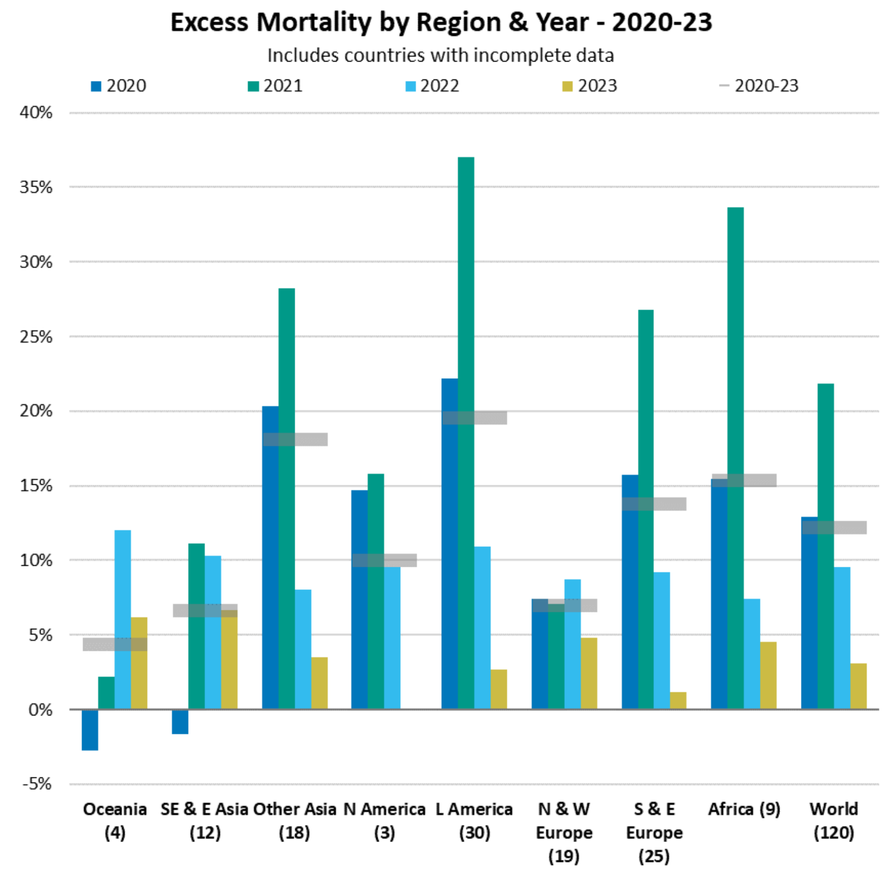


Figure 37 shows that excess mortality across the world (at least, the countries in our database) was high (13%) in 2020, very high (21%) in 2021 and still high (9%) in 2022, falling to 3% in 2023. However, it is clear from the chart that there are significant regional differences in mortality experience.

Oceania (dominated by Australia) had negative excess mortality in 2020 and a low positive excess in 2021, but it had the highest regional excess mortality in 2022 and the second highest in 2023.

SE & E Asia also had negative excess mortality in 2020. Excess mortality was over 10% in 2021 (still only half the world average), falling back below 10% in 2022, to a level just above the world average. At almost 7%, it had the highest regional excess mortality in 2023.

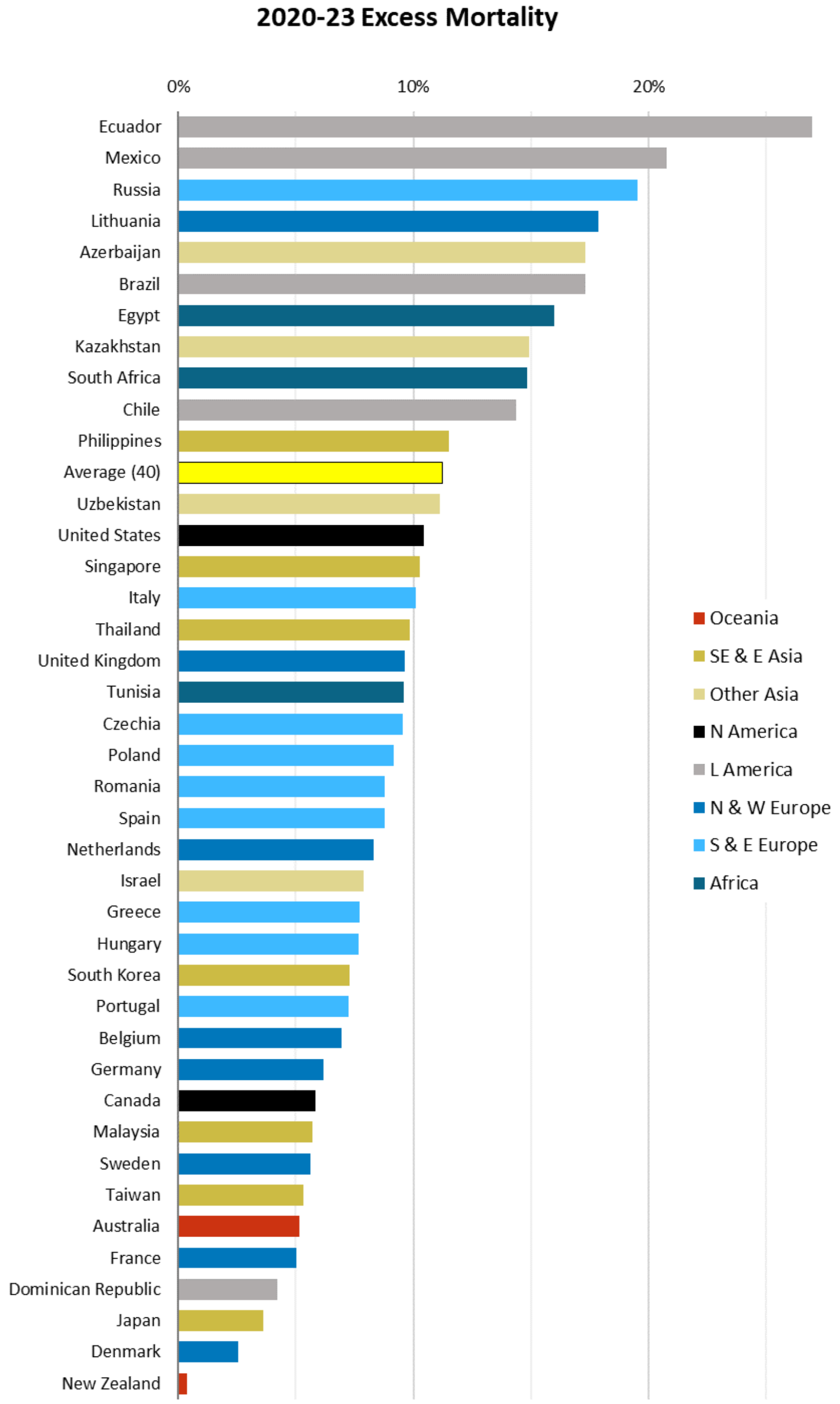
N & W Europe, which is generally quite wealthy, saw excess mortality below the world average each year to 2022, but it was above the world average in 2023.

North America (dominated by the USA) had excess mortality above the world average in 2020, with an increase in 2021 (though well below the world average) and a drop in 2022. There was virtually no excess mortality in the region in 2023.

All other regions had excess mortality that was high in 2020 and very high in 2021, dropping to relatively low levels (around or below the world average) in 2022 and 2023. There are few wealthy countries in these regions.

4.5 Overall excess mortality by country in 2020-23

Figure 38 – Excess mortality for four years ending 31/12/23, as a percentage of expected deaths



Source: Our World in Data (OWID) and analysis. Excess mortality relative to projected deaths.

Figure 38 shows that all of our 40 selected countries had positive total excess mortality across the four years, with an average of 11%. Ecuador was the highest, at 27% - representing more than an extra year of mortality across the period. New Zealand (0.4%) was the lowest.

Excess mortality has been very high in Latin America, averaging about 18% over the four years.

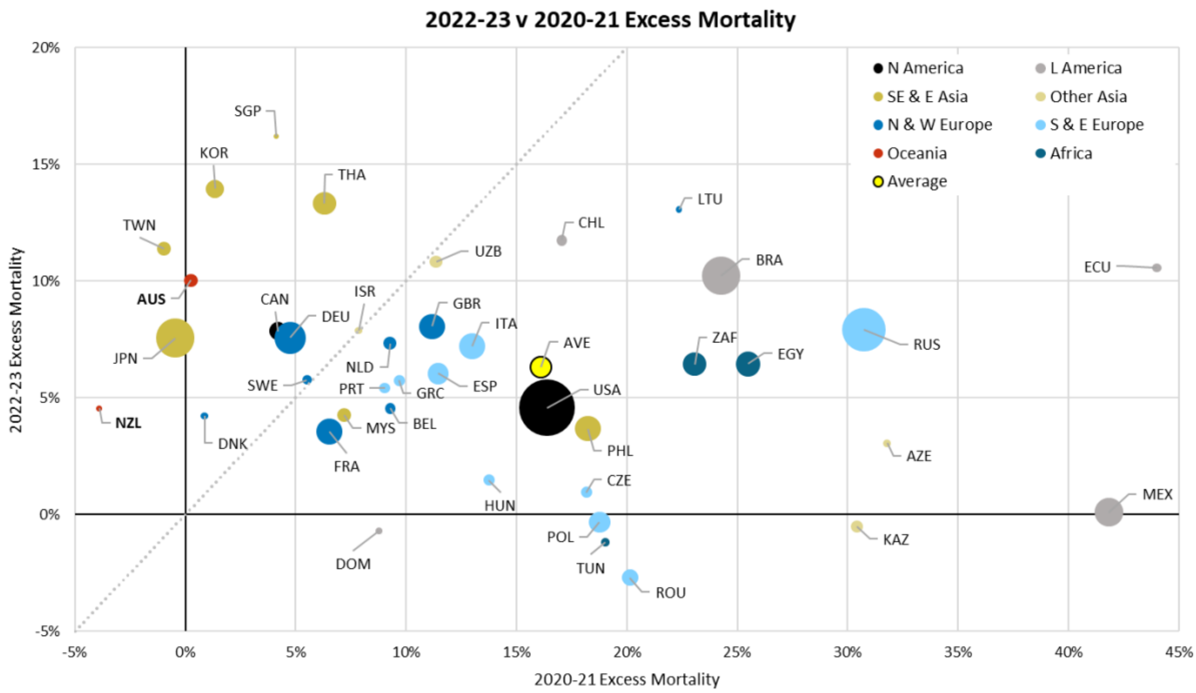
South-East and East Asia have generally had lower excess mortality than Other Asia. Similarly, Northern and Western Europe has generally lower excess mortality than Southern and Eastern Europe.

The United States has experienced 10% excess mortality across the four years, substantially higher than Canada (6%). The difference is mostly due to reported COVID-19, with excess mortality from other causes at about 1% in both countries. We note, however, that it is arguable that COVID-19 deaths are under-reported[53]. At the same time, there is evidence[54] that deaths from external causes (principally drug overdoses) have continued to climb in the United States; the US National Institute on Drug Abuse reports almost 108,000 drug overdose deaths[55] in 2022, more than double the number in 2015 and more than 3% of all deaths in the USA that year.

Despite high excess mortality in 2022 and 2023, Australian excess mortality over the four years (5%) is among the lowest of the countries included in our selection – at 35th out of 40.

In our regional analysis above (Figure 37), we have seen several examples of high 2020-21 excess mortality followed by quite low 2022-23 excess mortality, and vice versa. It is interesting to consider the comparison between 2020-21 and 2022-23 for all our selected countries. Figure 39 shows the excess mortality for the 2022-23 years versus the 2020-21 years, with a dotted line to show where excess mortality rates in the two periods are equivalent. Countries to the left of that line, including Australia, had higher excess mortality in 2022-23 than 2020-21.

Figure 39 – A comparison of 2020-21 and 2022-23 excess mortality, showing a general inverse relationship



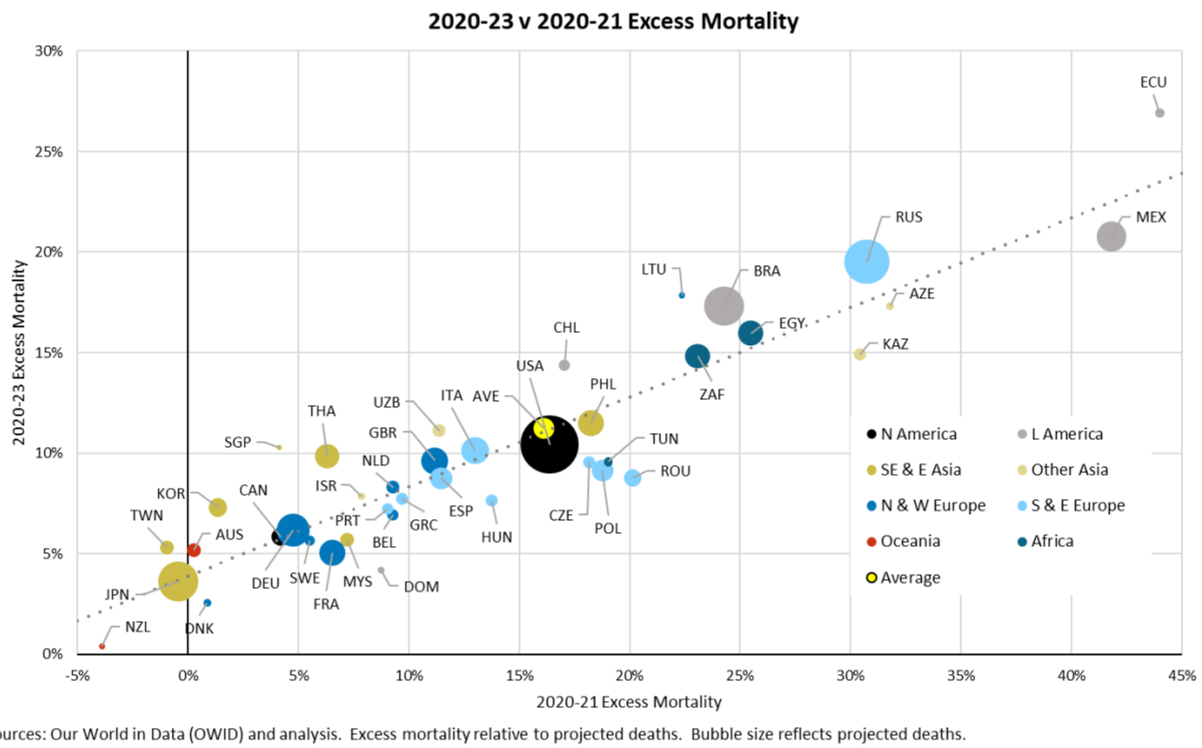
Sources: Our World in Data (OWID) and analysis. Excess mortality relative to projected deaths. Bubble size reflects projected deaths.

Figure 39 confirms that there is something of an inverse relationship[56] between excess mortality in 2020-21 and that in 2022-23. It is encouraging that most countries with high excess mortality in 2020-21 have relatively low excess mortality in 2022-23. Indeed, excess mortality rates fell for all countries with more than 10% excess mortality in 2020-21. It is likely that this reflects a degree of mortality displacement. This relates to the fact that there are many people whose age and health unfortunately mean that they are expected to die within one or two years – a period that can be cut short by respiratory disease

[53] See, for example, New Analysis Reveals Many Excess Deaths Attributed to Natural Causes Are Actually Uncounted COVID-19 Deaths | SPH, although it may be over-simplistic to attribute all of the rise in mortality during a COVID-19 wave to COVID-19
[54] See, for example, Overdose deaths continue to rise in the US, reaching another record level, provisional data shows | CNN
[55] Drug Overdose Death Rates | National Institute on Drug Abuse (NIDA) (nih.gov) – and note that almost 82,000 of these deaths involved opioids.
[56] The relationship is very weak: $R^2 = 0.07$.

such as flu. Contracting COVID-19 hastened death for some, while defence measures protected others from both COVID-19 and other respiratory diseases, gaining them an extra year or two of life.

Figure 40 – Comparison of excess mortality in 2020-23 with excess mortality in 2020-21, showing that overall excess mortality is highly correlated with experience in the first two years of the pandemic



Despite the comment above, Figure 40 shows that there is a strong correlation ($R^2 = 0.85$) between excess mortality in 2020-21 and the total excess over 2020-23 for our 40 countries. The period 2020-21 broadly corresponds to border closures in Australia and many other countries. While vaccines were available early in 2021, vaccination rates in many countries did not reach reasonable levels until late 2021 or even 2022. There has not been a significant relative mortality catch-up in 2022-23 of lives saved in 2020-21 by lockdowns and other defence measures, i.e. those measures appear to have had a net positive effect over the duration of the pandemic.

4.6 Excess mortality compared with COVID-19 mortality and vaccination rates

Our analysis of Australian mortality showed that the shape of excess mortality reflected COVID-19 waves. We also saw that there was no obvious relationship between the timing of vaccinations and the timing of excess mortality. Do these observations hold for other countries, too?

We have derived monthly excess mortality, COVID-19 mortality[57] and vaccination rates[58] from OWID data. Displaying this data in charts enables us to see any obvious relationships.

[57] We understand that this data comes from surveillance reporting. We have calculated monthly COVID-19 mortality rates as reported COVID-19 deaths divided by the expected deaths for that month

[58] Monthly vaccination rates calculated as the monthly increase in the cumulative ratio of vaccination doses to population

Figure 41 – Monthly excess mortality compared with Covid mortality and vaccination rates, by region

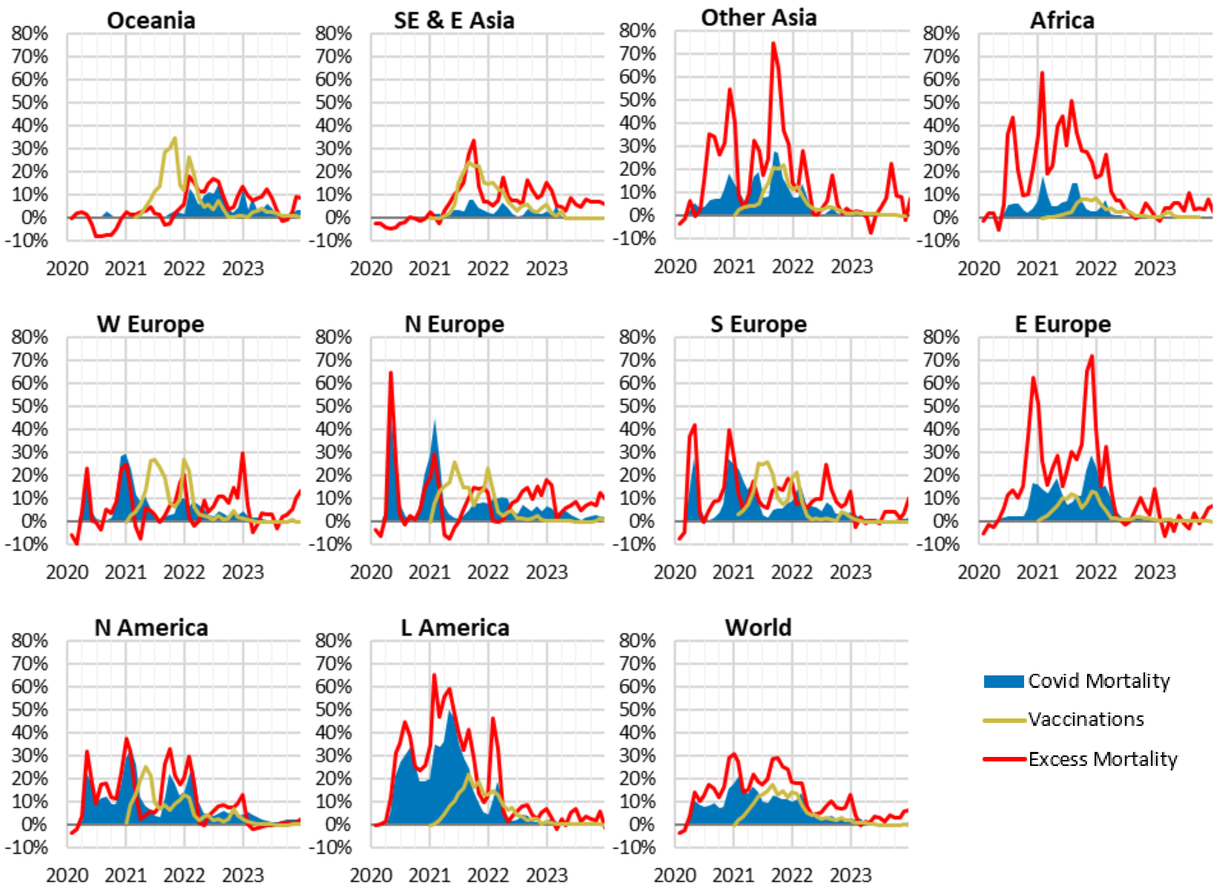


Figure 41 shows that there is a strong relationship between COVID-19 mortality and total excess mortality, which has experienced spikes when there have been regional COVID-19 waves. Note that surveillance reporting of COVID-19 mortality has varied between countries (and regions) and over time. There has been generally low reporting in Africa, SE & E Asia, Other Asia and Eastern Europe, and most regions appear to have been under-reporting in the past year or two. This recent under-reporting is consistent with our experience in Australia, where testing is far less prevalent for a start.

The first COVID-19 wave, in the northern spring of 2020, can be seen in Europe (other than Eastern Europe) and in North America, with delayed transmission to Latin America, Africa and Other Asia, while Oceania and SE & E Asia were in lockdown. Global waves are also apparent in the northern winter of 2020-21 and in the second half of 2021.

Some regional charts may suggest a link between vaccination rates and increased excess mortality, with or without a lag. However, there is no consistency in this apparent relationship. For example, the peak in vaccination rates in SE & E Asia coincided with the highest spike in excess mortality, while there is an apparent lag of about four months between vaccination peak and excess mortality peak in Oceania.

We believe that there are two key behavioural explanations for the relationship between vaccination rates and excess mortality:

- a COVID-19 wave (which drives excess mortality) encourages people to get vaccinated; and
- vaccination "permits" riskier behaviour, either by the individual or by the country – noting, for example, that the lift in excess mortality in Oceania in early 2022 corresponds to the reduction in restrictions, especially border closures.

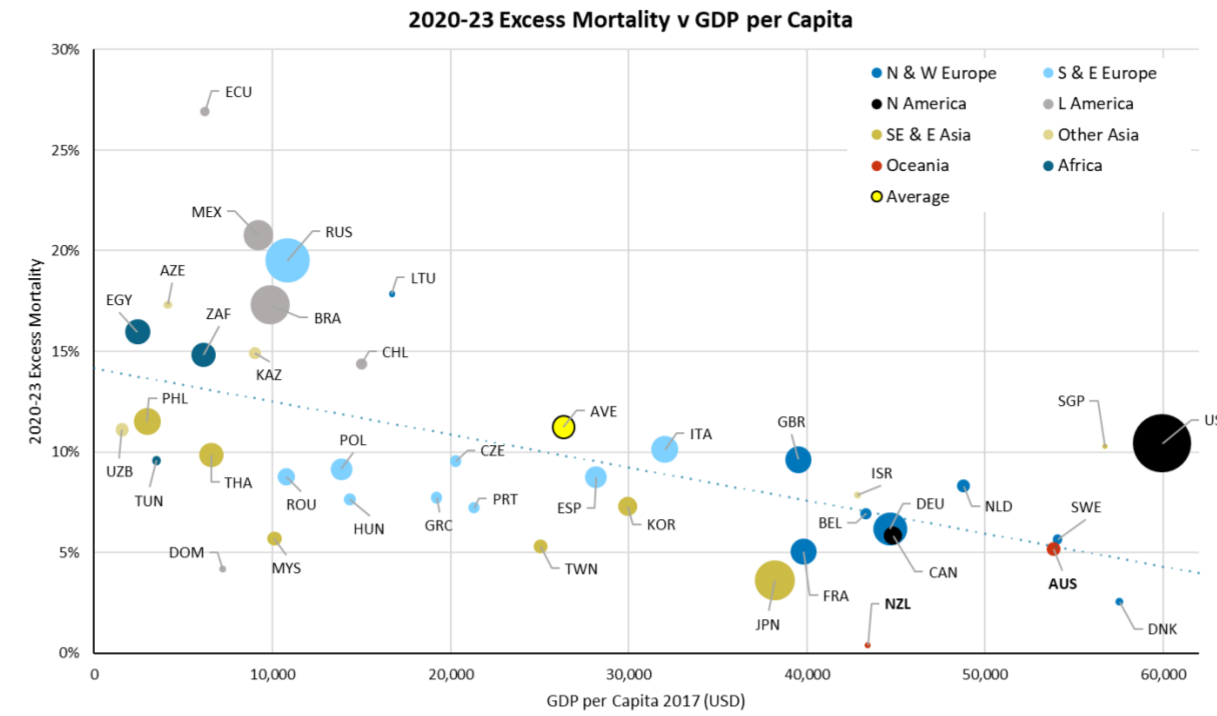
Neither of these explanations represents direct harm caused by vaccines. Indeed, after allowing for the Omicron spike in late 2021 or early 2022, the more obvious conclusion to be drawn from these charts is that vaccination is generally associated with a subsequent reduction in both excess mortality and COVID-19 mortality.

Appendix G contains the equivalent chart for each of the 61 countries represented in the regional charts in Figure 41, including the 40 countries discussed in this chapter.

4.7 Comparing excess mortality with GDP

It is also worth considering the impact of wealth (measured by GDP per capita) on excess mortality. To do this, we sourced 2017 GDP per capita in US dollars from Worldometer.

Figure 42 – Comparison of 2020-23 excess mortality with per capita GDP, showing a clear (but weak) inverse relationship



Sources: Our World in Data (OWID), Worldometer and analysis. Excess mortality relative to projected deaths. Bubble size is projected deaths.

A clear but weak ($R^2 = 0.31$) inverse relationship between per capita GDP and excess mortality for our 40 selected countries can be seen in Figure 42. Interestingly, the USA is an outlier. Given its wealth, it might be expected to have achieved a much lower level of excess mortality. Singapore, too, appears to be above the trend, while other countries in the SE & E Asia region appear to have done better than might have been expected based solely on per capita GDP.

Among the less wealthy countries in the chart, the Latin American countries are also above the trend, as are Russia and Lithuania.

Locally, Australia is on trend, while New Zealand has experienced considerably lower excess mortality than per-capita GDP would suggest.

Overall, although the relationship is weak, we consider that this chart demonstrates the advantage of wealth in the face of a pandemic.

Changing the perspective, was there an economic price to be paid for lower excess mortality – that is, for saving lives? We took the 42 countries for which relevant mortality data was available from OWID and GDP data from OECD.stat and compared excess real GDP with excess mortality. Excess real GDP is the difference between actual real GDP in Q3 of 2023[59] and what would have been

[59] This was the latest data available at the time of writing. Analysis of earlier periods gives similar results.

expected based on Q4 2019 GDP and the pre-pandemic growth trend. Excess mortality is the cumulative excess over that same period of 15 quarters.

Figure 43 – Comparison of excess real GDP with 2020-23 excess mortality, showing a very weak positive relationship

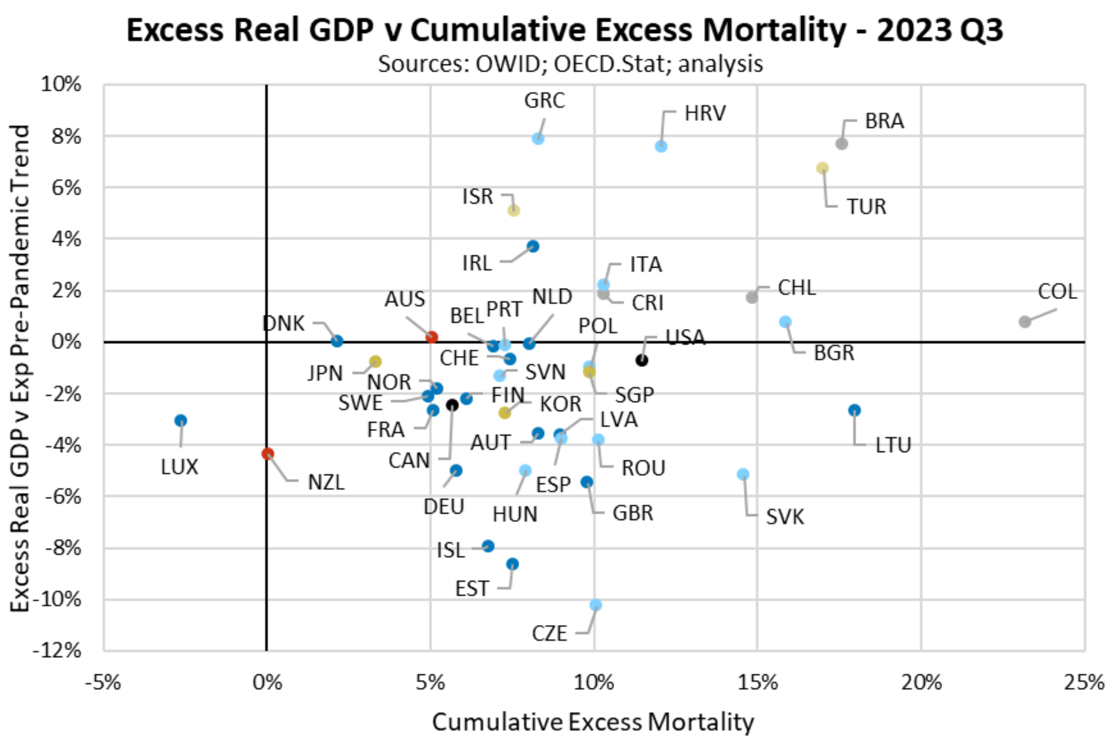
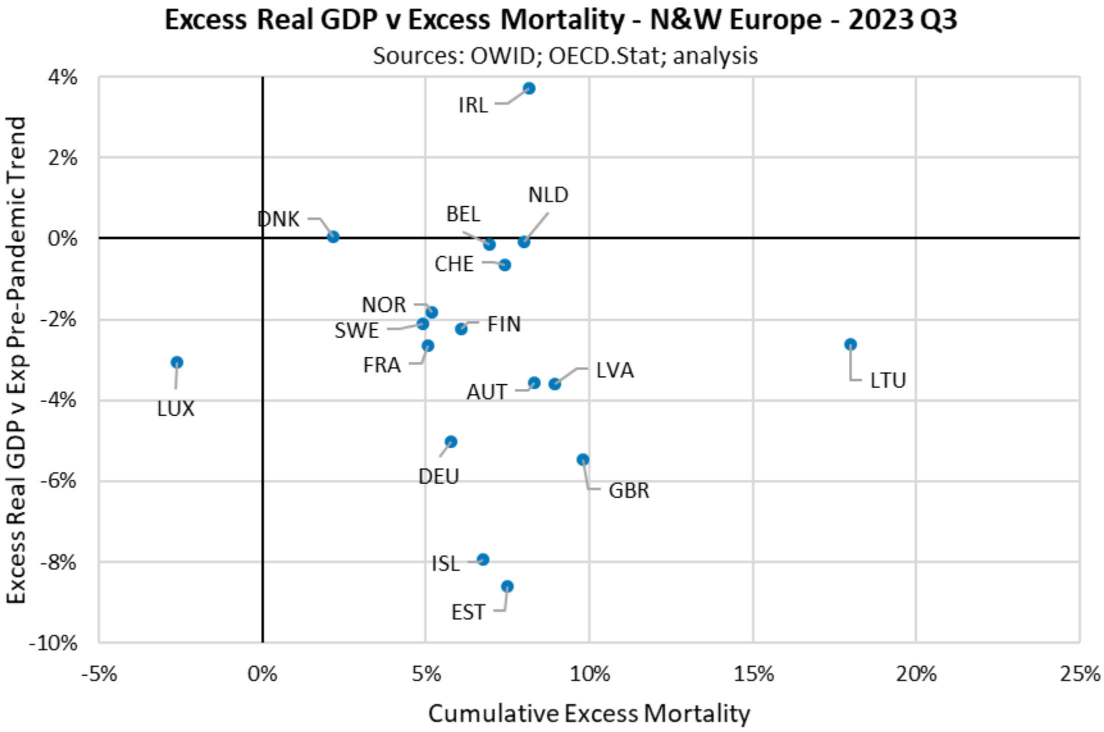


Figure 43, suggests a mixed impact, with a very weak positive relationship ($R^2 = 0.10$). It is likely that other factors are in play, making inter-country comparison difficult. We note that, within the four regions with more than two countries shown, the strongest relationship is a very weak negative one (in S & E Asia, with $R^2 = 0.10$). There is no statistically significant relationship between excess mortality and GDP impact in the other three regions ($R^2 = 0.00$ in each case).

For example, almost half of the countries in the chart (17) are in N & W Europe, which is relatively wealthy. Focusing on these, we can see (Figure 44) that there is no clear relationship at all. This suggests that saving lives has **not** resulted in an economic cost.

This is not to say that the pandemic itself had no economic cost; rather, there is no evidence that different government and/or individual actions (with correspondingly different mortality outcomes) would have significantly affected GDP in Q3 of 2023.

Figure 44 – Comparison of excess real GDP with 2020-23 excess mortality in N & W Europe, showing no relationship



4.8 Comparing excess mortality with state capacity

Given the weak – but clear – relationship between excess mortality and GDP, is there a better predictor? It turns out that there is.

Jonathan K. Hanson and Rachel Sigman have measured state capacity (the ability of a government to implement its policies and achieve its goals) by combining 21 different indicators related to three key dimensions:

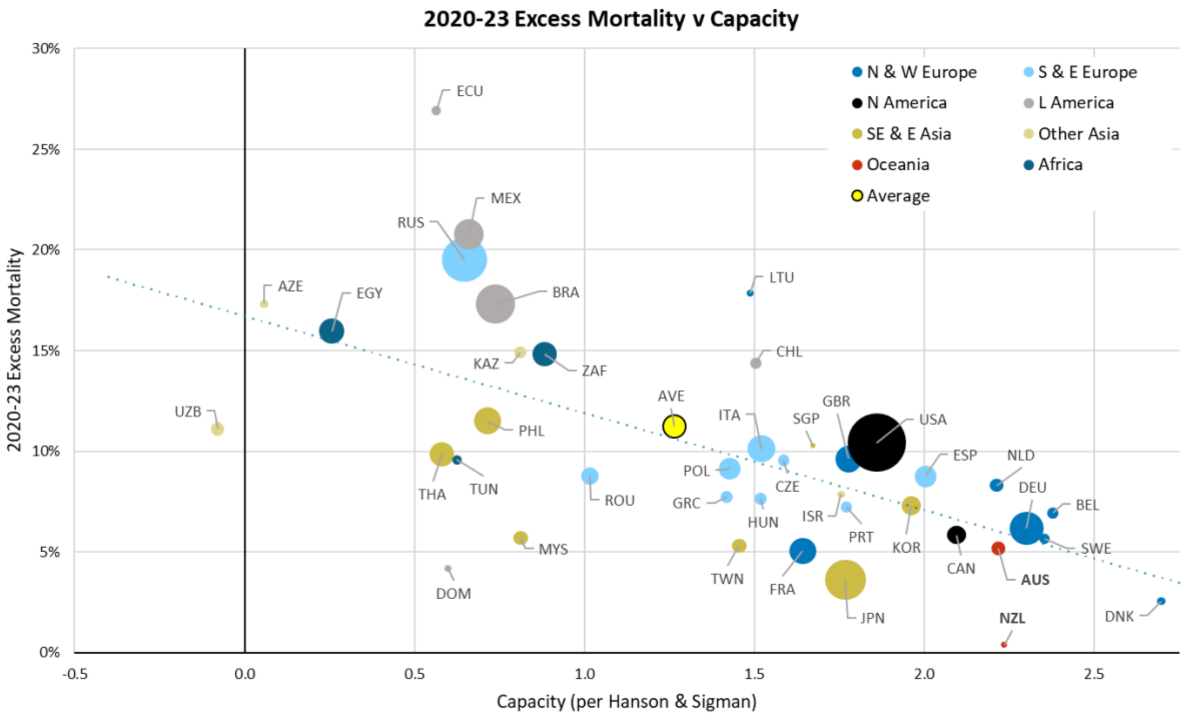
- extractive capacity – the state's ability to raise tax revenue;
- coercive capacity – the state's ability to preserve its borders, protect against external threats, maintain internal order, and enforce policy; and
- administrative capacity – a broader dimension that includes the ability to develop policy, the ability to produce and deliver public goods and services, and the ability to regulate commercial activity.

Higher values indicate greater state capacity. While there is a high correlation between per-capita GDP and state capacity, the latter is a more nuanced measure of the ability of a state to manage a crisis such as a pandemic.

OWID maintains a copy of the annual measures, updated every year. The latest values (updated in October 2023) relate to 2015.

We can compare excess mortality over the four years with state capacity.

Figure 45 – Comparison of 2020-23 excess mortality with state capacity, showing a clear (but somewhat weak) inverse relationship



Sources: Our World in Data (OWID) and analysis. Excess mortality relative to projected deaths. Bubble size reflects projected deaths.

Figure 45 shows this comparison for our 40 countries. The inverse relationship that we saw with GDP is still there, but it is less weak ($R^2 = 0.39$). We can see that the USA and Singapore are no longer outliers – because their measured state capacity is lower than would be implied by their per capita GDP. (We do not know why this is the case, because we do not have access to the component calculations.)

Once again, other countries in the SE & E Asia region generally appear to have done better than might have been expected based solely on per capita GDP, although South Korea is now on trend.

Among the less wealthy countries in the chart, the Latin American countries are still above the trend, as are Russia and Lithuania.

Locally, Australia is again on trend, while New Zealand has experienced considerably lower excess mortality than state capacity would suggest.

4.9 Excess mortality by age

OWID data allows us to drill into excess mortality by age group for some countries. The data gives weekly excess mortality rates, as a percentage of projected deaths. We derived annual excess mortality rates as a simple average of weekly rates. This will introduce a small error, because projected deaths are cyclical, but we think that the results are still meaningful.

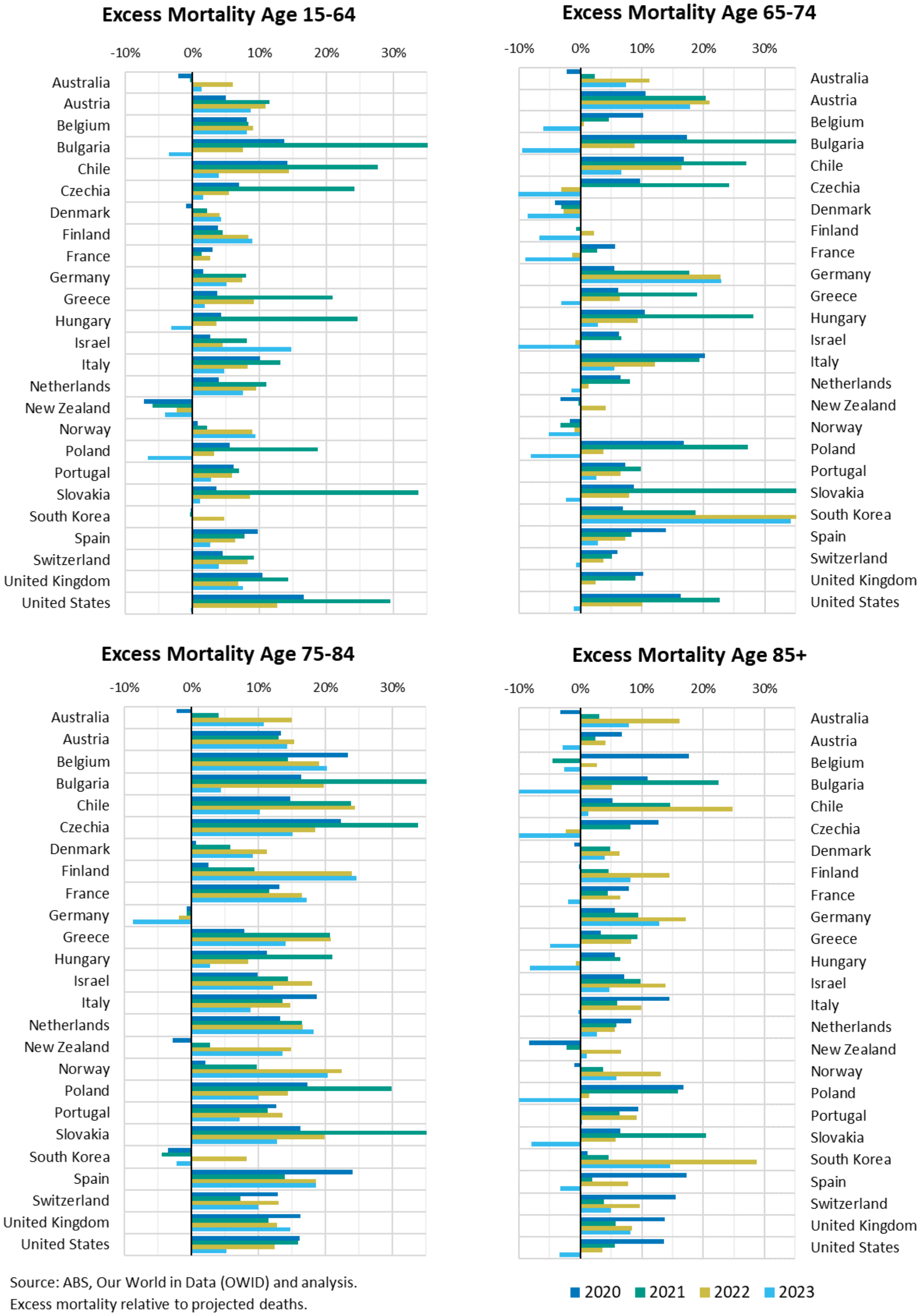
This OWID data does not include Australia, so we have used our analysis of ABS data. Our figures are not precisely comparable, because:

- our view of total excess mortality in Australia is a little different from OWID (our estimates are 1% to 2% lower than OWID for each year); and
- the ABS data has different age bands below age 65[60].

Recognising that only 5% of deaths in the 0-64 age group are of those aged under 15, we have assumed that Australian excess mortality rates in the 15-64 age group is equal to that for 0-64.

[60] ABS has 0-44 and 45-64, while OWID has 0-14 and 15-64.

Figure 46 – Excess mortality by age group and year for 25 countries, ages 15+, on a consistent scale



Source: ABS, Our World in Data (OWID) and analysis.
Excess mortality relative to projected deaths.

Figure 46 shows that excess mortality (as a percentage) has generally been highest in the 75-84 age group, although there are some high readings for those aged 65-74. The relatively low excess mortality in the 85+ age group (compared with those aged 75-84 in particular) suggests that the elderly were generally better protected, including being vaccinated sooner. We also think it likely that the elderly would have been greater beneficiaries of the reduction in prevalence of influenza and other respiratory conditions.

We note that the year-to-year comparisons may be affected by factors such as

delays in the registration of deaths, especially in younger age groups, where a high proportion of deaths would be referred to a coroner[61]. For this reason, we have not produced a chart for the 0-14 age group.

Table 6 – Simple unweighted average of excess mortality of 24 countries by age group and year

Age Group	2020	2021	2022	2023	All Years
0-14	-5.5%	-0.9%	2.4%	2.4%	**-0.4%**
15-64	5.4%	13.5%	7.0%	3.3%	**7.3%**
65-74	8.4%	15.0%	7.3%	0.5%	**7.8%**
75-84	11.5%	16.2%	15.6%	11.3%	**13.7%**
85+	7.9%	7.1%	8.7%	-0.1%	**5.9%**

Table 6 shows a simple, unweighted average of excess mortality by age group across all 24 countries for each year and for all four years combined. It confirms the observation that excess mortality (as a percentage) has been highest in the 75-84 age group. This may relate to the fact that this age group is more independent (and therefore less protected) than the 85+ but is still highly vulnerable to COVID-19 and its complications. Furthermore, as mentioned above, the 85+ may have gained more benefit from the reduction in prevalence of respiratory conditions. In relation to the 15-64 age group, we note that this range is wide and that the expected mortality rate of a 64-year-old is more than 30 times that of a 15-year-old, meaning that excess mortality at the top end of the range would dominate excess for the age group as a whole.

[61] We understand that this was the case in the UK, for example

5 What does the future hold?

Prediction is very difficult, especially if it's about the future![62]

We include this quote from Niels Bohr, as we did in our previous Research Papers, because it has been hard enough to form a view about what has already happened, and yet we will now attempt to predict (or at least sketch) the future.

5.1 Future mortality

How do we predict mortality in the future after these four years of COVID-19 experience?

Overall, in the authors' view, excess mortality (relative to pre-pandemic expectations) is likely to be remain above zero for some years for two main reasons:

1. COVID-19 is likely to remain a significant (perhaps top 10) cause of death, which increases total deaths in the population, and
2. a population which has experienced COVID-19 infection, particularly multiple times, is likely to be less healthy than it would have been without COVID-19 infections.

Working against these two forces that increase mortality, some population behaviour (staying home, staying away from vulnerable people, masking while sick, increased awareness of the importance of ventilation) seems to have reduced the incidence of a number of respiratory diseases in Australia, which will probably improve mortality longer term.

5.1.1 COVID-19 mortality

The biggest unknown is COVID-19, both in the acute phase and in relation to its longer-term impacts.

In the acute phase, we have seen each successive COVID-19 wave result in fewer deaths, but it is unclear whether this trend will continue. Undoubtedly some of this improvement will be due to survivorship bias, so we could expect the rate of improvement to perhaps slow down. There is also the possibility that a more deadly COVID-19 variant could emerge in the future. Population vaccination rates may also fall.

As to the longer-term impacts of COVID-19, it is unclear what the population-wide impact on mortality will be now that the vast majority have had COVID-19. To some degree, we can look to other countries where COVID-19 has been circulating in the population for longer than in Australia to understand what might happen with respect to COVID-19 mortality.

Section 4 shows a broad pattern that higher excess mortality in 2020 and 2021 tends to be correlated with lower excess mortality in 2022 and 2023 – i.e., those countries that had more excess deaths earlier in the pandemic tended to have a lower excess mortality experience in 2022 and 2023 than countries like Australia.

This suggests (but without a strong causal framework) that the direct contribution of COVID-19 to excess mortality is likely to reduce over time. However, as there are only a few countries where excess mortality has reduced to zero, it seems unlikely to disappear entirely.

It seems likely that COVID-19, directly or indirectly, will continue to increase mortality in Australia.

5.1.2 Contribution of non-COVID-19 issues to excess mortality

Understanding the likely causes (and directional movements) of non-COVID-19 excess mortality is crucial. In Section 3 we discussed a number of possible reasons for the high (non-COVID-19) excess deaths in Australia in 2022 and 2023. These issues will continue into the future to various extents, and

[62] Niels Bohr, atomic physicist

we have briefly reviewed their likely impact on future deaths here. In this section, when we talk about "the future impact" we are generally referring to impacts in the next 1-5 years.

Post-COVID-19 sequelae or interactions with other causes of death

As noted in Section 3, studies have shown that COVID-19 is associated with higher subsequent mortality risk from heart disease and other causes. We saw very high excess mortality in deaths from heart disease in 2022 and a lesser, although still high, impact in 2023. It seems likely that this impact will continue for some time into the future, although potentially reducing in severity.

Likely future impact in Australia: High

Mortality displacement

From looking at mortality around the world, it seems plausible that, while mortality displacement has almost certainly occurred over the last four years, it is unlikely to contribute significantly in future (other than potentially short-term fluctuations with influenza seasons occurring outside of their longer-term seasonal pattern).

Likely future impact in Australia: Low

Impacts of disruption to health services

Health services are still performing at lower levels than prior to the pandemic – the metrics around ambulance response times, emergency department treatment times and elective surgery waiting lists have all improved in 2023 but remain considerably worse than pre-pandemic levels.

The contribution of delays in emergency care to future mortality will be largely dependent on how well the health system copes with any strain from future COVID-19 (and influenza) waves, which will in turn depend on the size of the waves and the longer-term resourcing of the health sector.

Opportunities to diagnose or treat non-COVID-19 diseases have been missed over the last few years for various reasons, and we expect that the full impact on mortality of these delays to routine care have not yet been fully realised, given the long latency of some conditions such as cancer and chronic heart disease. However, in the current environment in Australia, it is likely that services have returned to normal or are close to doing so.

Likely future impact in Australia: Reducing

Undiagnosed COVID-19

There will be increasing numbers of deaths with undiagnosed COVID-19, as fewer people are tested for the disease. However, this is a categorisation issue and does not affect the overall contribution of COVID-19 to future mortality.

Likely future impact in Australia: Included in COVID-19 impact

Mental health issues, alcohol-induced deaths and road deaths

To date there has been little to no direct evidence of mental health issues increasing death rates in the population. Both alcohol-related deaths and deaths from road accidents have increased in the last 1-2 years, but the numbers involved are small, with the available statistics not showing a material increase at a population level.

Likely future impact in Australia: Low

Vaccine-related deaths

While there have been deaths in Australia identified as being caused by the administration of COVID-19 vaccines, the number of such deaths has been small. While vaccinations continue regularly, the total vaccinations per member of the population are much lower now than they were in 2021, thus reducing the risk of death from vaccines even further. In addition, the AstraZeneca vaccine, that was found responsible for 13 of the 14 vaccine-related deaths in Australia, has been discontinued.

Likely future impact in Australia: Not numerically significant

Non-pharmaceutical interventions

All of the above factors have been considered in the context of possible causes of **increased** mortality, but we have also seen that some of the non-pharmaceutical interventions introduced in Australia have acted to **reduce** mortality. To the extent that mask-wearing and other defence measures (such as isolation when sick), persist in vulnerable settings, this will likely lead to lower deaths from respiratory disease.

Likely future impact in Australia: Moderate to high negative contribution.

5.2 What is the new normal?

In our view, the "new normal" level of mortality is likely to be higher than it would have been in the absence of a pandemic. 2022 had 11% higher than predicted mortality while 2023 had 5% higher than predicted mortality. Looking ahead, we think that excess mortality (relative to pre- pandemic expectations) will probably reduce from the level in 2023.

COVID-19 is likely to continue to cause **some** excess mortality for some years to come, directly as a cause of death and less directly, as a contributor to other causes such as heart disease. There will also be an indirect impact, with the largest contributor likely to be the ongoing consequences of disruption to usual healthcare practices in the earlier years of the pandemic. Counter to this, to the extent that mask-wearing and other defence measures persist in vulnerable settings, this will likely lead to lower deaths from respiratory disease.

There has been a long-term underlying trend of mortality improvement in Australia (i.e. over decades). Although the rate of improvement has gradually been slowing, we do not think that it will cease. The underlying drivers of mortality improvement, such as medical advances, reduction in smoking rates, and other societal improvements are continuing (noting that improvements in many causes of death are "baked in" from population-wide changes years, or even decades, beforehand). The question remains as to whether mortality will eventually return to the pre-pandemic trajectory, or whether there may be a permanent loss of a few years of mortality improvement.

5.3 Change to baseline measure for 2024

As set out in our Actuaries Digital article[63], the Mortality Working Group has changed its approach to setting the baseline (or expected deaths) for 2024. We have moved away from answering the question "how has the pandemic affected mortality?" to instead ask "how is current mortality tracking relative to last year?"

More completely, our estimate of excess deaths measures how 2024 mortality compares to the expected level based on 2023, after allowing for one year's mortality improvement. Specifically:

- for deaths due to COVID-19, we have adopted age-standardised death rates (SDRs) for 2024 that allow for two waves per annum, with each successive wave resulting in 20% fewer deaths than the previous wave, reflecting the trend that we have seen since borders were re-opened;
- for respiratory causes, we have adopted the 2023 SDRs for 2024, since it seems reasonable not to allow for any year-to-year mortality trend; and
- for all other causes of death, we have adopted the 2023 SDRs plus an allowance for the pre-pandemic rate of mortality improvement to continue into 2024.

In adopting a 2024 baseline based on 2023 mortality (adjusted as discussed above), we note that:

[63] Excess Mortality: Considerations in Moving Away from a Pre-pandemic Baseline, published 24 April 2024

- this baseline will include any temporary pandemic impacts affecting 2023 mortality;
- any such temporary pandemic impacts are impossible to quantify;
- we are assuming that underlying non-COVID-19 mortality will continue to improve, which it had done for decades prior to the pandemic;
- it remains unclear whether – and to what extent – the underlying mortality improvement rate would, by now, be higher or lower than the pre-pandemic trend; and
- therefore, there is more than usual uncertainty around the appropriate baseline for expected mortality and this uncertainty will continue as we move towards "new normal" post-pandemic mortality.

We stress the high uncertainty (and correspondingly wide confidence interval) relating to the resultant calculation of excess mortality.

Our analysis[64] of the latest ABS *Provisional Mortality Statistics* shows small (1%) excess mortality relative to this new baseline in the first quarter of 2024.

[64] https://www.actuaries.digital/2024/06/19/excess-mortality-in-first-two-months-of-2024-was-nil-noting-the-new-baseline/

Appendix A IBNR factors and scaling of deaths

This appendix sets out the allowances we have made for late-reported deaths (incurred but not reported or "IBNR" factors) and also the factors used to scale past deaths to 2023 values for the age band/gender. These scaling factors are used as a proxy as standardised death rates are not available by age band/gender.

A.1 IBNR Factors

Table 7 shows the adjustments made for late-reported deaths for 2023.

Table 7 – Adjustments for late-reported deaths

	Doctor certified deaths				Coroner referred deaths			
Week ending	Registered	Late Reporting	Percent Loading	Adopted deaths	Registered	Late Reporting	Percent Loading	Adopted deaths
2-Jan to 2-Jul	79,549	456	0.6%	80,005	11,121	56	0.5%	11,177
09-Jul-23	3,359	22	0.7%	3,381	464	2	0.5%	466
16-Jul-23	3,244	22	0.7%	3,266	468	2	0.5%	470
23-Jul-23	3,287	22	0.7%	3,309	442	2	0.5%	444
30-Jul-23	3,265	22	0.7%	3,287	476	2	0.5%	478
06-Aug-23	3,174	22	0.7%	3,196	463	2	0.5%	465
13-Aug-23	3,203	23	0.7%	3,226	430	3	0.6%	433
20-Aug-23	3,227	23	0.7%	3,250	455	3	0.7%	458
27-Aug-23	3,082	22	0.7%	3,104	449	3	0.7%	452
03-Sep-23	3,083	23	0.7%	3,106	421	3	0.7%	424
10-Sep-23	3,010	24	0.8%	3,034	448	3	0.8%	451
17-Sep-23	3,112	24	0.8%	3,136	436	4	1.0%	440
24-Sep-23	2,941	23	0.8%	2,964	425	5	1.1%	430
01-Oct-23	3,013	25	0.8%	3,038	429	5	1.1%	434
08-Oct-23	2,927	25	0.9%	2,952	418	6	1.4%	424
15-Oct-23	3,074	28	0.9%	3,102	455	8	1.7%	463
22-Oct-23	2,910	27	0.9%	2,937	401	7	1.8%	408
29-Oct-23	2,892	28	1.0%	2,920	413	7	1.8%	420
05-Nov-23	3,019	31	1.0%	3,050	408	10	2.5%	418
12-Nov-23	3,083	40	1.3%	3,123	419	12	3.0%	431
19-Nov-23	3,085	41	1.3%	3,126	417	16	3.8%	433
26-Nov-23	2,957	40	1.4%	2,997	404	15	3.8%	419
03-Dec-23	3,001	43	1.4%	3,044	416	19	4.6%	435
10-Dec-23	2,961	54	1.8%	3,015	418	23	5.6%	441
17-Dec-23	2,874	58	2.0%	2,932	449	34	7.5%	483
24-Dec-23	2,909	66	2.3%	2,975	459	35	7.6%	494
31-Dec-23	2,815	77	2.7%	2,892	457	44	9.7%	501

A.2 Scaling factors – by age band/gender

Table 8 – Population and other adjustments applied to actual deaths for each age band/gender

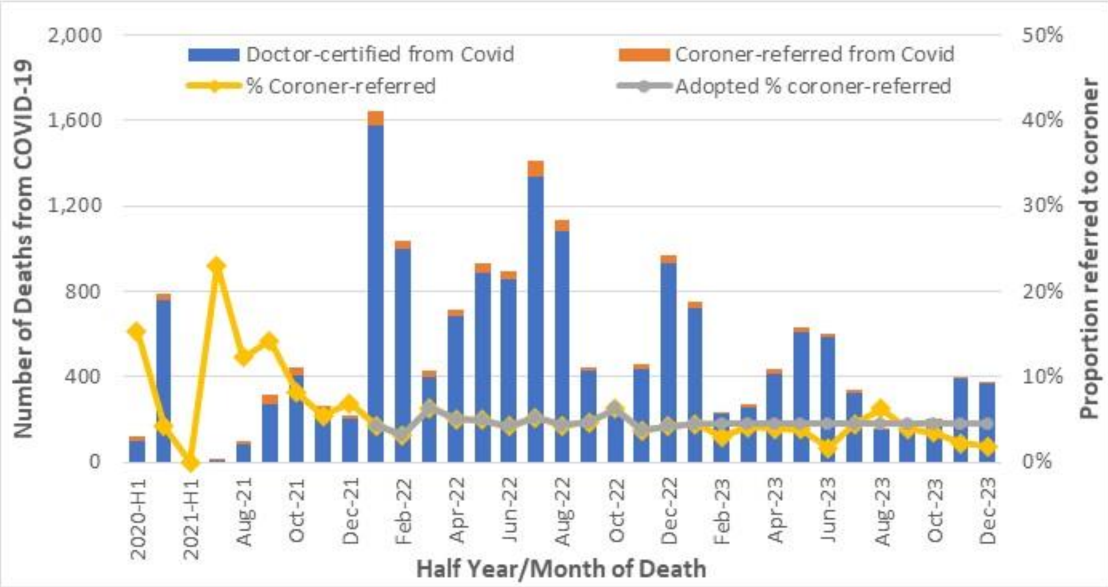
	Gender/Age Group										
Year	M, 0-44	M, 45-64	M, 65-74	M, 75-84	M, >85	F, 0-44	F, 45-64	F, 65-74	F, 75-84	F, >85	Total
Reported deaths											
2015	5,339	13,280	15,027	22,659	25,552	2,869	8,160	9,552	18,547	38,930	159,915
2016	5,180	12,910	15,253	22,657	25,892	2,856	7,980	9,572	17,932	38,219	158,451
2017	5,323	13,077	15,919	23,201	27,088	2,832	8,138	10,196	18,581	39,569	163,924
2018	5,057	12,996	15,629	22,632	26,485	2,666	8,202	9,985	17,855	37,575	159,082
2019	5,248	13,322	15,880	23,607	27,423	2,750	8,101	10,394	18,533	39,128	164,386
2020	5,159	13,200	16,292	24,007	27,695	2,751	8,226	10,426	18,771	38,247	164,774
2021	4,997	13,172	16,548	25,525	29,407	2,722	8,093	10,977	19,741	40,535	171,717
2022	5,183	13,905	17,843	29,112	33,549	2,845	8,742	11,575	22,174	45,396	190,324
2023	5,007	13,296	17,009	28,283	31,526	2,783	8,314	11,192	22,019	42,087	181,516
Population (m)											
2015	7.29	2.88	0.99	0.50	0.17	7.12	2.97	1.02	0.58	0.30	23.82
2016	7.38	2.91	1.03	0.51	0.18	7.21	3.02	1.06	0.60	0.30	24.19
2017	7.48	2.96	1.06	0.53	0.18	7.30	3.07	1.10	0.61	0.31	24.59
2018	7.57	2.99	1.09	0.55	0.19	7.39	3.11	1.14	0.63	0.31	24.96
2019	7.66	3.03	1.12	0.58	0.19	7.47	3.14	1.18	0.66	0.31	25.33
2020	7.70	3.07	1.15	0.61	0.20	7.50	3.19	1.22	0.69	0.32	25.65
2021	7.64	3.09	1.17	0.64	0.21	7.45	3.19	1.25	0.71	0.33	25.69
2022	7.74	3.10	1.18	0.68	0.22	7.54	3.21	1.27	0.76	0.33	26.01
2023	7.99	3.11	1.19	0.72	0.22	7.76	3.23	1.29	0.80	0.34	26.65
Population adjusted deaths											
2015	5,595	14,248	17,805	29,145	31,043	3,002	8,761	11,784	22,750	42,645	172,467
2016	5,368	13,690	17,431	28,300	30,165	2,952	8,423	11,360	21,520	40,986	168,240
2017	5,443	13,654	17,662	27,860	30,699	2,890	8,454	11,673	21,655	41,996	171,208
2018	5,108	13,403	16,823	26,194	29,260	2,689	8,422	11,007	20,235	39,475	163,684
2019	5,236	13,575	16,688	26,079	29,472	2,743	8,226	11,087	20,195	40,624	166,661
2020	5,122	13,273	16,600	25,168	28,814	2,731	8,234	10,696	19,551	39,076	165,006
2021	4,997	13,172	16,548	25,525	29,407	2,722	8,093	10,977	19,741	40,535	171,717
2022	5,119	13,854	17,752	27,349	32,461	2,811	8,704	11,443	20,874	44,581	187,917
2023	4,792	13,185	16,739	25,222	29,422	2,670	8,228	10,867	19,687	40,621	174,953
Age Mix adjustments											
2015	99.1%	100.9%	102.2%	99.2%	103.6%	99.2%	101.3%	102.1%	98.6%	104.6%	110.2%
2016	99.5%	100.9%	102.0%	99.4%	102.6%	99.7%	101.4%	102.0%	99.0%	103.7%	108.7%
2017	99.9%	100.9%	101.2%	99.6%	102.0%	100.3%	101.3%	101.2%	99.2%	102.7%	107.5%
2018	100.2%	100.9%	100.6%	99.6%	101.4%	100.7%	101.1%	100.7%	99.3%	102.0%	106.3%
2019	100.4%	100.6%	100.3%	99.7%	100.8%	100.8%	100.8%	100.5%	99.4%	101.2%	104.9%
2020	100.2%	100.3%	100.1%	99.8%	100.3%	100.6%	100.3%	100.3%	99.7%	100.5%	102.8%
2021	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2022	99.7%	99.6%	100.3%	100.5%	100.1%	99.7%	99.7%	100.2%	100.8%	100.3%	98.7%
2023	99.2%	99.4%	100.4%	101.0%	100.1%	99.6%	99.6%	100.3%	101.4%	100.6%	98.4%
Age mix adjusted deaths											
2015	5,544	14,376	18,203	28,921	32,147	2,978	8,877	12,028	22,429	44,625	190,129
2016	5,340	13,813	17,785	28,137	30,958	2,944	8,537	11,588	21,304	42,513	182,918
2017	5,437	13,783	17,868	27,750	31,323	2,898	8,563	11,814	21,487	43,149	184,073
2018	5,118	13,522	16,922	26,093	29,662	2,707	8,517	11,087	20,088	40,247	173,962
2019	5,255	13,660	16,740	26,010	29,720	2,765	8,291	11,139	20,077	41,131	174,789
2020	5,135	13,311	16,620	25,119	28,888	2,746	8,261	10,723	19,483	39,284	169,568
2021	4,997	13,172	16,548	25,525	29,407	2,722	8,093	10,977	19,741	40,535	171,718
2022	5,104	13,805	17,798	27,496	32,499	2,802	8,679	11,467	21,036	44,709	185,396
2023	4,755	13,107	16,808	25,474	29,450	2,659	8,192	10,900	19,960	40,856	172,160
Delayed reporting allowance											
2021	18	48	60	94	110	10	29	40	73	151	633
2022	37	100	129	199	235	20	63	83	152	322	1,339
2023	43	118	152	229	264	24	74	98	180	366	1,548
Total scaled deaths											
2015	5,544	14,376	18,203	28,921	32,147	2,978	8,877	12,028	22,429	44,625	190,129
2016	5,340	13,813	17,785	28,137	30,958	2,944	8,537	11,588	21,304	42,513	182,918
2017	5,437	13,783	17,868	27,750	31,323	2,898	8,563	11,814	21,487	43,149	184,073
2018	5,118	13,522	16,922	26,093	29,662	2,707	8,517	11,087	20,088	40,247	173,962
2019	5,255	13,660	16,740	26,010	29,720	2,765	8,291	11,139	20,077	41,131	174,789
2020	5,135	13,311	16,620	25,119	28,888	2,746	8,261	10,723	19,483	39,284	169,568
2021	5,015	13,220	16,608	25,619	29,517	2,732	8,123	11,017	19,814	40,686	172,351
2022	5,141	13,905	17,927	27,695	32,734	2,823	8,742	11,550	21,188	45,031	186,736
2023	4,798	13,225	16,960	25,702	29,714	2,683	8,266	10,998	20,140	41,223	173,708

Appendix B Coroner-referred deaths from COVID-19

The ABS Provisional Mortality Statistics publications include the number of deaths *from* COVID-19 that were doctor-certified, while the COVID-19 Mortality in Australia articles (accompanying the Provisional Mortality Statistics) include total deaths *from* COVID-19. Taking the difference between the two gives the number of coroner-referred deaths *from* COVID-19.

Figure 47 shows the number of deaths *from* COVID-19 split between doctor-certified and coroner-referred, plus the proportion that are coroner-referred.

Figure 47 – Doctor-certified versus Coroner-referred deaths from COVID-19



In 2020 and early 2021, Australia experienced relatively small numbers of deaths *from* COVID-19 and the proportion that were coroner-referred varied quite significantly given the low numbers. We have assumed that coroner-referred deaths *from* COVID-19 will be 4.5% of all deaths *from* COVID-19 for each month of 2023, based on the experience of late 2021 and 2022. We have deducted these estimated coroner-referred deaths *from* COVID-19 from other coroner-referred deaths.

Appendix C Predicting deaths using a linear model

We perform simple linear regression on standardised SDRs or death counts to predict weekly expected SDRs for each cause of death (11 causes) plus coroner-certified deaths, as well as weekly expected number of deaths for each age band/gender combination (10 combinations).

The standardisation procedure and the linear regression are described in Section C.1and Section C.2, respectively. These sections describe the approach used for setting the predicted values for the 2020 and 2021 years (which are based on the 2015-19 years' actual data). The same approach is adopted in setting the predicted values for 2022 and 2023, although for some causes of death (respiratory diseases, dementia, other cardiac conditions and diabetes) we use the 2015-21 years' data (see Section 2.2.1).

C.1 Standardisation and smoothing

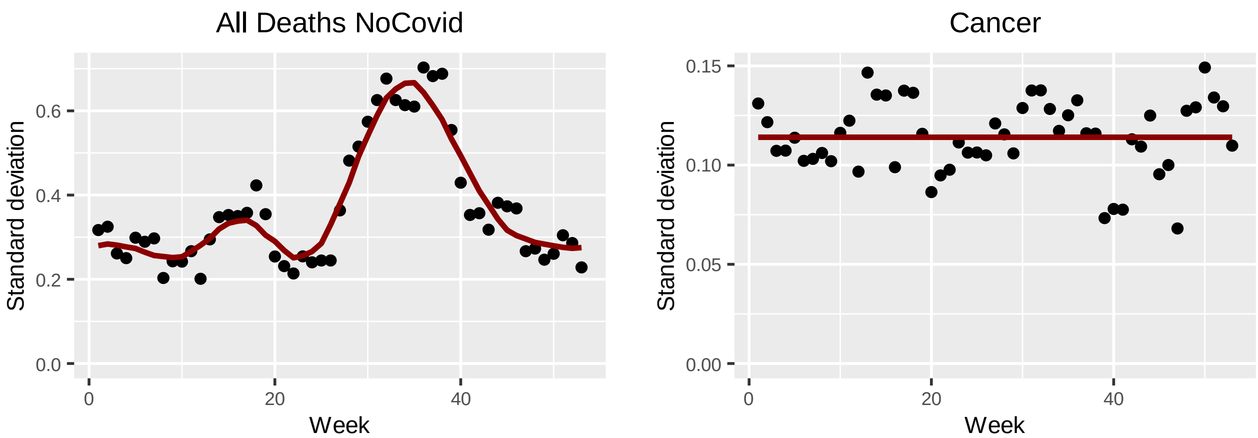
The standardised SDRs or death counts are obtained by subtracting the means from the original series and then dividing by the smoothed standard deviations.

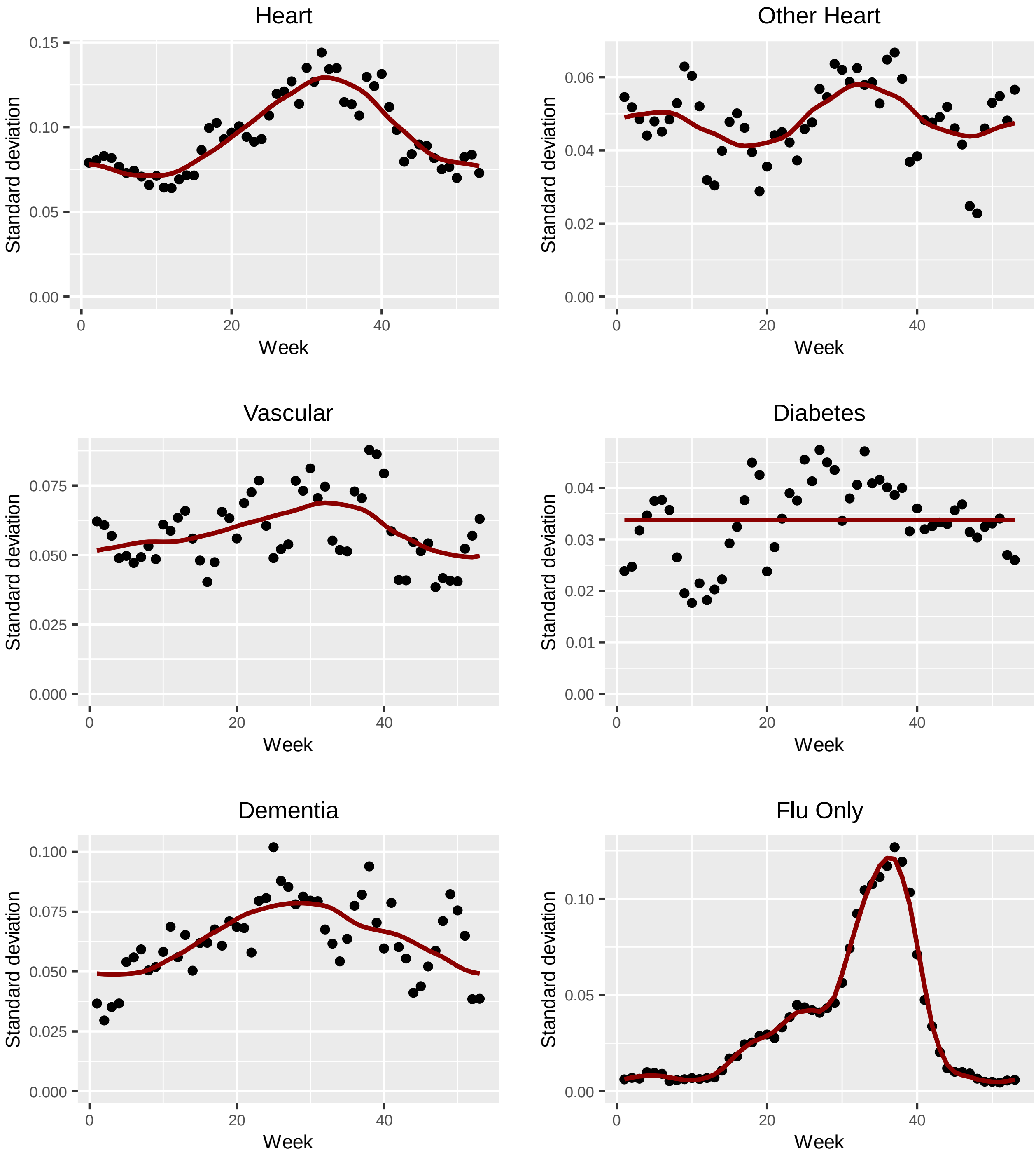
The mean (standard deviation) in Week x is calculated by taking the average (sample standard deviation) of SDRs/deaths in Weeks $x-1$, x, and $x+1$ between 2015 and 2019. For the first week in each year, Week $x-1$ refers to the last week of the previous year; for the last week in each year, Week $x+1$ refers to the first week of the following year.

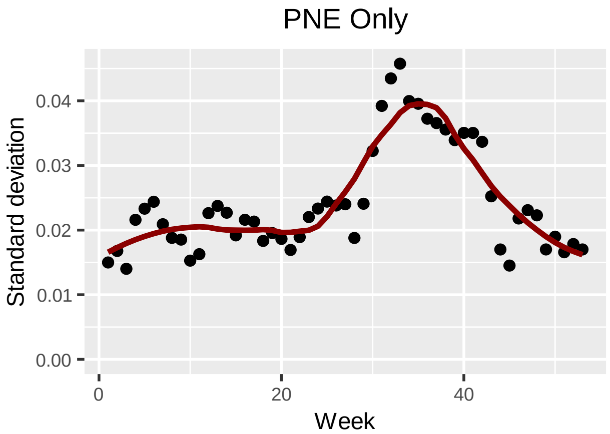
The standard deviation series are volatile, so we perform a local regression, namely LOESS (locally estimated scatterplot smoothing) to reduce the noise. When performing the LOESS, we also ensure a smooth transition from Week 52/53 to Week 1. For cancer, diabetes and the three age groups under age 75, the standard deviations are noisy and lack clear seasonality, so we have adopted the average over all weeks as the smoothed standard deviations.

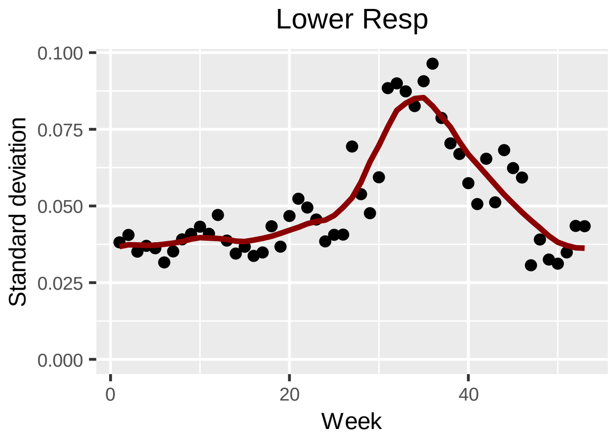
Figure 48 shows the actual (black dots) and adopted (red line) standard deviations for each cause of death, while Figure 49 shows the same information for each age/gender combination.

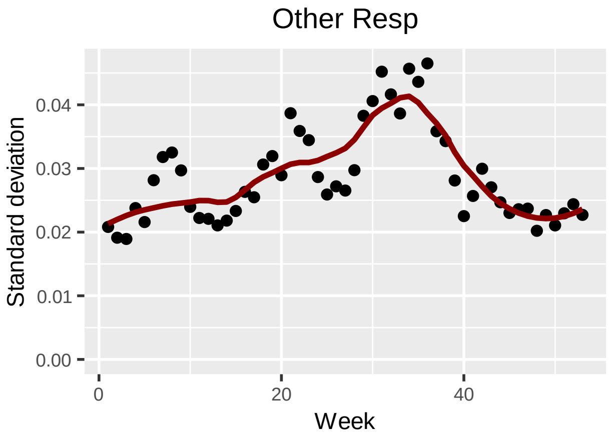
Figure 48 – Actual and adopted standard deviations by cause of death

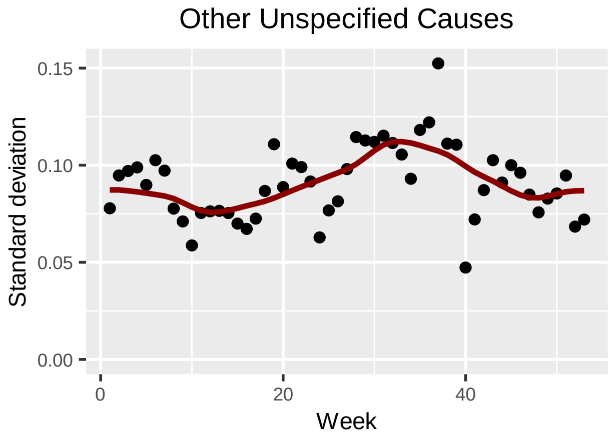



Heart
Standard deviation
0.15
0.10
0.05
0.00
0
20
40
Week
Other Heart
Standard deviation
0.06
0.04
0.02
0.00
0
20
40
Week
Vascular
Standard deviation
0.075
0.050
0.025
0.000
0
20
40
Week
Diabetes
Standard deviation
0.04
0.03
0.02
0.01
0.00
0
20
40
Week
Dementia
Standard deviation
0.100
0.075
0.050
0.025
0.000
0
20
40
Week
Flu Only
Standard deviation
0.10
0.05
0.00
0
20
40
Week


PNE Only
Standard deviation
0.00
0.01
0.02
0.03
0.04
0
20
40
Week


Lower Resp
Standard deviation
0.000
0.025
0.050
0.075
0.100
0
20
40
Week


Other Resp
Standard deviation
0.00
0.01
0.02
0.03
0.04
0
20
40
Week


Other Unspecified Causes
Standard deviation
0.00
0.05
0.10
0.15
0
20
40
Week

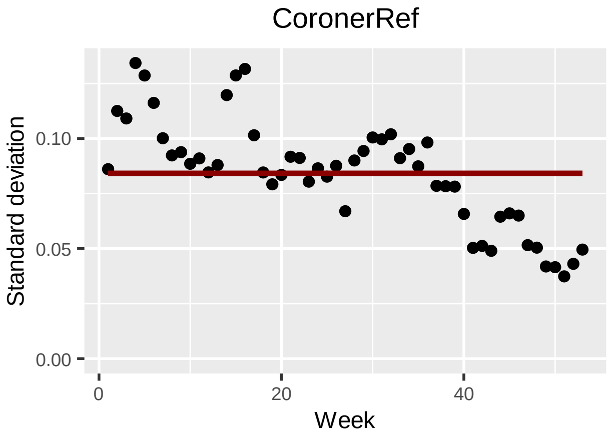
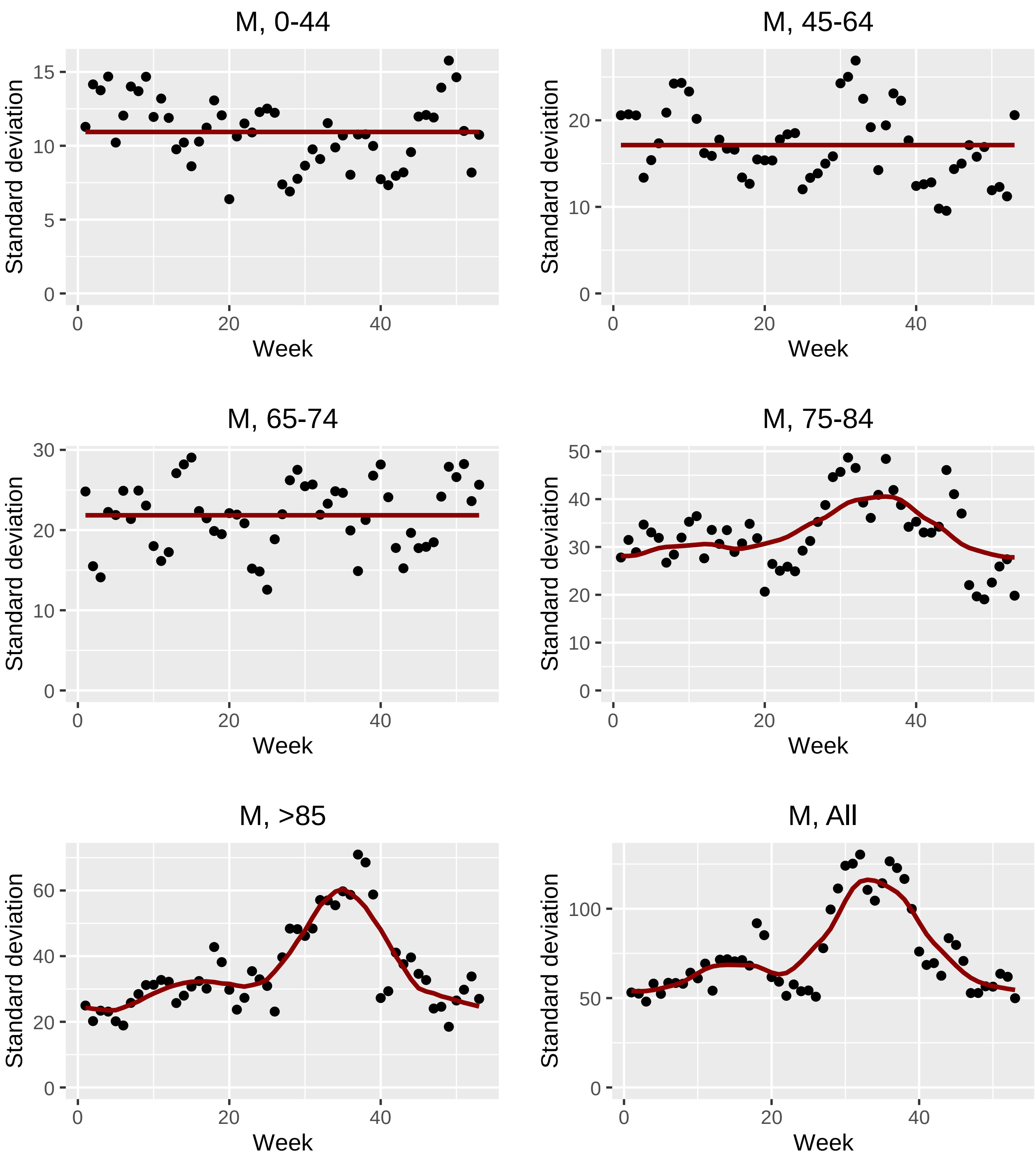
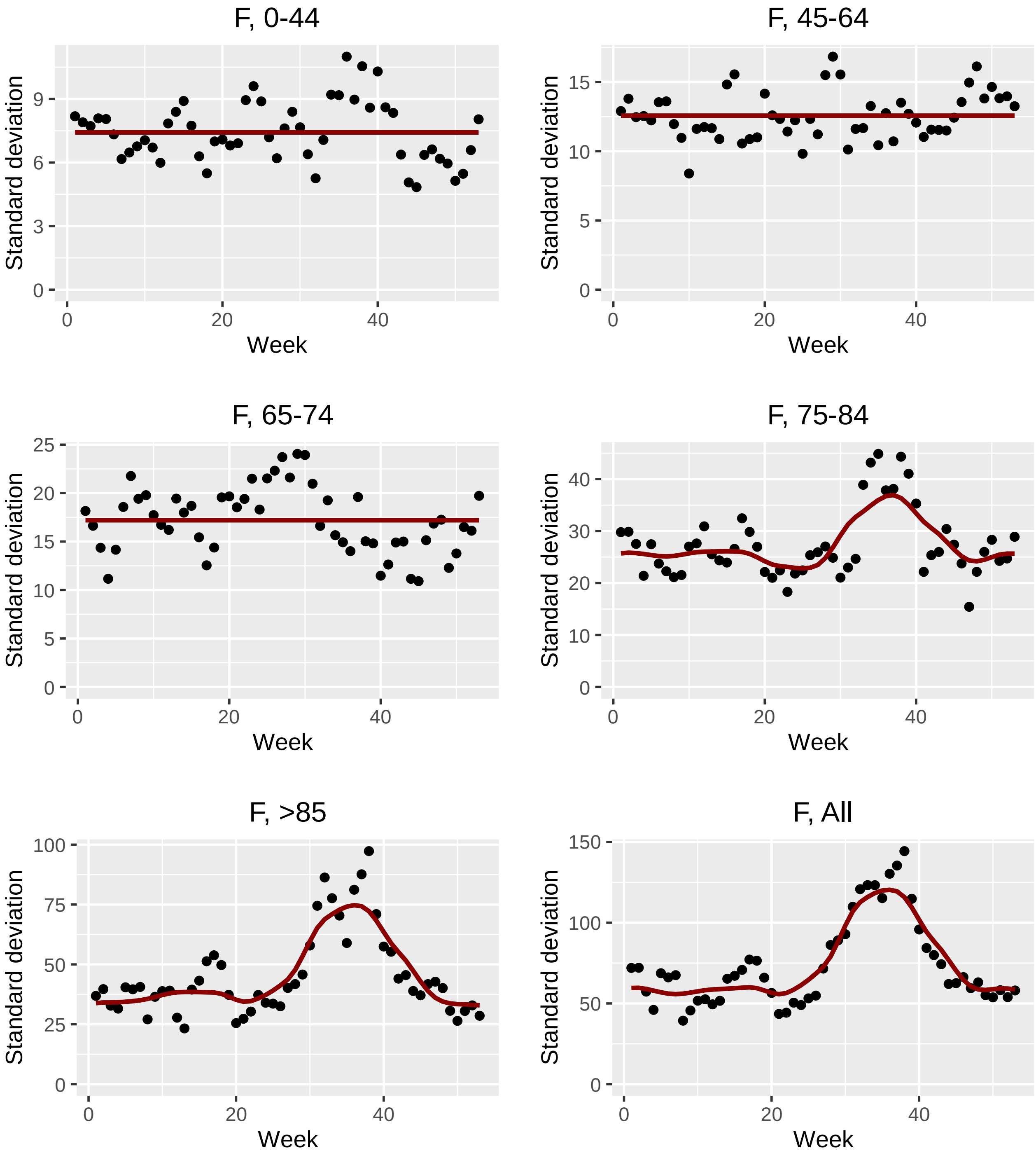

CoronerRef
Standard deviation
0.00
0.05
0.10
0
20
40
Week

Figure 49 – Actual and adopted standard deviations by age/gender





C.2 Simple linear regression

For the 2020 and 2021 prediction years, the linear model is fitted to the weekly SDRs/deaths data (after scaling adjustments) from the first week of 2015 to the last week of 2019. We then use the estimated parameters to predict the expected number of deaths from the first week of 2020 to the last week of 2021.

For the 2022 and 2023 prediction years, the linear model is fitted to data from:

- the first week of 2015 to the last week of 2019 in the case of deaths from respiratory diseases, dementia, other cardiac conditions and diabetes
- the first week of 2015 to the last week of 2021 for all other causes and coroner referred deaths.

We then use the estimated parameters to predict the expected number of deaths from the first week of 2022 onwards.

The explanatory variable in the regression is a time index that takes the value based on both year and week [65]. The response variable in the regression is the standardised death count where seasonality has been removed from the series.

Table 9 - The value of time index in the simple linear regression

Year	Week	Time index
2015	1	1
2015	2	2
⋮	⋮	⋮
2015	53	53
2016	1	54
⋮	⋮	⋮
2016	52	105
2017	1	106
⋮	⋮	⋮

C.3 Prediction intervals

We generate the prediction intervals for the weekly expected SDRs/deaths using the simulation method. The residuals of the simple linear regression show strong serial correlation, so we fit a time series model to the residuals of each linear regression. We then simulate 100,000 paths based on the fitted time series model. Each of the 100,000 paths is then added to the weekly expected SDRs/number of deaths, and the sum becomes one simulated path of weekly SDRs/number of deaths. We use the 2.5% and 97.5% quantiles of the simulated weekly SDRs/number of deaths as our prediction intervals. One week in 40 is expected to show deaths above this range and one week in 40 should be below the range.

In addition to the weekly figures, we are also interested in the cumulative number of deaths in a year. The cumulative expected number of deaths is the sum of the weekly expected number of deaths. To generate the prediction intervals, we first calculate the cumulative SDRs/number of deaths in each simulated path of weekly SDRs/number of deaths, and then use the 2.5% and 97.5% quantiles as our prediction intervals.

C.4 Forecast Reconciliation

Once predictions on SDRs or death counts are generated via the linear models described in Section C.2, we implement a forecast reconciliation approach to ensure coherence of forecasts across different causes.[66] Forecast reconciliation is a useful tool that eliminates the discrepancy resulting from

[65] We fit a horizontal line with no time trend to the deaths due to influenza because the number of influenza deaths are volatile from year-to-year, and Australia experienced a severe flu seasons in 2017 and 2019. Fitting a linear model to the five years 2015-2019 leads to an upward trend that predicts unrealistically high figures in later years.

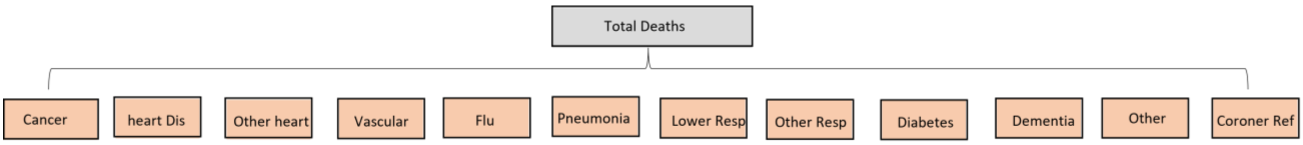
[66] For more details of this approach, please refer to:

1. Li, H., Li, H., Lu, Y., and Panagiotelis, A. (2019). A forecast reconciliation approach to cause-of-death mortality modeling. *Insurance: Mathematics and Economics*, 86, 122-133; and
2. Wickramasuriya, S. L., Athanasopoulos, G., and Hyndman, R. J. (2019). Optimal forecast reconciliation for hierarchical and grouped time series through trace minimization. *Journal of the American Statistical Association*, 114(526), 804-819.

conflicting forecasts. Essentially, this technique ensures that the individual predictions for each cause or age/gender combination adds up to the total. By incorporating information from all levels, reconciliation methods also improve overall forecast accuracy.

The cause-specific SDRs follow a hierarchical setting illustrated in Figure 50. For each time series in the hierarchy, we model and forecast the SDR using separate models. However, it is very unlikely that these forecasts will add up in the same way as specified in the underlying hierarchy structure. Therefore, we need to reconcile these forecasts so that they fulfil certain aggregation constraints.

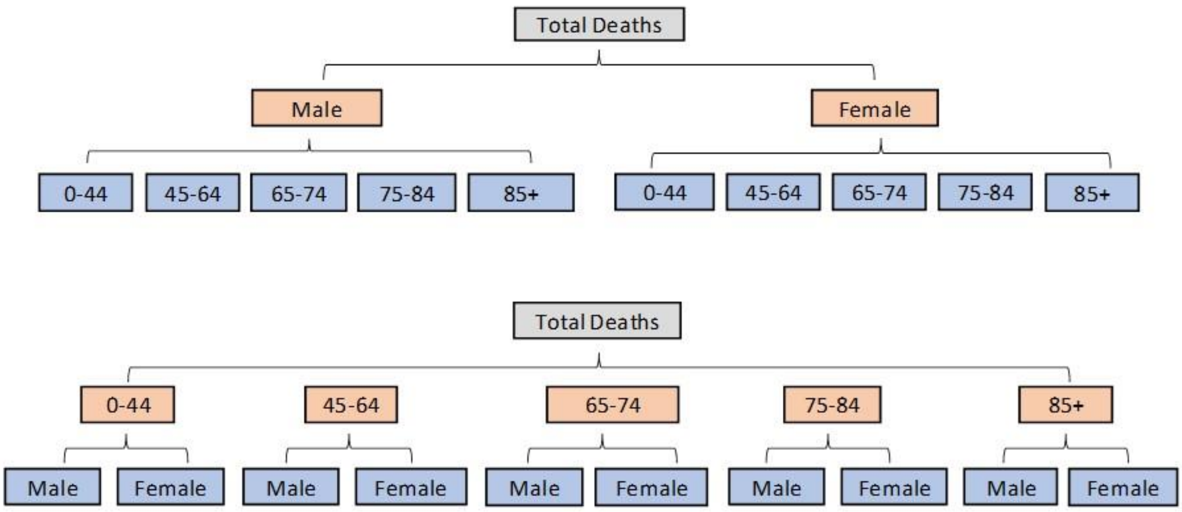
Figure 50 – Hierarchy of causes of death



For the hierarchical structure of SDRs, we need to ensure that forecast of deaths from individual causes add up to forecast of total SDR.

For the age/gender combinations, there are two hierarchies as shown in Figure 51. We perform forecast reconciliation on the two hierarchies simultaneously.

Figure 51 – Hierarchies of age/gender



The following sets out how the forecast reconciliation process is implemented for the cause of death models. A similar process is followed for the age/gender models. Following the trace minimization (MinT) reconciliation method proposed by Wickramasuriya et al. (2019), we define the following notation

- Let $y = (Total\ deaths, Cancer, Diabetes, Dementia, Flu, Pne, Lower\ Resp, Other\ Resp, Vascular, HeartDis, OtherHeart, Other, Coroner\ Ref)$ be a vector that contains observations of all series in the hierarchy.
- Let $x = (Cancer, Diabetes, Dementia, Flu, Pne, Lower\ Resp, Other\ Resp,$
- $Vascular, HeartDis, OtherHeart, Other, Coroner\ Ref)$ be a vector that contains observations at the bottom level only.

We can then link these two vectors by the equation

$y = Sx,$

where S is a summing matrix of dimension 13 (representing all series, including the overall total) ×12 (representing the bottom level only), which aggregates cause-specific death counts to the total level, and it is given by

$$S = \begin{pmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ \square & \square & \square & \square & \square & \square & \square & \square & \square & \square & \square & \square \\ \square & & \square & & \square & & \square & & & \square & & \\ \square & & \square & & \square & & \square & & & \square & & \\ \square & \square & & & I_{12} & \square & & & & & & \\ \square & \square & & & \square & \square & & & & \square & & \\ \square & & & & \square & & & & & \square & & \end{pmatrix},$$

where I_{12} denotes a 12×12 identity matrix. The aggregation constraints in the hierarchy are reflected by the first two rows of the matrix.

Let $\hat{y}_h$ be a vector of independently obtained *h*-step-ahead forecasts of all series in the hierarchy, and $\hat{b}_h$ be a vector of independently obtained *h*-step-ahead forecasts of bottom-level series only. According to Wickramasuriya et al. (2019), the MinT reconciliation methods can be expressed as

$\tilde{y}_h = SP\hat{y}_h.$

$\tilde{y}_h$ is the reconciled forecasts, and P is a matrix of dimension 12×13, and it is given by

$P = (S'W_h^{-1}S)^{-1}S'W_h^{-1},$

where W_h is a variance-covariance matrix of the *h*-step-ahead in-sample forecast errors.

As proved by Wickramasuriya et al. (2019) and the references therein, the linear reconciliation produces unbiased forecasts and leads to improved overall forecast accuracy.

C.5 Limitations

Our analysis is based on the ABS mortality statistics registered by 29 February 2024. We have made actuarial adjustments to allow for changes in population numbers and age profile and to reflect the likely emergence of more reported deaths for the period as time passes. These adjustments are quite simple. In particular:

- the same allowance for late-reported deaths was applied to each cause of death, with the exception of coroner-referred deaths which has a larger allowance. Examination of late reporting by cause of death indicates that there is no discernible difference, however for some causes of death the number of deaths is small hence variable. For each age/gender combination and state/territory, we have used the same overall allowance for late-reported deaths; and
- the same age mix adjustment was applied to each cause of death due to limitations in the available data.

Appendix D Excess deaths by Cause

This appendix includes:

- A table showing the detailed information on actual and predicted deaths for each of the four pandemic years 2020 to 2023; and
- graphs for each cause of death, showing:
    - The actual standardised death rates (SDRs)
    - The modelled SDRs (for the 2015-2019 years) and predicted SDRs (2020-2023 years)
    - The 95th percentile prediction interval for the 2020 to 2023 years.

Table 10 – Actual and Predicted deaths for 2020 to 2023 – by cause of death

	2023						2022						2021				2020			
	Non-Covid	Covid	Actual	Predicted	Excess	% Excess	Non-Covid	Covid	Actual	Predicted	Excess	% Excess	Actual	Predicted	Excess	% Excess	Actual	Predicted	Excess	% Excess
From COVID-19																				
Doctor-certified	-	4,422	4,422	-	4,422	n/a	-	9,801	9,801	-	9,801	n/a	1,230	-	1,230	n/a	855	-	855	n/a
Coroner-referred	-	208	208	-	208	n/a	-	463	463	-	463	n/a	125	-	125	n/a	51	-	51	n/a
All From COVID-19	**-**	**4,630**	**4,630**	**-**	**4,630**	n/a	**-**	**10,264**	**10,264**	**-**	**10,264**	n/a	**1,355**	**-**	**1,355**	n/a	**906**	**-**	**906**	n/a
Doctor-certified other respiratory disease																				
Influenza	401	4	405	700	(290)	-42%	283	6	289	680	(390)	-57%	2	660	(660)	-100%	43	640	(590)	-93%
Pneumonia	2,320	6	2,330	2,840	(510)	-18%	2,340	-	2,340	2,770	(430)	-15%	1,980	2,750	(780)	-28%	1,940	2,690	(750)	-28%
Lower respiratory	7,800	29	7,830	8,490	(660)	-8%	8,010	63	8,080	8,370	(290)	-3%	7,410	8,230	(820)	-10%	6,820	8,100	(1,280)	-16%
Other respiratory	3,830	17	3,840	3,850	-	0%	3,760	27	3,780	3,720	70	2%	3,630	3,640	(10)	0%	3,090	3,540	(440)	-13%
All doctor-certified respiratory	**14,350**	**56**	**14,410**	**15,880**	**(1,470)**	-9%	**14,400**	**97**	**14,490**	**15,530**	**(1,040)**	-7%	**13,020**	**15,280**	**(2,260)**	-15%	**11,890**	**14,960**	**(3,070)**	-21%
Doctor-certified other diseases																				
Cancer	51,080	384	51,470	50,770	700	1%	49,970	749	50,720	50,160	560	1%	49,790	49,680	110	0%	48,290	48,930	(640)	-1%
Ischaemic heart disease	13,190	135	13,320	12,670	660	5%	14,820	237	15,060	13,190	1,860	14%	14,130	13,310	830	6%	13,700	13,810	(110)	-1%
Other cardiac conditions	10,160	85	10,250	9,340	910	10%	10,180	171	10,350	9,350	1,000	11%	9,640	9,200	440	5%	8,640	9,120	(480)	-5%
Cerebrovascular disease	8,830	53	8,880	8,620	260	3%	9,240	130	9,370	8,890	480	5%	9,350	8,990	360	4%	9,110	9,200	(90)	-1%
Diabetes	5,400	51	5,450	4,790	660	14%	5,530	115	5,650	4,810	840	17%	5,080	4,720	360	8%	4,990	4,660	330	7%
Dementia	16,830	230	17,060	18,720	(1,670)	-9%	17,180	559	17,740	17,860	(120)	-1%	16,520	17,070	(550)	-3%	15,300	16,280	(980)	-6%
Other unspecified diseases	35,210	344	35,560	33,260	2,300	7%	35,040	600	35,640	32,280	3,360	10%	32,740	30,380	2,360	8%	29,710	29,820	(120)	0%
All other doctor-certified disease	**140,700**	**1,282**	**141,980**	**138,170**	**3,810**	3%	**141,970**	**2,561**	**144,530**	**136,540**	**7,990**	6%	**137,240**	**133,340**	**3,900**	3%	**129,740**	**131,820**	**(2,080)**	-2%
Coroner-referred excl. From COVID-19	**22,520**	**139**	**22,660**	**21,230**	**1,430**	7%	**22,540**	**327**	**22,870**	**20,820**	**2,050**	10%	**21,060**	**20,320**	**740**	4%	**20,130**	**20,280**	**(140)**	-1%
Total	**177,600**	**6,108**	**183,700**	**175,300**	**8,400**	5%	**178,900**	**13,248**	**192,200**	**172,900**	**19,300**	11%	**172,700**	**168,900**	**3,800**	2%	**162,700**	**167,000**	**(4,300)**	-3%

* Figures shaded green indicate that the observed values are below the 95% prediction interval while figures shaded red are above the 95% prediction interval. COVID-19 data from ABS customised report 2023 and analysis

Figure 52 – Deaths from all causes

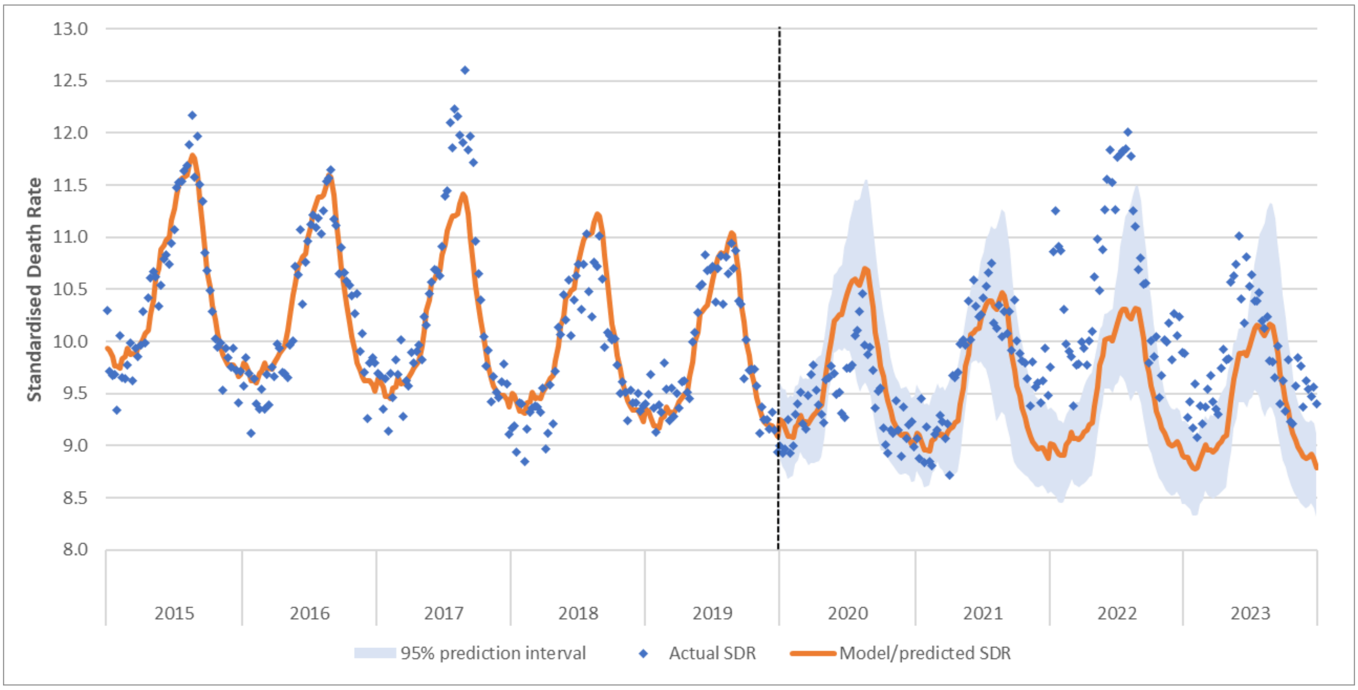


Figure 53 – Doctor-certified influenza deaths

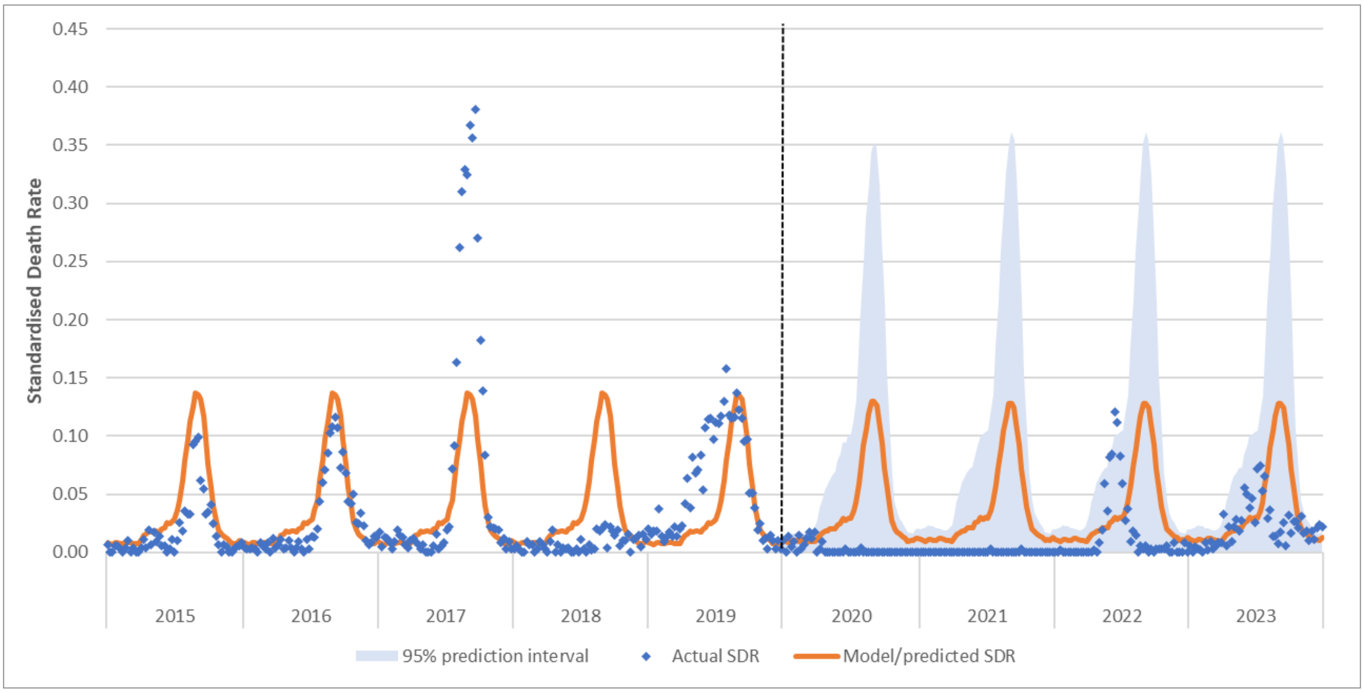


Figure 54 – Doctor-certified pneumonia deaths

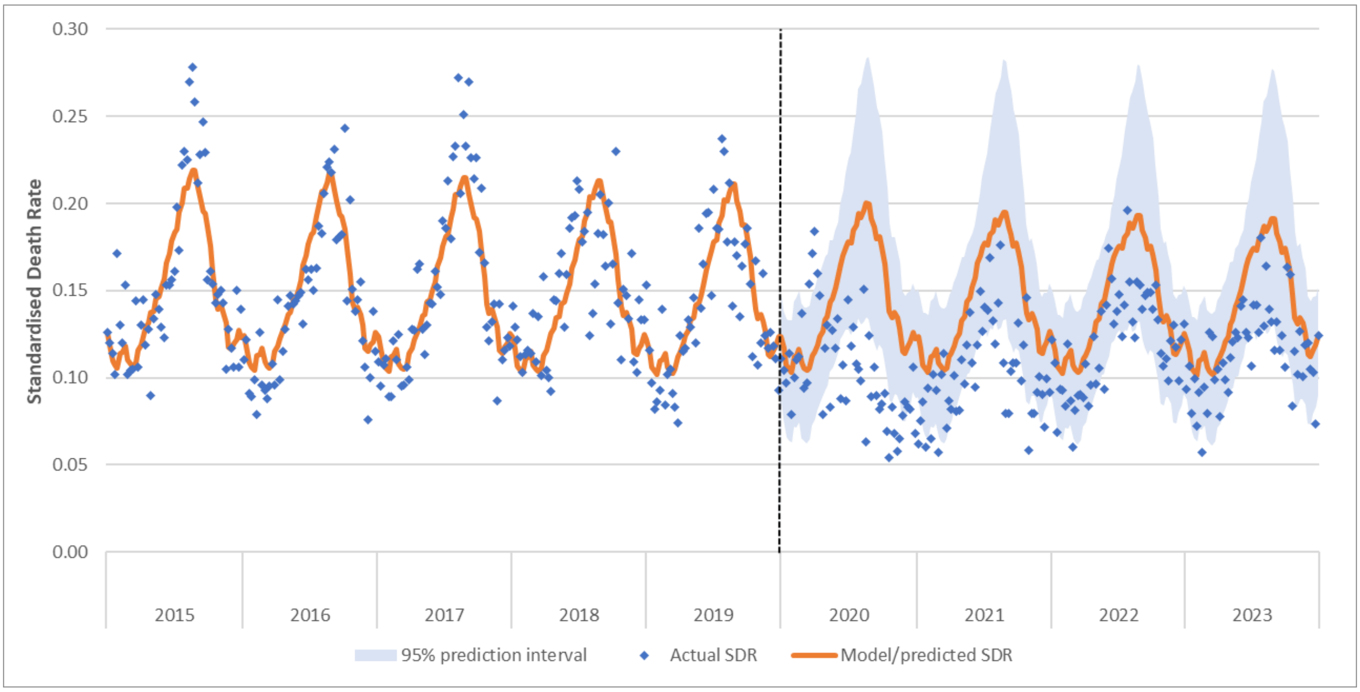


Figure 55 – Doctor-certified lower respiratory disease deaths

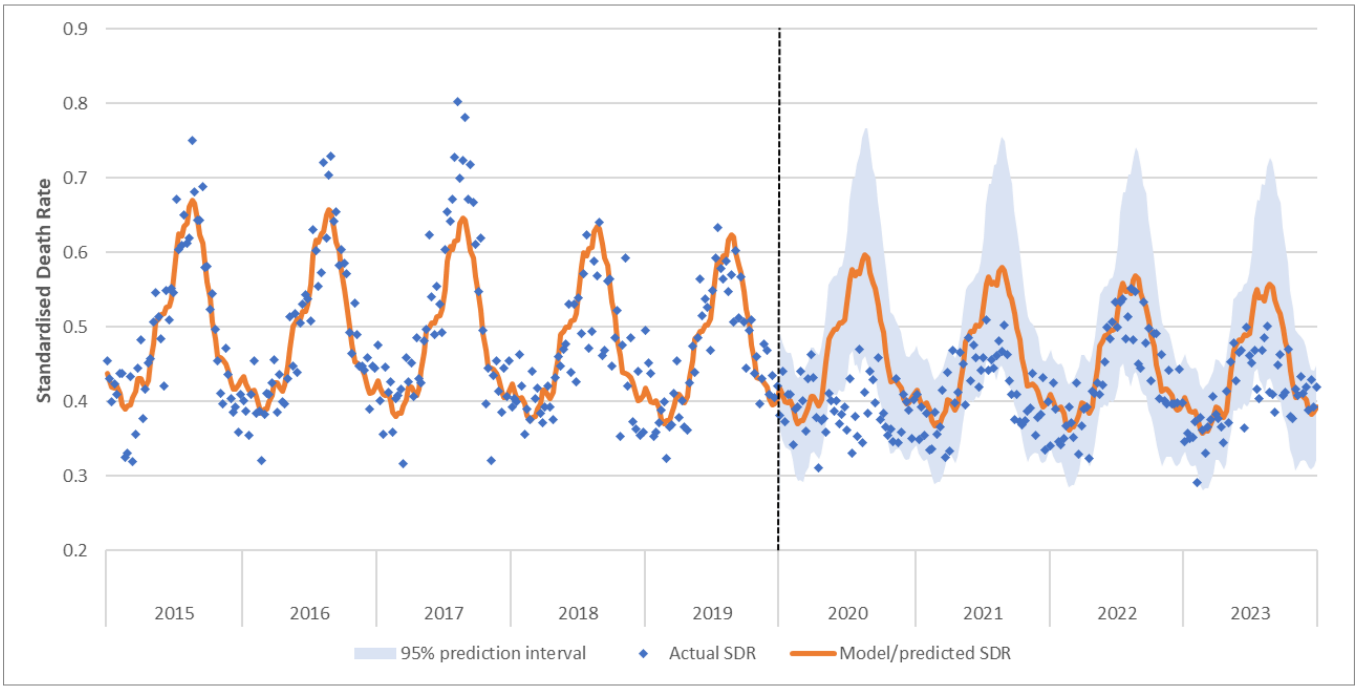


Figure 56 – Doctor-certified deaths from other respiratory diseases

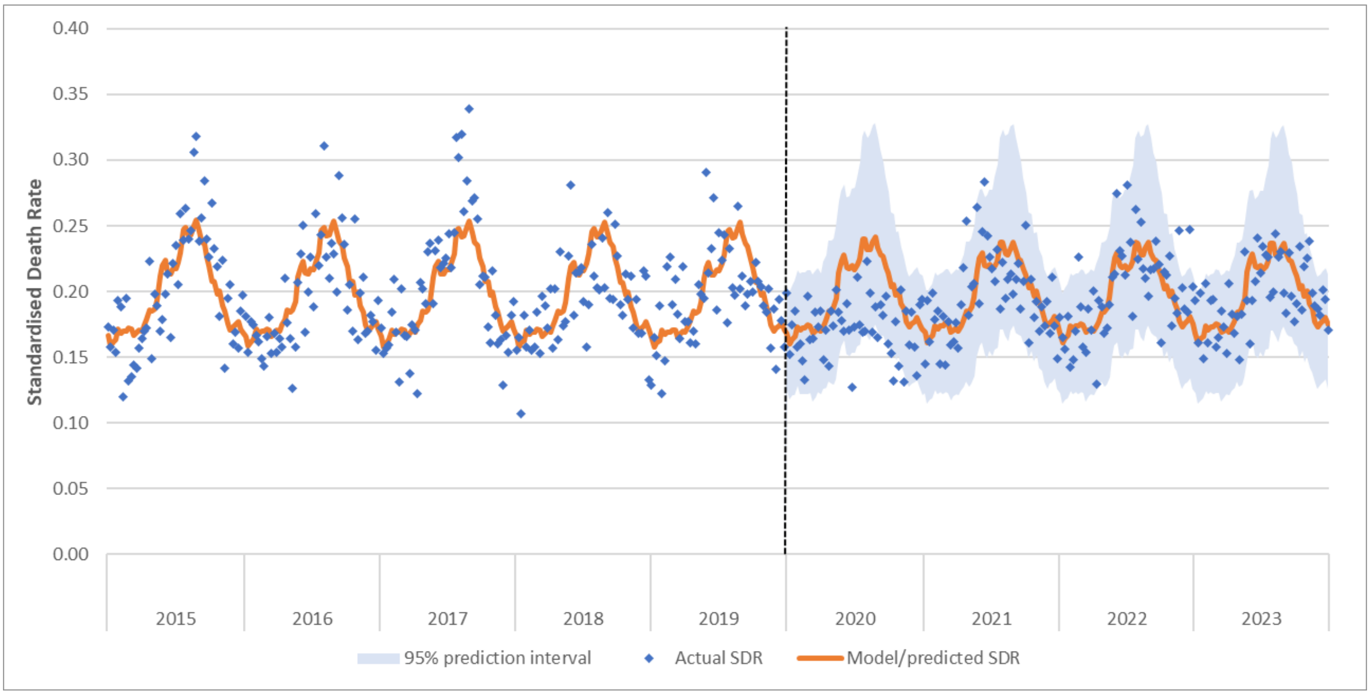


Figure 57 – Doctor-certified cancer deaths

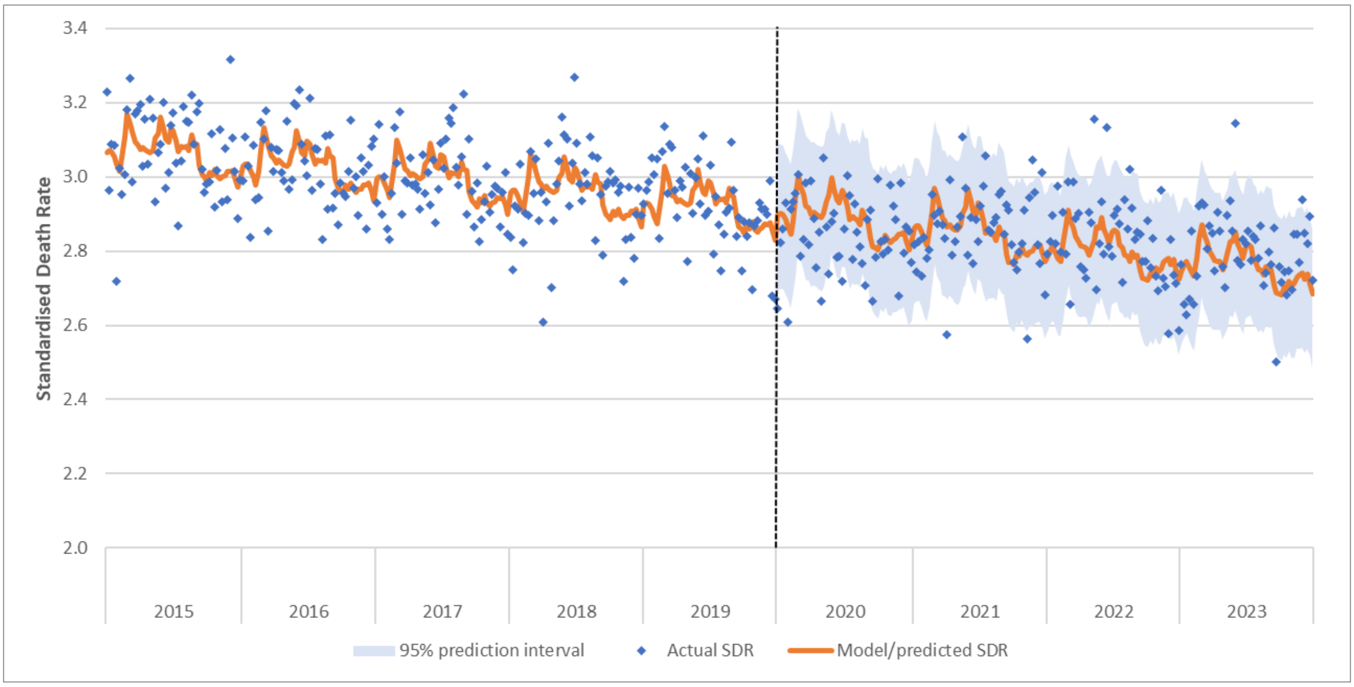


Figure 58 – Doctor-certified deaths from ischaemic heart disease

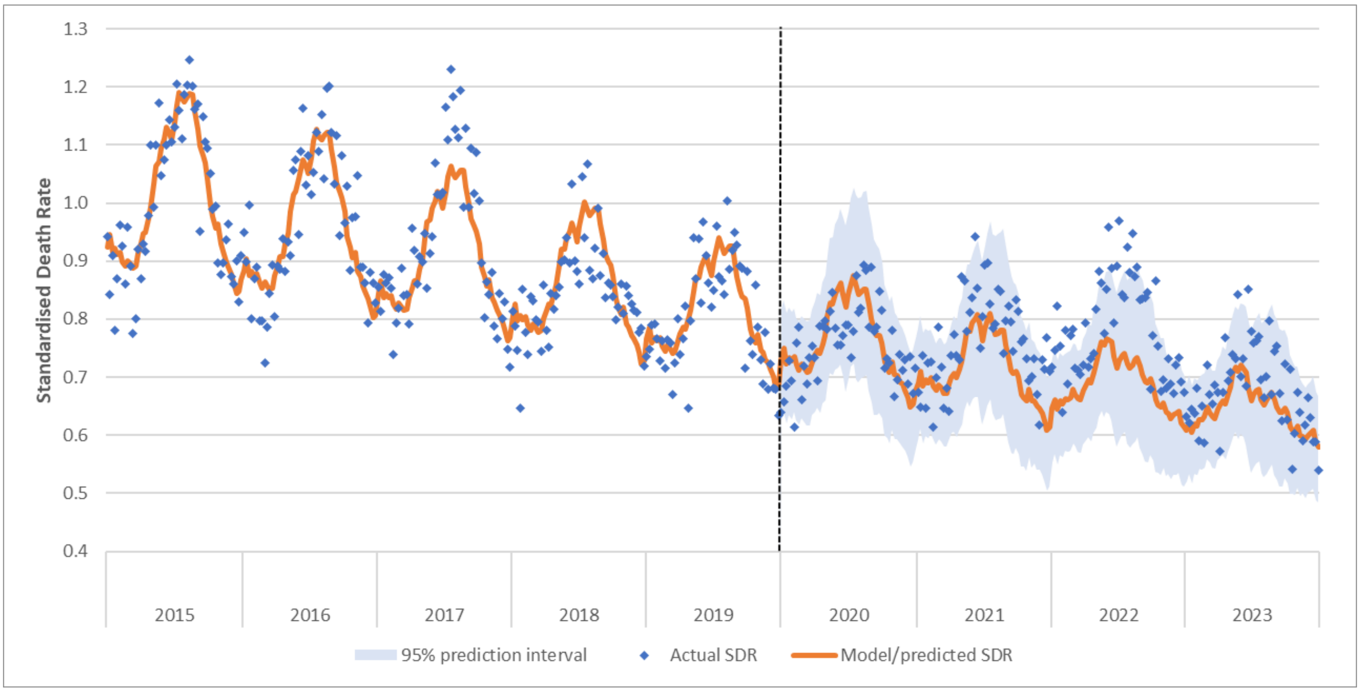


Figure 59 – Doctor-certified deaths from other cardiac conditions

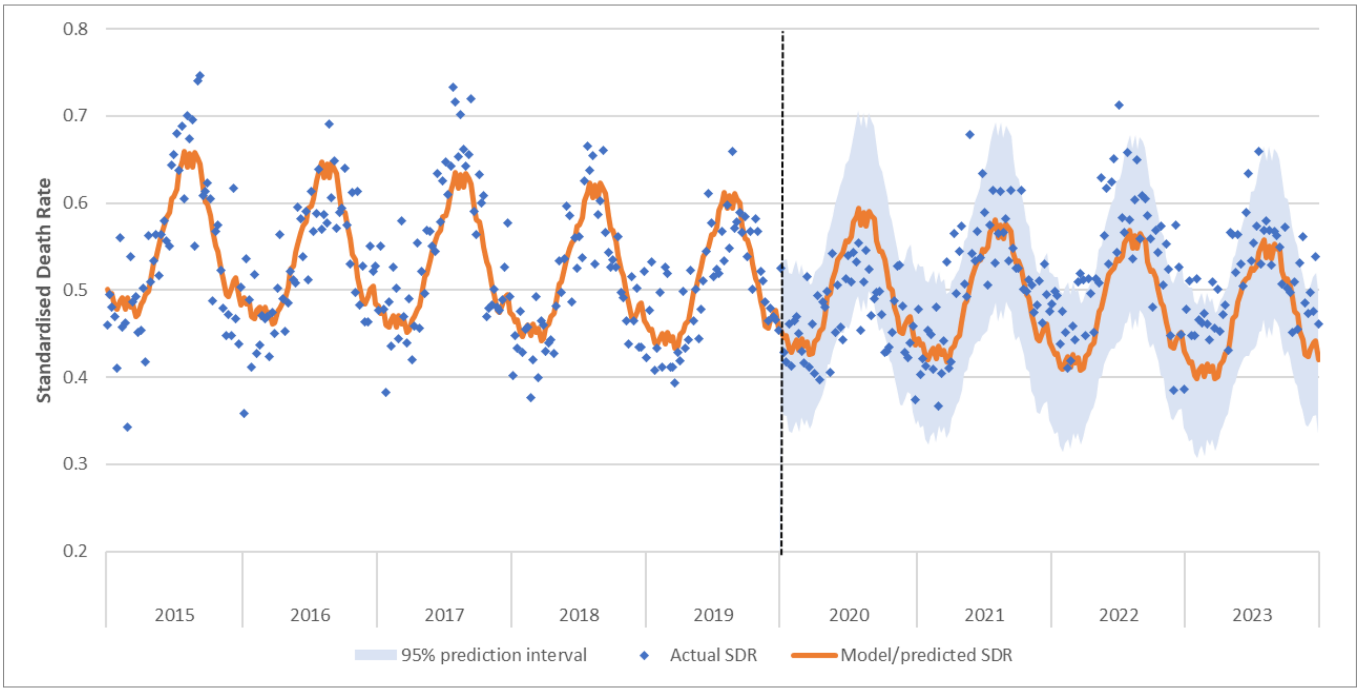


Figure 60 – Doctor-certified deaths from cerebrovascular disease (stroke, etc)

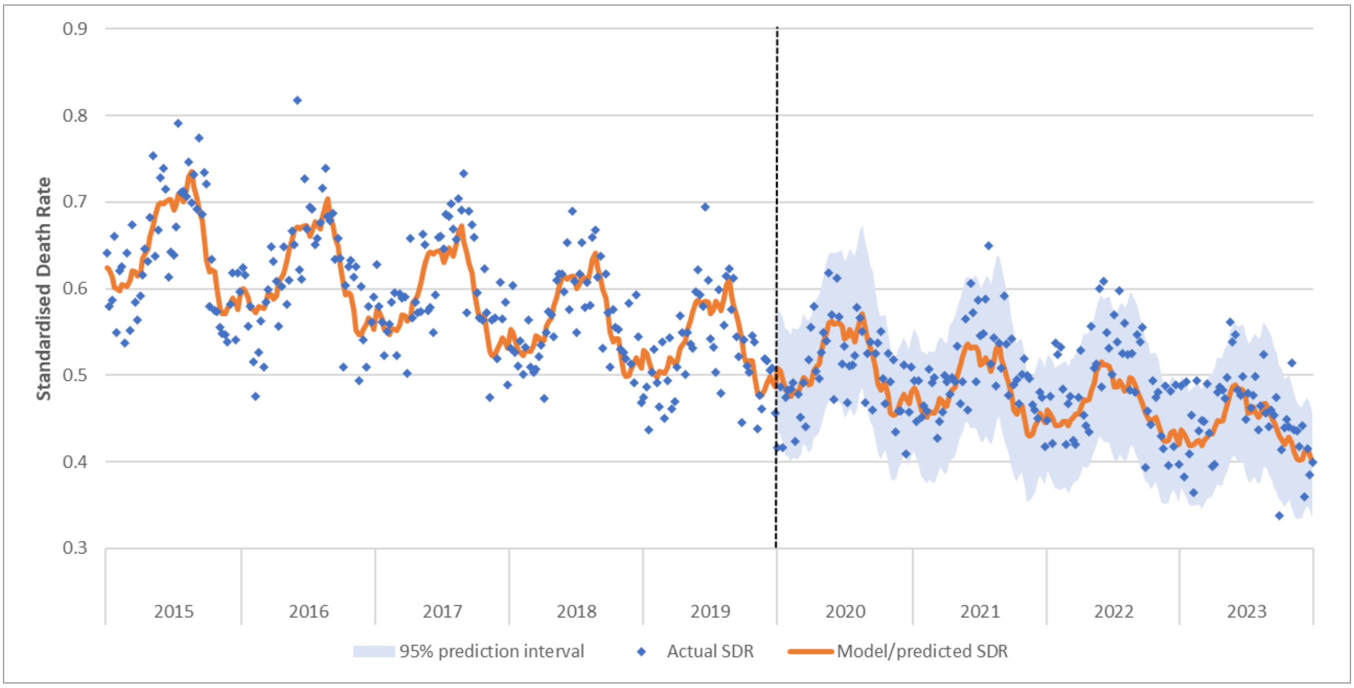


Figure 61 – Doctor-certified diabetes deaths

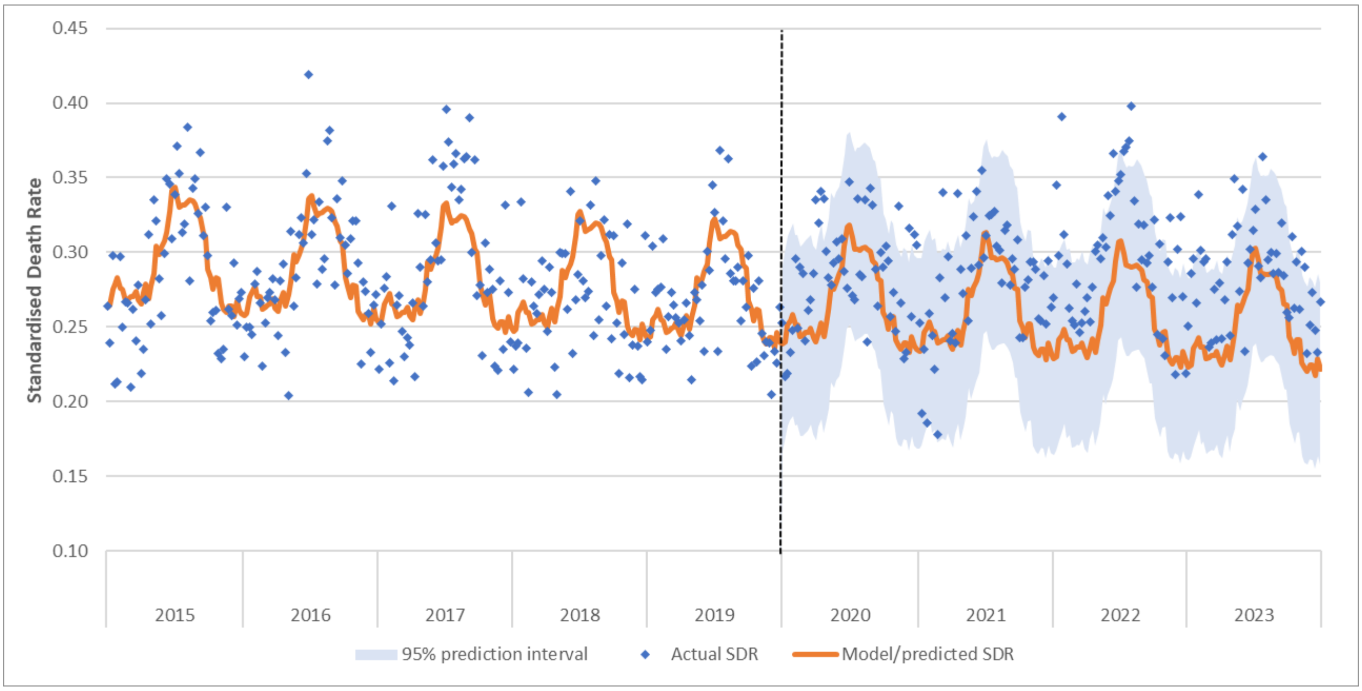


Figure 62 – Doctor-certified dementia deaths

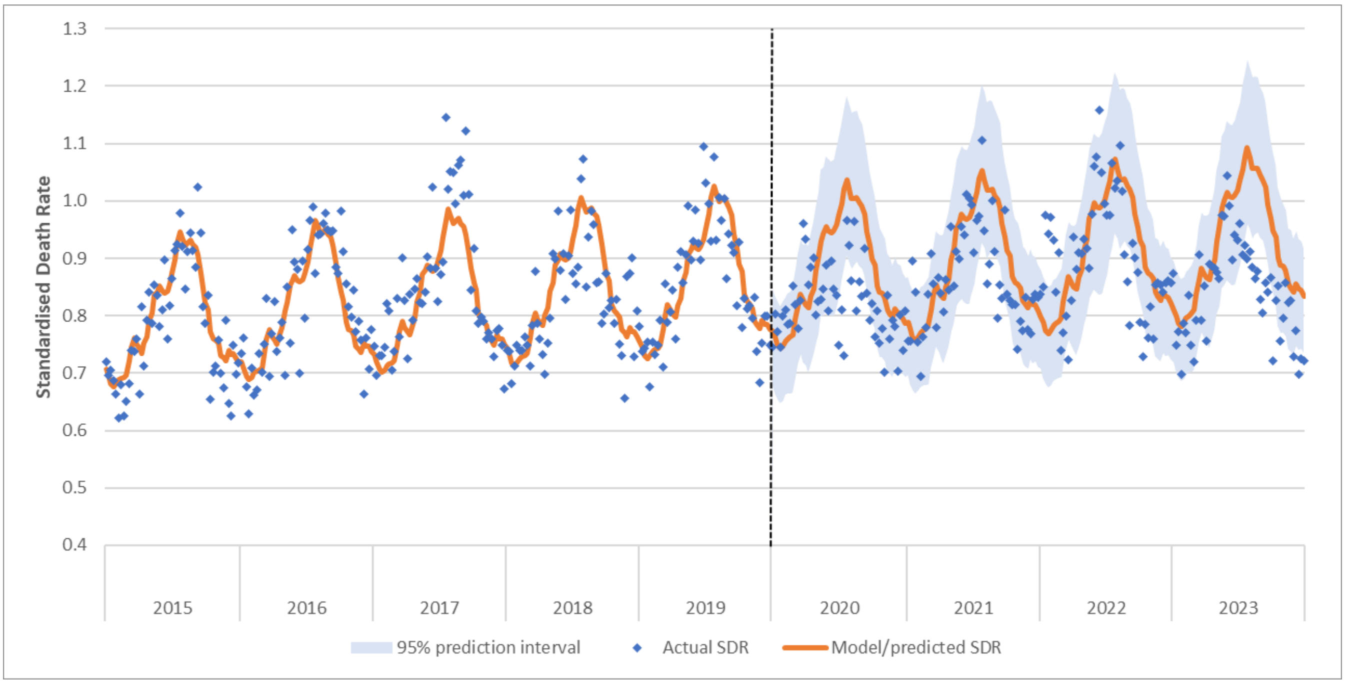


Figure 63 – Doctor-certified deaths from other causes, not explicitly identified in the ABS report

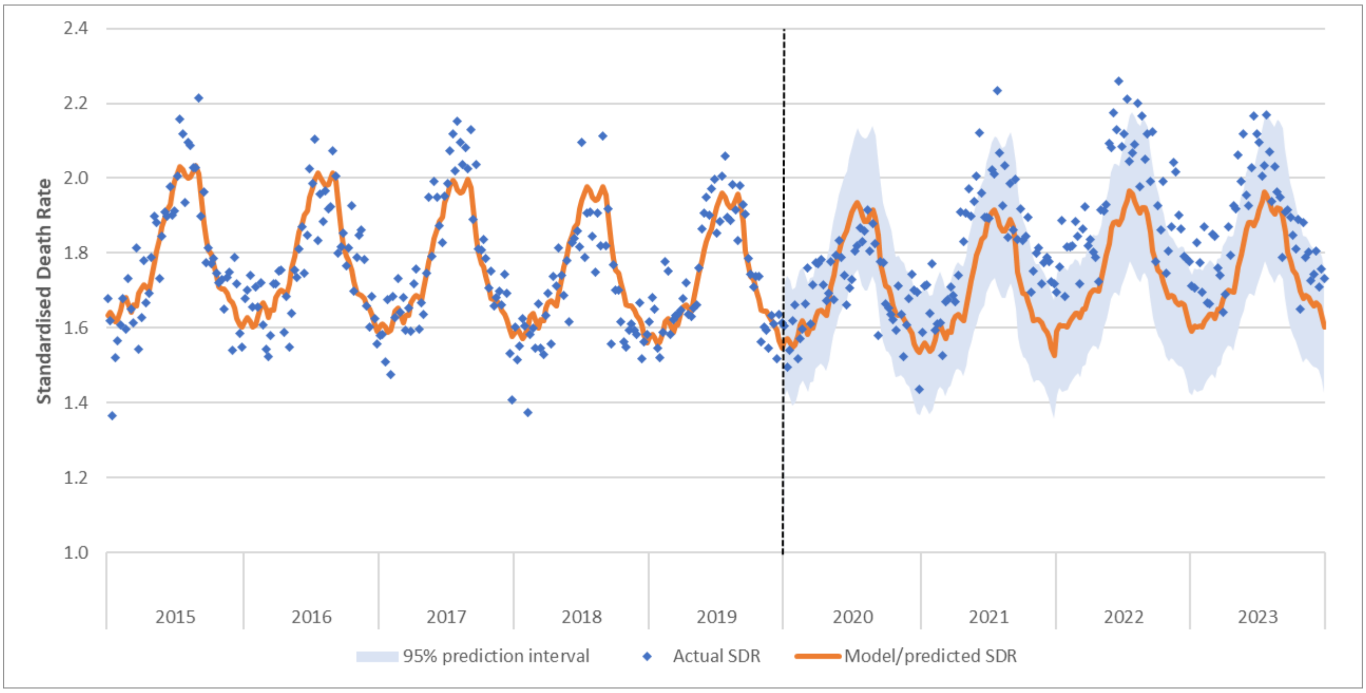
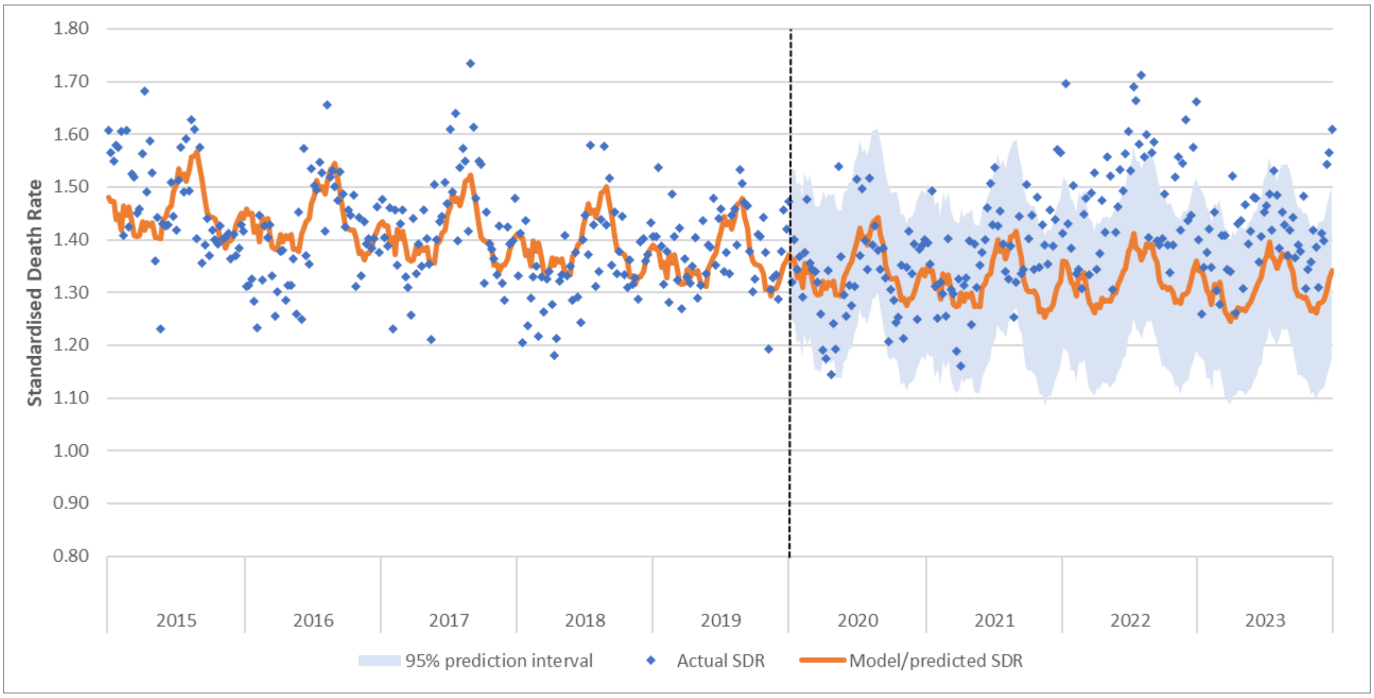


Figure 64 – Coroner-referred deaths from all causes



Appendix E Excess deaths by Gender and Age Band

This appendix includes:

- A table showing the detailed information on actual and predicted deaths for each of the four pandemic years 2020 to 2023 by age band and gender; and
- graphs for each age band and gender combination, showing:
    - The actual scaled deaths (scaled to reflect the 2023 population size and age mix)
    - The modelled scaled deaths (for the 2015-2019 years) and predicted scaled deaths (2020-2023 years)
    - The 95th percentile prediction interval for the 2020 to 2023 years.

Table 11 – Actual and Predicted deaths for 2020 to 2023 – by age band and gender

Age Band and Gender	2023 (52 weeks)						2022 (52 weeks)						2021 (52 weeks)						2020 (53 weeks)					
	Actual	Predicted	Excess	% Excess	COVID-19	% Net	Actual	Predicted	Excess	% Excess	COVID-19	% Net	Actual	Predicted	Excess	% Excess	COVID-19	% Net	Actual	Predicted	Excess	% Excess	COVID-19	% Net
Males, 0-44	5,050	5,250	-200	-4%	25	-4%	5,220	5,120	100	2%	138	-1%	5,010	5,090	-80	-2%	26	-2%	5,160	5,280	-120	-2%	2	-2%
Males, 45-64	13,420	13,250	170	1%	169	0%	14,010	13,280	730	5%	511	2%	13,220	13,300	-80	-1%	143	-2%	13,200	13,560	-360	-3%	23	-3%
Males, 65-74	17,160	15,810	1,350	9%	451	6%	17,970	15,970	2,000	13%	1,070	6%	16,610	16,230	380	2%	185	1%	16,290	16,500	-210	-1%	60	-2%
Males, 75-84	28,540	25,850	2,690	10%	1,007	6%	29,320	25,350	3,970	16%	2,255	7%	25,620	24,610	1,010	4%	248	3%	24,010	24,590	-580	-2%	132	-3%
Males, 85 and over	31,810	29,840	1,970	7%	1,515	2%	33,790	29,250	4,540	16%	3,339	4%	29,520	28,790	730	3%	215	2%	27,700	28,540	-840	-3%	224	-4%
Males, All ages	**96,000**	**90,000**	**6,000**	**7%**	**3,167**	**3%**	**100,300**	**89,000**	**11,300**	**13%**	**7,313**	**5%**	**90,000**	**88,000**	**2,000**	**2%**	**817**	**1%**	**86,400**	**88,500**	**-2,100**	**-2%**	**441**	**-3%**
Females, 0-44	2,810	2,640	170	6%	20	6%	2,870	2,610	260	10%	86	6%	2,730	2,630	100	4%	16	3%	2,750	2,740	10	0%	0	0%
Females, 45-64	8,390	8,110	280	3%	113	2%	8,800	8,140	660	8%	331	4%	8,120	8,170	-50	-1%	77	-2%	8,230	8,370	-140	-2%	14	-2%
Females, 65-74	11,290	10,690	600	6%	246	3%	11,660	10,680	980	9%	587	4%	11,020	10,760	260	2%	106	1%	10,430	10,840	-410	-4%	27	-4%
Females, 75-84	22,220	19,980	2,240	11%	721	8%	22,330	19,600	2,730	14%	1,383	7%	19,810	19,070	740	4%	144	3%	18,770	19,180	-410	-2%	118	-3%
Females, 85 and over	42,460	39,020	3,440	9%	1,676	5%	45,720	39,180	6,540	17%	3,615	7%	40,690	39,290	1,400	4%	220	3%	38,250	39,630	-1,380	-3%	307	-4%
Females, All ages	**87,200**	**80,400**	**6,700**	**8%**	**2,776**	**5%**	**91,400**	**80,200**	**11,200**	**14%**	**6,002**	**6%**	**82,400**	**79,900**	**2,400**	**3%**	**563**	**2%**	**78,400**	**80,800**	**-2,300**	**-3%**	**466**	**-3%**
Person, 0-44	7,860	7,880	-20	0%	45	-1%	8,090	7,730	360	5%	224	2%	7,750	7,720	30	0%	42	0%	7,910	8,020	-110	-1%	2	-1%
Person, 45-64	21,800	21,370	430	2%	282	1%	22,810	21,420	1,390	7%	842	3%	21,340	21,470	-130	-1%	220	-2%	21,430	21,940	-510	-2%	37	-2%
Person, 65-74	28,460	26,500	1,960	7%	697	5%	29,630	26,650	2,980	11%	1,657	5%	27,630	26,990	640	2%	291	1%	26,720	27,340	-620	-2%	87	-3%
Person, 75-84	50,750	45,840	4,910	11%	1,728	7%	51,660	44,950	6,710	15%	3,638	7%	45,430	43,670	1,760	4%	392	3%	42,780	43,760	-980	-2%	250	-3%
Person, 85 and over	74,270	68,860	5,410	8%	3,191	3%	79,510	68,430	11,080	16%	6,954	6%	70,200	68,080	2,120	3%	435	2%	65,940	68,170	-2,230	-3%	531	-4%
Person, All ages	**183,100**	**170,400**	**12,700**	**7%**	**5,943**	**4%**	**191,700**	**169,200**	**22,500**	**13%**	**13,315**	**5%**	**172,400**	**167,900**	**4,400**	**3%**	**1,380**	**2%**	**164,800**	**169,200**	**-4,500**	**-3%**	**907**	**-3%**

* Figures shaded green indicate that the observed values are below the 95% prediction interval while figures shaded red are above the 95% prediction interval. COVID-19 data from ABS customised report 2023 and analysis

E.1 Deaths for Males by Age Band

Figure 65 – Deaths of males aged 0-44

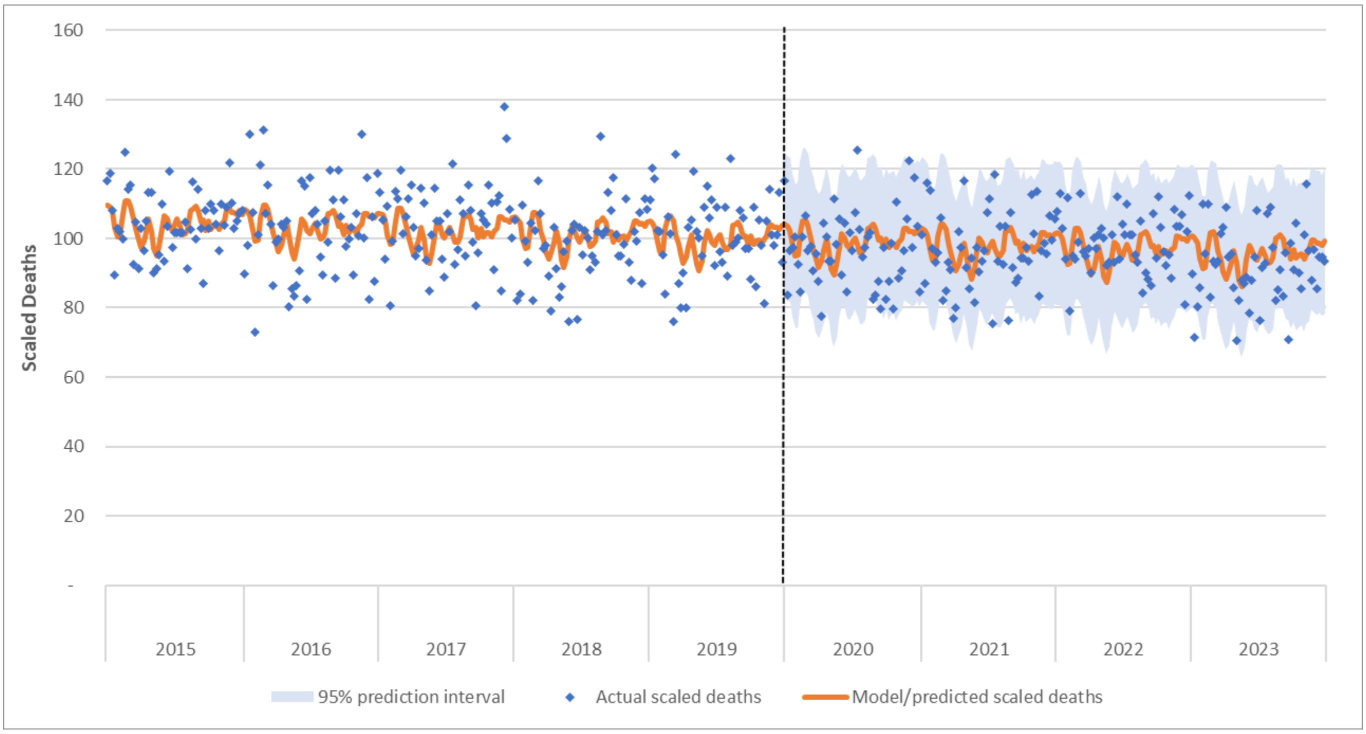


Figure 66 – Deaths of males aged 45-64

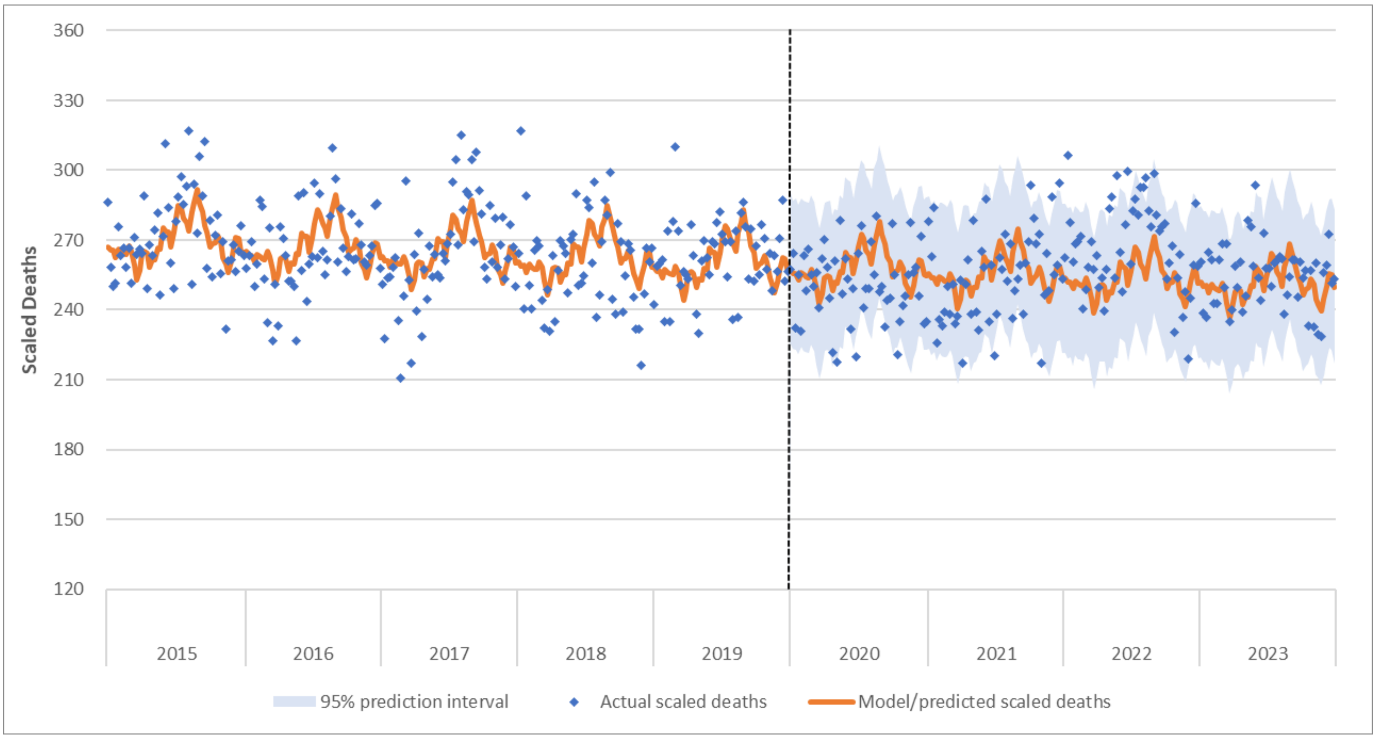


Figure 67 – Deaths of males aged 65-74

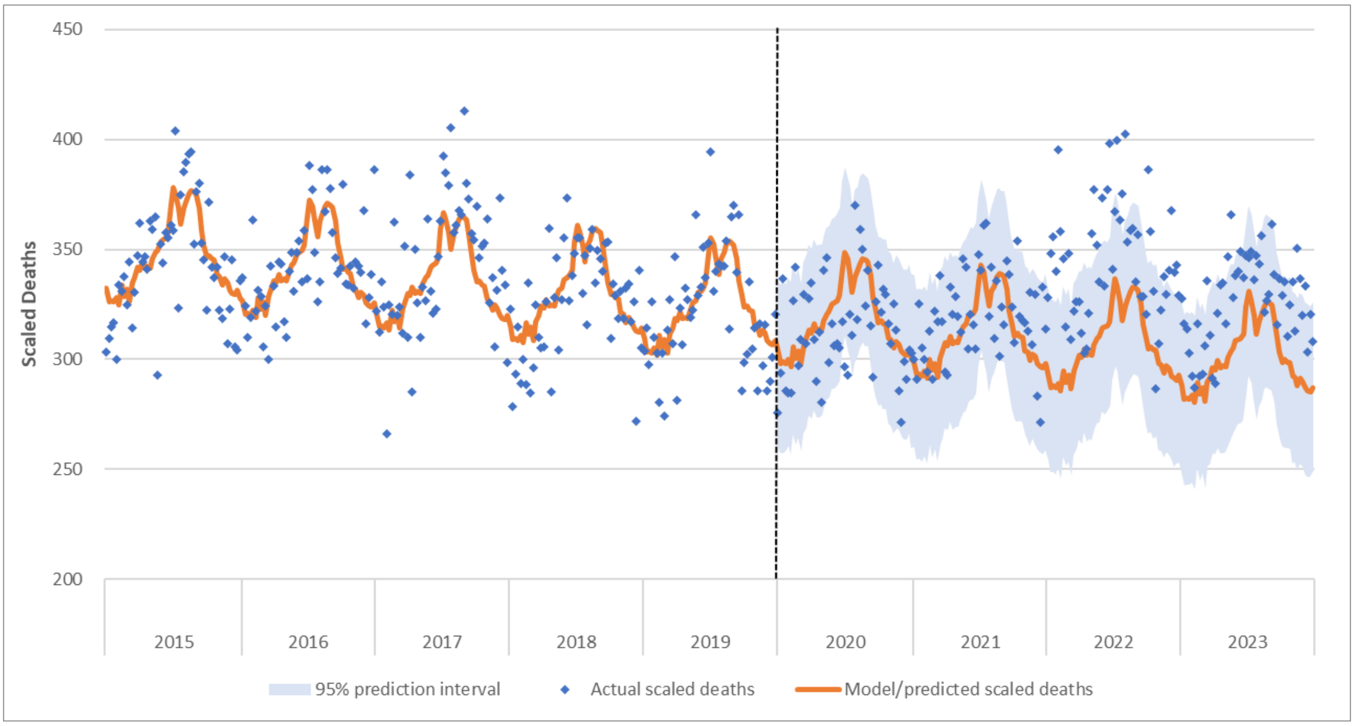


Figure 68 – Deaths of males aged 75-84

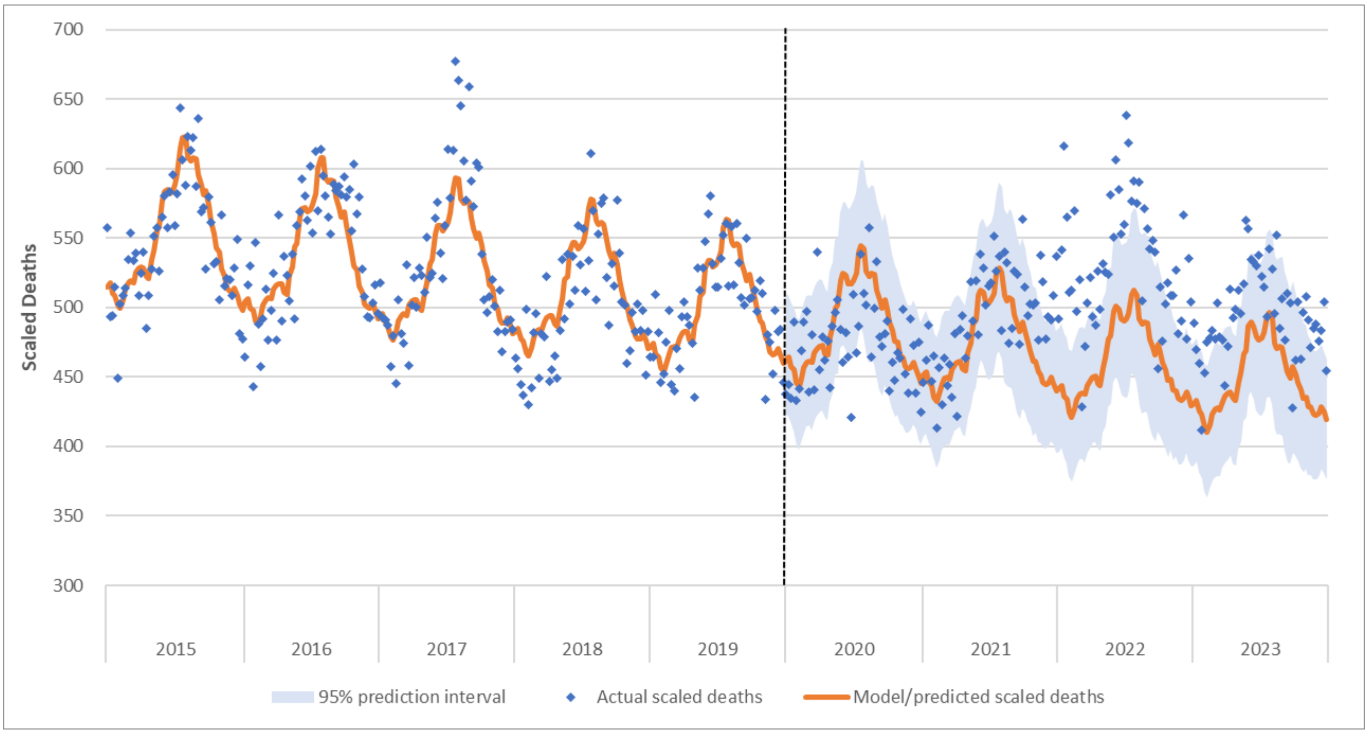


Figure 69 – Deaths of males aged 85+

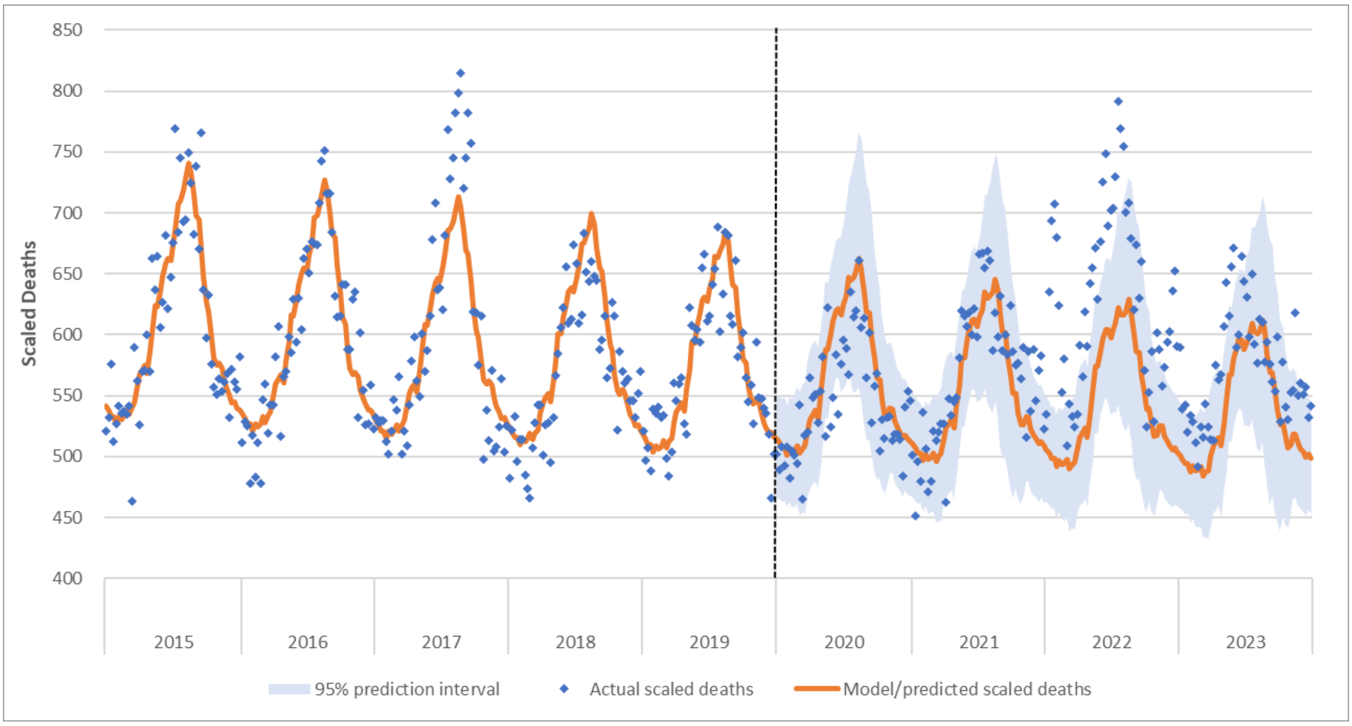
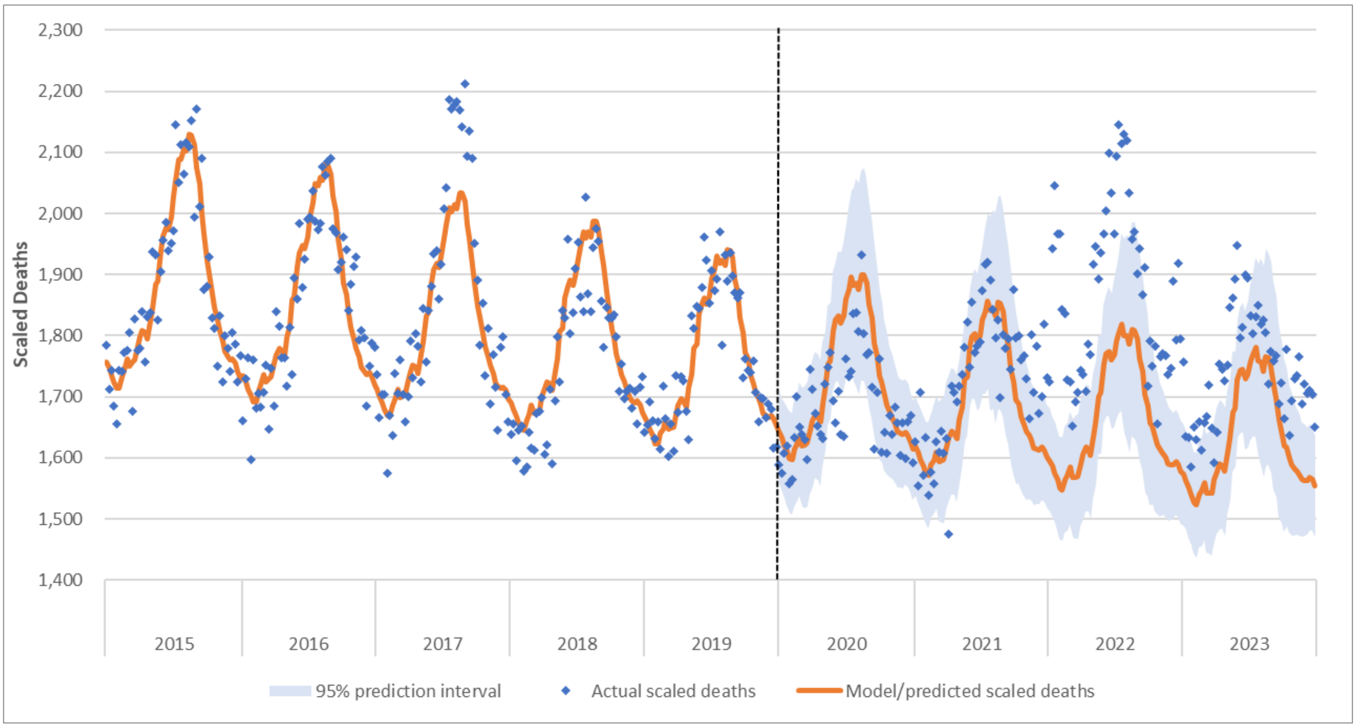


Figure 70 – Deaths of all males



E.2 Deaths for Females by Age Band

Figure 71 – Deaths of females aged 0-44

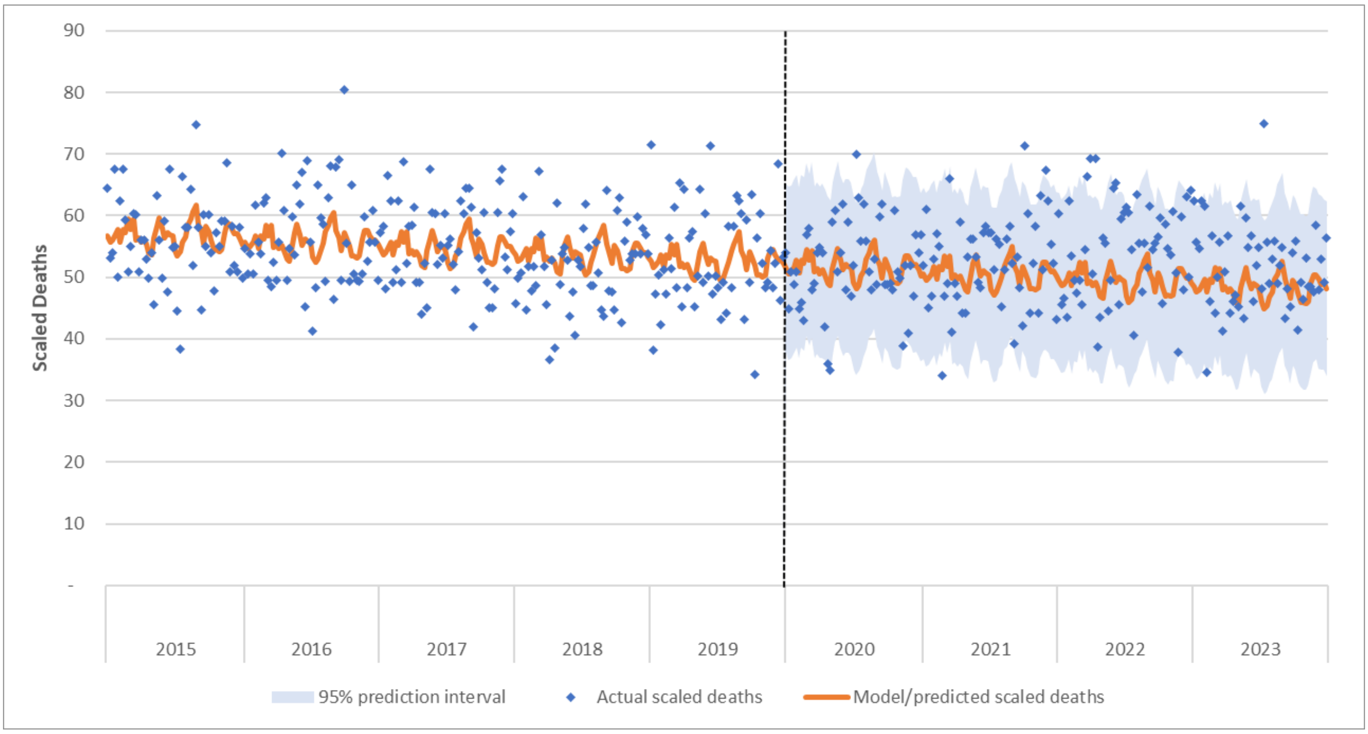


Figure 72 – Deaths of females aged 45-64

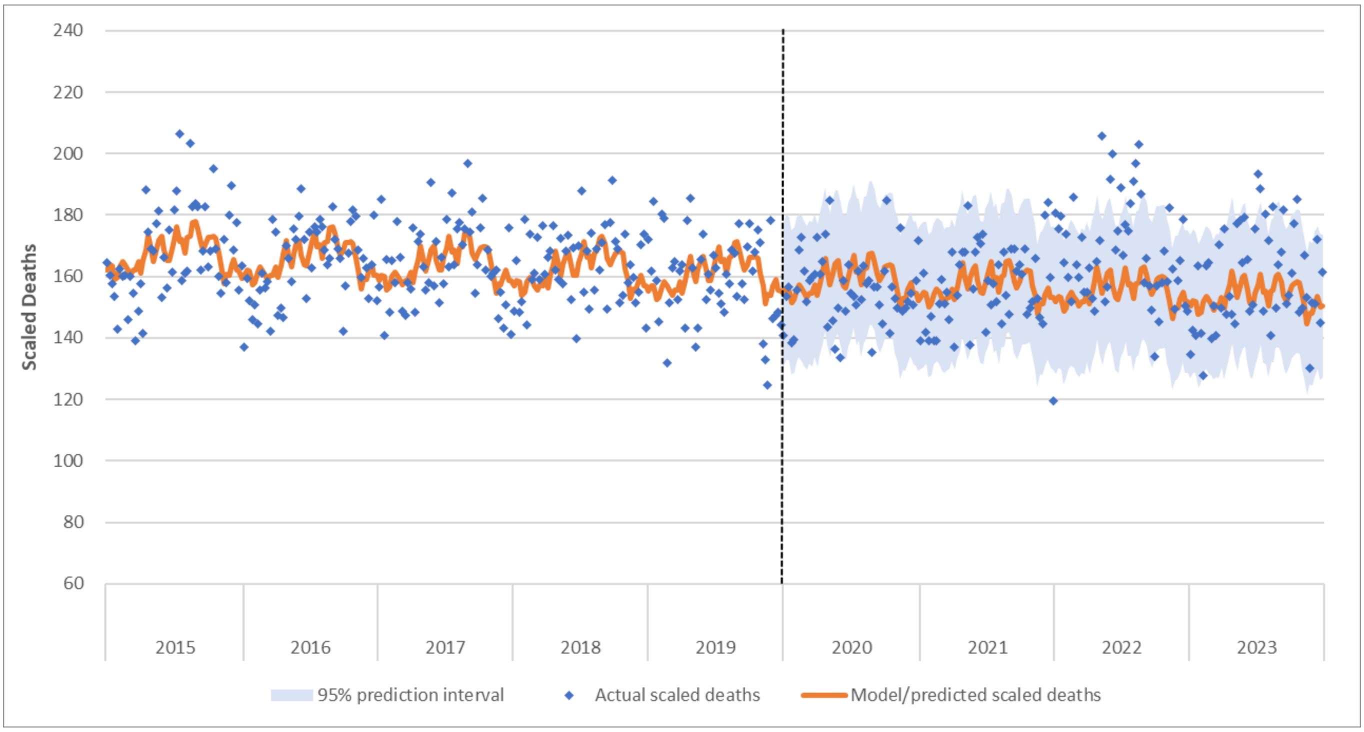


Figure 73 – Deaths of females aged 65-74

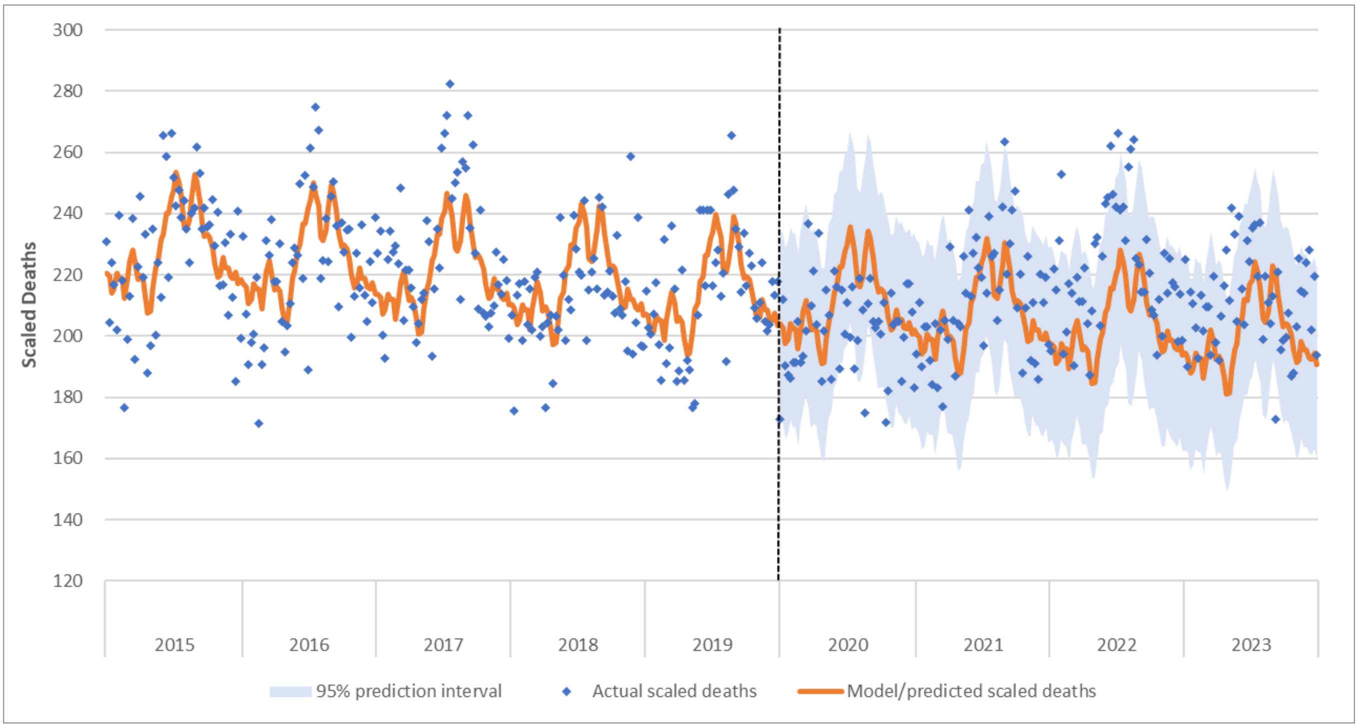


Figure 74 – Deaths of females aged 75-84

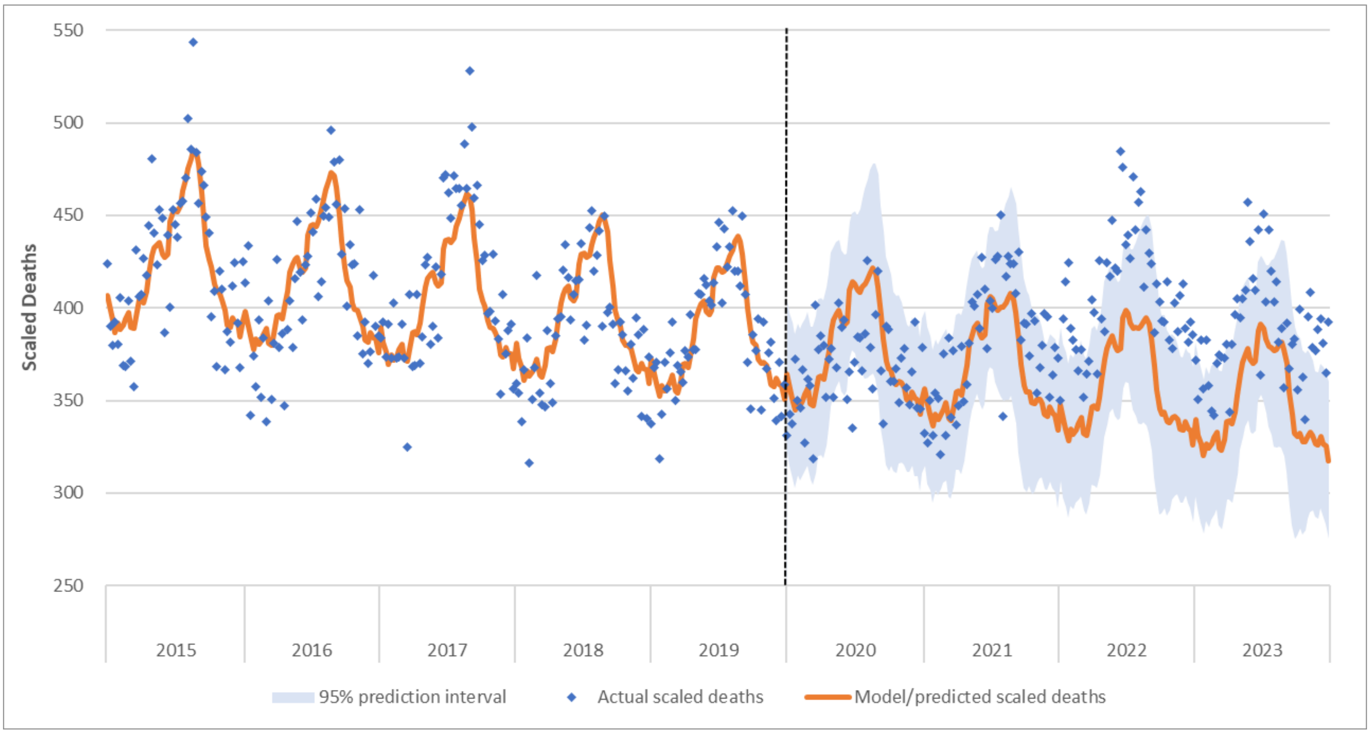


Figure 75 – Deaths of females aged 85+

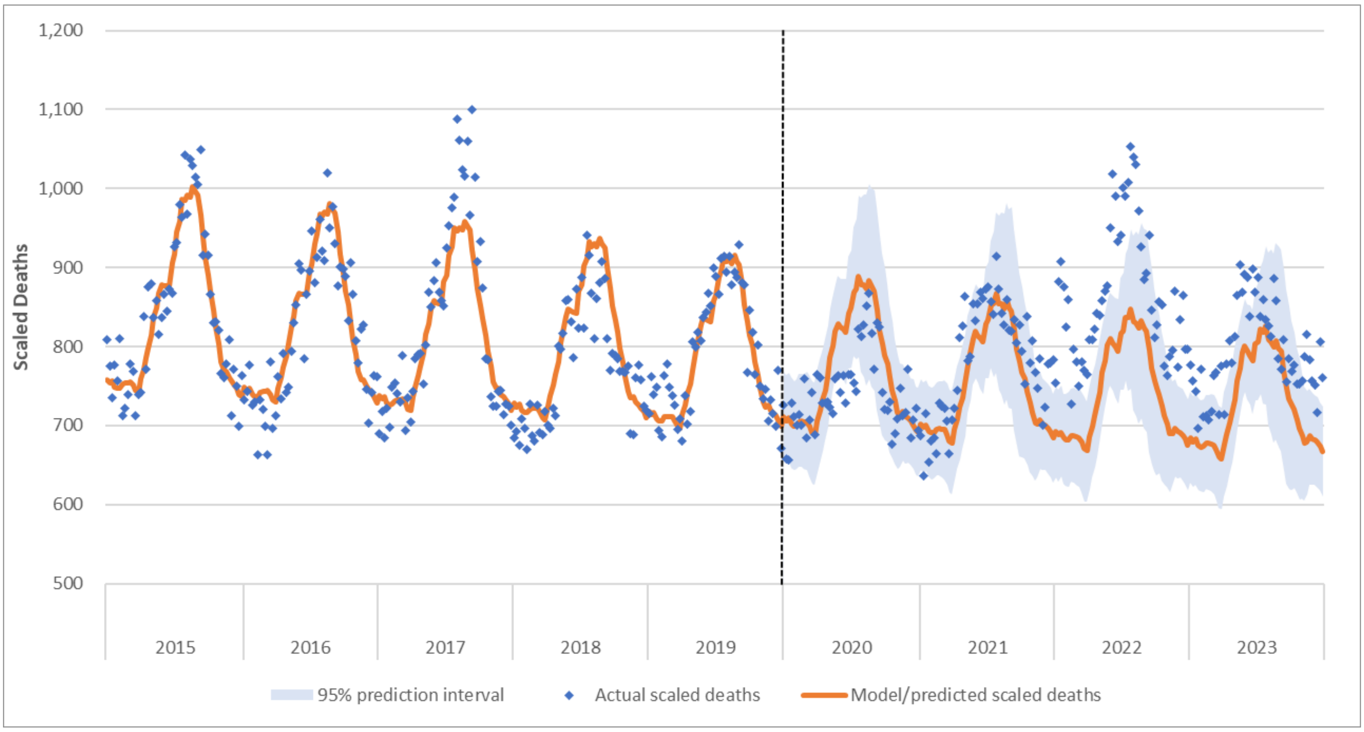
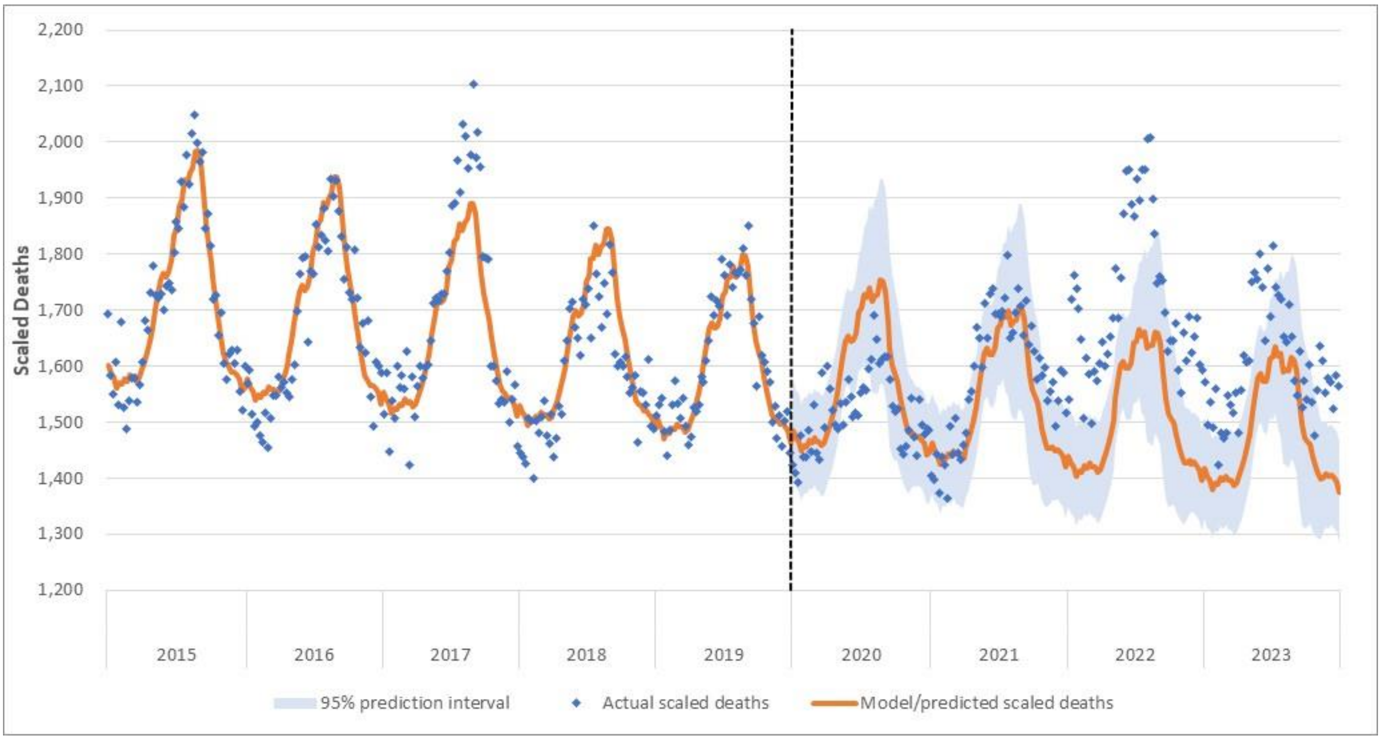


Figure 76 – Deaths of all females



Appendix F Excess deaths by State/Territory

This appendix includes:

- A table showing the detailed information on actual and predicted deaths for each of the four pandemic years 2020 to 2023 by state/territory; and
- graphs for each state/territory combination, showing:
    - The actual deaths
    - The modelled deaths (for the 2015-2019 years) and predicted deaths (2020-2023 years), taken from the ABS publication on excess mortality to the end of December 2023
    - The 95th percentile prediction interval for the 2020 to 2023 years.

Table 12 – Actual and Predicted deaths for 2020 to 2023 – by state/territory

State/Territory	2023 (52 weeks)						2022 (52 weeks)						2021 (52 weeks)						2020 (53 weeks)					
	Actual	Predicted	Excess	%Excess	Covid-19	%Net	Actual	Predicted	Excess	%Excess	Covid-19	%Net	Actual	Predicted	Excess	%Excess	Covid-19	%Net	Actual	Predicted	Excess	%Excess	Covid-19	%Net
NSW	58,600	56,300	2,300	4%	2,078	0%	62,500	55,800	6,700	12%	4,833	3%	55,600	55,400	200	0%	642	-1%	53,600	55,900	-2,300	-4%	63	-4%
Victoria	45,000	42,000	3,000	7%	1,336	4%	47,700	41,600	6,100	14%	3,464	6%	43,000	41,400	1,600	4%	718	2%	41,600	42,000	-400	-1%	806	-3%
Queensland	37,500	35,600	1,900	5%	1,116	2%	38,600	34,800	3,800	11%	2,345	4%	34,300	34,000	300	1%	4	1%	32,300	33,800	-1,500	-4%	4	-4%
South Australia	15,400	14,600	800	6%	475	2%	16,000	14,500	1,500	10%	1,062	3%	14,400	14,300	100	0%	4	0%	14,000	14,400	-400	-3%	3	-3%
Western Australia	17,600	16,600	1,000	6%	633	2%	17,500	16,300	1,200	8%	971	2%	16,100	15,900	200	1%	0	1%	15,300	15,900	-600	-4%	11	-4%
Tasmania	5,100	4,600	500	11%	187	7%	5,100	4,700	400	10%	342	3%	4,800	4,700	100	3%	0	3%	4,500	4,700	-200	-5%	17	-6%
Northern Territory	1,220	1,150	70	6%	25	4%	1,350	1,130	220	20%	91	12%	1,200	1,120	80	7%	2	7%	1,160	1,140	20	2%	0	2%
ACT	2,750	2,690	60	2%	93	-1%	2,900	2,600	300	11%	207	3%	2,500	2,600	-100	-4%	12	-4%	2,400	2,500	-100	-4%	2	-4%
Australia	**183,200**	**173,700**	**9,600**	**6%**	**5,900**	**2%**	**191,600**	**171,400**	**20,200**	**12%**	**13,123**	**4%**	**171,800**	**169,400**	**2,400**	**1%**	**1,374**	**1%**	**164,800**	**170,400**	**-5,600**	**-3%**	**907**	**-4%**

Figure 77 – Deaths NSW

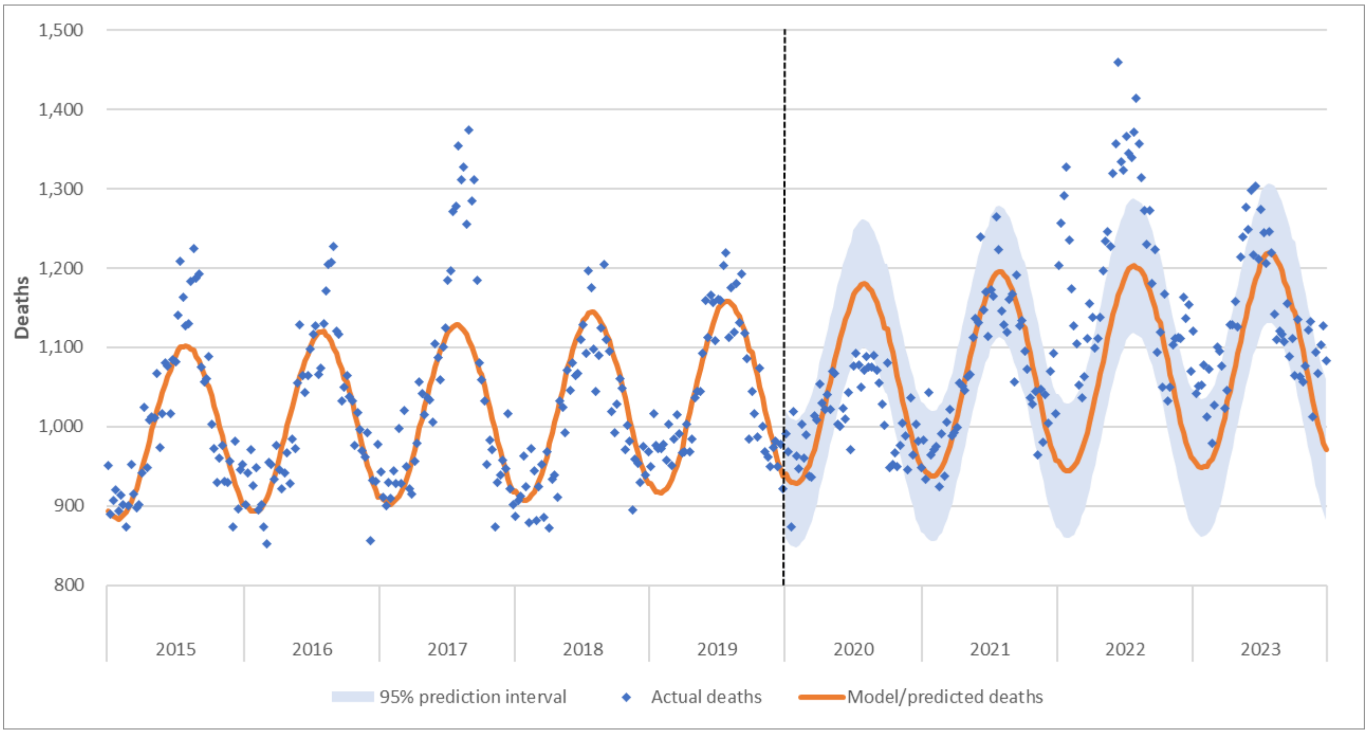


Figure 78 – Deaths Victoria

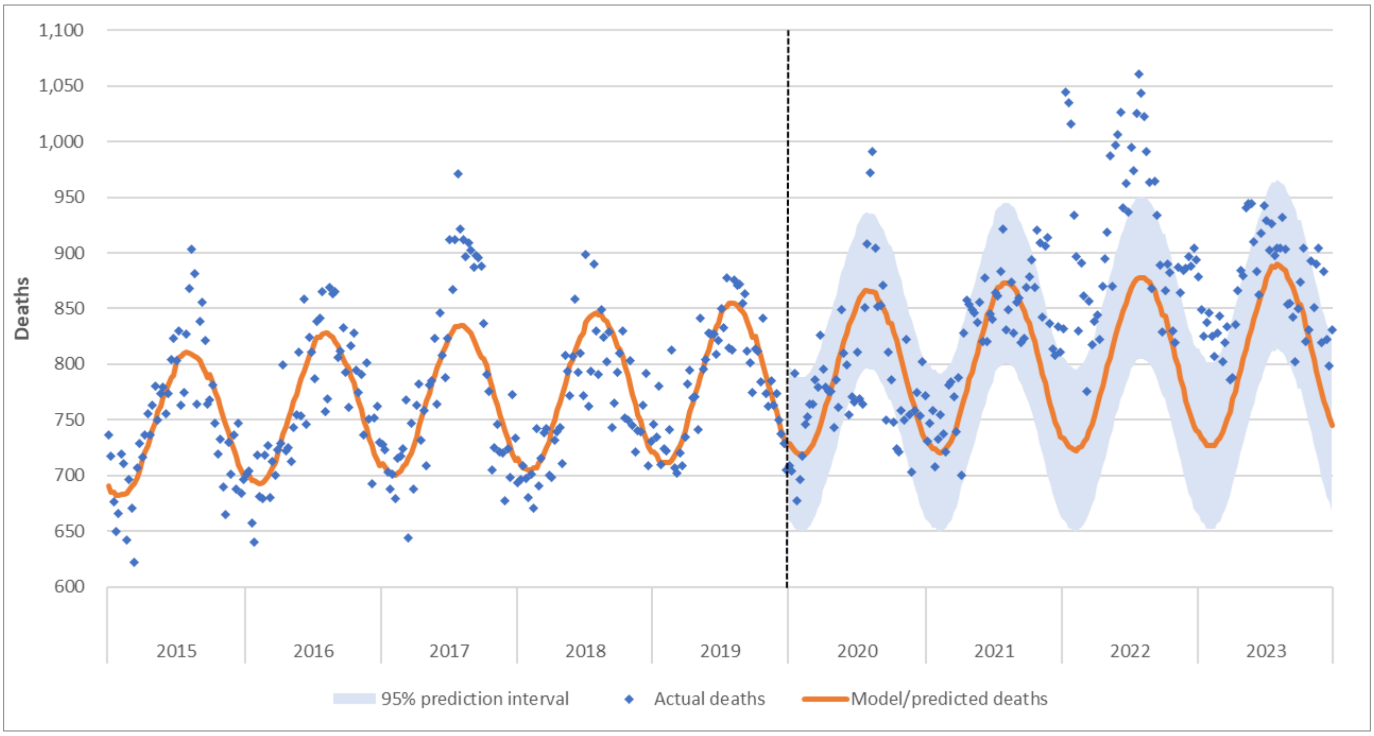


Figure 79 – Deaths Queensland

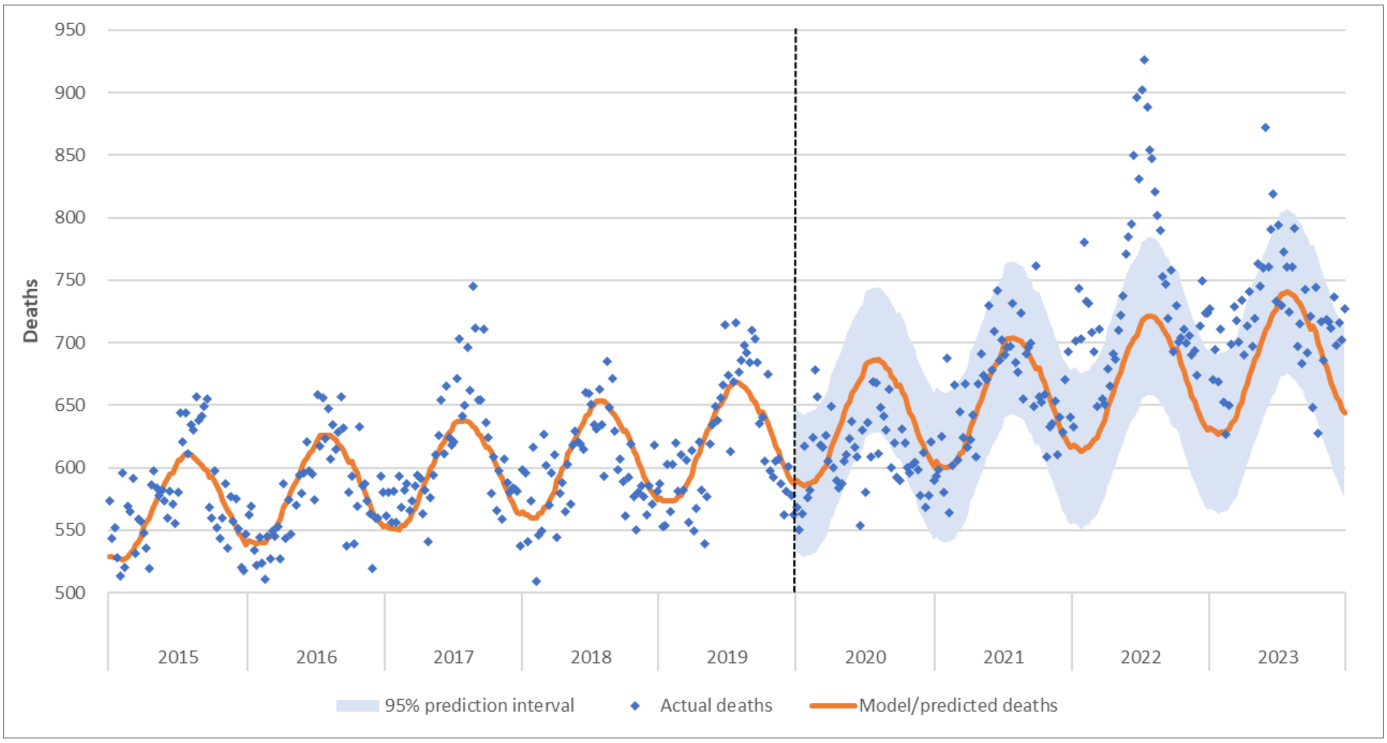


Figure 80 – Deaths South Australian

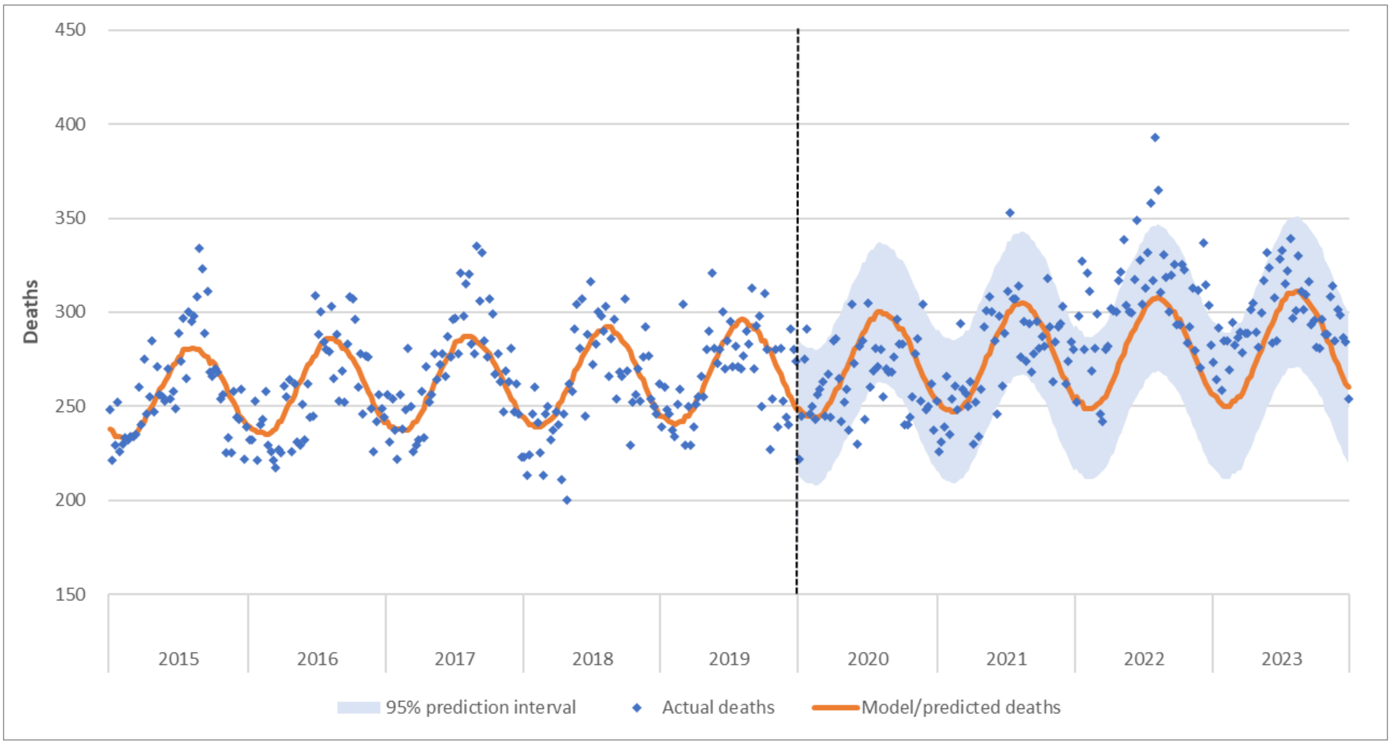


Figure 81 – Deaths Western Australia

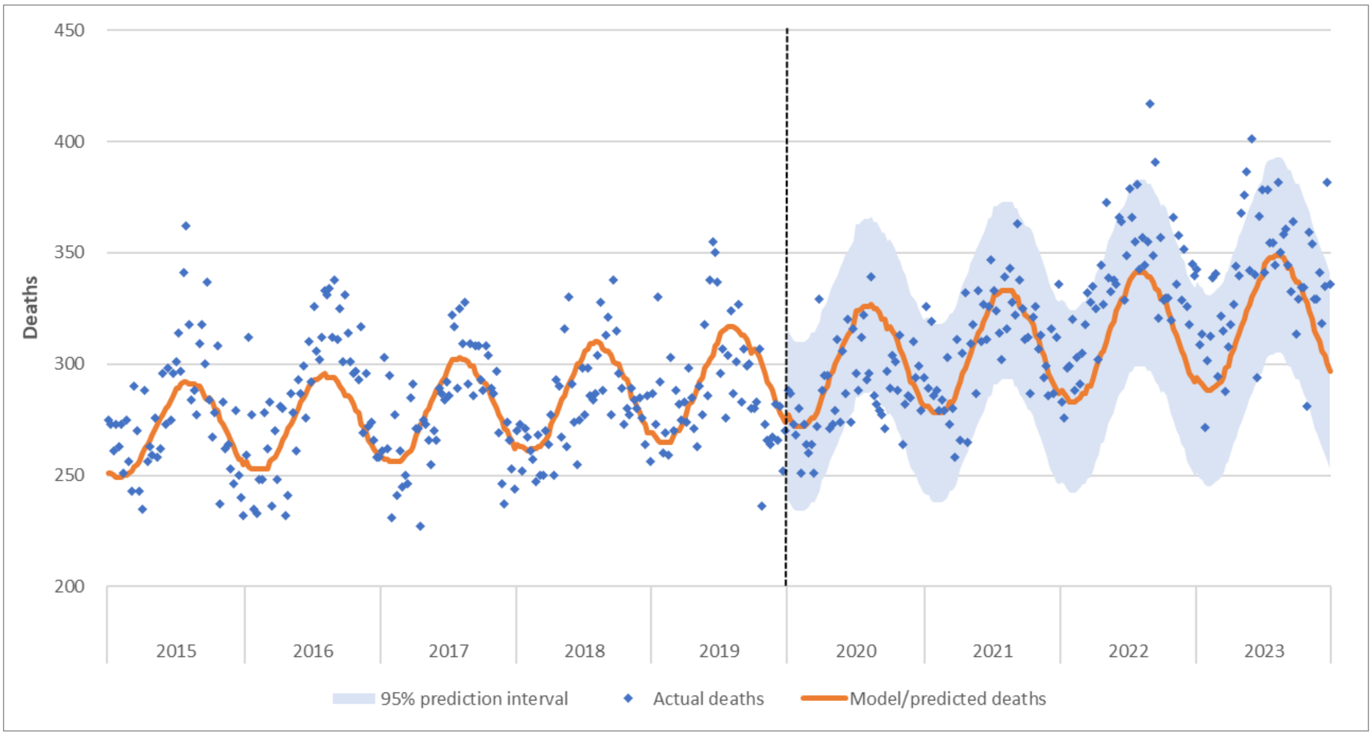


Figure 82 – Deaths Tasmania

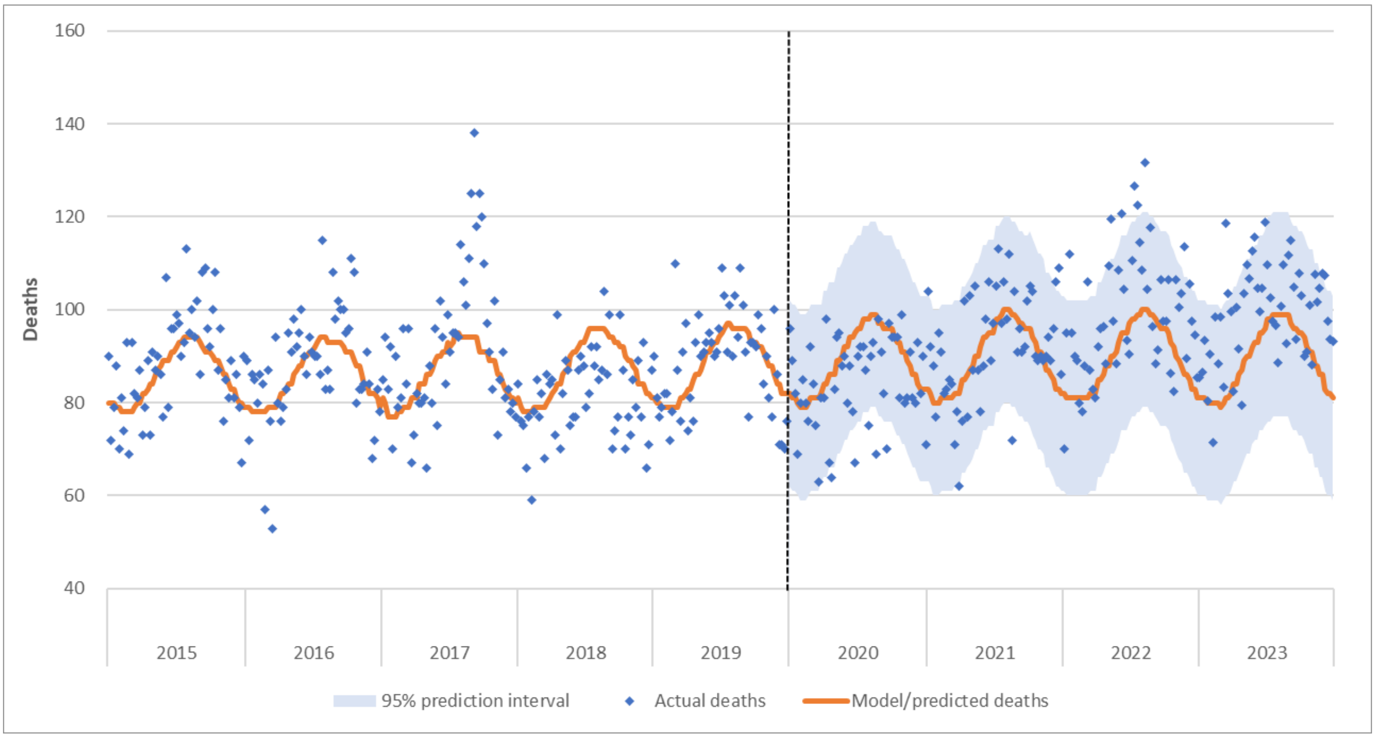


Figure 83 – Deaths Northern Territory

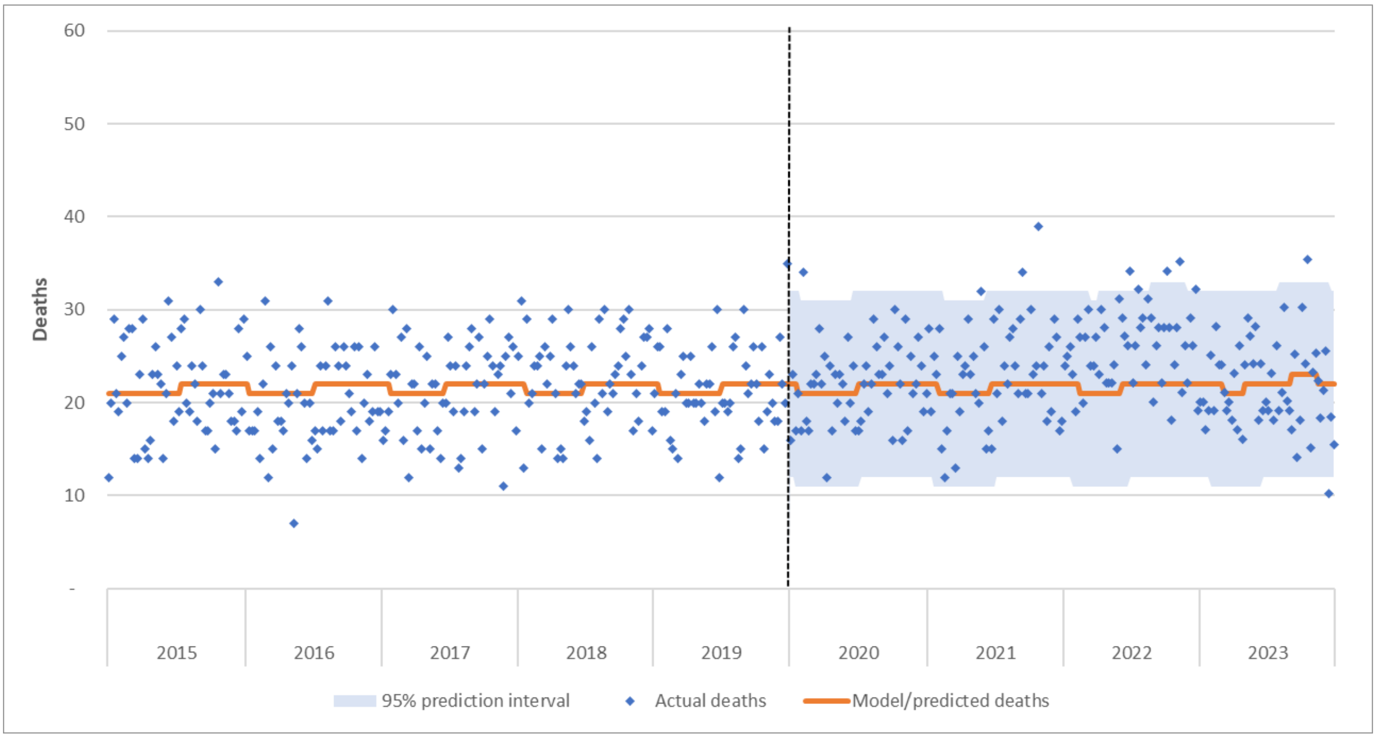
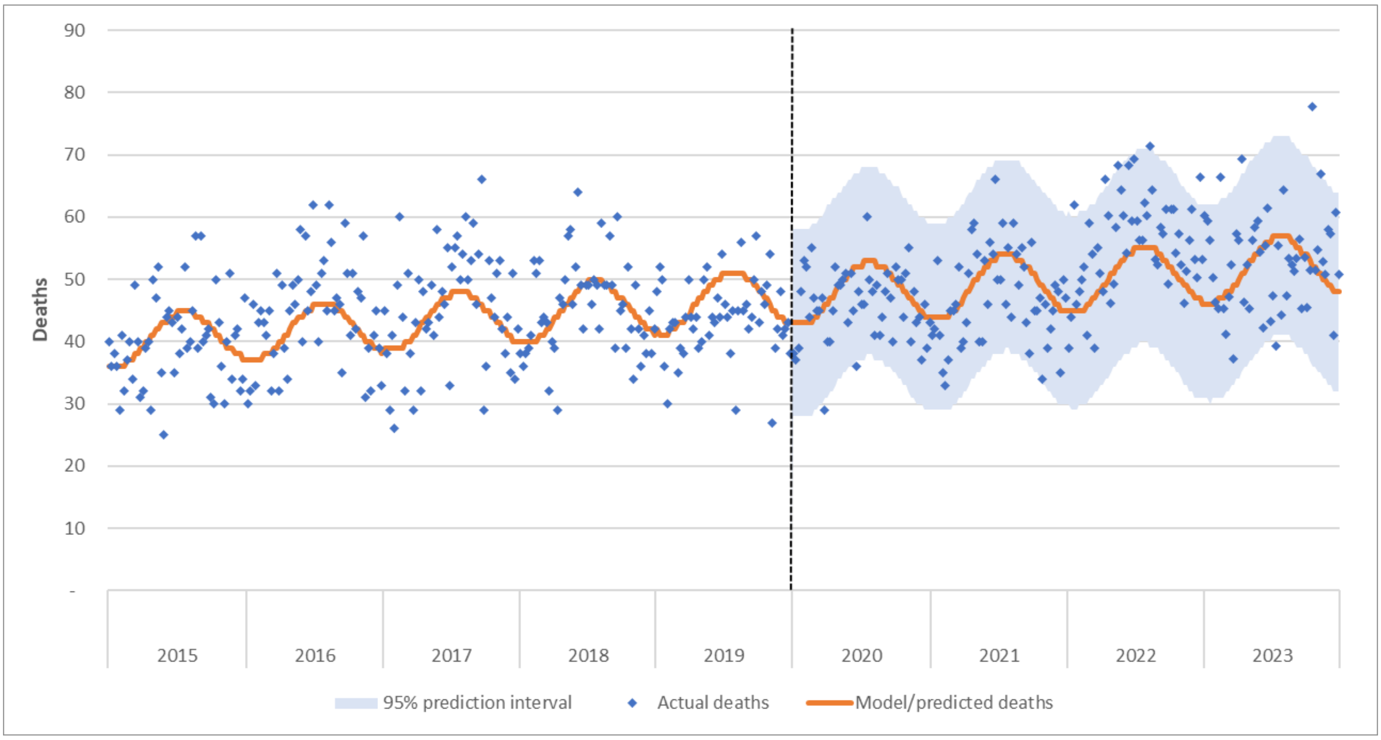
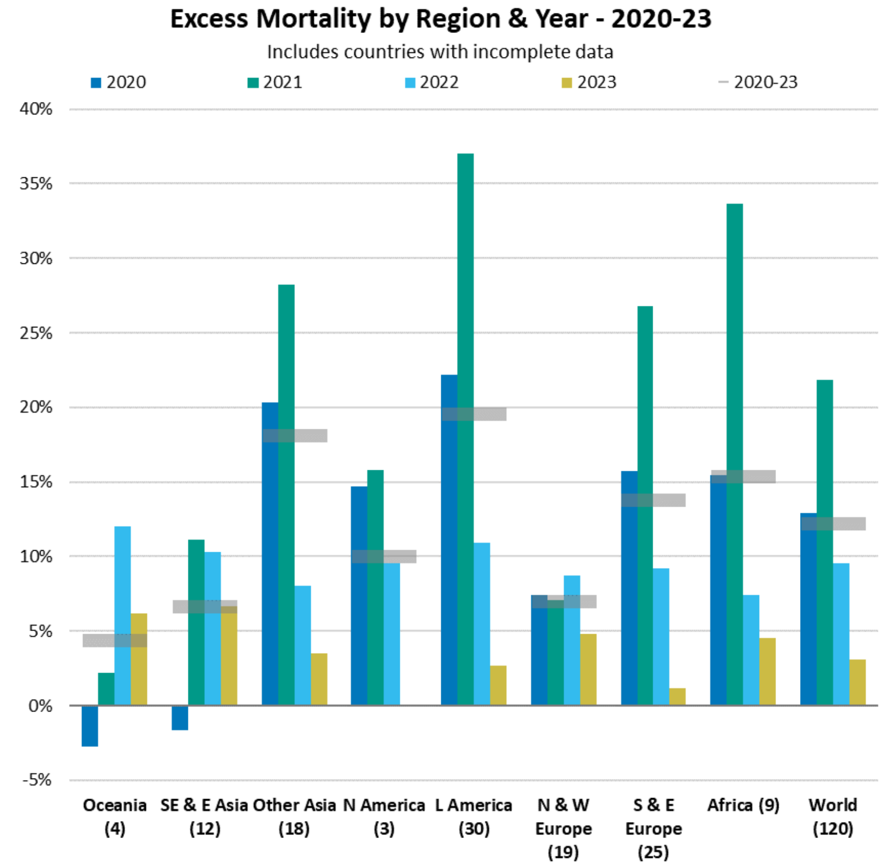


Figure 84 – Deaths Australian Capital Territory



Appendix G Excess mortality by region in 2020-23

Figure 85 – Excess mortality by region in 2020-23, showing differences in regional trends



Source: Our World in Data (OWID) and analysis. Excess mortality relative to projected deaths.

Figure 85 is a repeat of Figure 37, showing the different shapes of annual excess mortality in different regions. In this Appendix, we will look at these regions in more detail. In so doing, we will look at both annual excess mortality and a monthly comparison of COVID-19 mortality, vaccination rates and excess mortality for each of our selected countries. Because this comparison no longer requires data for the majority of 2023, we are also able to include several other countries.

In the monthly comparison, we have adopted a style modelled on charts produced by The Economist. Each country chart, apart from a few Latin American countries[67], uses the same scale for ease of comparison across countries[68]. We have included a regional chart for each region, noting that, for this purpose alone, we have not combined Northern and Western Europe or Southern and Eastern Europe. Each of those charts also uses the same scale, which is different from that used for the country charts.

For all the monthly comparison charts, COVID-19 deaths (as a percentage of expected deaths[69]) are shown in blue, vaccination rates are shown by a tan line and total excess deaths are shown by a red line.

[67] Excess mortality has been so high in Bolivia, Cuba, Ecuador and Peru that we have had to use double the standard scale
[68] For some countries, a peak of excess mortality exceeds the top end of the scale (-25% to +125%), but we consider that this does not detract from the reader's understanding
[69] Where necessary, expected deaths have been estimated, but any consequent error in the COVID-19 mortality rate will be extremely small

Oceania

Figure 86 – Annual excess mortality in Oceania in 2020-23, showing the dominance of Australia

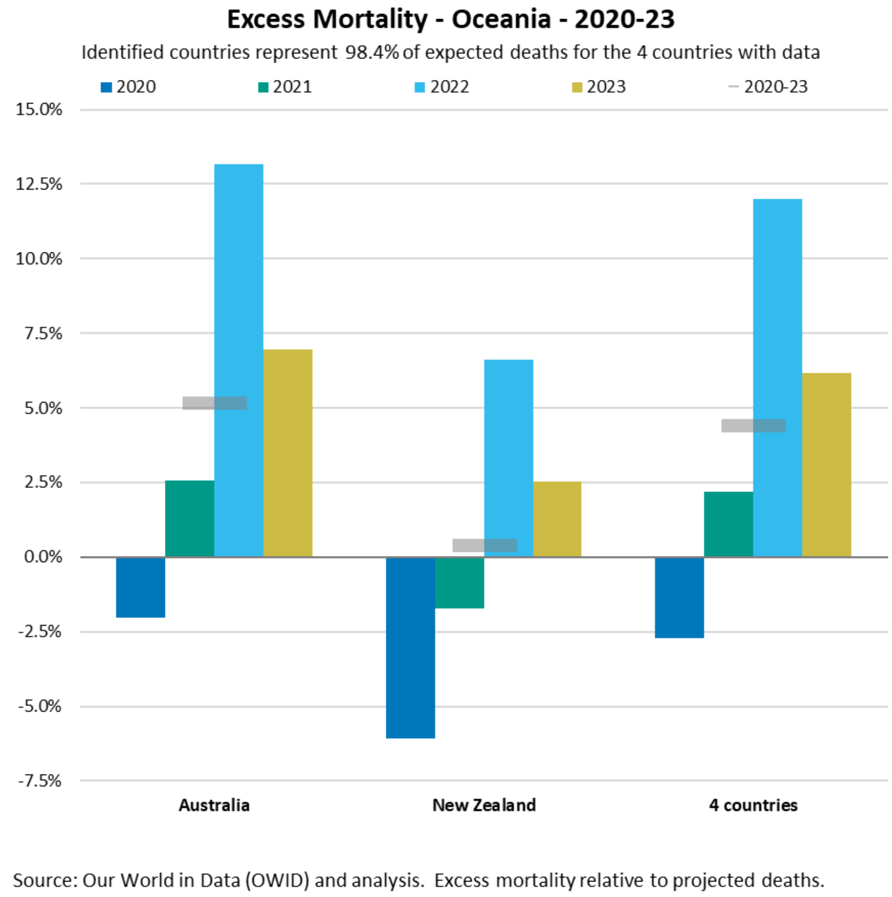
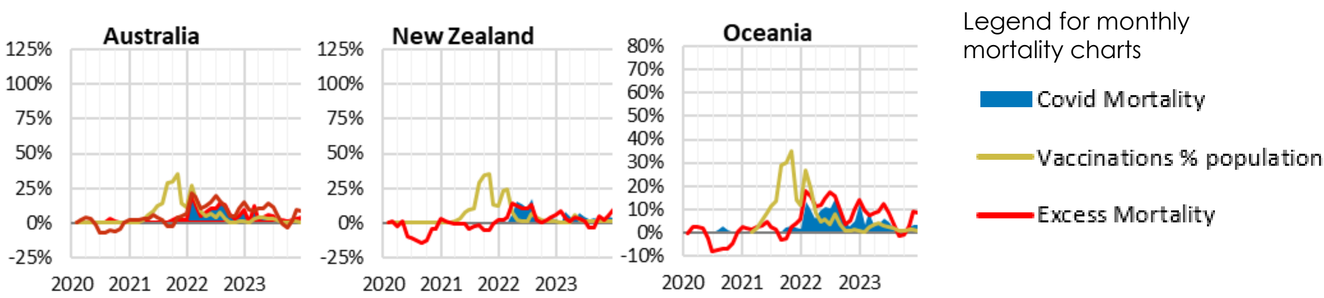


Figure 87 – Comparison of monthly COVID-19 mortality, vaccination rates and total excess mortality in Oceania in 2020-23, showing similar trends in Australia and New Zealand



As Figure 86 shows, excess mortality in Oceania is dominated by Australia. New Zealand has experienced consistently lower excess mortality than Australia every year. In fact, in the OWID database, only three countries have lower aggregate excess mortality than New Zealand over the four years[70].

Figure 87 shows the similarity in mortality patterns between Australia and New Zealand, apart from the Omicron peak in early 2022 in Australia, when New Zealand's borders were still closed. The excess mortality in Oceania in 2022 can be attributed to the opening of borders and consequent high prevalence of COVID-19, rather than the (delayed) impact of vaccination.

[70] These three are Mongolia (Other Asia), Luxembourg (W Europe) and Greenland (N America), the only country with negative excess mortality every year

South-East & East Asia

Figure 88 – Annual excess mortality in SE & E Asia in 2020-23, showing significant differences between countries

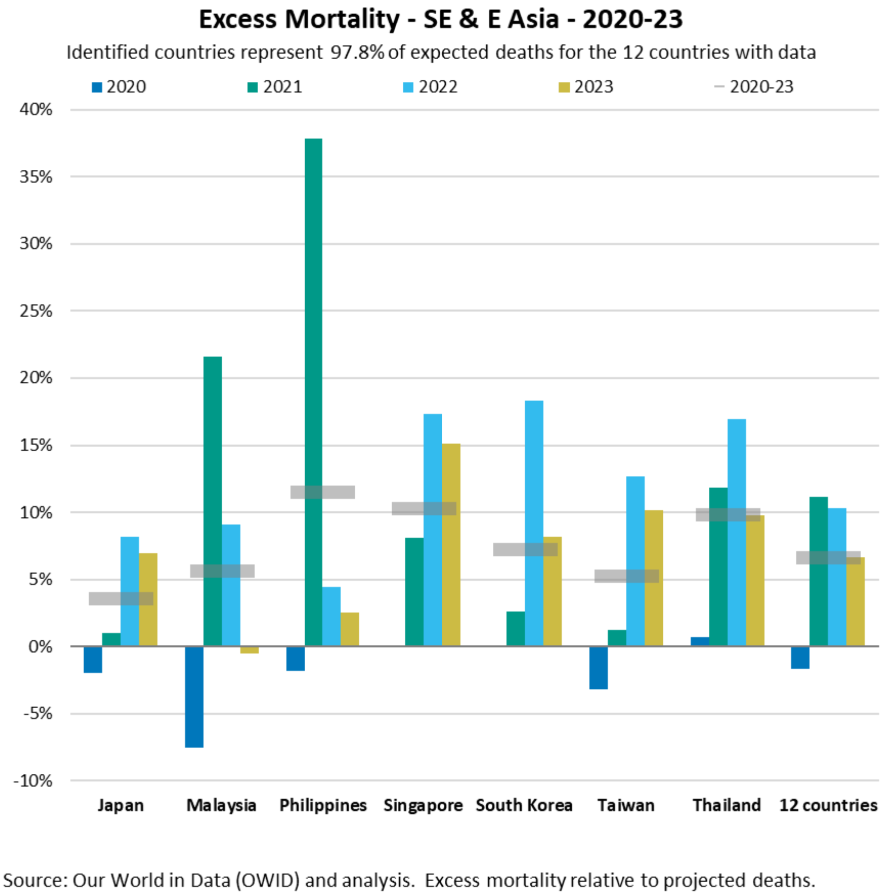
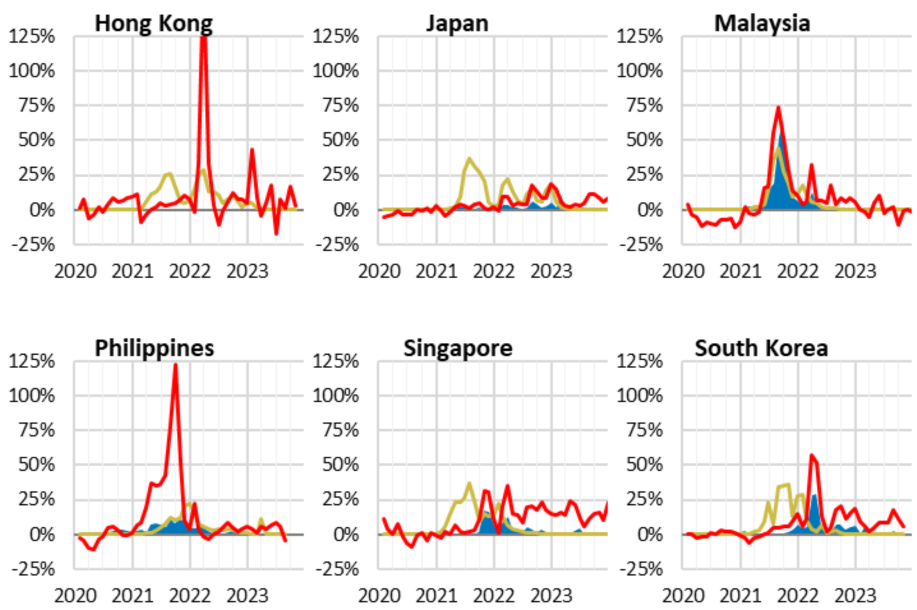
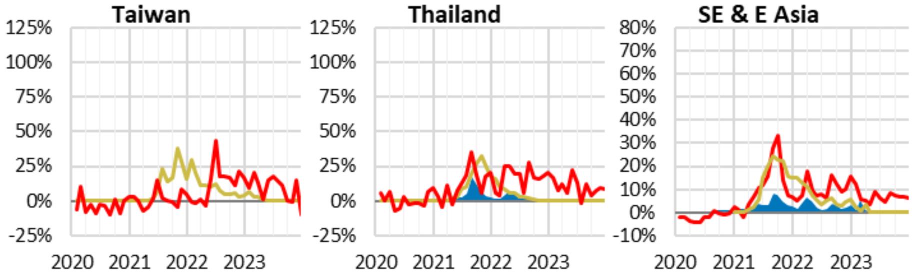


Figure 89 – Comparison of monthly COVID-19 mortality, vaccination rates and total excess mortality in SE & E Asia in 2020-23, showing high mortality spikes in Malaysia and the Philippines in 2021 (Delta) and in Hong Kong and South Korea in 2022 (Omicron)





We see (Figure 88) significant annual mortality differences between countries in SE & E Asia. Some (including Japan, South Korea and Taiwan) show a similar pattern to Australia. However, Malaysia and the Philippines saw very high excess mortality in 2021 and a decline in 2022. All saw a decline in 2023.

These observations are borne out by Figure 89, where it is also clear that COVID-19 deaths have surely been under-reported in some countries and/or time periods. For the region as a whole, the peak vaccination rate coincided with the peak excess mortality rate, but relativities were different in different countries.

Other Asia

Figure 90 – Annual excess mortality in Other Asia in 2020-23, showing a generally consistent pattern

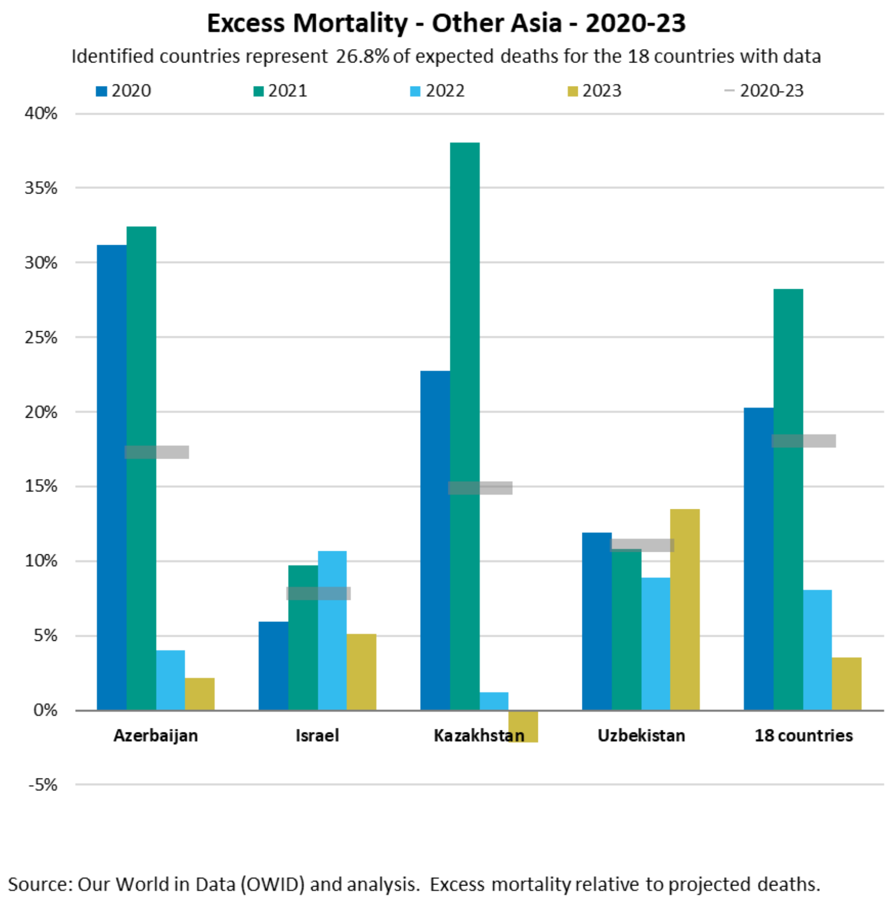
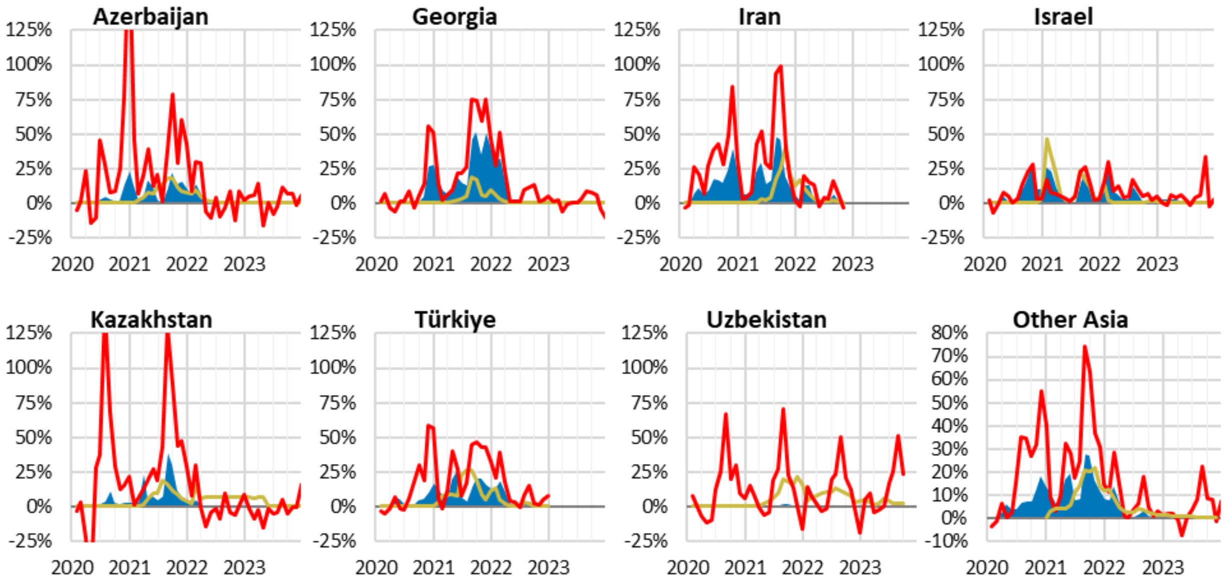


Figure 91 – Comparison of monthly COVID-19 mortality, vaccination rates and total excess mortality in Other Asia in 2020-23, showing high spikes in several countries at various times



In Figure 90, we can see a general pattern of high 2020 excess mortality, increasing in 2021 and dropping to much lower levels in 2022, declining further in 2023. Israel, however, has behaved more like a North or West European country, and Uzbekistan is also different.

Figure 91 shows that Uzbekistan has had a mortality spike in August of each of the four years. It is not clear why this should be the case. There are spikes in other countries at various times. Vaccination rates are lower than most other regions.

North America

Figure 92 – Annual excess mortality in North America in 2020-23, showing the dominance of the USA

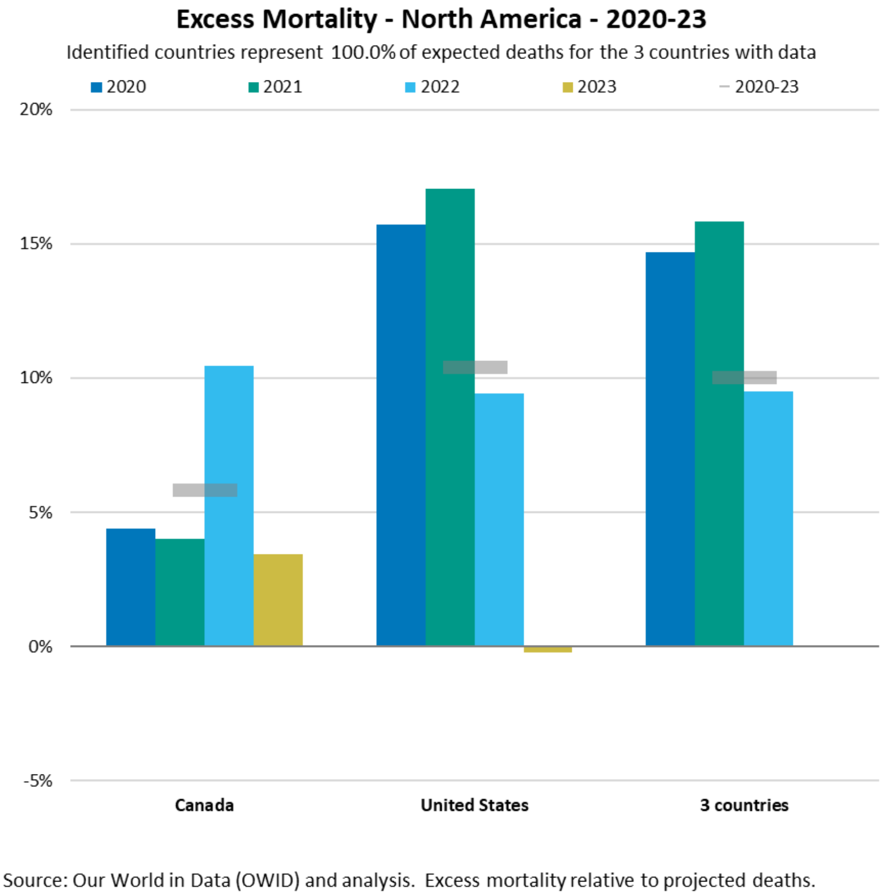


Figure 93 – Comparison of monthly COVID-19 mortality, vaccination rates and total excess mortality in North America in 2020-23, showing that mortality in Canada has been consistently much better than in the USA

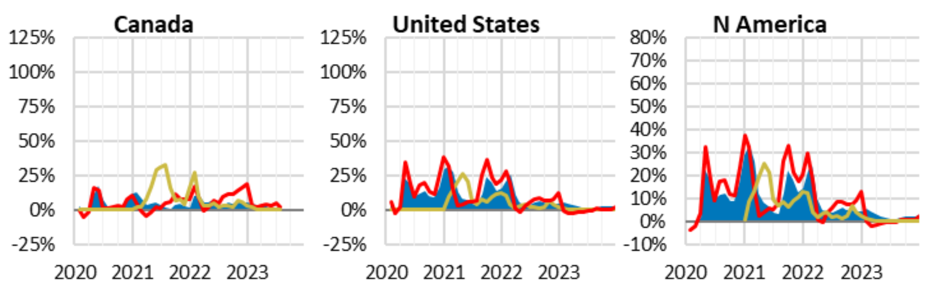
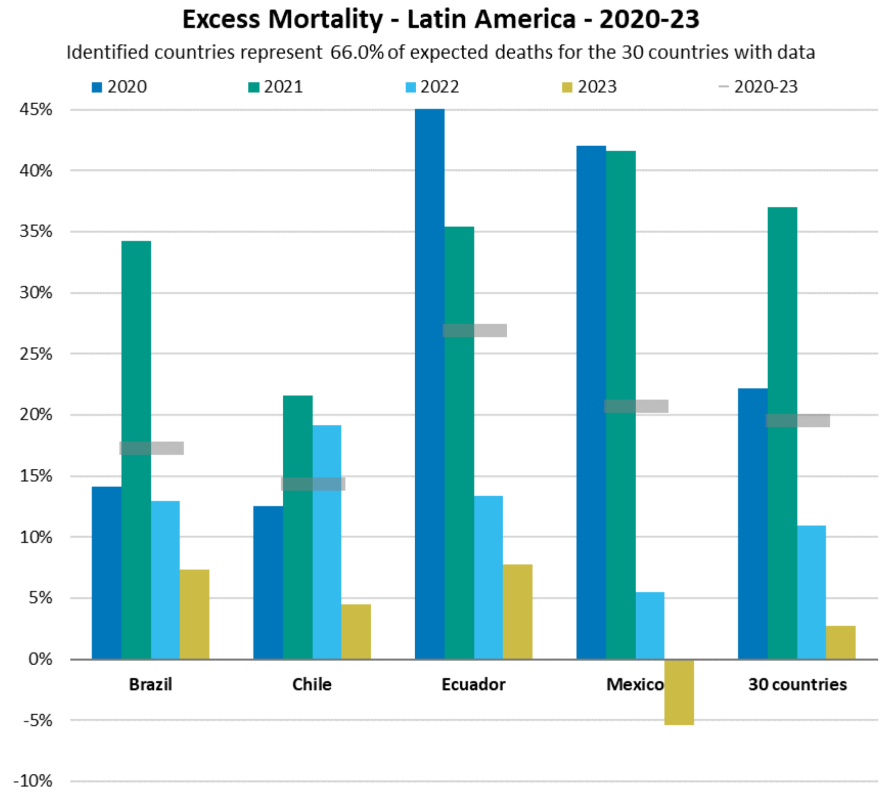


Figure 92 shows that excess mortality in the USA was above 15% in 2020 and even higher in 2021, dropping just below 10% in 2022 and negative in 2023. Annual Canadian excess mortality was much lower than the USA in 2020 and 2021 but has since been higher. Figure 93 shows this on a monthly basis. There was strong vaccination take-up in 2021, but rates have been low since then.

Note that the UN geoscheme includes Mexico in Latin America and the Caribbean.

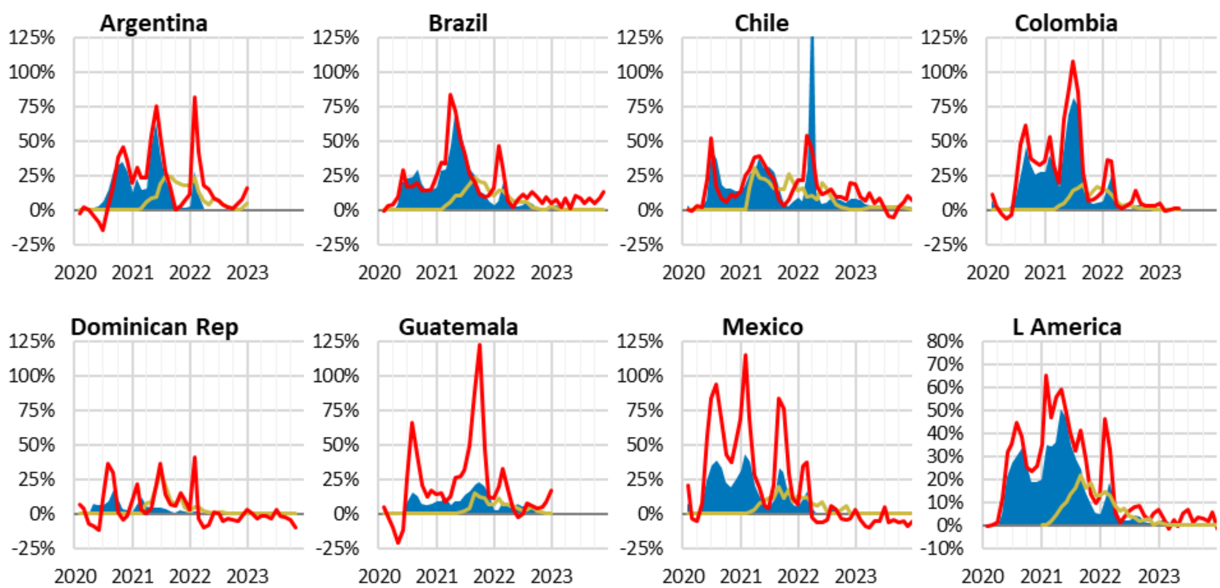
Latin America and the Caribbean

Figure 94 – Annual excess mortality in Latin America and the Caribbean in 2020-23, showing a range of outcomes



Source: Our World in Data (OWID) and analysis. Excess mortality relative to projected deaths.

Figure 95 – Comparison of monthly COVID-19 mortality, vaccination rates and total excess mortality in Latin America and the Caribbean in 2020-23, with four countries shown on a double scale due to extremely high excess mortality spikes



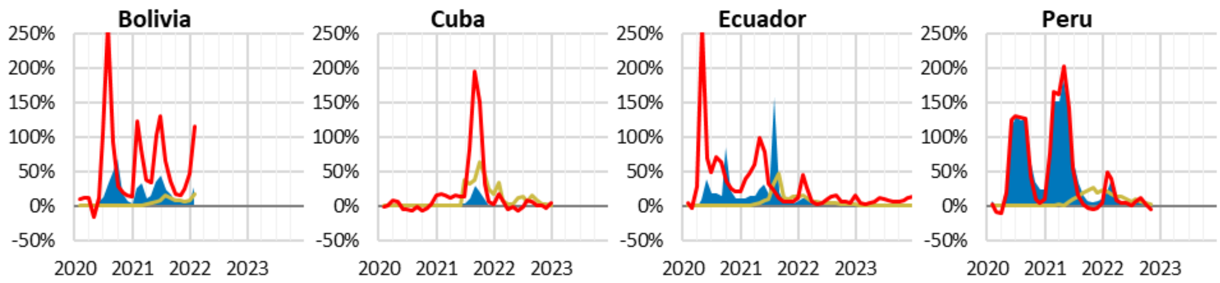


Figure 94 demonstrates the phenomenon of (very) high excess mortality in 2020 and 2021 being associated with low excess mortality in 2022 and 2023 – with Mexico registering negative excess in 2023.

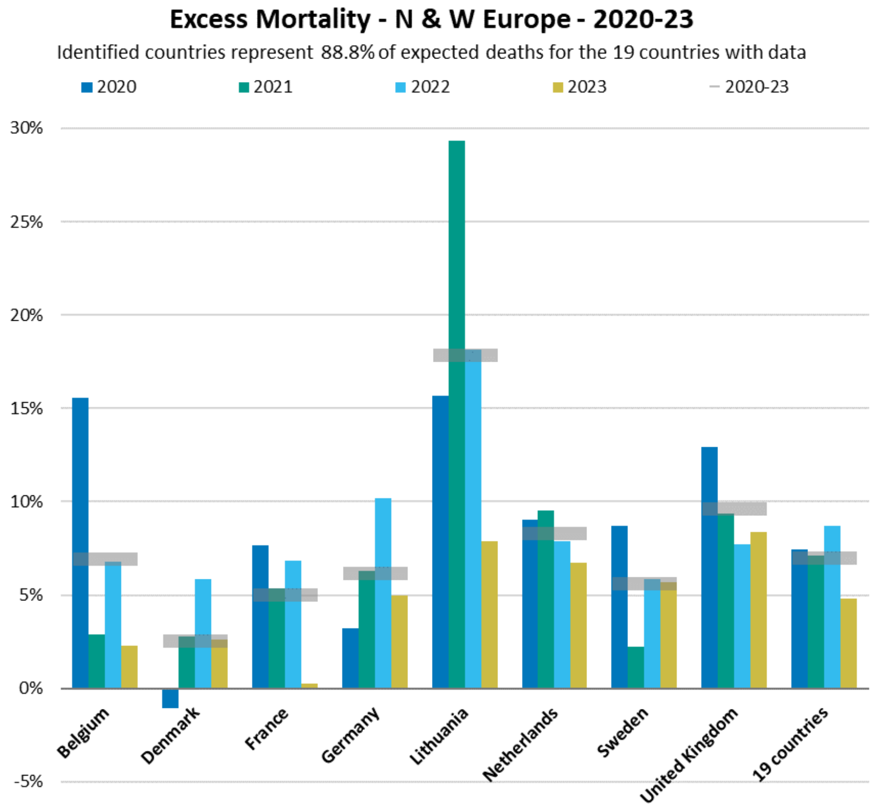
Figure 95 sheds further light on this. Where there is data, every country shows an Omicron spike in early 2022, but the relative level of that spike depends on how bad mortality has been in 2020 and 2021. Moreover, there has generally been little (or negative) excess mortality after early 2022, particularly in countries where mortality was very high in 2020 and 2021.

Countries in this region tend to be poor, with little financial or health services capacity to support their population through a pandemic. Some of these charts perhaps demonstrate the achievement of a form of "herd immunity", albeit at the cost of a huge loss of life. Overall, this region has the highest excess mortality across the full period, at 20%.

In this context, it is interesting to note that total reported vaccinations per capita are running slightly higher in Peru (about 2.7) than in Australia (2.6), while Chile is the stand-out, at 3.4 vaccinations per person. By comparison, both Mexico and Colombia were at about 1.75 vaccinations per person at last report and Brazil was at 2.25.

Northern and Western Europe

Figure 96 – Annual excess mortality in Northern and Western Europe in 2020-23, showing a range of outcomes



Source: Our World in Data (OWID) and analysis. Excess mortality relative to projected deaths.

Figure 97 – Comparison of monthly COVID-19 mortality, vaccination rates and total excess mortality in Northern Europe in 2020-23, showing countries that experienced or avoided very high excess mortality spikes in 2020 & 2021

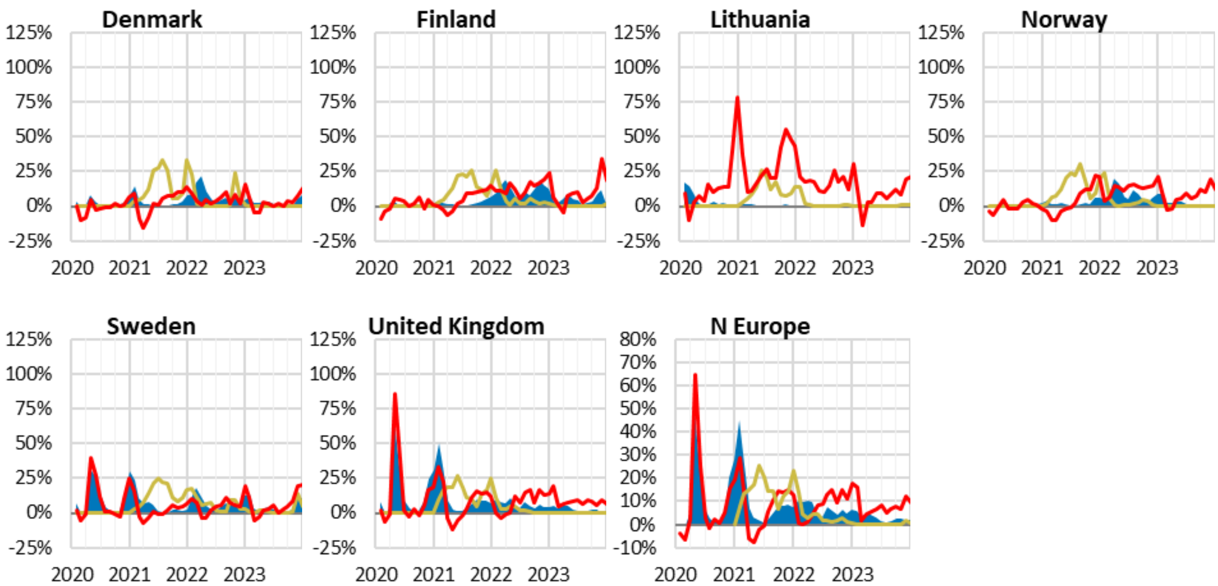


Figure 98 – Comparison of monthly COVID-19 mortality, vaccination rates and total excess mortality in Western Europe in 2020-23, showing countries that experienced or avoided very high excess mortality spikes in 2020 & 2021

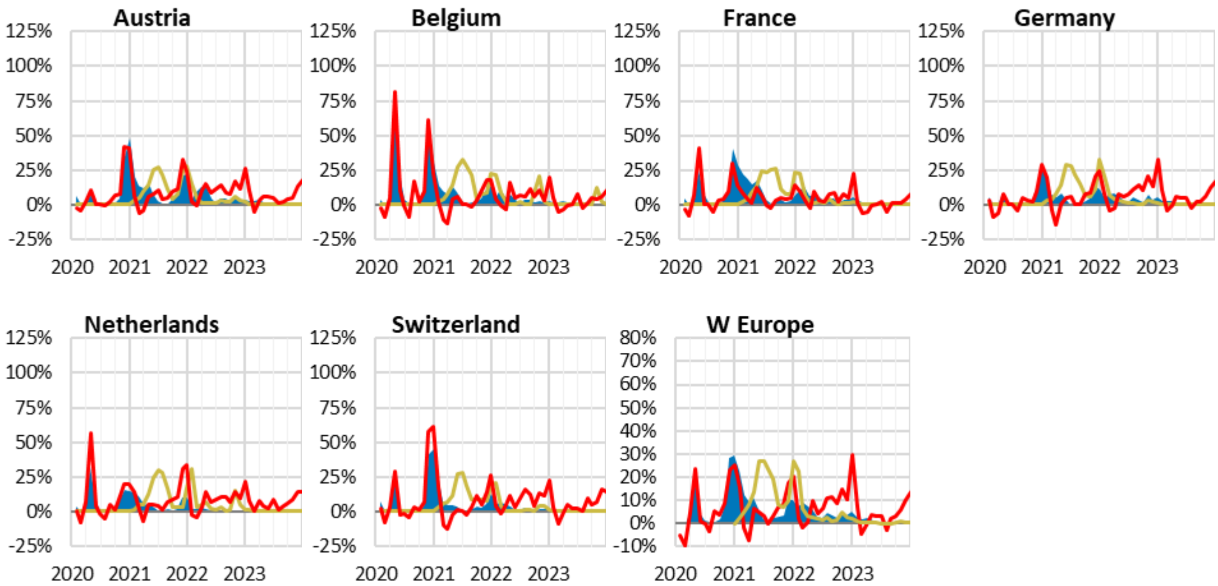


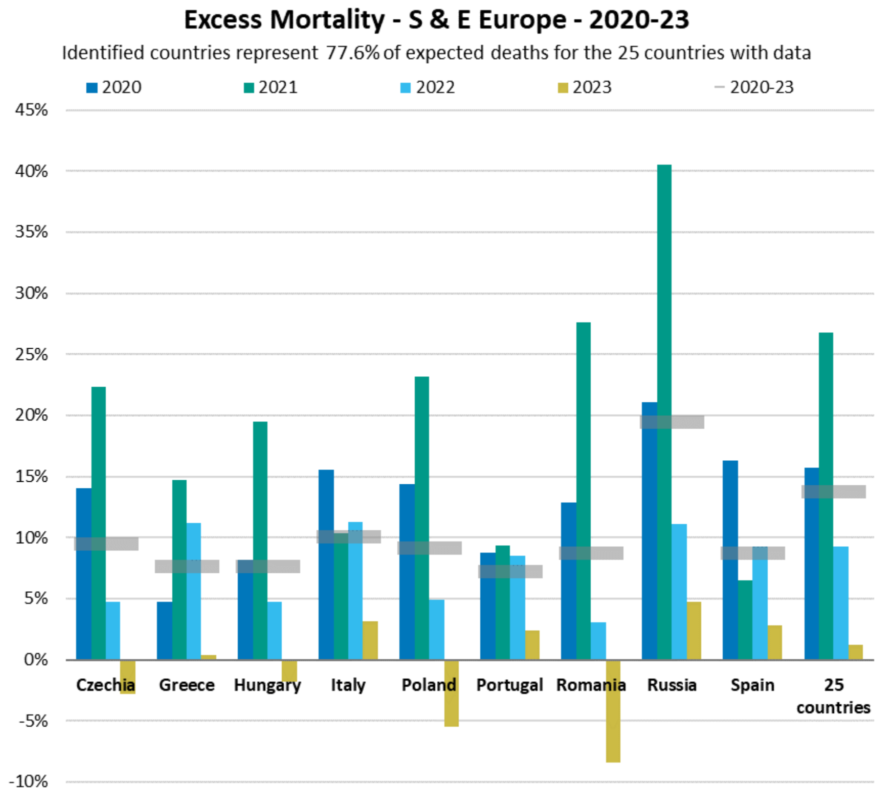
Figure 96 shows that excess mortality in Northern and Western Europe was quite flat in 2020 and 2021, rising in 2022 and dropping in 2023. But this has **not** been the case for individual countries in the region; indeed, there is no consistent pattern at all. Neighbouring countries have had quite different experience – see, for example, Belgium and the Netherlands, France and Germany, and Denmark and Sweden. On the other hand, Lithuania has had mortality experience that more closely mirrors its East European neighbours (Poland, Belarus and Russia – see below) than its Northern European and Baltic neighbour, Latvia (not shown here).

Figure 97 shows that some neighbours are similar after all (for example, Norway and Finland, and Denmark and Sweden after 2020). It also shows that much of the difference between neighbours relates to how well they avoided mortality spikes, particularly in 2020. The UK represents two-thirds of the expected deaths in Northern Europe, so it is no surprise that the regional experience is similar to the UK's. Vaccination rates have been high in Northern Europe, other than in the Baltic states (Lithuania, Latvia and Estonia).

Figure 98 shows that excess mortality in Western Europe had the same broad shape as in Northern Europe, but with lower COVID-19 spikes in 2020 and the winter of 2020-21. From early 2021, the experience is quite consistent across the region. Apart from Switzerland (around the World average of 190%), vaccination rates are about the same as for the non-Baltic states in Northern Europe.

Southern and Eastern Europe

Figure 99 – Annual excess mortality in Southern and Eastern Europe, generally showing higher excess mortality in 2021 than in either 2020 or 2022



Source: Our World in Data (OWID) and analysis. Excess mortality relative to projected deaths.

Figure 100 – Comparison of monthly COVID-19 mortality, vaccination rates and total excess mortality in Southern Europe in 2020-23, showing clear differences between countries

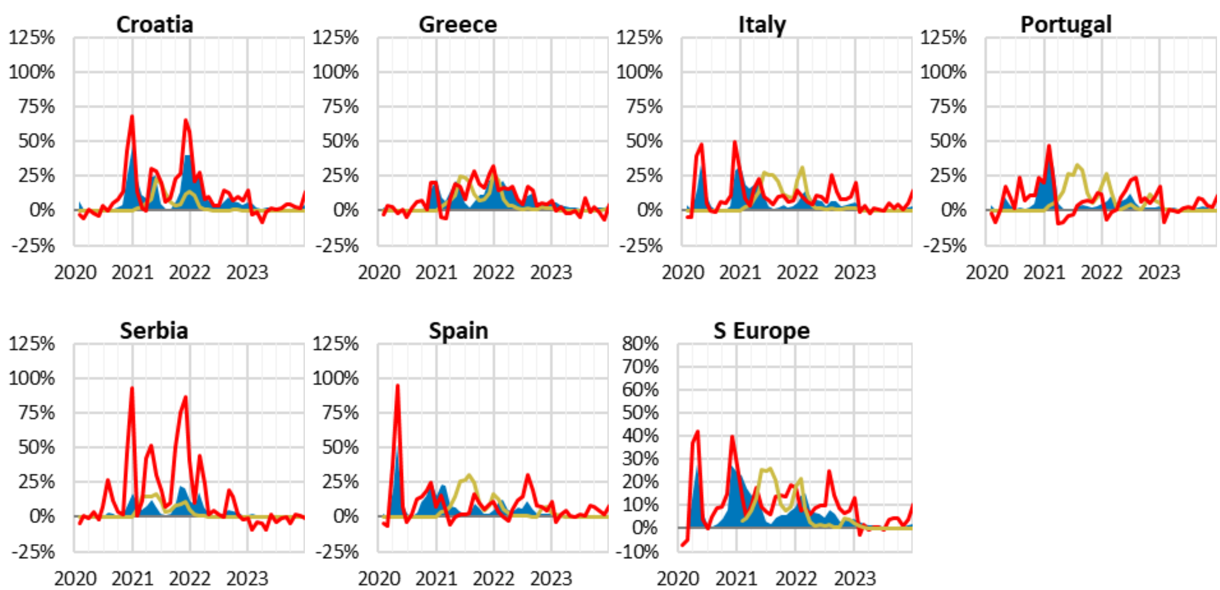


Figure 101 – Comparison of monthly COVID-19 mortality, vaccination rates and total excess mortality in Eastern Europe in 2020-23, showing multiple high excess mortality spikes

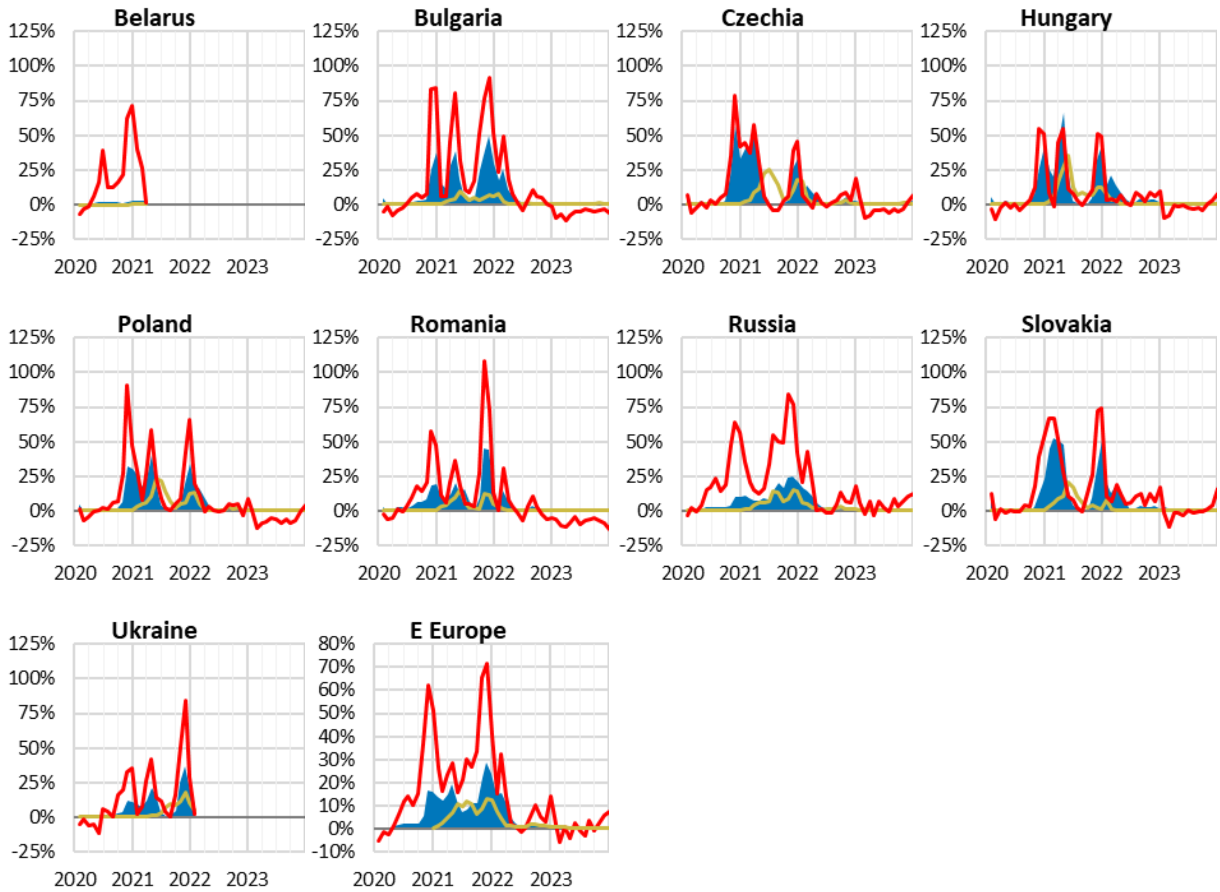


Figure 99 shows that Czechia, Hungary, Poland, Romania and Russia (all in Eastern Europe) had relatively high excess mortality in 2020 – generally above 10% – and even higher mortality in 2021, with much lower mortality in 2022. All bar Russia had negative excess mortality in 2023[71]. For 2020 to 2022, this is quite similar to what we saw for Lithuania (like its fellow Baltic States, a former member of the Soviet Union), with excess mortality rising in 2021 before falling in 2022.

Figure 100 and Figure 101 show that two countries in Southern Europe that were once part of Yugoslavia (Croatia and Serbia) had similar mortality experience to that in Eastern Europe, with clear winter spikes in 2020-21 and 2021-22. Vaccination rates in these countries were also at similar (low) levels to Eastern Europe. Per capita vaccination rates in Eastern Europe, the former Yugoslavia and the Baltic States range from about 0.7 in Bulgaria to about 1.8 in Czechia. Despite these low vaccination rates, excess mortality in 2023 was low (generally negative). However, overall excess mortality in 2020-23 was almost 16%, suggesting that this outcome has been achieved through mortality displacement. As with Latin America, "herd immunity" has perhaps been bought with a high loss of life.

Apart from differences in 2020 and the winter of 2020-21, the other countries in Southern Europe display broadly the same mortality patterns as those in Northern and Western Europe.

[71] Note that Russian excess mortality in 2022 and 2023 would include war deaths in Ukraine. Estimates of that number vary significantly, but it seems likely that there were at least 100,000 such deaths by the end of 2023. As the annual baseline for excess mortality in Russia is about 1.8 million deaths, it is not unreasonable to suppose that the war contributed about 2.5% excess mortality in 2022 and 3% in 2023.

Africa

Figure 102 – Annual excess mortality in Africa, showing very high excess mortality in 2021

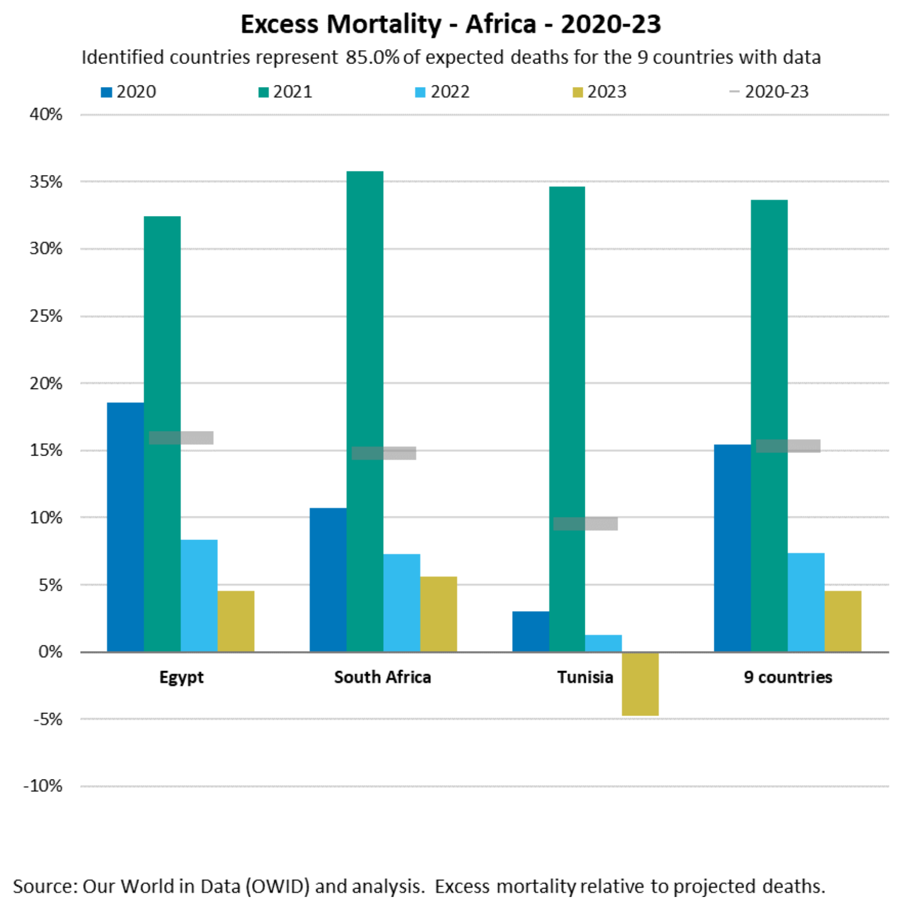
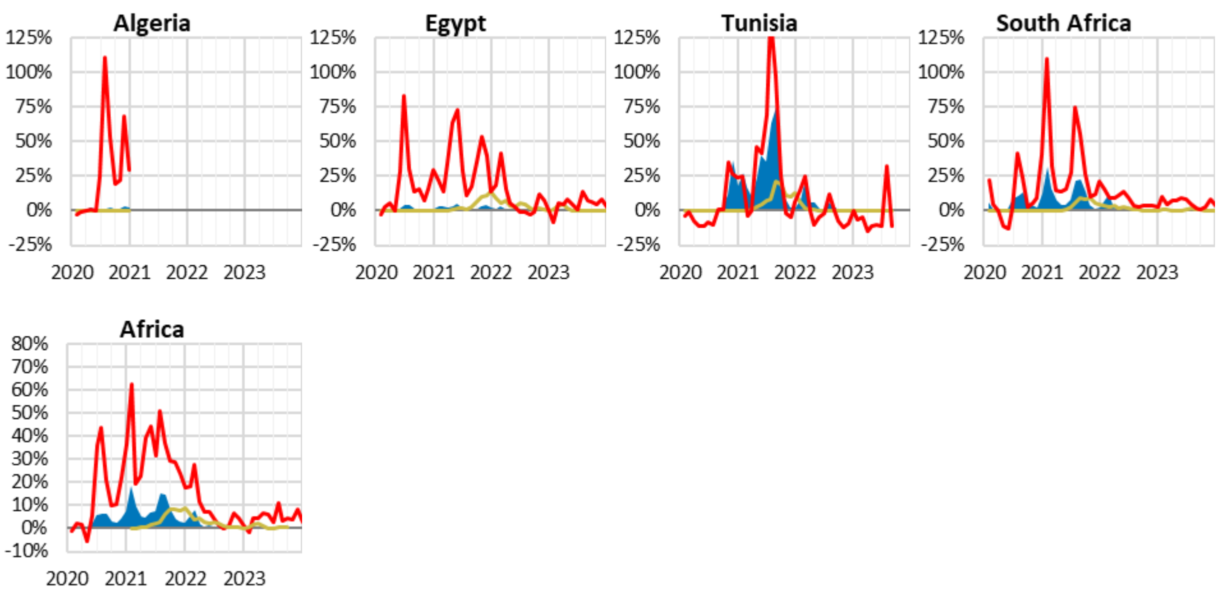


Figure 103 – Comparison of monthly COVID-19 mortality, vaccination rates and total excess mortality in Africa in 2020-23, showing high excess mortality spikes



As previously mentioned, we have little useful data on African countries. Figure 102 shows that Egypt and South Africa had similar patterns of annual excess mortality, and Figure 103 suggests that this is typical of other African countries as well, noting that Tunisia's Delta wave in 2021 was particularly high.

OWID data suggests that very few African nations have per capita vaccination rates above 1. Of the four shown in Figure 103, Tunisia (1.1) has the highest rate and Algeria (0.3) the lowest. Egypt is at 0.9 and South Africa at 0.6.

As with Latin America and ex-Soviet countries, it seems that a degree of "herd immunity" has been achieved – again, at a very high cost of lives rather than through high vaccination rates.

Appendix H COVID-19 and Other Excess Deaths in 40 Countries

Table 13 – COVID-19 and other excess deaths in 40 countries – 2020-23 combined

Region	Country	Code	COVID-19 Deaths	Total Deaths	Expected Deaths	COVID-19 %	Other Excess %	Total Excess %
Average	Average (40)	AVE	115,932	1,914,623	1,721,279	6.7%	4.5%	11.2%
Oceania	Australia	AUS	24,420	707,499	672,713	3.6%	1.5%	5.2%
Oceania	New Zealand	NZL	2,288	144,178	143,615	1.6%	-1.2%	0.4%
SE & E Asia	Japan	JPN	55,813	6,009,369	5,799,498	1.0%	2.7%	3.6%
SE & E Asia	Malaysia	MYS	36,835	790,503	747,894	4.9%	0.8%	5.7%
SE & E Asia	Philippines	PHL	66,795	2,622,665	2,352,172	2.8%	8.7%	11.5%
SE & E Asia	Singapore	SGP	1,954	100,125	90,788	2.2%	8.1%	10.3%
SE & E Asia	South Korea	KOR	35,934	1,256,170	1,170,720	3.1%	4.2%	7.3%
SE & E Asia	Taiwan	TWN	No Data	769,486	730,726	No Data	5.3%	5.3%
SE & E Asia	Thailand	THA	33,654	2,227,045	2,027,314	1.7%	8.2%	9.9%
Other Asia	Azerbaijan	AZE	10,353	273,485	233,096	4.4%	12.9%	17.3%
Other Asia	Israel	ISR	12,707	201,159	186,490	6.8%	1.1%	7.9%
Other Asia	Kazakhstan	KAZ	19,072	611,275	531,916	3.6%	11.3%	14.9%
Other Asia	Uzbekistan	UZB	1,016	651,916	586,708	0.2%	10.9%	11.1%
N America	Canada	CAN	51,826	1,147,795	1,084,441	4.8%	1.1%	5.8%
N America	United States	USA	1,164,382	13,172,230	11,928,232	9.8%	0.7%	10.4%
L America	Brazil	BRA	701,335	6,388,744	5,445,949	12.9%	4.4%	17.3%
L America	Chile	CHL	65,659	522,047	456,454	14.4%	0.0%	14.4%
L America	Dominican Repub	DOM	4,384	181,302	174,002	2.5%	1.7%	4.2%
L America	Ecuador	ECU	36,024	401,277	316,114	11.4%	15.5%	26.9%
L America	Mexico	MEX	331,322	3,771,390	3,122,629	10.6%	10.2%	20.8%
N & W Europe	Belgium	BEL	34,339	467,635	437,327	7.9%	-0.9%	6.9%
N & W Europe	Denmark	DNK	9,493	229,809	224,081	4.2%	-1.7%	2.6%
N & W Europe	France	FRA	167,985	2,583,690	2,459,742	6.8%	-1.8%	5.0%
N & W Europe	Germany	DEU	165,738	4,106,520	3,867,906	4.3%	1.9%	6.2%
N & W Europe	Lithuania	LTU	9,773	171,967	145,923	6.7%	11.2%	17.8%
N & W Europe	Netherlands	NLD	22,978	679,435	627,355	3.7%	4.6%	8.3%
N & W Europe	Sweden	SWE	26,686	379,685	359,412	7.4%	-1.8%	5.6%
N & W Europe	United Kingdom	GBR	232,112	2,681,354	2,446,129	9.5%	0.1%	9.6%
S & E Europe	Czechia	CZE	43,354	502,551	458,759	9.5%	0.1%	9.5%
S & E Europe	Greece	GRC	35,771	544,509	505,507	7.1%	0.6%	7.7%
S & E Europe	Hungary	HUN	48,991	561,658	521,733	9.4%	-1.7%	7.7%
S & E Europe	Italy	ITA	184,168	2,832,790	2,572,464	7.2%	3.0%	10.1%
S & E Europe	Poland	POL	120,238	1,859,124	1,703,302	7.1%	2.1%	9.1%
S & E Europe	Portugal	PRT	27,183	493,373	460,145	5.9%	1.3%	7.2%
S & E Europe	Romania	ROU	67,638	1,146,149	1,053,728	6.4%	2.4%	8.8%
S & E Europe	Russia	RUS	393,383	8,238,996	6,893,666	5.7%	13.8%	19.5%
S & E Europe	Spain	ESP	118,943	1,841,351	1,693,069	7.0%	1.7%	8.8%
Africa	Egypt	EGY	24,830	2,598,611	2,240,686	1.1%	14.9%	16.0%
Africa	South Africa	ZAF	102,588	2,392,995	2,083,927	4.9%	9.9%	14.8%
Africa	Tunisia	TUN	29,375	323,068	294,813	10.0%	-0.4%	9.6%

Table 13 contains the excess mortality data used in Figure 38, with COVID-19 mortality shown for comparison. It should be read in conjunction with descriptions of the data, methodology and caveats in the paper.

Table 14 – COVID-19 and other excess mortality in 40 countries – 2022-23 v 2020-21

Region	Country	Code	COVID-19 2020-21 %	COVID-19 2022-23 %	Other 2020-21 %	Other 2022-23 %	Total 2020-21 %	Total 2022-23 %
Average	Average (40)	AVE	10.8%	3.2%	6.3%	3.1%	17.1%	6.4%
Oceania	Australia	AUS	0.7%	6.5%	-0.4%	3.5%	0.3%	10.0%
Oceania	New Zealand	NZL	0.1%	3.1%	-4.0%	1.5%	-3.9%	4.6%
SE & E Asia	Japan	JPN	0.6%	1.3%	-1.1%	6.3%	-0.5%	7.6%
SE & E Asia	Malaysia	MYS	8.6%	1.4%	-1.4%	2.8%	7.2%	4.3%
SE & E Asia	Philippines	PHL	4.1%	1.4%	14.2%	2.2%	18.2%	3.7%
SE & E Asia	Singapore	SGP	1.8%	2.4%	2.3%	13.8%	4.1%	16.2%
SE & E Asia	South Korea	KOR	0.9%	5.5%	0.5%	8.4%	1.4%	13.9%
SE & E Asia	Taiwan	TWN	No Data		-1.0%	11.4%	-1.0%	11.4%
SE & E Asia	Thailand	THA	2.2%	1.2%	4.1%	12.2%	6.3%	13.3%
Other Asia	Azerbaijan	AZE	7.2%	1.8%	24.6%	1.3%	31.8%	3.1%
Other Asia	Israel	ISR	8.9%	4.8%	-1.0%	3.1%	7.8%	7.9%
Other Asia	Kazakhstan	KAZ	6.9%	0.3%	23.6%	-0.8%	30.4%	-0.5%
Other Asia	Uzbekistan	UZB	0.3%	0.1%	11.1%	10.8%	11.4%	10.8%
N America	Canada	CAN	5.0%	4.5%	-0.8%	3.3%	4.2%	7.9%
N America	United States	USA	13.7%	5.8%	2.6%	-1.3%	16.4%	4.6%
L America	Brazil	BRA	22.5%	3.1%	1.8%	7.2%	24.3%	10.2%
L America	Chile	CHL	17.3%	11.5%	-0.2%	0.2%	17.1%	11.7%
L America	Dominican Reput	DOM	4.7%	0.2%	4.1%	-0.9%	8.8%	-0.7%
L America	Ecuador	ECU	21.7%	1.5%	22.3%	9.1%	44.0%	10.6%
L America	Mexico	MEX	19.6%	1.8%	22.2%	-1.7%	41.8%	0.1%
N & W Europe	Belgium	BEL	12.8%	2.8%	-3.5%	1.7%	9.3%	4.5%
N & W Europe	Denmark	DNK	2.9%	5.6%	-2.0%	-1.4%	0.9%	4.2%
N & W Europe	France	FRA	10.1%	3.6%	-3.6%	0.0%	6.5%	3.6%
N & W Europe	Germany	DEU	6.1%	2.5%	-1.3%	5.1%	4.8%	7.6%
N & W Europe	Lithuania	LTU	9.7%	3.5%	12.6%	9.6%	22.4%	13.1%
N & W Europe	Netherlands	NLD	6.7%	0.6%	2.6%	6.7%	9.3%	7.3%
N & W Europe	Sweden	SWE	8.4%	6.4%	-2.9%	-0.6%	5.5%	5.8%
N & W Europe	United Kingdom	GBR	14.4%	4.6%	-3.2%	3.5%	11.2%	8.1%
S & E Europe	Czechia	CZE	15.7%	3.2%	2.5%	-2.3%	18.2%	1.0%
S & E Europe	Greece	GRC	8.1%	6.0%	1.6%	-0.3%	9.7%	5.7%
S & E Europe	Hungary	HUN	14.6%	4.1%	-0.9%	-2.6%	13.8%	1.5%
S & E Europe	Italy	ITA	10.5%	3.7%	2.4%	3.5%	13.0%	7.2%
S & E Europe	Poland	POL	11.2%	3.0%	7.6%	-3.4%	18.8%	-0.3%
S & E Europe	Portugal	PRT	8.2%	3.6%	0.8%	1.8%	9.0%	5.4%
S & E Europe	Romania	ROU	11.1%	1.7%	9.1%	-4.4%	20.1%	-2.7%
S & E Europe	Russia	RUS	8.7%	2.6%	22.1%	5.3%	30.7%	7.9%
S & E Europe	Spain	ESP	10.7%	3.3%	0.7%	2.8%	11.5%	6.0%
Africa	Egypt	EGY	1.9%	0.3%	23.6%	6.2%	25.5%	6.4%
Africa	South Africa	ZAF	8.6%	1.1%	14.4%	5.3%	23.1%	6.4%
Africa	Tunisia	TUN	16.3%	2.8%	2.8%	-4.0%	19.0%	-1.2%

Table 14 contains the excess mortality data used in Figure 39, with COVID-19 mortality again shown for comparison.

Table 15 – Excess mortality compared with GDP per capita (2017, USD) and state capacity (2015)

Region	Country	Code	Expected 2020-23	Excess 2020-23	GDP per Capita	Capacity	Excess v GDP	Excess v Capacity	Vax % 2020-22
Average	Average (40)	AVE	1,721,279	11.2%	26,351	1.26495	1.4%	0.6%	196%
Oceania	Australia	AUS	672,713	5.2%	53,831	2.21800	-0.1%	-0.9%	243%
Oceania	New Zealand	NZL	143,615	0.4%	43,415	2.23500	-6.6%	-5.6%	231%
SE & E Asia	Japan	JPN	5,799,498	3.6%	38,214	1.76800	-4.3%	-4.6%	301%
SE & E Asia	Malaysia	MYS	747,894	5.7%	10,118	0.81170	-6.8%	-7.1%	213%
SE & E Asia	Philippines	PHL	2,352,172	11.5%	2,982	0.71460	-2.2%	-1.8%	147%
SE & E Asia	Singapore	SGP	90,788	10.3%	56,746	1.67200	5.4%	1.6%	261%
SE & E Asia	South Korea	KOR	1,170,720	7.3%	29,958	1.96100	-1.9%	0.0%	250%
SE & E Asia	Taiwan	TWN	730,726	5.3%	25,062	1.45500	-4.7%	-4.4%	271%
SE & E Asia	Thailand	THA	2,027,314	9.9%	6,579	0.57950	-3.2%	-4.1%	199%
Other Asia	Azerbaijan	AZE	233,096	17.3%	4,139	0.05768	3.9%	0.9%	134%
Other Asia	Israel	ISR	186,490	7.9%	42,852	1.75500	0.7%	-0.4%	198%
Other Asia	Kazakhstan	KAZ	531,916	14.9%	9,009	0.81130	2.2%	2.1%	172%
Other Asia	Uzbekistan	UZB	586,708	11.1%	1,554	(0.07955)	-2.8%	-6.0%	210%
N America	Canada	CAN	1,084,441	5.8%	44,841	2.09500	-0.9%	-0.8%	250%
N America	United States	USA	11,928,232	10.4%	59,939	1.86000	6.1%	2.7%	197%
L America	Brazil	BRA	5,445,949	17.3%	9,881	0.73820	4.8%	4.2%	223%
L America	Chile	CHL	456,454	14.4%	15,001	1.50300	2.7%	4.9%	319%
L America	Dominican Reput	DOM	174,002	4.2%	7,223	0.59860	-8.8%	-9.6%	144%
L America	Ecuador	ECU	316,114	26.9%	6,214	0.56360	13.8%	12.9%	218%
L America	Mexico	MEX	3,122,629	20.8%	9,224	0.65930	8.1%	7.2%	174%
N & W Europe	Belgium	BEL	437,327	6.9%	43,325	2.37900	-0.1%	1.7%	253%
N & W Europe	Denmark	DNK	224,081	2.6%	57,545	2.69700	-2.2%	-1.2%	254%
N & W Europe	France	FRA	2,459,742	5.0%	39,827	1.64200	-2.6%	-3.8%	226%
N & W Europe	Germany	DEU	3,867,906	6.2%	44,680	2.30100	-0.6%	0.5%	230%
N & W Europe	Lithuania	LTU	145,923	17.8%	16,709	1.48800	6.4%	8.3%	165%
N & W Europe	Netherlands	NLD	627,355	8.3%	48,796	2.21300	2.2%	2.3%	225%
N & W Europe	Sweden	SWE	359,412	5.6%	54,075	2.35400	0.4%	0.3%	242%
N & W Europe	United Kingdom	GBR	2,446,129	9.6%	39,532	1.77700	2.0%	1.5%	221%
S & E Europe	Czechia	CZE	458,759	9.5%	20,291	1.58600	-1.3%	0.5%	177%
S & E Europe	Greece	GRC	505,507	7.7%	19,214	1.41800	-3.3%	-2.2%	212%
S & E Europe	Hungary	HUN	521,733	7.7%	14,364	1.51700	-4.1%	-1.8%	168%
S & E Europe	Italy	ITA	2,572,464	10.1%	32,038	1.52100	1.2%	0.7%	244%
S & E Europe	Poland	POL	1,703,302	9.1%	13,871	1.42800	-2.7%	-0.7%	145%
S & E Europe	Portugal	PRT	460,145	7.2%	21,316	1.77100	-3.4%	-1.0%	273%
S & E Europe	Romania	ROU	1,053,728	8.8%	10,781	1.01600	-3.6%	-3.0%	86%
S & E Europe	Russia	RUS	6,893,666	19.5%	10,846	0.64630	7.1%	5.9%	127%
S & E Europe	Spain	ESP	1,693,069	8.8%	28,175	2.00300	-0.8%	1.7%	219%
Africa	Egypt	EGY	2,240,686	16.0%	2,441	0.25690	2.2%	0.5%	91%
Africa	South Africa	ZAF	2,083,927	14.8%	6,120	0.88330	1.7%	2.4%	64%
Africa	Tunisia	TUN	294,813	9.6%	3,494	0.62410	-4.0%	-4.1%	107%

Table 15 contains the data used to compare excess mortality with per-capita GDP (Figure 42) and state capacity (Figure 45), also showing the differences between excess mortality and the relevant trend lines. For added interest, and as a point of reference for the monthly charts, the table also shows the vaccination dose rates per capita up to December 2022.

The countries in these tables and the associated figures were selected on the following basis:

First, we identified the 79 countries in the OWID database for which relevant data was available for all of 2020, 2021 and 2022, and more than half of 2023[72].

Of these, we selected the 30 with the highest expected deaths, on the basis that these would give the greatest global coverage and relevance and the least spurious variation. These countries included Australia (21st on this list).

Then, we identified a further ten countries with special relevance. These were (in decreasing order of expected deaths):

- Sweden (33), because it adopted a COVID-19 strategy that differed greatly from the other Nordic nations;
- Tunisia (35), because it is in Africa, which is not very well represented in the OWID data;
- Ecuador (36), because there was insufficient data for Colombia, which we had included last year;
- Azerbaijan (38), because of its very high mortality in late 2020;
- Denmark (39), because it represents the Nordic nations other than Sweden;
- Israel (44), because it was a leader in vaccine take-up;
- Dominican Republic (46), because it is a Caribbean state (included in Latin America in our analysis);
- Lithuania (48), because it is representative of the Baltic states;
- New Zealand (50), for direct comparison to Australia; and
- Singapore (57), because it always seemed to be a point of comparison for Australia, at least early in the pandemic.

The resultant list of 40 countries differs from the 40 in our previous analysis as follows:

- Iran, Peru and Colombia have been omitted, due to insufficient data; and
- Tunisia, the Dominican Republic and Ecuador have been added.

[72] If we had required complete data for 2023, we would have excluded Brazil, Mexico, The Philippines, South Korea, Canada, Uzbekistan, Tunisia and the Dominican Republic

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