PUBLIC HEALTH COMMUNICATION CENTRE AOTEAROA

Covid-19 Case-Fatality Risk & Infection-Fatality Risk – important measures to help guide the pandemic response

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In this blog we explore two useful mortality indicators: Case-Fatality Risk (CFR) and Infection-Fatality Risk (IFR). We estimate the cumulative CFR in Aotearoa New Zealand (NZ) to be around 0.08%, which is lower than other jurisdictions who have used elimination approaches in the past, such as Australia, Singapore, Taiwan and Hong Kong. The cumulative number of Covid-19 infections in NZ is not known, but if we assume it is ~50%, the IFR would sit at ~0.03%. We recommend that the NZ Government improve Covid-19 surveillance in order to improve estimates of CFR, IFR and other key indicators to help guide future decisions around control measures.

Aotearoa New Zealand (NZ) is in the post-peak stages of its first Omicron wave of Covid-19. The sharp increase in the number of reported cases in 2022 indicates how much more transmissible the Omicron variant is, compared to previous variants, after it spread widely when border control failed in early 2022. This picture is similar to other nations which had previously used border controls to manage Covid-19. As of 9 May 2022, NZ has reported ~826 deaths from Covid-19.

As we have discussed previously, NZ has managed through a range of public health measures to maintain a relatively low Covid-19 mortality rate which now sits at ~16-17 deaths per 100,000 population (also known as a crude mortality rate) during the pandemic compared to many other nations. This even resulted in an increase in life expectancy, and net decline in excess mortality (further supported in a May 2022 Report by the World Health Organization [WHO]). In this blog, we briefly look at two other Covid-19 mortality indicators; the case-fatality risk (CFR; also incorrectly referred to as a rate or ratio) and infection-fatality risk (IFR).

The Covid-19 CFR in NZ and internationally

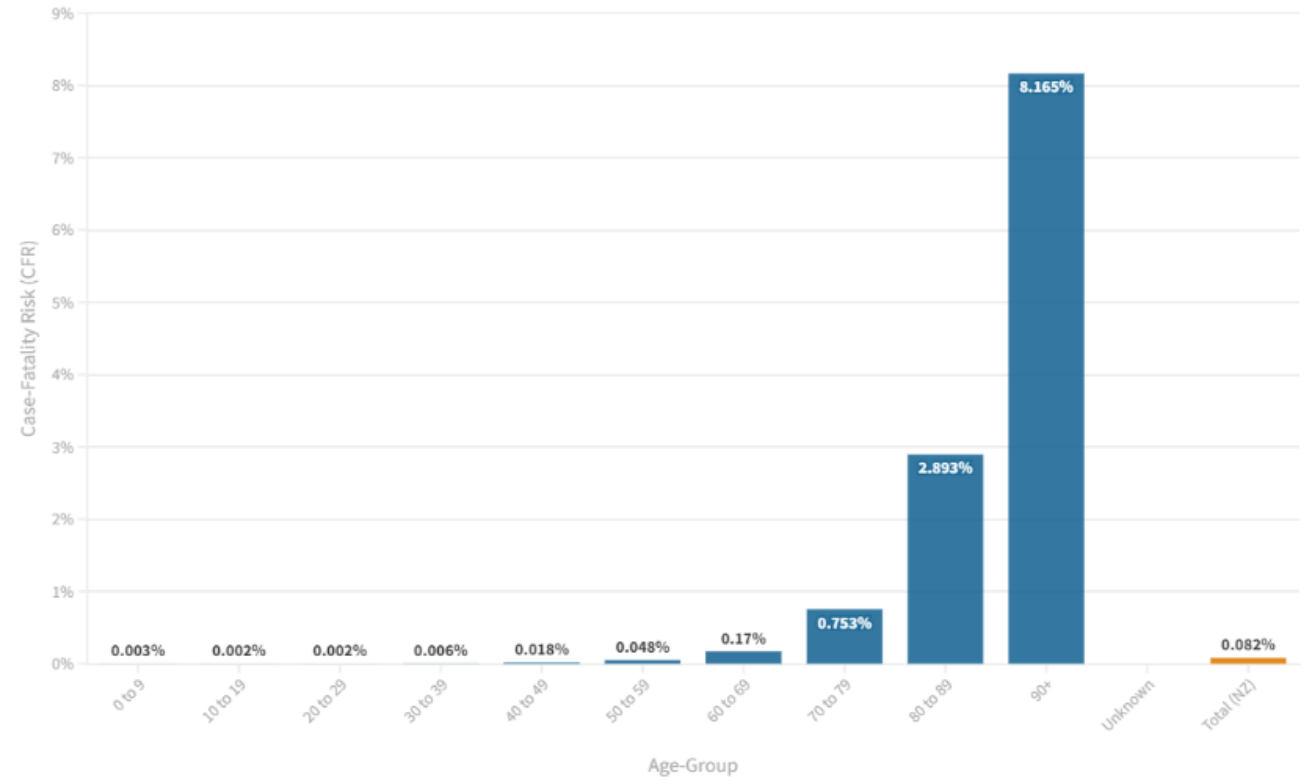
The WHO describes the CFR as *'the proportion of individuals diagnosed with a disease who die from that disease and is therefore a measure of severity among detected cases'*:

$$Case-fatality\ risk\ (CFR, in\ \%) = \frac{Number\ of\ deaths\ from\ disease}{Number\ of\ diagnosed\ cases\ of\ disease} \times 100$$

Basically, the CFR *'expresses the percentage of people that have been diagnosed with a disease that die from it'*. A recent CDC study by Focacci, Lam & Bai (2022) found that of the various Covid-19 mortality indicators (such as the IFR and crude mortality rate), the CFR was best placed to *'drive policy preferences that help stop the spread of the virus, as well as boost the level of concern with respect to a potential economic crisis'*. However, the CFR is not an estimate of risk of death for an infected person, it is nevertheless useful when trying to increase understanding of the seriousness of an outbreak, such as Covid-19.

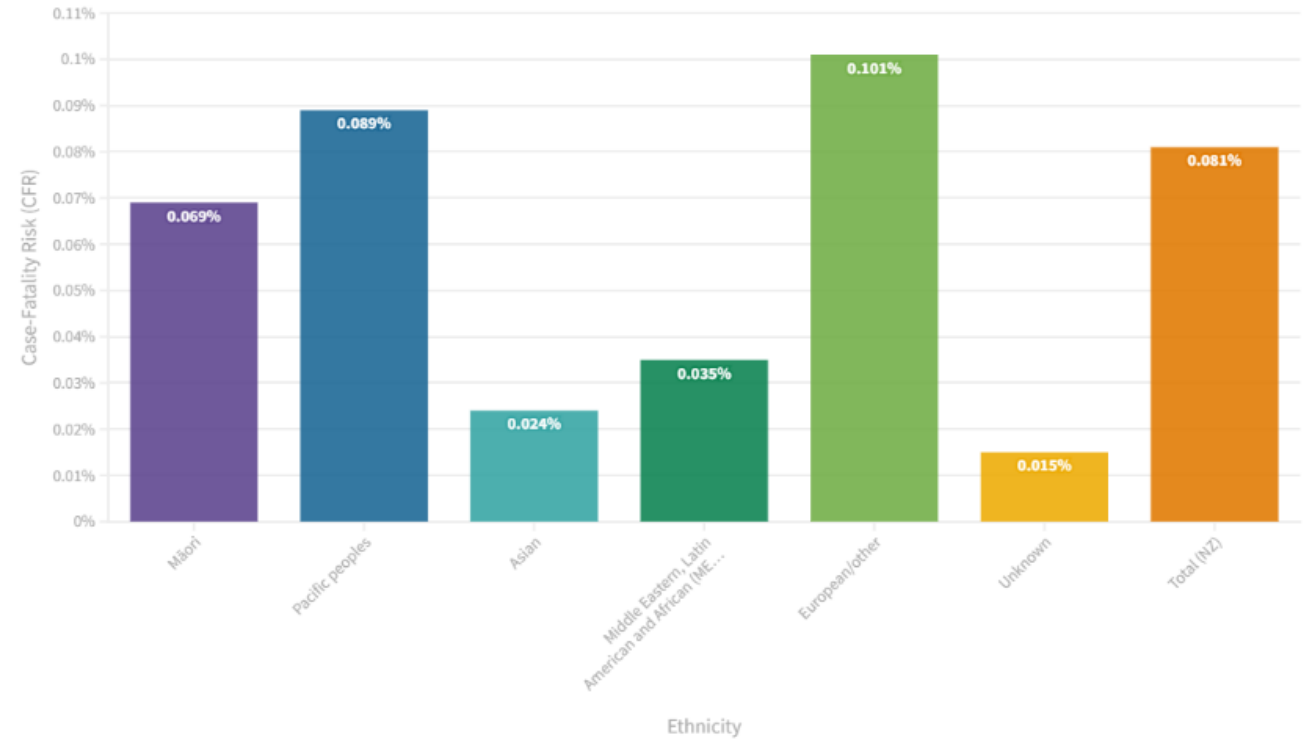
If we look at the data available from the NZ Ministry of Health, we can estimate the CFR based on the reported deaths and reported cases. Figure 1 shows the CFR in NZ by age group up to 4 May 2022 and Figure 2 shows the CFR in NZ by ethnicity. Whilst the CFR increases with age, the total CFR for the whole of NZ is 0.08%. The higher CFR seen at older ages in NZ is consistent with the international picture. The European/other ethnic group has the highest CFR at 0.1% and Asian the lowest at 0.024%. Care must be taken when interpreting these statistics, for example, there are different testing levels (along with underreporting), different vaccination levels and furthermore, different ethnic groups have differing age structures, ie, Māori and Pacific peoples have a much younger age structure compared to European/other which inevitably lowers the total CFR.

Figure 1: Case-Fatality Risk by Age Group in NZ (for the whole Covid-19 pandemic period)



Source: Ministry of Health – Manatū Hauora • Data covers period up to 11:59 pm 8 May 2022, data extracted 9 May 2022

Figure 2: Case-Fatality Risk by Ethnicity in NZ (for the whole Covid-19 pandemic period; not age-adjusted)

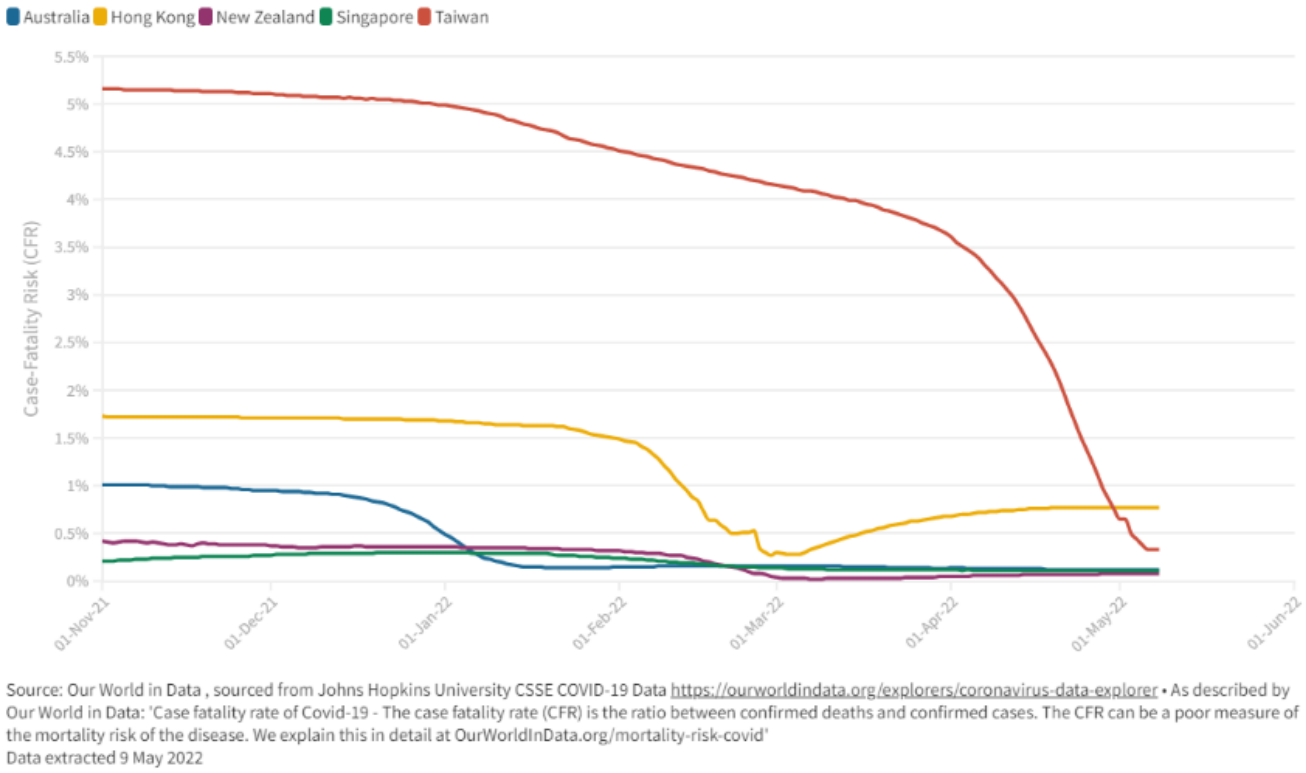


Source: Ministry of Health – Manatū Hauora • Data covers period up to 11:59 pm 8 May 2022, data extracted 9 May 2022

Using Our World in Data for the entire pandemic period, along with NZ, we have briefly

looked at several other largely high-income jurisdictions who at some period during the Covid-19 pandemic utilised elimination approaches (Figure 3). Using these data up to 8 May 2022, NZ's cumulative CFR sits around 0.08% (matching the NZ Ministry of Health based estimates), Singapore is 0.11%, Australia is 0.12%, Taiwan is 0.75% and Hong Kong sits at 0.77%. These cumulative CFR's vary substantially when looking at the entirety of the pandemic, depending on several variables, such as country-specific demographic characteristics of the population (ie, age and underlying risk factors), the circulating variant(s) and in particular, surveillance and detection/reporting capabilities (see appendix Figure 1). If we exclusively calculate the CFR for the Omicron period in NZ (from mid-January 2022 when community transmission was detected along with the decrease in the Delta variant), the cumulative CFR still remains at 0.08% for NZ. Before Omicron, the cumulative CFR in NZ was ~0.34%.

Figure 3: Omicron Period – Covid-19 Case-Fatality Risk – Cumulative (selected jurisdictions that used elimination strategies in the initial response to the pandemic)



Source: Our World in Data , sourced from Johns Hopkins University CSSE COVID-19 Data https://ourworldindata.org/explorers/coronavirus-data-explorer • As described by Our World in Data: 'Case fatality rate of Covid-19 - The case fatality rate (CFR) is the ratio between confirmed deaths and confirmed cases. The CFR can be a poor measure of the mortality risk of the disease. We explain this in detail at OurWorldInData.org/mortality-risk-covid'
Data extracted 9 May 2022

Singapore, and Hong Kong, like NZ, are currently post-peak of their first Omicron waves. For Australia, the first Omicron wave peaked in January 2022, and most states and territories are now probably past the peak of their second Omicron waves (except for Western Australia which is slightly delayed). For Taiwan, the Omicron wave is probably still to reach its peak, with the current outbreak the largest so far in the pandemic. There are also reports from the Taiwanese Central Epidemic Command Center that the majority of deaths up to 3 May 2022 in the Omicron wave are amongst the unvaccinated. A recent study (still to be peer-reviewed) suggests that in Hong Kong, '*a similar fatality risk for unvaccinated cases in the early part of our fifth wave* [Omicron BA.2 variant wave] *compared to earlier waves, indicating that the intrinsic severity of BA.2 may not be much lower than the ancestral strain if at all…*". In NZ, about half of the Covid-19 deaths have occurred amongst those who have not had a booster, although proportionality, deaths are higher amongst the unvaccinated. However, to truly understand the reason for the current

~10 fold difference between NZ's CFR and that of Hong Kong and Taiwan would require more extensive investigation.

There are also limitations to using CFR statistics during an ongoing outbreak to inform disease management and policy (as also made clear by Our World in Data), and also for cross country/jurisdiction comparisons. For example, the CFR may be underestimated due to the time lag from diagnosis of cases to reporting of deaths. Working in the opposite direction, the CFR may be overestimated if cases are undercounted. We only need to look at NZ to see potential underreporting of cases during the current Omicron period. Producing valid estimates of the IFR may be even more difficult again during an outbreak unless there is an ongoing measurement of infection rates (for example by using serological surveillance as is done in a recent CDC seroprevalence report).

The Covid-19 IFR in NZ

Our World in Data describes how the IFR is able to address the question of what the likelihood is of dying is for an infected individual. It does however require a reliable estimate of the total number of cases (including asymptomatic), not just the diagnosed cases like the CFR:

$$Infection-fatality\ risk\ (IFR, in\ \%) = \frac{Number\ of\ deaths\ from\ disease}{Number\ of\ infected\ individuals} \times 100$$

A recent systematic review published in the *Lancet* estimated from multiple seroprevalence surveys that during the pre-vaccine phase of the pandemic, the IFR in 190 countries/territories varied substantially based on age, location, time and with public health intervention. Age patterns for mortality and IFR from Covid formed a *'J-shaped curve, with the lowest risk occurring at approximately age 7 years'.* For countries, the highest age-standardised IFR estimates were for Peru and Portugal at 0.911% and 0.850% respectively. The specific estimates for NZ suggest that the pre-vaccine IFR was 1.217% (95% confidence interval [CI]: 0.810% to 1.866%) on 15 April 2020, and decreased to 0.79% (95%CI: 0.605% to 1.056%) by 1 January 2021. When this measure is age-standardised (to the global age distribution of the world's population), the pre-vaccine IFR in NZ is estimated to decrease to 0.445% (95%CI: 0.341% to 0.595%) on 1 January 2021.

The impact of different variants contributing to the current true number of cases in NZ (not just those which are confirmed), along with the wide-spread vaccination and potential immunity from previous infections in NZ would substantially change the IFR estimate from these pre-vaccine IFR estimates. If we apply the results of a recent CDC seroprevalence report indicating that ~50% of all Americans have SARS-CoV-2 antibodies, NZ would have a IFR of 0.03% (for the period of the entire pandemic) with ~50% of the population having been infected (whether having symptoms or not).

One estimate for seasonal influenza IFR in NZ is 0.039%, so if we assume that ~50% of New Zealanders have/had Covid-19, the IFR for Covid-19 of 0.03% (for the period of the entire pandemic) is lower than the IFR for seasonal influenza. However, this IFR Covid-19 estimate for NZ is not robust, and would need be adjusted for age/ethnicity/vaccination status to allow valid comparison with seasonal influenza (for which vaccination rates are much lower than for Covid-19). Such a comparison should ideally consider the impact of long-term

complications from either Covid-19, such as long-Covid, or seasonal influenza.

What could the NZ Government do to improve surveillance and disease control?

To robustly explore the impact of Covid-19 in terms of mortality, in particular amongst different groups in the NZ population, accurate data inputs are needed. These data would help inform future Covid-19 pandemic policy decisions, along with helping to identify at-risk populations more accurately. The following are actions that the NZ Government could consider to improve Covid-19 surveillance and management:

- Ideally, NZ would conduct a similar population-based antibody survey to the recent CDC seroprevalence report to give more quality estimates of the number of people who have been infected with SARS-CoV-2, the virus that causes Covid-19 . This would allow for the calculation of a more valid IFR estimate for NZ.
- As we have described previously, there is the ongoing potential for new Covid-19 variants. In general, genome sequencing needs to be maintained (eg, of a random sample of people arriving in NZ and for a random sample of cases admitted to hospitals). There may even be a case for routinely sampling wastewater from incoming international flights – as successfully used in Australia.
- As part of targeting interventions to those who are most vulnerable to dying from Covid-19, the NZ Government should consider enabling a second booster/fourth dose for high-risk groups, ideally before the upcoming winter period (as approved in Australia for higher-risk individuals). Similarly, consideration should be made to reducing the minimum age for boosters in NZ, which currently is 16 years of age (as recommended by the CDC) along with reducing the time period between child doses.
- Further efforts should be made to encourage both Covid-19 vaccinations and seasonal influenza vaccinations before the upcoming winter period.
- Further efforts are need to improve indoor ventilation (eg, schools and offices), but also to maintain high levels of mask use in indoor settings.

Unfortunately, NZ can expect future Covid-19 pandemic waves, so these above actions will help strengthen the populations' immunity to both Covid-19, but also other respiratory infections such as seasonal influenza. Furthermore, by strengthening surveillance in NZ, the NZ Government can more accurately assess Covid-19 mortality risks, giving insight into the burden amongst the most at-risk populations, along with giving more robust analysis to feed into future Government policies.

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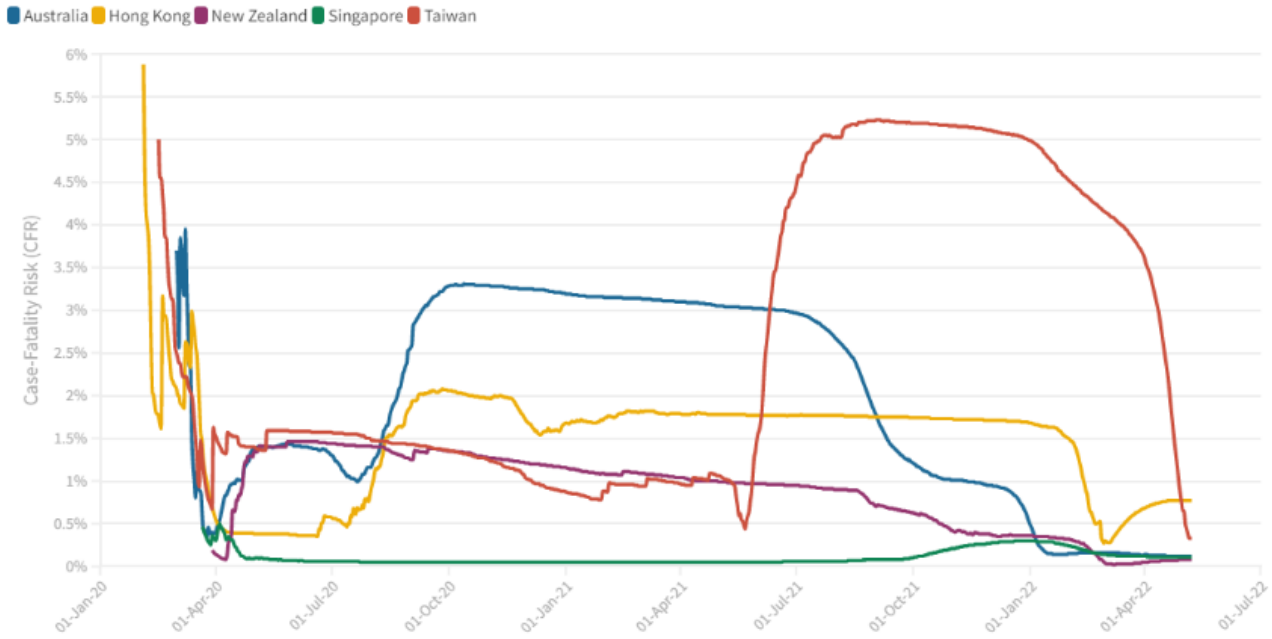
Appendix

Appendix Figure 1: Entire Pandemic Period – Covid-19 Case-Fatality Risk – Cumulative (for those jurisdictions that used elimination strategies at some point during the first two years of the pandemic)



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