Comment on Cumulative Excess Deaths in New Zealand in the COVID-19 Era: Biases from Ignoring Changes in Population Growth Rates

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This is the Github repo for my letter of comment on Gibson's article. The letter references the code data files in the support folder available here. For context, the final draft/ preprint of the letter is included below, though this final draft may differ slightly from any published version.

This is a response to the (Gibson, 2024) paper in which, to give my summary of the paper, Gibson asserts that New Zealand authorities' measurement of mortality in the pandemic period is based on a flawed metric. Gibson's own metric, based on regression of deaths with an additive component of total population, is asserted as a more accurate model and produces approximately 4% excess mortality for the 2020-2022 period. If New Zealand authorities are using flawed metrics with significantly different results to reality, this would have profound governance and policy implications.

In particular, the paper asserts two broad claims:

- That claims of negative New Zealand mortality are underpinned by the "Our World In Data" projection graph using the method of (Karlinsky & Kobak, 2021) [1].
- That Gibson's method, producing positive excess mortality, is more effective than Karlinsky & Kobak in determining excess mortality as it adjusts for immigration-based changes in the rate of population growth.

Neither of these claims are accurate.

[1] The analysis code for (Karlinsky & Kobak, 2021) is available from https://github.com/dkobak/excess-mortality

The underpinning of New Zealand's mortality measurement

For centuries, it has been established practice among actuaries, demographers, and health researchers to measure mortality using age-adjusted death rates where such data is available (Price, 1773). This method supersedes the use of Crude Mortality Rates[2] by acknowledging that different ages have different risks of death, so comparing age-based risk of death on a uniform basis. In New Zealand, tutorials on making mortality comparisons by using death rates by age and standardising to a reference population have been published since the 1890s (Didsbury et al., 1891).

Age Standardised Mortality directly adjusts for both population growth and aging, as it is based on the number of deaths of the current resident population divided by the current resident population, stratified by age group and time period. This directly measures the population change effects Gibson is trying to model.

While calculation of New Zealand's cumulative excess mortality for 2020-2022 can vary by a couple of percentage points depending on the exact method adopted, using an age-standardised death rates method the UK's Institute and Faculty of Actuaries finds New Zealand's excess mortality from week 10 2020 to the end of 2022 to be -4% (that there are 4% fewer deaths than would be expected based on pre-COVID-19 trends) (Institute & Faculty of Actuaries, 2024).

The Our World in Data graph, and the Karlinsky and Kobak method that underlies it, is an approximation (if it is a better or worse approximation to Gibson's method will be discussed later). While recognising the Our World In Data graph is an approximation, there are still several practically useful implicit features about it:

- Being based on trends only of deaths, it enables a common, consistent basis comparison with countries that lack age stratified current population information, or indeed countries that lack any current population information. As Gibson notes, Karlinsky and Kobak were initially able to provide comparison data for 103 countries (later 127). By contrast the mortality.org website has weekly death rates by age (suitable for age standard mortality comparisons) for 38 countries[3].
- It makes weekly comparisons available.
- It is able to be checked by any member of the public for the latest current worldwide information. This last is a function of Our World in Data presentation rather than the method, but it is still a practical benefit.

[2]The Crude Mortality Rate (CMR) is a simple calculation of the total number of deaths in a population divided by that population. The CMR allows comparability of populations of different sizes, but does not make any allowance for differences in composition between populations

[3]The count of 38 countries was obtained from counting the countries in the STMF metadata file https://mortality.org/File/GetDocument/Public/STMF/DOC/STMFmetadata.pdf

The existence of centuries of mortality measurement establishes that it is best practice in mortality calculations to recognise that people of different ages die at different rates not mentioned in Gibson's article. While New Zealand medical professionals have used the Karlinsky and Kobak method/ Our World in Data graphs in media presentations, it is not established if that was for the designed purpose while still being aware of more accurate methods or because K & K was considered definitive. We can check if New Zealand medical professionals are aware of best practice methods by asking them.

> '*...the key point being any comparisons both within country (over time) or between countries should be age standardised to provide the most accurate picture possible (and of course be based on high quality and complete underlying deaths data which we can say NZ's are!)*' (Bloomfield, 2024)

Age Standardised Mortality Review

As Age Standardised Mortality is a standard across multiple disciplines, but is not raised in the Gibson paper, a brief review is in order.

Death rates for an age stratified group, for a time period in a given location, measure the rate at which that age group dies. These can be directly compared to death rates in other time periods and locations to measure if the group experience is more, or less, deadly. As it is a rate, it automatically adjusts for differences in the size of the age group.

While this enables direct comparisons of people of the same age, it does not enable total population comparisons (as total populations may have different age structures). Standardisation with a reference population addresses this by assessing the total population deaths on the basis of death rates by age if the places and times being compared had the same age structure.

The total of standardised deaths can optionally be divided by the standard population to make age standardised mortality rates.

Some variation in calculated results can be caused by the choice of standard population, due to the variation of young and old within a population. However, pragmatically, variations arising from the choice of standard population are likely to be immaterial to the results. Using single year age death rates by sex to 94 then 95+, and a linear baseline from 2013-2019, a standard reference population of 2023 gives a cumulative excess[4] of -2% for 2020 to 2022. Using a standard reference population of 2021 when the borders were restricted gives a cumulative excess of -2%. Using a pre-COVID-19 standard population of 2019 gives a cumulative excess of -2%. Using the standard population of 1961, used by Stats NZ to maintain long-term continuity, cumulative excess is -2%[5].

[4] Using the standard cumulative excess measure of 100*((sum(actual)/sum(expected)) -1).

[5] NZ annual deaths are available from https://infoshare.stats.govt.nz in Population : Deaths - VSD : Deaths by age and sex (Annual-Dec). NZ mean annual population is available from Population : Population Estimates - DPE : Estimated Resident Population by Age and Sex (1991+) (Annual-Dec) : Mean year

These methods use StatsNZ annual counts of resident deaths and resident population, rather than the weekly counts from mortality.org, as mortality.org takes the raw StatsNZ data and interpolates ages to the weekly totals based on the typical annual age distribution of deaths. This is why New Zealand data for weekly death counts at mortality.org contains decimal places.

Using detailed annual StatsNZ age counts of resident deaths and population prevents inaccuracy in results from overly broad age groups. In 2019 the age specific death rate[6] of 10-14 year olds (0.17 per 1000 residents of that age per year) approximately doubles by age 15-19 (0.41), and doubles again by 35-39 (0.83). More doubling takes place by 45-49 (1.95), 55-59 (4.45), and 65-69 (10.27). With the speed of doubling being even faster in older aged that make up the majority of deaths, mortality measurements can be very sensitive to even a few years of change in the population balance.

Excess mortality is the difference between actual mortality and what is expected. The expected value is an estimate based on certain underlying premises, so excess mortality calculations using any method are sensitive to what is considered "normal": the baseline. For Age Standardised Mortality the regular process is to use a linear trend of preceding years, and where trying to measure the impact of a major multi-year event like a pandemic, the linear trend of pre-pandemic years.

As New Zealand, no different to most other advanced economies, has seen the rate of decrease in mortality slow over time, the length of the linear trend baseline period should be short enough not to be introducing error as a result of applying a straight line of best fit to curved data.

After thorough investigation of the data, the Australian Bureau of Statistics (ABS) considers 2013-2019 to give the best baseline for the pandemic period (Australian Bureau of Statistics, 2023). New Zealand has seen a similar trend in mortality in this period to Australia, with the added limitation that using 2011, the year of the Christchurch Earthquake and the residents of the second largest city living in broken housing through the following winter, is an extremely poor choice to include in baselines as such an event is not a reoccurring annual one.

While many international studies use a 5 year baseline range to increase the number of countries for which weekly level data is available, in practice the results for New Zealand do not differ substantively between a 5 (2015-2019) and 7 (2013-2019) year baseline period. Using a 2022 standard population and a 2015-2019 baseline gives -2% excess mortality for 2020-2022, while using a 2013-2019 baseline gives -2%[7].

ended. The 1961 age standardised mortality rate figures are in Population: Death Rates - DMM : Standardised death rates (Maori and total population) (Annual-Dec). Raw data and analysis code at https://github.com/thoughtfulbloke/letter2ed in the support_files folder.

[6] https://infoshare.stats.govt.nz/ Population : Death Rates - DMM : Age-specific death rates by sex, December years (total population) (Annual-Dec)

[7] Raw data and analysis code at https://github.com/thoughtfulbloke/letter2ed in the support_files folder.

Comparison of Gibson and Karlinsky & Kobak

To assess the accuracy of approximations of mortality, the difference of an approximation to age-standardised mortality methods can be measured. Earlier age-stratified methods give a cumulative excess mortality for 2020-2022 in the -2% to -4% range.

The Our World in Data cumulative excess (Projection based on Karlinsky & Kobak) gives cumulative excess mortality for 2020-2022 as 0%.

Gibson's model gives an excess mortality for 2020-2022 range of 1.7% to 5.3% with the central estimate rounding to 4%.

Though not mentioned in Gibson's paper, the commonest method for measuring deaths in relation to total population (without aging) is the Crude Mortality Rate (deaths among the total resident population / total living resident population). This is available for any country producing both an annual count of resident deaths and an annual resident population count. A 2015-2019 linear regression of the annual CMR[8] gives an 2020-2022 cumulative excess of 0%.

Gibson's method produces results further from actuarial standard methods than the Karlinsky & Kobak method. The reason for Gibson's model performing so poorly compared to Karlinsky & Kobak lies in the age imbalance of death rates. Young people frequently migrate and infrequently die (see Figure 1). Old people infrequently migrate and frequently die. Applying a correction based on the amount of migration to the mortality of the total population (dominated by people not migrating) introduces structural error.

Conversely, because the Karlinsky & Kobak method uses only death data, it implicitly limits itself to the population that dies. The population mainly dying are not migrating, so the model does not diverge as far from age standardised mortality as the Gibson method when border changes cause major fluctuations in migration.

If 2020 had the same single year of age death rates as 2019, and new migrant 2020 death rates were the same as the equivalently aged non-migratory population in 2019, then we can calculate the expected deaths from the 35,744 reduction in net migration from 2019 to 2020. Using single age death rates, the youthful migrating population would be expected to result in 85 fewer deaths for the 35,744 reduction in total population[9].

[8] NZ crude death rates are available from https://infoshare.stats.govt.nz in Population : Death Rates - DMM Crude death rate (Maori and total population) (Annual-Dec). Raw data and analysis code at https://github.com/thoughtfulbloke/letter2ed in the support_files folder.

[9] NZ migration data available from https://infoshare.stats.govt.nz in Tourism : International Travel and Migration - ITM : Table: Estimated migration by direction, age group and sex, 12/16-month rule (Annual-Dec). NZ death data available in Population : Deaths - VSD : Deaths by age and sex (Annual-Dec). NZ population data available in Population : Population Estimates - DPE : Estimated Resident Population by Age and Sex (1991+) (Annual-Dec). Raw data and analysis code at https://github.com/thoughtfulbloke/letter2ed in the support_files folder.

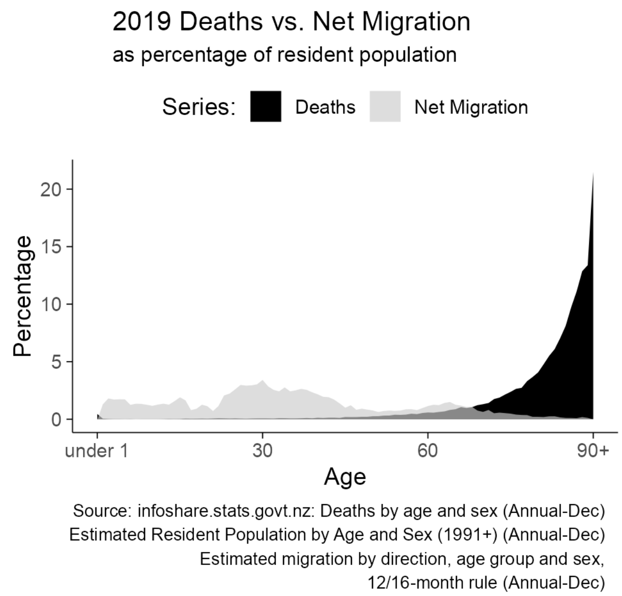

Figure 1: Ages of migration and ages of death have little overlap

Conversely, the expected increase in deaths due to aging can be calculated by aging the 2019 resident population by one year, and subtracting annual deaths of that age, and applying the single year death rates of 2019 (the same assumption as deaths expected from migration). For the resident population, excluding under one year olds, there would be an expected rise of 837 deaths while the total population decreased by about 33,963[10].

Gibson's decision not to apply total population but not age to the model minimises an expected increase in deaths of an approximate order of magnitude greater than the effects of migration. But all these complexities are avoided by incorporating both migration and aging by using age standardised mortality.

Gibson asserted that it was not important to incorporate aging "If societal aging was a cause of the increased number of deaths, as Gabel and Knox (2023) put forward as a reason for the excess mortality in 2022, it should also show up prior to the COVID-19 era, given that societal aging is a long-term process." (Gibson, 2024, pp.5)

The assumption that aging is a long-term process so should show up as a long slow process only applies if there are no sudden demographic shifts among age groups that alter the risk of death. As the pre-COVID-19 era, tautologically, the baseline for COVID-19 comparisons and

[10]NZ death data available from https://infoshare.stats.govt.nz in Population : Deaths - VSD : Deaths by age and sex (Annual-Dec). NZ population data available in Population : Population Estimates - DPE : Estimated Resident Population by Age and Sex (1991+) (Annual-Dec). Raw data and analysis code at https://github.com/thoughtfulbloke/letter2ed in the support_files folder.

trends fitted to it automatically best fit the data of the period, to see the pre-COVID-19 rise requires using a slightly earlier baseline.

The number of 75 and older residents has been growing at an accelerating rate in the decade prior to COVID-19 (see Figure 2). This matches a "sudden" demographic shift of an acceleration in the age distribution that began decades earlier and naturally aged into ranges that play a more significant role in total deaths.

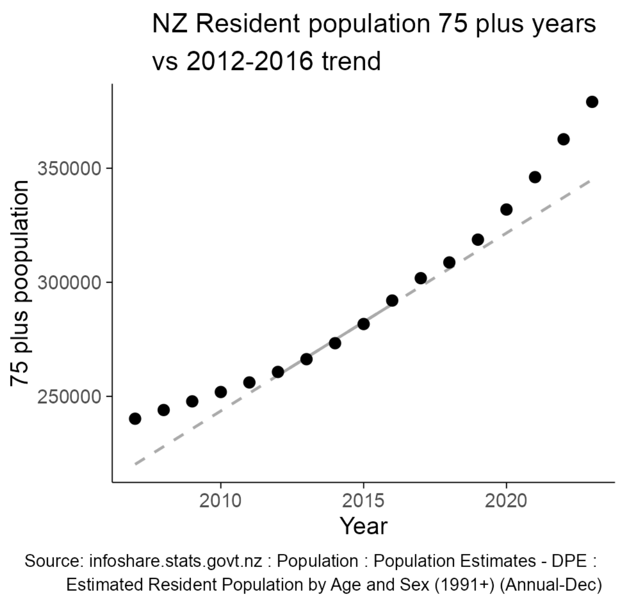

Figure 2: The elderly population grew at an accelerating rate in the decade before COVID-19

But the dramatic increase in elderly is only one of several interacting factors contributing to mortality. Others are factors influencing the age specific risk environment. A more direct measure of the importance of age stratification is the difference in outcome between the Crude Mortality Rate (ignoring age structure) and the Age Standardised Mortality Rate (based on age stratified death rates). The difference in excess mortality between those two methods of 2% to 4% is exactly, and solely, the difference caused by not using age specific death rates.

Of more surprise than the comparison to age standardised methods is that Gibson's results for 2020-22 less well approximate the crude mortality rate than Karlinsky & Kobak, since the crude mortality rate is the normal method of comparing death rates while ignoring the effects of age. While there is not enough information in the paper to exactly replicate Gibson's method and achieve the same outcome, part of the reason for the difference seems likely to be the unusual step of treating population as an additive contributor to deaths in his modification of Karlinsky & Kobak. But, compared to the differences with methods acknowledging age, such problems are minor.

Karlinsky & Kobak also appears superior for comparisons between countries, as Gibson's results are a worse approximation with ASMR based methods calculated by other countries statistical authorities. The Australian Bureau of Statistic's age based mortality analysis has excess mortality of 3.4% across 2020-2022 (Australian Bureau of Statistics, 2023). Karlinsky & Kobak's approximation of 4% is much closer to the ABS result than Gibson's result of -3%.

Conclusion

Specific methods are employed to achieve particular objectives, such as broadening the scope of comparison. It is reasonable to critique the use of such methods if they are applied to different objectives, such as ensuring accuracy on a country-specific level. However, in making such critiques, it is essential to identify the current best practices for achieving that specific objective. Additionally, when making claims about enhanced accuracy, it is crucial to benchmark each method against the most accurate standard to establish the comparative value of different approaches.

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