Australian Government
Centre for Population

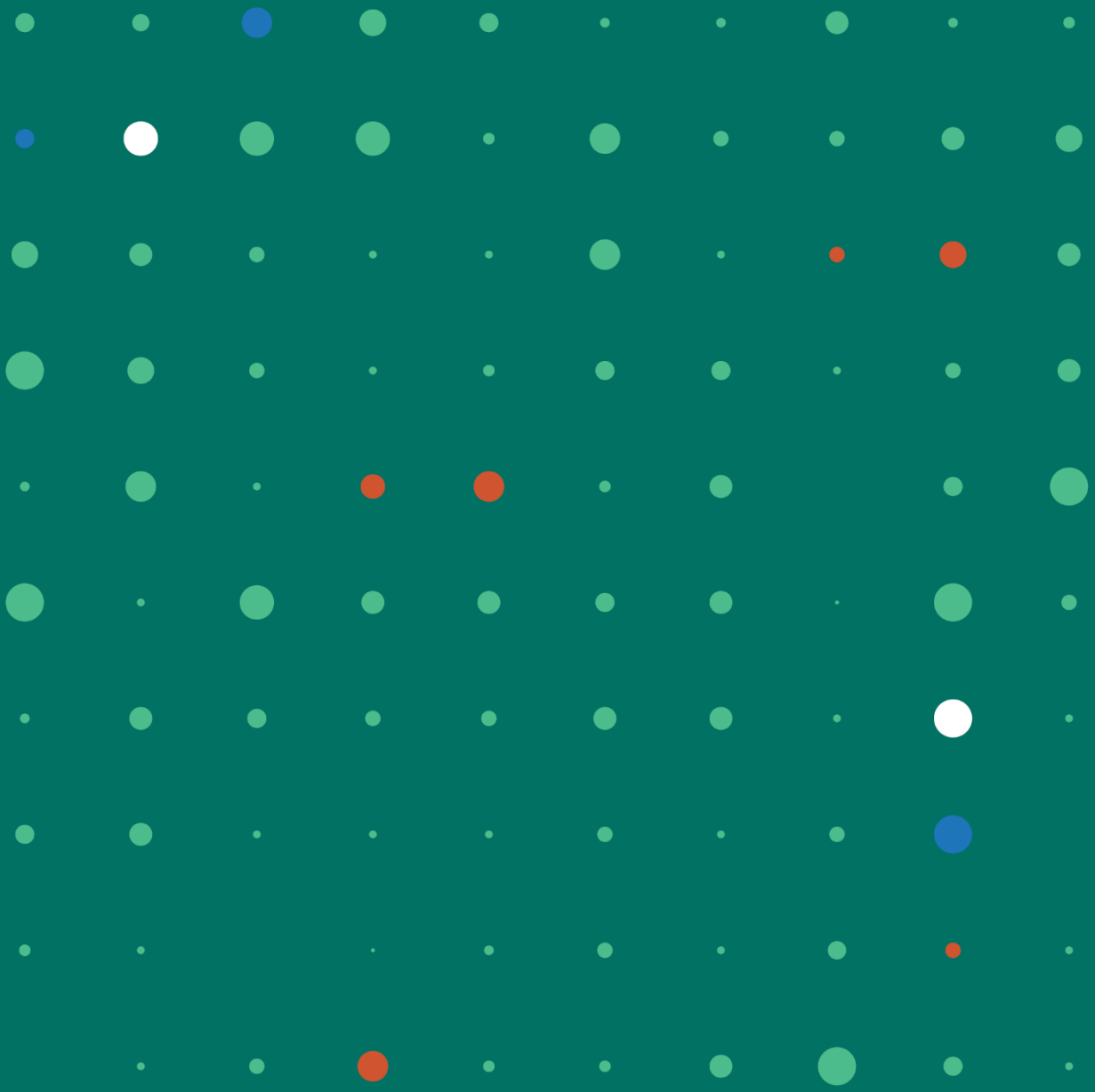
Australian Government
Australian Government Actuary

LIFE TABLES BY BIRTHPLACE

A MICRODATA APPROACH TO RESIDENT SUB-GROUP LIFE TABLES

PREPARED BY THE AUSTRALIAN GOVERNMENT ACTUARY FOR THE CENTRE FOR POPULATION

December 2021



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1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE

The Australian Government Actuary (AGA) prepared this paper for the Centre for Population (the Centre) to inform assumptions about future mortality. The Centre asked the AGA to investigate the mortality experience of sub-groups of the Australian resident population. This paper explores the mortality experience of Australian residents born overseas compared to those born in Australia. The AGA have also prepared separate papers that explore the different mortality experiences of residents of different states and territories, and residents classified by relative socio-economic advantage and disadvantage.

In contrast to the Australian Life Tables produced by the AGA and the life tables produced by the Australian Bureau of Statistics (ABS), this sub-group life table project uses confidential microdata to investigate the mortality experience of the population sub-groups of interest. This microdata is sourced from the ABS DataLab as part of the Multi-Agency Data Integration Project (MADIP). We thank the ABS for access to this confidential unit record data. A disclaimer on the use of this data is provided in section 1.2.

The lead researchers of this work are Limin Wang (of the AGA) and Guy Thorburn (the Australian Government Actuary), with additional review provided by Aaron Bruhn (also of the AGA).

1.2 DISCLAIMER

Legislative requirements ensure that privacy and secrecy of the data is maintained. For access to MADIP data under Section 16A of the *Australian Bureau of Statistics Act 1975* or enabled by section 15 of the *Census and Statistics (Information Release and Access) Determination 2018*, source data is de-identified. Data about specific individuals has not been viewed in conducting this analysis. In accordance with the *Census and Statistics Act 1905*, results have been treated where necessary to ensure that they are not likely to enable identification of a particular person or organisation.

The results of these studies are based, in part, on migration data supplied by the Department of Home Affairs (Home Affairs) to the ABS under the *Australian Border Force Act 2015*, which requires that such data is only used for the purposes of the *Census and Statistics Act 1905* or performance of functions of the ABS as set out in section 6 of the *Australian Bureau of Statistics Act 1975*. Any discussion in this paper of data limitations or weaknesses is in the context of using the data for this specific purpose, and not related to the ability of the data to support Home Affairs' core operational requirements.

2. METHODOLOGY

2.1 DATA

In contrast to the traditional approach of calculating mortality rates from grouped data, these sub-group life tables are based on unit record data comprising the entire resident population of interest. This approach allows us to analyse mortality experience at the level of an individual, which can then be aggregated to form the specific sub-groups of interest, from which the population-level mortality tables can be determined.

We have relied on the MADIP Basic Longitudinal Extract data (BLE 2011 - 2016). This is formed from the Medical Enrolment Data Base (MEDB), Social Security Related Information (SSRI), Personal Income Tax (PIT) and 2016 Census data. The BLE serves as a base data set that represents the population normally resident in Australia.

In addition to BLE 2011 - 2016, registries death data and the quarterly Home Affairs net overseas migration data (from Q1 2006 to Q4 2017) were also used.

The data includes the country of birth, and this was used to determine whether the Australian resident was born in Australia or overseas.

2.2 CRUDE MORTALITY RATES

The calculation of the crude mortality rates requires a measure of both the number of deaths and the population which was at risk of dying over the same period. These need to be calculated for each age and gender.

The exposed-to-risk and the number of deaths should refer to the same population. Effectively this means that a person in the population should be included in the exposed-to-risk only if their death (had they died) would have been included in the relevant death count. Deaths in this paper refer to those who were Australian residents and whose death occurred in Australia during the calendar years 2015 and 2016. The appropriate exposed-to-risk is, therefore, exposure of people who were residents of Australia during the same period.

To determine the exposed-to-risk, we identified all individuals within the BLE 2011 - 2016 data who had any activity in any particular year in Australia. Combining this extracted BLE data with both the death registration data, and the Home Affairs net overseas migration data, allowed the construction of an Australian resident population suitable for life table purposes.

The exposed-to-risk is calculated directly from the underlying dates (dates of residency, date of birth, and date of death if applicable) pertinent to each individual. This is referred to as the direct or individual exposure method, which is made possible via the available ABS DataLab microdata. The central exposed-to-risk is then calculated by aggregating the individual exposure for all individuals in the sub-group of interest.

The exposed-to-risk on 30 June 2016 differed slightly (<1 per cent) from the official estimated resident population (ERP) produced by the ABS, as at 30 June 2016. There are many legitimate reasons why the 2 data sources may not reconcile exactly. To maintain consistency with the official ERP, we developed a series of adjustment factors to apply to the exposures calculated from the MADIP population. Separate factors were developed for each age-gender-country of birth combination. The 2015 resident population was based on the 2016 resident population, with further adjustments based on the occurrence of deaths as well as traveller data.

The crude mortality rates (mx) are then calculated by dividing the number of deaths at a particular age and gender by the exposed-to-risk for that age.

2.3 CREATION OF SUB-GROUP LIFE TABLES

Having established crude mortality rates for each age, gender and location of birth, life tables for each sub-group can be derived. The first step was to graduate (smooth) the crude rates up to age 97. As roughly 30 per cent of Australians are born overseas, the data was sufficiently rich to support a direct graduation for all tables. Smoothing splines were used.

Due to the sparseness of data beyond age 97, mortality rates were extrapolated to older ages using a Makeham curve. This is similar to the procedure adopted within the AGA Australian Life Tables 2015-17. It should be noted that, due to the sparsity of data, the exact shape of the extrapolated curve is quite subjective, and the resulting mortality rates are likely to exhibit a high variance at these older ages.

To determine appropriate mortality rates as at 30 June 2016, we added 0.5 years of age and gender-specific historic mortality improvement to the graduated mortality rates. This is because the data on which our analysis was based was from 1 January 2015 to 31 December 2016 – in other words, the experience across the 2 years occurred on average at 31 December 2015, or 6 months short of 30 June 2016. We sourced the mortality improvement factors from the AGA Australian Life Tables 2015-2017.

Four life tables were produced, one for each gender across each of the 2 categories of location of birth (that is born in Australia and born overseas).

2.4 STATISTICAL TESTS OF FIT

All tables were subject to a series of statistical tests to assess the quality of the graduation. Similar to the testing conducted for the AGA Australian Life Tables 2015-17, these tests indicated that the deviations between the crude rates and graduated rates were consistent with the hypothesis that the observed deaths represented a random sample from an underlying mortality distribution following the smoothed rates. Applying 7 different tests to each of the 4 life tables meant 28 tests altogether were conducted. All tests passed.

3. RESULTS

3.1 RESULTS BY GENDER

The aggregate results for Australia have been presented in the research paper *Life tables by state and territory*. In this paper we present the results for each of the 4 life tables, by gender and across the 2 locations of birth.

The mortality for each gender, across each sub-group location of birth is presented in Chart 1 and Chart 2.

Chart 1. MALE MORTALITY RATES BY BIRTHPLACE, 30 JUNE 2016

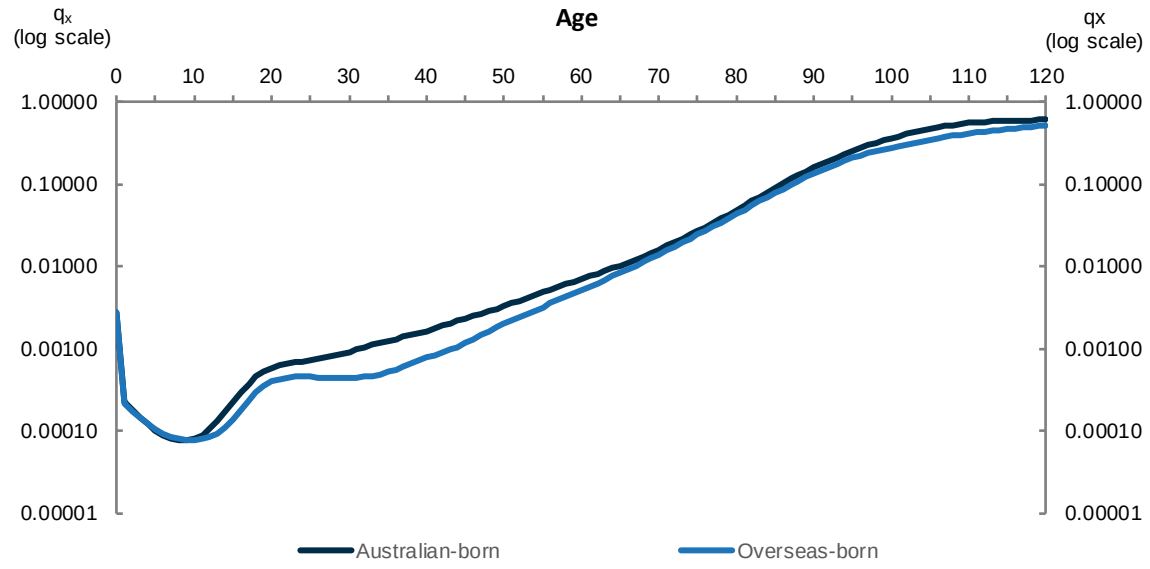
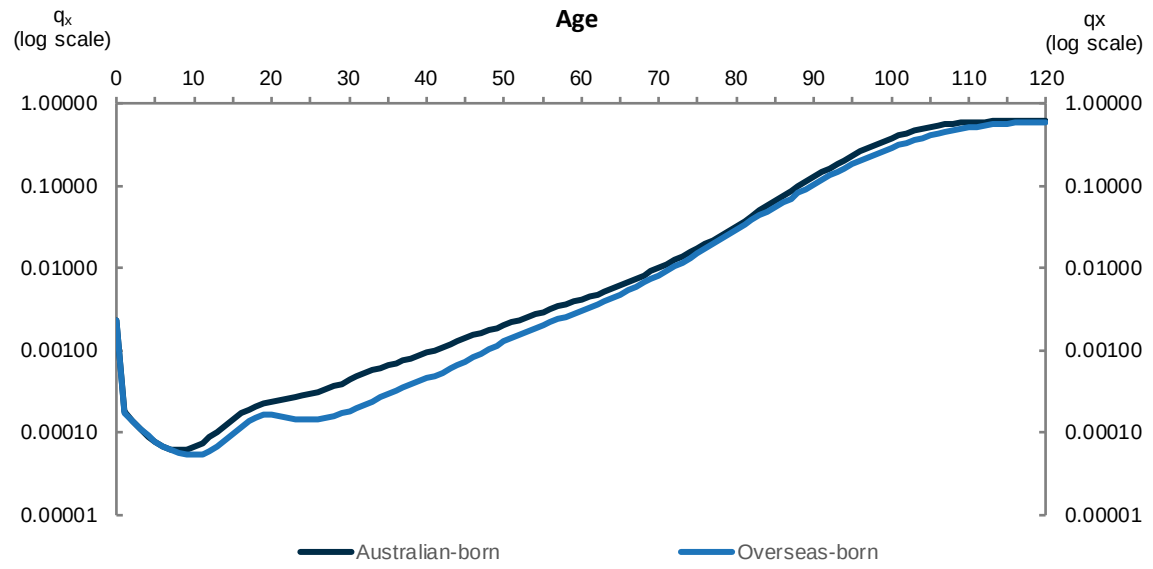


Chart 2. FEMALE MORTALITY RATES BY BIRTHPLACE, 30 JUNE 2016



There are very few overseas-born Australians below aged 10. To overcome this, the mortality curves were fitted to aggregate crude rates below age 10 for all sub-groups. This explains the consistency in the mortality exhibited at the youngest ages.

For both males and females, some differences are apparent depending on whether an Australian resident is born in Australia or overseas. Despite the lower volume of data for overseas-born residents, relativities are broadly similar between those born locally and those born overseas for both genders.

Between ages 10 and 60, the mortality of those born overseas is clearly lower than those born in Australia. It is interesting to speculate about potential reasons for this. One likely explanation may be the presence of a selection effect for those moving to Australia. This could arise because, in general, [1] healthy people are probably more inclined to relocate to a new country, [2] those seeking permanent residency must pass minimum health requirements, thereby providing an underwriting effect, and [3] many immigrants arrive on a work visa, often a skilled work visa. This points to selection pressures operating at multiple levels, giving rise to the 'healthy migrant effect'.[1]

Furthermore, residents who have significant ties with overseas families may also be more likely to relocate back to their country of birth when faced with serious illness. This may act to reduce the number of deaths among some Australian residents who are born overseas.

The differences in mortality reduce significantly around the age of 60 years. The sub-groups remain relatively close thereafter, noting the greater uncertainty in the mortality at advanced ages. This is also in part due to migration generally being at younger ages, and any relative health advantage with newly migrated residents likely to decrease over time and with length of residence.[2]

[1] AIHW 2008, Australia's Health 2008. Cat. No. PHE 157. Canberra: AIHW.

[2] AIHW 2002, Singh M & de Looper M, Australian Health Inequalities: 1 birthplace. Bulletin no. 2. AIHW Cat. No. AUS 27. Canberra: AIHW.

Of particular interest is the distinctly different shapes of the mortality curves for the 2 sub-groups. Those born overseas exhibit something much closer to the traditional accident hump between ages 20 and 35. By contrast, this feature is much less apparent among those born locally.

As expected, Chart 3 and Chart 4 show females exhibit lower mortality than males across both sub-groups. The crossover of relative mortality at very old ages is also apparent for both sub-groups but is more pronounced for those born overseas.

The relative gaps between males and females are similar for each sub-group, subject to differences around the age of the traditional accident hump. The relative experience reflects the underlying data, except for ages below 10, where aggregate crude rates were used to overcome the sparseness of the data for overseas-born Australian residents.

Chart 3. AUSTRALIAN-BORN MORTALITY RATES BY GENDER, 30 JUNE 2016

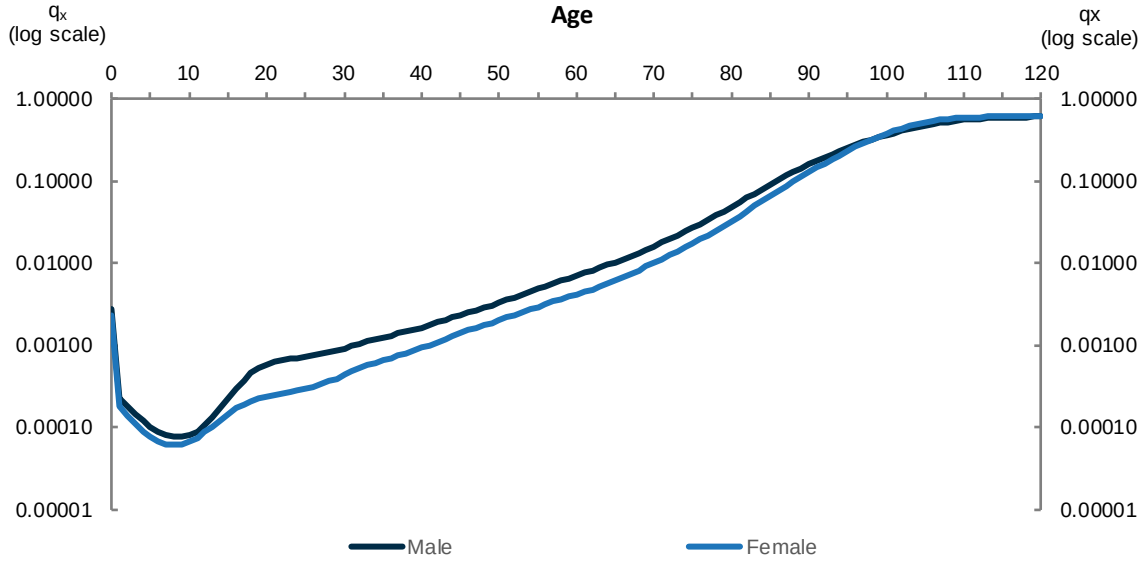
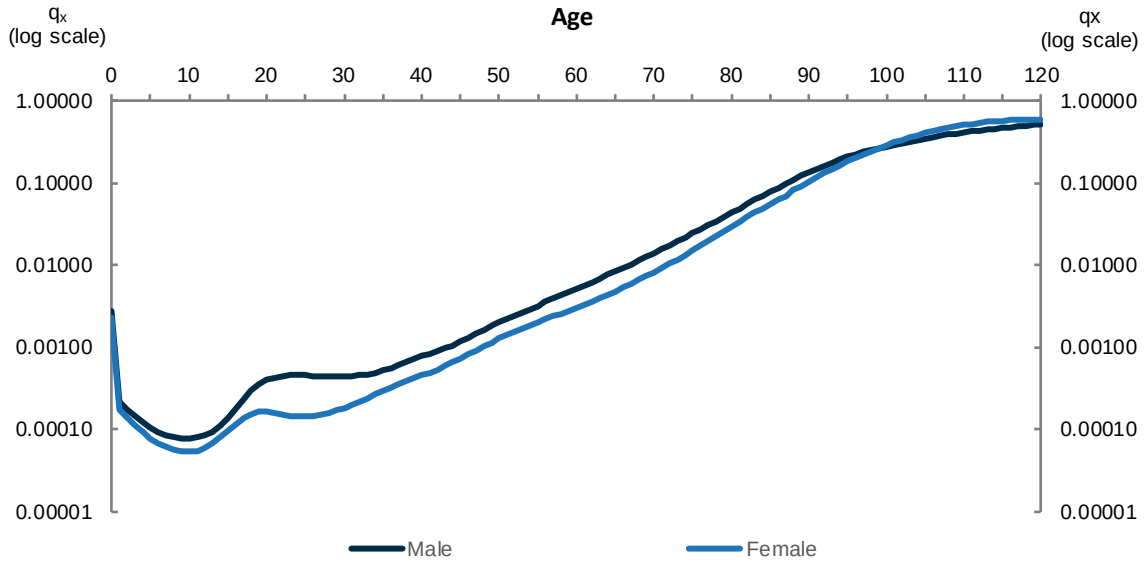


Chart 4. OVERSEAS-BORN MORTALITY RATES BY GENDER, 30 JUNE 2016



4. LIFE EXPECTANCIES

The relativities between the sub-groups and across the genders can be seen further by examining the inferred life expectancies, for various ages, for both the sub-groups and the aggregate Australian population.

In terms of aggregate Australian experience, we compare the life expectancies at ages 0, 25, 65 and 85 between the approach in this paper and those arising from the AGA's Australian Life Tables 2015-17.

Table 1. DIFFERENCES IN NATIONAL LIFE EXPECTANCIES, 30 JUNE 2016

	MALE				FEMALE			
AGE	0	25	65	85	0	25	65	85
AUSTRALIAN LIFE TABLES 2015-17	80.8	56.5	19.9	6.4	84.9	60.4	22.5	7.4
MADIP MICRODATA 2016	80.9	56.5	19.9	6.3	84.9	60.3	22.5	7.3
AUSTRALIAN-BORN	80.0	55.7	19.5	6.0	84.2	59.6	22.1	7.0
OVERSEAS-BORN	82.5	58.1	20.5	6.8	86.3	61.7	23.3	8.0

The life expectancies of the sub-groups are above and below the aggregate Australian life expectancy in the manner that is expected. The life expectancy for those who are Australian-born is closer to the national average life expectancy as this sub-group is the larger of the 2 groups.

5. DISCUSSION

5.1 MORTALITY TABLES

Mortality modelling using microdata is a point of difference of this study, compared to the approaches the AGA uses to develop the Australian Life Table and the ABS uses to develop its life tables. The use of microdata allows a more detailed estimation of exposed-to-risk, which in turn opens the path for mortality investigations across new, previously unexplored, sub-groups. Having demonstrated the concept in the research paper *Life tables by state and territory*, this research paper applies the same principles to investigate the mortality of the resident Australian population based on whether they were born in Australia or born overseas.

The Australian Institute of Health and Welfare (AIHW) have produced occasional analyses into mortality differences between various sub-groups of the Australian population, including Australian-born versus overseas-born residents. A standardised mortality rate across all ages (and both genders) is used as a single measure of aggregate mortality, to compare across sub-groups. We understand that the most recent and relevant publication was in 2014[3], for mortality experience over 2009-2011. Their years of investigation, source and type of data, and development of crude rather than graduated mortality rates, are all points of difference with our study.

We understand this is the first time that microdata-based life tables with graduated mortality, for Australian-born and overseas-born residents, has been generated.

The graduated mortality rates pass a series of statistical tests that indicate the results of the overall graduation of the underlying crude mortality rates are sound and fit for purpose (adoption into Treasury population projections). As an additional sense check, the AIHW study observes the same major features as observed in

[3] AIHW 2014. Mortality inequalities in Australia 2009-2011. Bulletin no. 124. Cat. No. AUS 184. Canberra: AIHW.

our study. That is, the relatively lower mortality of overseas-born residents compared to Australian-born residents, and differences across the ages of the traditional accident hump.

The results of this study show that some differences in mortality experience do exist depending on whether the Australian resident is born locally or born overseas. Subject to sparse data below age 10, where aggregate crude rates were used in the graduation, those born overseas typically experience lower mortality, on average, than those born locally.

From age 20 to 35, the different shape of mortality experienced by the 2 sub-groups is particularly interesting. The declining presence of the accident hump has been discussed over several Australian Life Tables. The fact that it is far less prevalent in the mortality of Australians born locally is particularly interesting. It will be interesting to monitor this in future, along with any changes in the accident hump for the overseas-born sub-group, to see if this is a persistent feature.

5.2 Implications for mortality improvement

In this same age group (20 to 35 years) the differences in mortality and the changing proportion of residents born overseas may also have implications for the rates of improvement in mortality that is observed in the Australian Life Tables over time. Chart 5 shows how the proportion that is Australian-born has changed over time, by age.

Chart 5. Proportion of Australian-born residents to total population by age group for selected years

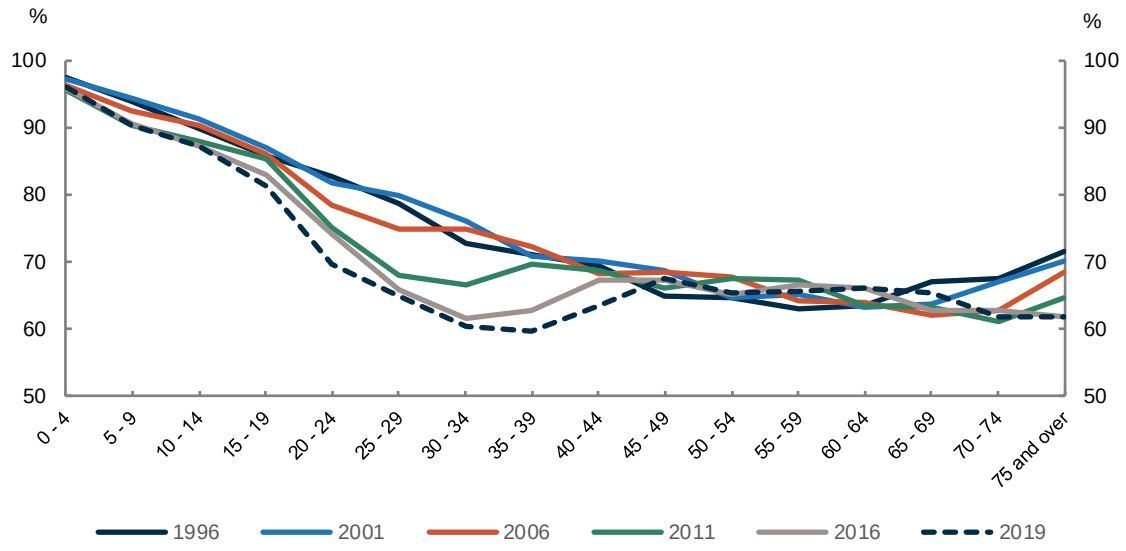
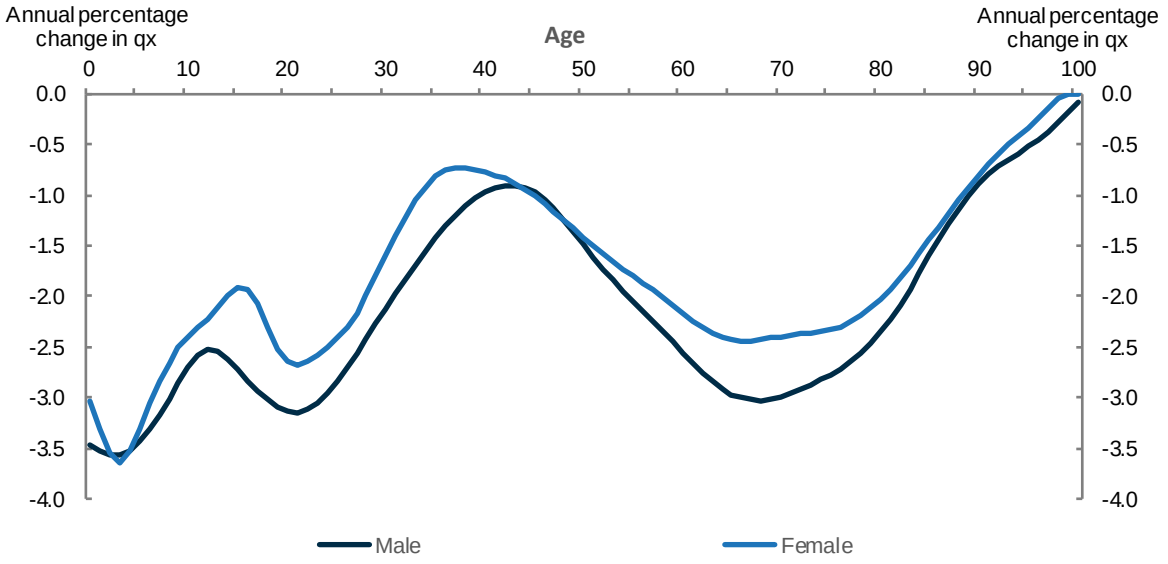


Chart 5 shows that the proportion of Australian residents aged in their 20s and 30s and born in Australia has reduced materially over time, particularly in 2016 and 2019. As residents born overseas exhibit lower mortality at these ages, it is likely that this changing mix of residents is contributing to the mortality improvement that is evident at the national level. By way of comparison, the annual rates of mortality improvement, sourced from the Australian Life Table 2015-17 is reproduced below.

Chart 6. 25 Year Mortality Improvement by Age (ALT2015-17)



The higher rates of improvement in the 20s or 30s are likely to be, at least in part, a function of the growing proportion of overseas-born residents in these ages. Further analysis of the impact of the changing population mix (between those born in Australia and those born overseas) on mortality improvement can be shown in Chart 7 and Chart 8. These charts indicate the relative direction of the likely impact rather than the actual magnitude of mortality improvement.

Chart 7. Percentage improvement from 2011 to 2016 – Male

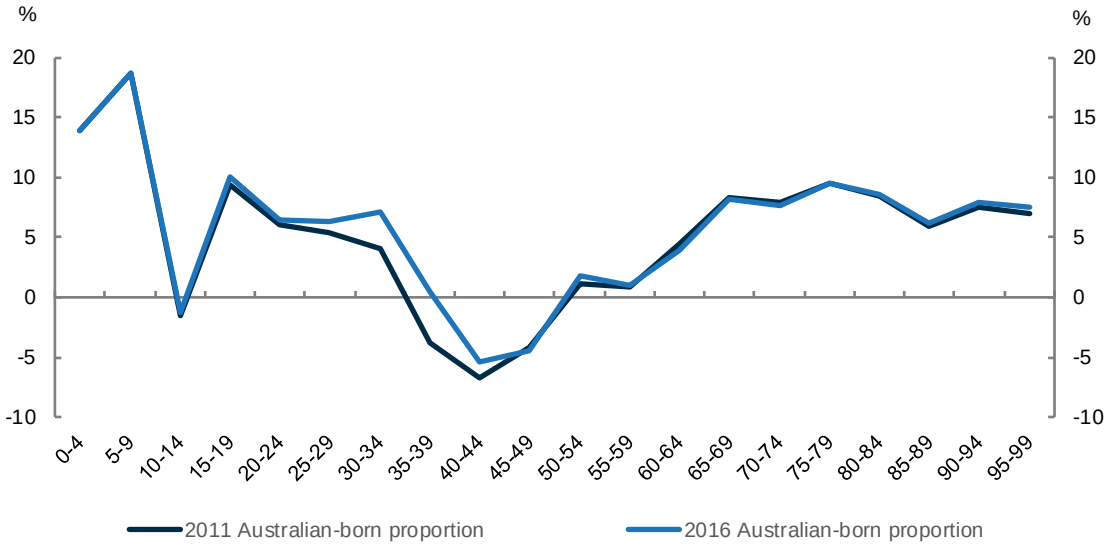
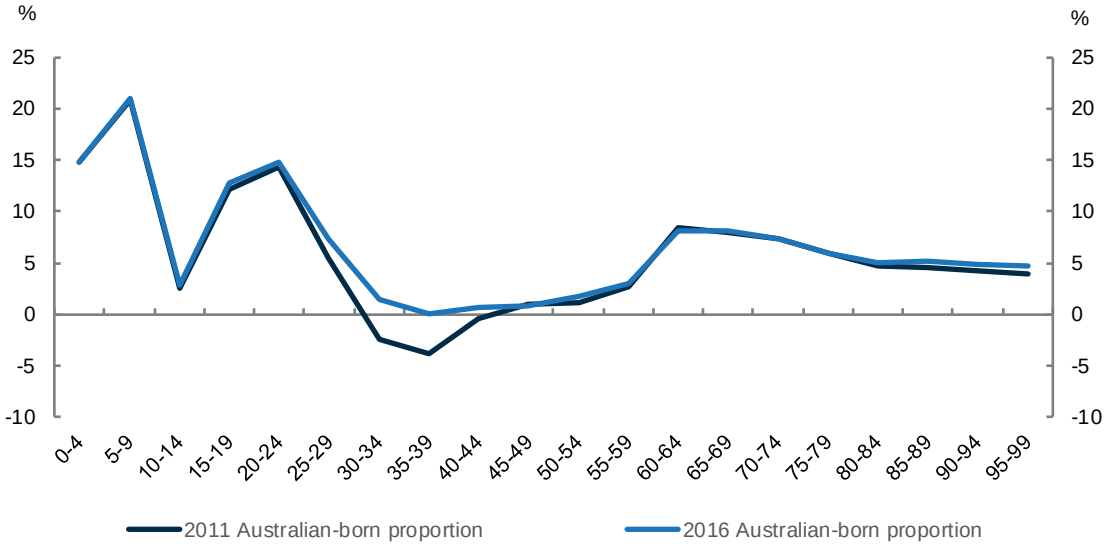


Chart 8. PERCENTAGE IMPROVEMENT FROM 2011 TO 2016 - FEMALE



To interpret Chart 7 and Chart 8, had there been no changes in the Australian-born proportion of the population between 2011 and 2016 (keeping Australia-born proportions at the 2011 level), the percentage improvement between 2016 and 2011 would have reduced from the light blue curve to the dark blue curve. The biggest impacts occurred from the early 20s to the late 30s.

This raises numerous avenues of inquiry about future (national) mortality improvement and how mortality improvement could be applied in sub-group population projections. This issue is complex and beyond the scope of this paper. However, some examples for consideration, in respect of mortality improvement are:

- COVID-19 has reduced immigration in 2020. This reduces the number of overseas-born arrivals. All else being equal, it may mean we see reduced levels of national mortality improvement in the short term for those aged in their 20s and 30s.
- The mix of immigrants may also differ from what is normally experienced. We have not analysed mortality by visa type. The selection effect noted earlier may differ by visa type. A changing mix may affect any impact that we see on national mortality improvement.
- The way immigration recovers to prior levels (if at all) is likely to create a persisting effect on future mortality improvement.
- It may be more appropriate to examine the effect of immigration on population mortality through the lens of a selection effect, resulting in a single national ultimate mortality table with mortality rates adjusted for recent arrivals based on the duration since arrival. This may assist in removing the effect of a changing population mix on the overall national rates of mortality improvement.

Mortality at older ages tends to converge between the 2 sub-groups. Given that most Australians born overseas arrive in their 20s and 30s, this suggests support for the observation that any relative health advantage with newly migrated residents does decrease over time, in line with length of residence. It also

suggests that the number of those who migrate at these older ages is low, relative to those who migrated earlier at younger ages, and have aged in Australia.[4]

[4] In terms of recent migration data, the majority of migrants are young adults, with a median age of 26 and over 60 per cent aged between 18 and 34 years (https://www.abs.gov.au/AUSSTATS/abs@.nsf/featurearticlesbyCatalogue/7A40A407211F35F4CA257A2200120EAA?OpenDocument).