Australian

Life Tables

2020–22

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Definitions of Symbols

Australian Life Tables 2020–22 sets out the following functions:

l_x = the number of persons surviving to exact age x out of 100,000 births

d_x = the number of deaths in the year of age x to (x + 1) among the l_x persons who are alive at the beginning of that year

p_x = the probability of a person aged exactly x surviving the year to age (x + 1)

q_x = the probability of a person aged exactly x dying before reaching age (x + 1)

μ_x = the force (or instantaneous rate) of mortality at exact age x

$\mathring{e}_x$ = the complete expectation of life (that is, the average number of years lived after age x) of persons aged exactly x

L_x = the total number of years of life experienced between age x and (x + 1) by l_x persons aged exactly x

T_x = the total number of years of life experienced after age x by l_x persons aged exactly x

NOTE: Figures in the Tables are rounded and hence the usual identities between these functions may not be satisfied exactly.

INTRODUCTION

This publication presents the *Australian Life Tables 2020–22* (the Tables), which are based on the mortality of male and female Australians over the three calendar years centred on the 2021 Census of Population and Housing (the Census).

This report discusses the major features of the 2020–22 Life Tables. It reviews developments in mortality since the previous Australian Life Tables and over the longer term. A number of measures of longevity are considered and the historic rates of decline in mortality rates are used to estimate past mortality improvement factors. The impact of future mortality improvement on life expectancies and the lifespan distribution is also considered.

As this investigation spans three years where mortality experience varies due to the impact of the COVID-19 pandemic, we have provided additional analysis in respect of each year of investigation to assist readers in the interpretation and application of this report.

This discussion is followed by the Tables, together with the technical notes on their construction. The appendices include supporting information referred to in the text.

The Tables are also available on the AGA website (www.aga.gov.au) together with past mortality rates and life expectancies and the mortality improvement factors referred to in the body of the report.

This is the twentieth in the series of official Australian Life Tables. Tables were initially prepared by the Commonwealth Statistician, but since the 1946–48 Tables, the construction of the Australian Life Tables has been the responsibility of the Australian Government Actuary (or Commonwealth Actuary as the position was formerly designated). The first three Tables, for the years 1881–90, 1891–1900 and 1901–10, took into account deaths over a ten year period and incorporated information from two Censuses. All subsequent Tables have been based on deaths and estimates of population over a period of three years centred on a Census. Since 1960–62, the Censuses, and hence the Tables, have been produced quinquennially.

Guy Thorburn FIAA
Australian Government Actuary

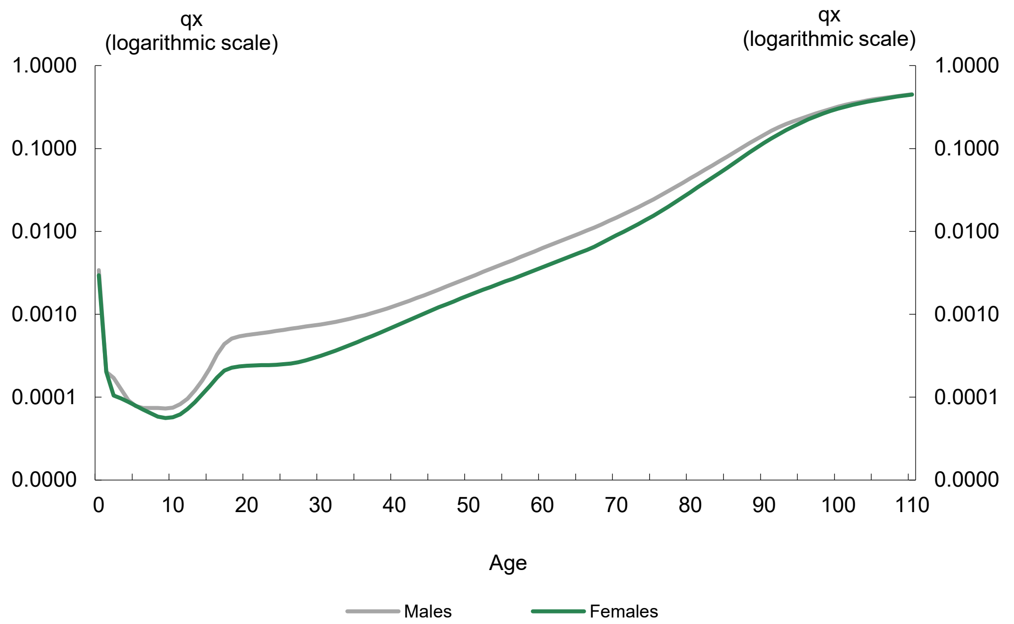
December 2024

1 Mortality of the Australian population

1.1 Results for 2020–22

Figure 1 shows the mortality rates reported in the 2020–22 Life Tables on a logarithmic scale.

Figure 1: Mortality rates 2020–22



The pattern of mortality observed in Figure 1 is typical of developed countries. Mortality rates during the first year of life are relatively high for both males and females, primarily due to congenital abnormalities and perinatal conditions. After the first year of life, an increasing capacity to ward off disease and limited exposure to life threatening situations results in rapidly dropping mortality rates. The mortality rates reach a minimum during school ages (6 to 12 years) where the probabilities of dying within the year are all less than 1 in 10,000 for both males and females.

Accidents are the single largest cause of death in childhood. With developing autonomy of the teenage years, mortality attributable to accidental or self-inflicted causes increases steeply, particularly for males. This growth slows in the early twenties before rates start to rise again as the falling mortality from accidents is more than offset by increasing rates of death due to disease.

The shape of the curves around ages 18 to 21 has not changed greatly since the 1990–92 Tables, when the previous 'accident hump' flattened for the first time in several decades.

The shapes of the mortality curves for males and females are similar, but the absolute rates are different, with female mortality being less than male mortality at all but the very oldest ages. This difference is consistent with a number of factors, including:

- a greater level of risk-taking behaviour by young males;
- the greater hazards associated with some occupations which have traditionally been dominated by men (such as mining and construction);
- the differences in the incidence of some diseases between men and women; and
- the differences in fatality from diseases which affect both genders.

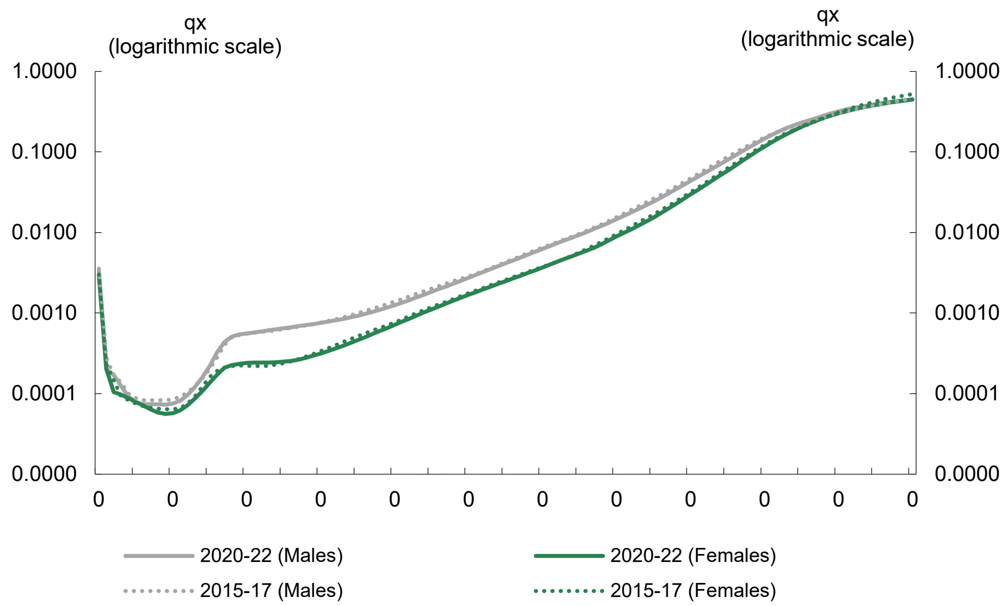
The first two of these factors relate to behavioural differences, including gender stratification in the labour force, rather than physiological differences between men and women. Physiological differences may, however, in part explain the behavioural divergence. The latter two factors could be expected to be the result of both physiological and lifestyle differences.

Mortality rates at the very oldest ages are subject to a higher level of uncertainty due to the smaller cohort of Australians reaching these ages. Since the 1990–92 table, we have seen a consistent ‘crossover’ in the male and female mortality, which has occurred between ages 98 to 103. This is feature is not present in the 2020–22 Australian Life Table until age 113. It may be more appropriate to describe this feature as a convergence of mortality rates in the current table.

1.2 Changes since 2015–17

Figure 2 charts the mortality rates from the current Tables together with those reported 5 years earlier. It shows that mortality rates have fallen for the majority of ages. There are three exceptions where mortality rates have increased slightly; the first being for very young children, the second occurring for those nearing and in their twenties, and then for those at very advanced ages. The increase in mortality rates at advanced ages has been observed, albeit to varying degrees, in each life table since 2005–07.

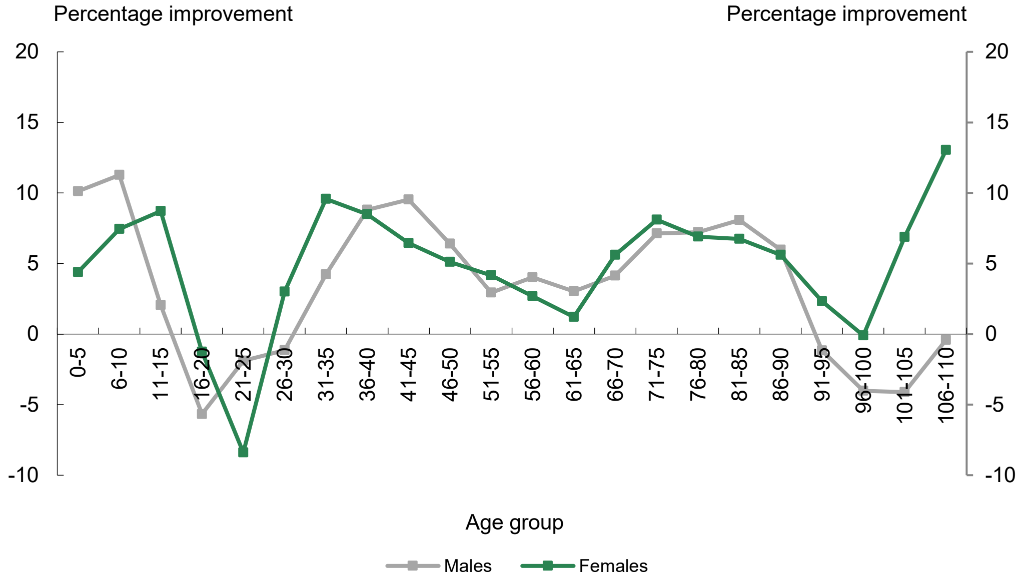
Figure 2: Mortality rates 2015–17 and 2020–22



Four decades ago, there was a clear peak in male mortality around age 20, with mortality rates roughly comparable to those applying to males 20 years older. This phenomenon is known as the accident hump. A similar, but less distinct peak also existed in female mortality. While rates still increase substantially over the teenage years, the distinct peak no longer exists. This is, however, the age group with the greatest disparity between male and female rates and, as illustrated overleaf, the gap remains significant.

Figure 3 shows the average percentage improvement in mortality rates over the 5 years following the 2015–17 Tables by gender for 5 year age bands.

Figure 3: Percentage improvement in mortality since 2015–17 by gender



Infant mortality (age 0) continued to fall, as it has in every published Table. Since the previous Tables, infant mortality has fallen by around 0.9 per cent and 0.5 per cent per annum for males and females respectively.

Mortality in the childhood years has also improved at the majority of pre teenage ages; however, the number of deaths observed at these ages is very small. There is a high variability in the number of deaths reported at these ages. Rates of improvement at individual ages, and the shape of the smoothed mortality curve, will be impacted by this variability. Limited significance should be attached to the changes in mortality at these individual ages.

There has been no improvement in mortality for males in the early teenage years, whilst females have shown improvement. However, as individuals approach age 20, mortality has deteriorated for both males and females.

Over the period since 2015–17 there has been a noticeable improvement in mortality rates for both males and females from around age thirty through to age ninety for both males and females.

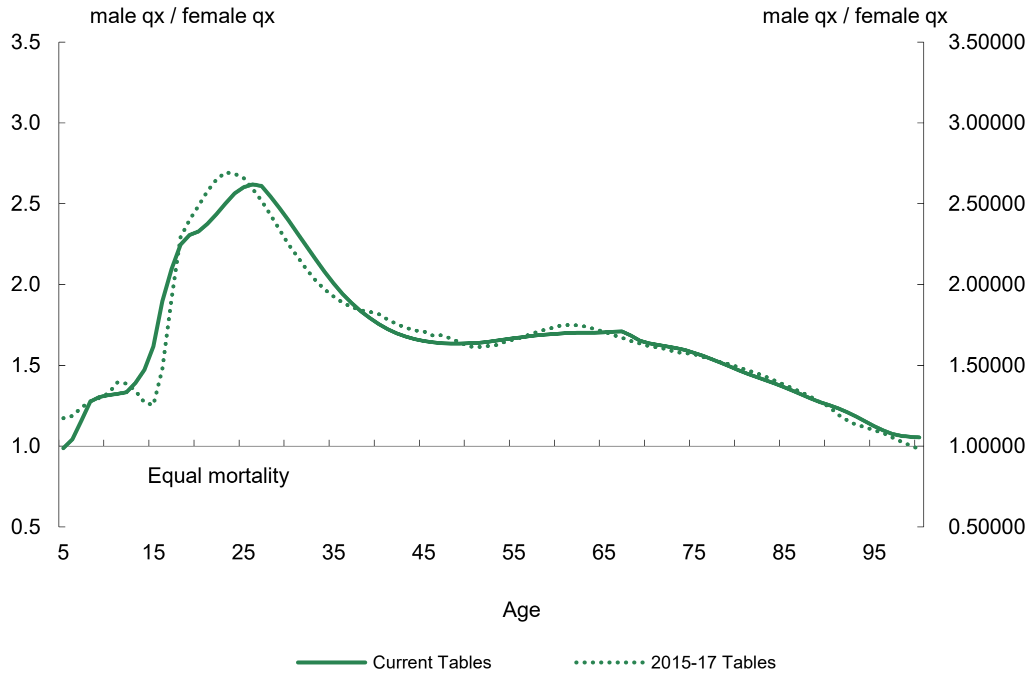
Some deterioration in mortality above age 90 has been a feature of the last four life tables. However, this trend has not been consistent over time. For those aged in the mid to late nineties, deterioration was evident in ALT2005-07 and ALT2010-12. This trend did not persist in 2015–17, however it has re-emerged in this investigation for males.

For centenarians, we continue to find evidence of mortality deterioration in males in all tables since 2005–07. For females, we have observed some deterioration in the previous three reports (2005–07 to 2015–17), however this trend has not persisted in this investigation. There is limited data at advanced ages and therefore additional uncertainty in these observations. With each new life table, there is a growing body of evidence to suggest these age groups are not experiencing the improvements generally associated with younger ages. It will be interesting to continue to monitor mortality improvement at advanced ages in future investigations.

Changes in mortality improvement by age are to be expected over time.

Figure 4 compares the gender differential in mortality rates for the current and previous Table. At most ages there has been little change, indicating that male and female mortality rates have broadly been improving in tandem. The exceptions arise in teenage and early adult years where differing rates of improvement on relatively low mortality rates can have a material impact.

Figure 4: Ratio of male to female mortality rates — Ages 5 to 100, 2015–17, 2020–22



1.3 Inter-year variation

This section compares the crude central rate of mortality for each individual year (2020, 2021 and 2022) with the average crude central rate of mortality across the three year period of investigation.

The primary purpose of the Australian Life Table is to provide an historical record of the mortality experience of Australia during the period of investigation. The Table has not been adjusted for the effects of the COVID-19 pandemic, or indeed any other cause of variation in this period. This information has been provided as some users may wish to further understand the impact of year-to-year variations when developing their assumptions in respect of future mortality.

Comparison of crude central rate of mortality for each single year of investigation with average for 2020–22

	Males			**Females**		
Age band	2020	2021	2022	2020	2021	2022
05-09	*-24%*	**4%**	**20%**	*-38%*	**10%**	**29%**
10-14	*-8%*	**3%**	**5%**	**2%**	*-1%*	*-1%*
15-19	**5%**	**4%**	*-9%*	**10%**	**1%**	*-10%*
20-24	**1%**	*-2%*	**1%**	*-10%*	**4%**	**6%**
25-29	**1%**	**2%**	*-4%*	**4%**	*-8%*	**4%**
30-34	*-2%*	*-1%*	**4%**	**3%**	*-5%*	**3%**
35-39	**2%**	*-8%*	**6%**	**0%**	*-4%*	**4%**
40-44	*-2%*	*-4%*	**6%**	*-6%*	**1%**	**4%**
45-49	*-1%*	*-2%*	**3%**	*-2%*	*-4%*	**5%**
50-54	*-3%*	*0%*	**3%**	*-2%*	*-5%*	**7%**
55-59	*-2%*	*-1%*	**3%**	*-5%*	**1%**	**4%**
60-64	*-3%*	*-3%*	**5%**	*-1%*	*-2%*	**3%**
65-69	*-5%*	*-2%*	**6%**	*-6%*	**1%**	**5%**
70-74	*-3%*	*-2%*	**4%**	*-3%*	**0%**	**3%**
75-79	*-4%*	*-3%*	**6%**	*-4%*	*-2%*	**5%**
80-84	*-5%*	*-1%*	**6%**	*-4%*	*-2%*	**5%**
85-89	*-5%*	*-2%*	**7%**	*-5%*	*-3%*	**7%**
90-94	*-7%*	*-2%*	**8%**	*-7%*	*-2%*	**8%**
95+	*-8%*	**3%**	**4%**	*-9%*	**2%**	**6%**

Statistics have been grouped into age bands to allow for the reduced amount of data in each single year.

This table shows that the underlying mortality experience in this investigation was quite different in each year. 2020 and 2021 generally experienced mortality that was lower than the three year average; only a small number of (mostly younger) age groups had higher than average mortality. The 2020 experience for ages 65 and older is particularly low. Conversely, 2022 experienced mortality that was materially above the three year average at most ages. This is broadly consistent with the experience of excess mortality reported during the COVID-19 pandemic[1].

The two main drivers of the variance observed from year to year are: 1) the absence of influenza in Australia in 2020 and 2021 due to the measures introduced to curb the spread of COVID-19. This resulted in "negative" mortality displacement, with some deaths that would normally have occurred in 2020 (if not for the pandemic) occurring in 2021 and 2022 instead; and 2) relatively widespread COVID-19 in 2022 once pandemic restrictions were lifted and borders re-opened.

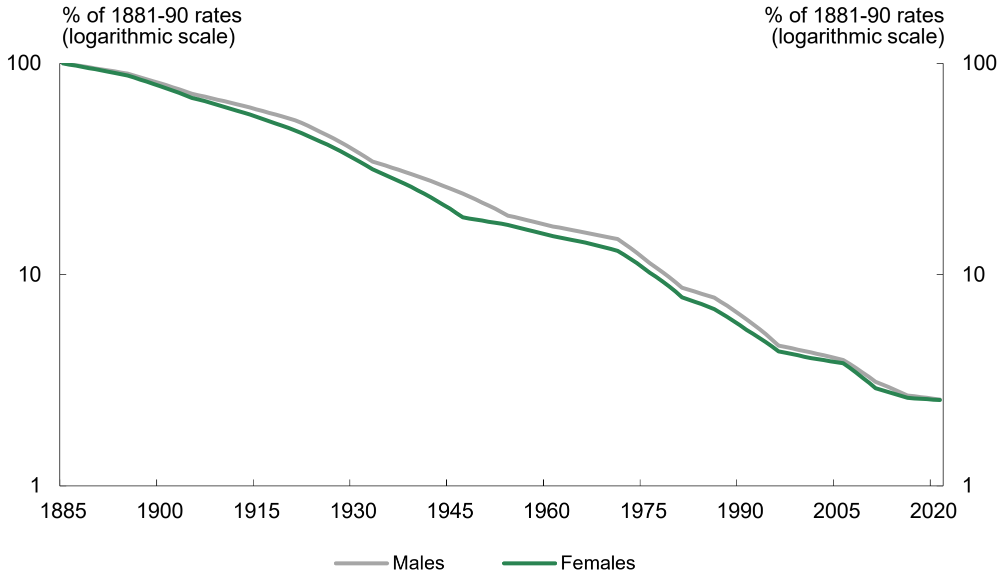
We note that year-to-year variations are not confined to these Tables; for example, the same information for the 2015–17 Tables is expected to have shown the 2017 year materially higher than the three year average due to the impact of the adverse influenza season on mortality in that year.

1.4 Past improvements in mortality

The first official Life Tables for Australia were prepared based on data from the period 1881–90 and there is now a history of 135 years of mortality data. Figure 5 to Figure 8 plot the change in mortality rates over time expressed as a percentage of the rates reported in 1881–90 for selected ages. The data for the four ages shown clearly illustrates the diversity of experience for different ages and genders.

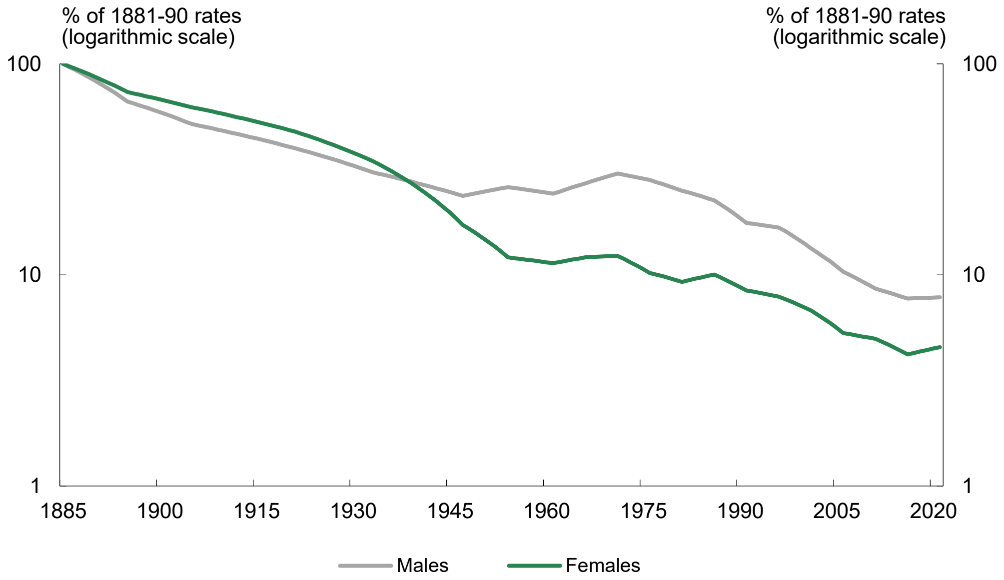
1 Actuaries Institute, *How COVID-19 Has Affected Mortality in 2020 to 2023*, July 2024

Figure 5: Improvements in mortality at age 0



Infant mortality has shown a sustained and substantial improvement over the entire period, with the improvement for males and females moving closely in parallel. The rates for both males and females are now around 2.6 per cent of their level in 1881–90 and are still steadily declining. They do not appear to have reached an underlying minimum rate, although the rate of improvement has slowed.

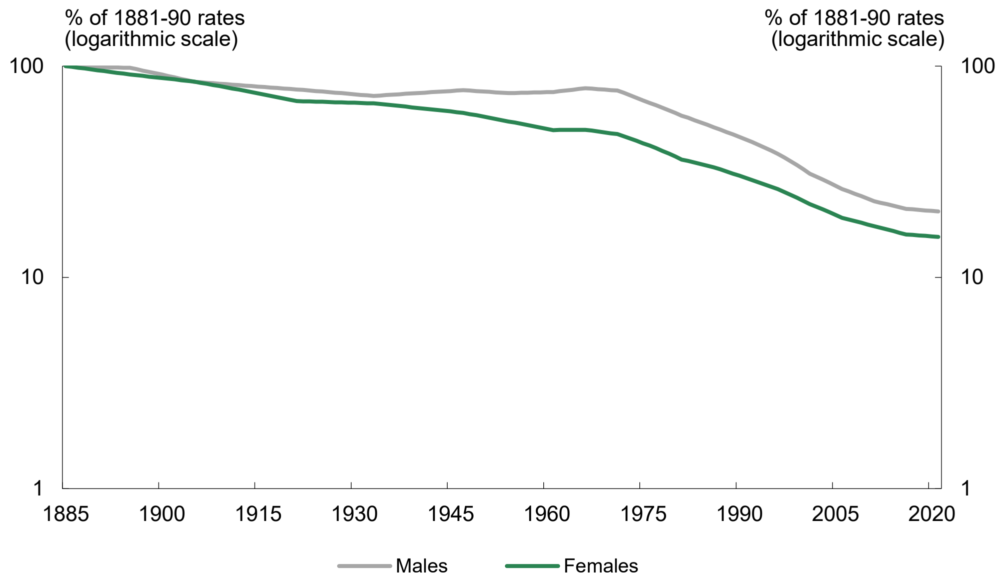
Figure 6: Improvements in mortality at age 20



The picture at age 20 is quite different, with male rates initially improving marginally more quickly than female rates but then deteriorating from about 1945 to 1970 as the accident hump emerged, before declining again as the accident hump subsided and then disappeared. For females at this age, the biggest improvements occurred from the 1930s to the 1950s and probably reflected improved maternal mortality experience as medical procedures were reformed and became accessible to more of the population, coupled with the use of antibiotics from the mid-1940s. Mortality rates for 20 year old females are about 4.5 per cent of the corresponding rates from 135 years ago. For males of the same age, the relativity is around 7.8 per cent.

Most recently, mortality rates for 20 year olds have increased a little. We believe this effect is related to the pandemic as many international students returned home. This reduced the population exposed to risk at these ages, without a corresponding reduction in the number of deaths. We have previously shown that those born overseas have lighter mortality than those born in Australia, particularly during ages typically associated with university study[2].

Figure 7: Improvements in mortality at age 65

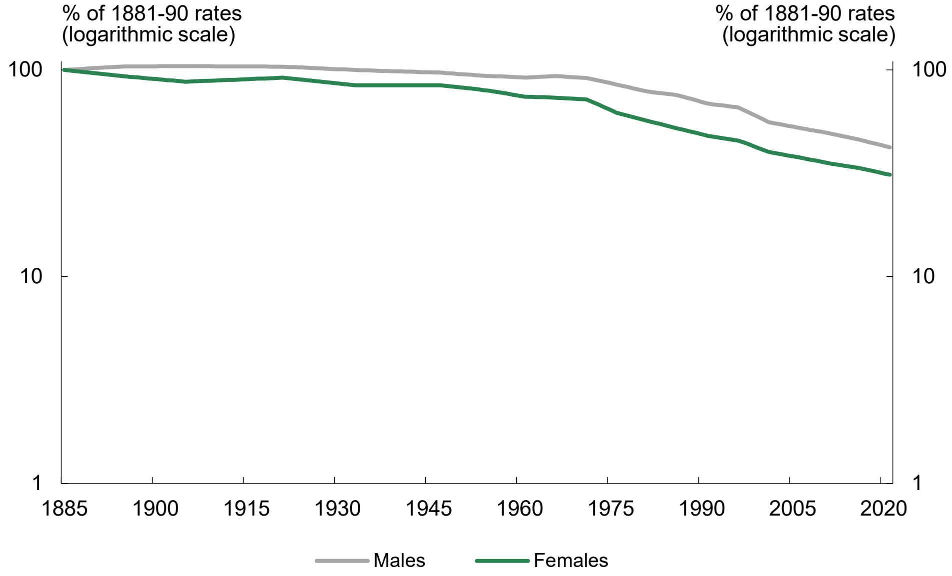


At age 65, the rate of improvement was relatively slow for both males and females until around 1965. This is consistent with the benefits of medical advances up to that time primarily accruing to the young. Since the mid-1960s, however, mortality rates for 65 year olds have reduced considerably. Male rates for 65 year olds in the 2020–22 Tables are about a fifth of the corresponding rates from the original Tables, while for females the 2020–22 rates are around 16 per cent of the corresponding rates. Whilst we have seen significant improvement in mortality at this age since the mid-1960s, the male

2 Australian Government Actuary, Life Tables by Birthplace, December 2021

rate of improvement has been reducing in each consecutive life table since 1995–97. The rate of improvement for females has not reduced with the same pattern as for males, but has also reduced over this period.

Figure 8: Improvements in mortality at age 85



The final chart shows the improvement in rates at age 85. Again, mortality rates at this age showed minimal improvement until the mid-1960s. Since then, there has been a steady improvement in mortality leading to mortality rates for males that are 42 per cent of what they were 135 years ago. For females, the rates are now 31 per cent of what they were.

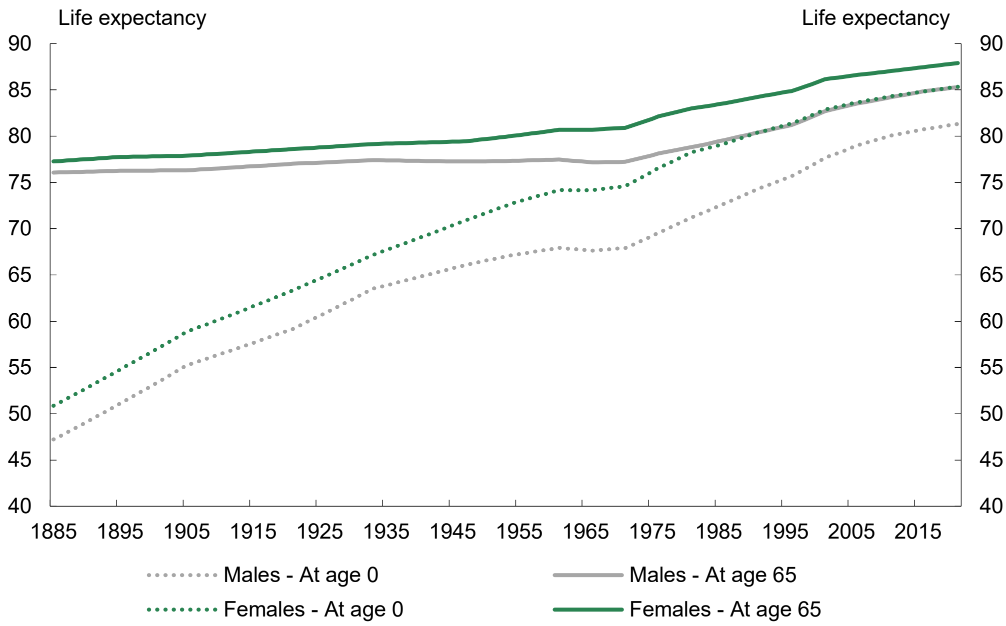
1.5 Longevity

One natural corollary of improving mortality is increasing longevity. Increased longevity has significant implications, both for individuals trying to estimate the resources needed for retirement and governments dealing with rising pension and health and aged care obligations.

There are a number of measures of longevity. The most commonly used is life expectancy, which measures the average number of years that would be lived by a representative group of individuals of the same age if they experienced mortality at given rates.

Figure 9 shows how the improvements in mortality described in the previous section have translated into longer life expectancies at birth and age 65 as reported in the relevant Life Tables (Appendix A sets out the numbers on which this figure is based).

Figure 9: Total life expectancy at selected ages

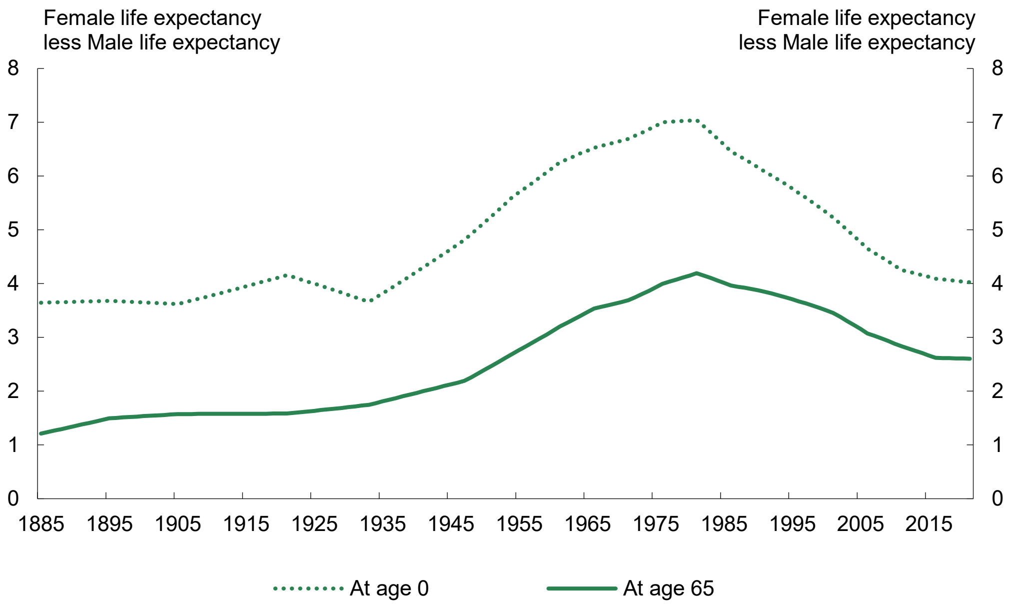


Note that these reported life expectancies are known as period life expectancies and do not make allowance for any future improvements in mortality which might be experienced over a person's lifetime. In other words, they are based on the assumption that the mortality rates reported in a particular set of Tables would continue unchanged into the future and, as such, represent a summary of mortality at a particular point in time rather than a projection of mortality over future periods. The impact of continuing mortality improvement is discussed in the next section.

Period life expectancy at birth has shown dramatic improvement since the inception of the Life Tables, increasing by almost 35 years for both males and females. At older ages, the substantial improvements in mortality rates since the early 1970s have also flowed through into significantly increased life expectancies for this group. For example, since 1885, life expectancy at age 65 has increased by more than nine years (84 per cent) for males and nearly eleven years (87 per cent) for females.

Figure 10 plots the gap between reported male and female life expectancies at birth and age 65. It shows that over the first third of the twentieth century, male and female life expectancies moved roughly in parallel, with the gap at birth steady at around four years. The gap at age 65 was steady at around one and a half years during this period. From about 1930, the gap widened for both ages, reaching a maximum in the 1980–82 Tables. Since then, the differential has been declining for both ages. At birth, the gap has declined by almost three years from its peak, falling to levels last seen around 85 years ago.

Figure 10: Gender differentials in life expectancy at selected ages

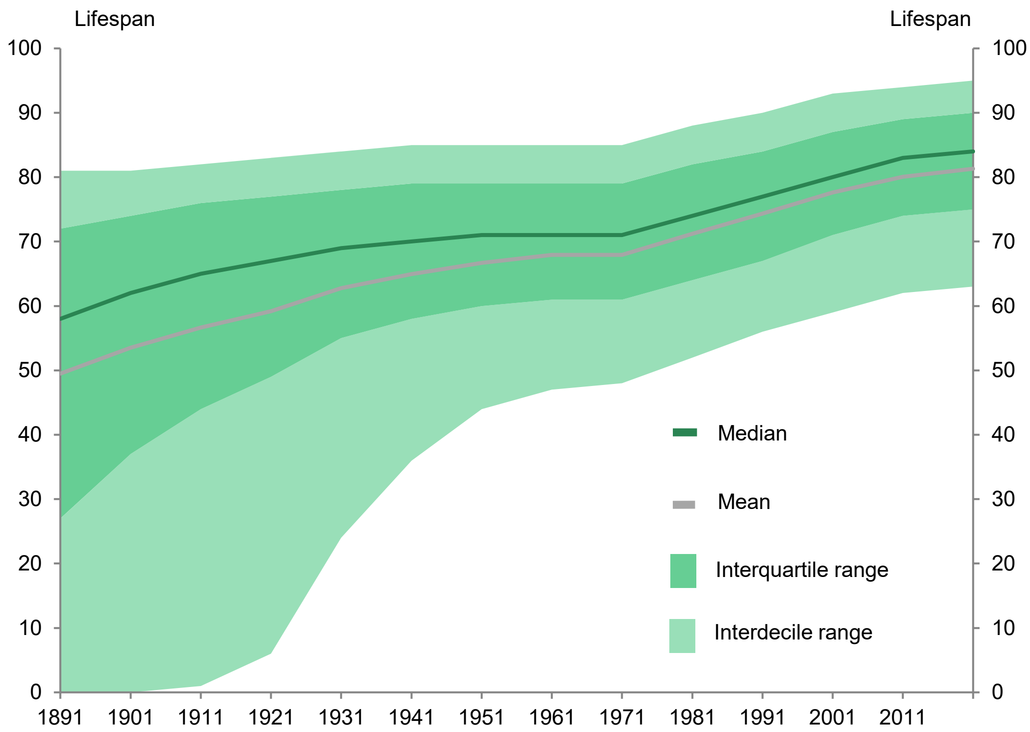


Life expectancy at birth is a commonly used measure to describe population mortality. However, as a single summary statistic, it cannot provide information on the diversity of outcomes. For example, under the mortality rates reported in the current Tables, around 60 per cent of both males and females would be expected to survive beyond the reported life expectancy. This result is separate from the issue of mortality improvements that might occur over an individual's life, which is discussed in the following section.

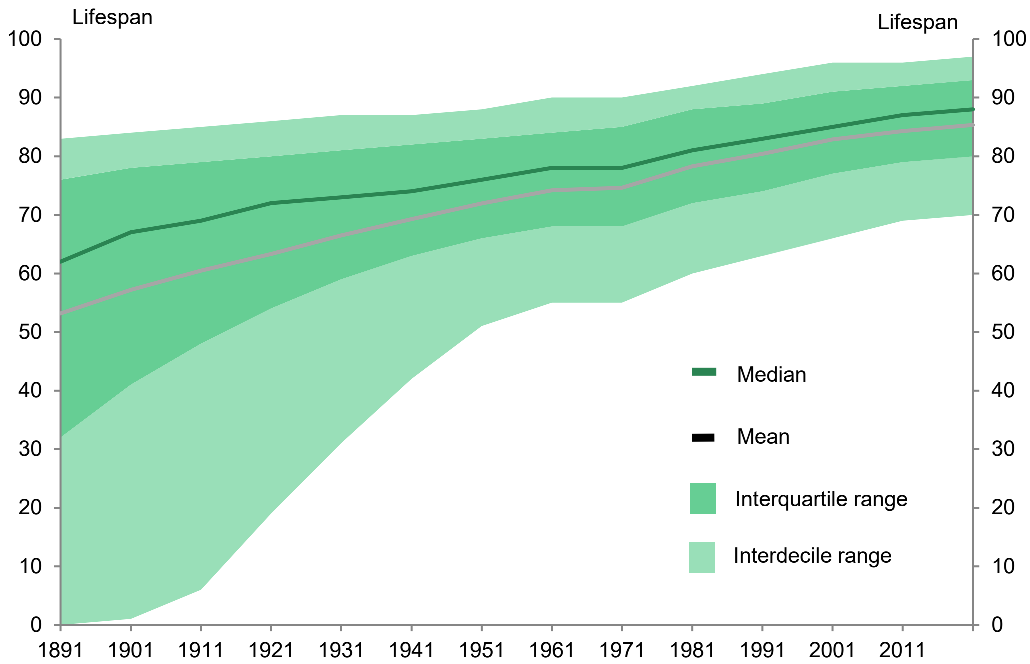
Figure 11 shows how the distribution of lifespan has changed over the past 130 years. The distributions shown here are based on the prevailing mortality rates and do not make allowance for future mortality improvement. The chart shows the period life expectancy (represented by the mean), the median of the lifespan distribution and the interquartile and interdecile ranges.

Figure 11: Distribution of lifespan at birth

Males



Females



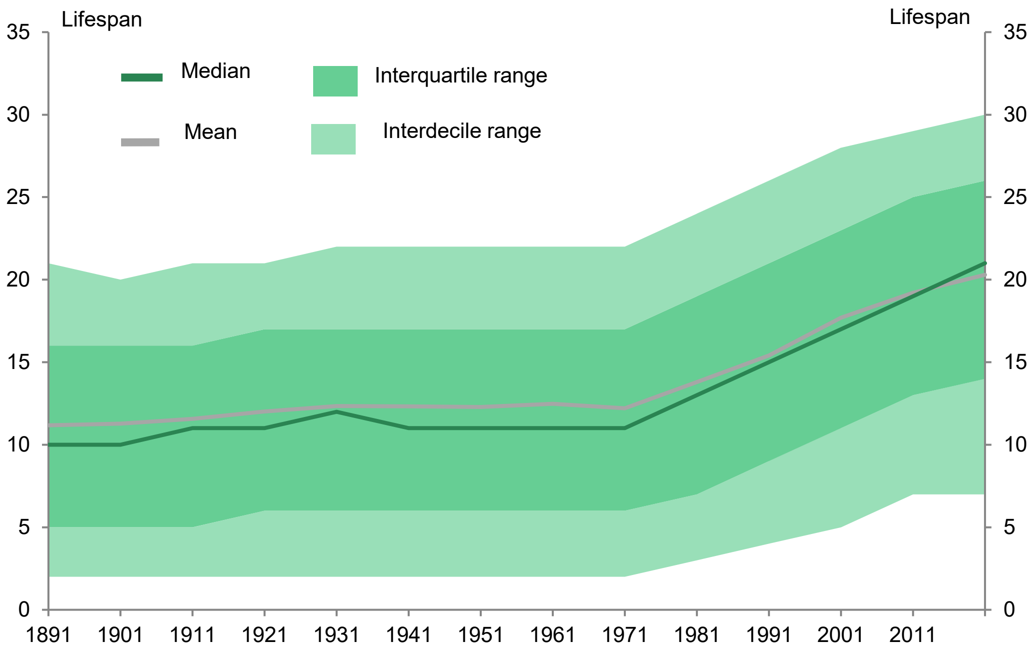
It can be seen that the reported life expectancy (mean) and the median age of death have moved roughly in parallel. However, since 1891, the gap between the two measures has declined by around six years for males and females, reflecting the dramatic improvements in infant mortality that have had a greater impact on life expectancy than on median age at death.

While improving mortality at younger ages has tended to concentrate the age of death within a narrower range, outcomes for individuals can still vary widely. The interdecile range, for example, spans a range of over 30 years for males, from 63 to 95, and only slightly less for females, from 70 to 97.

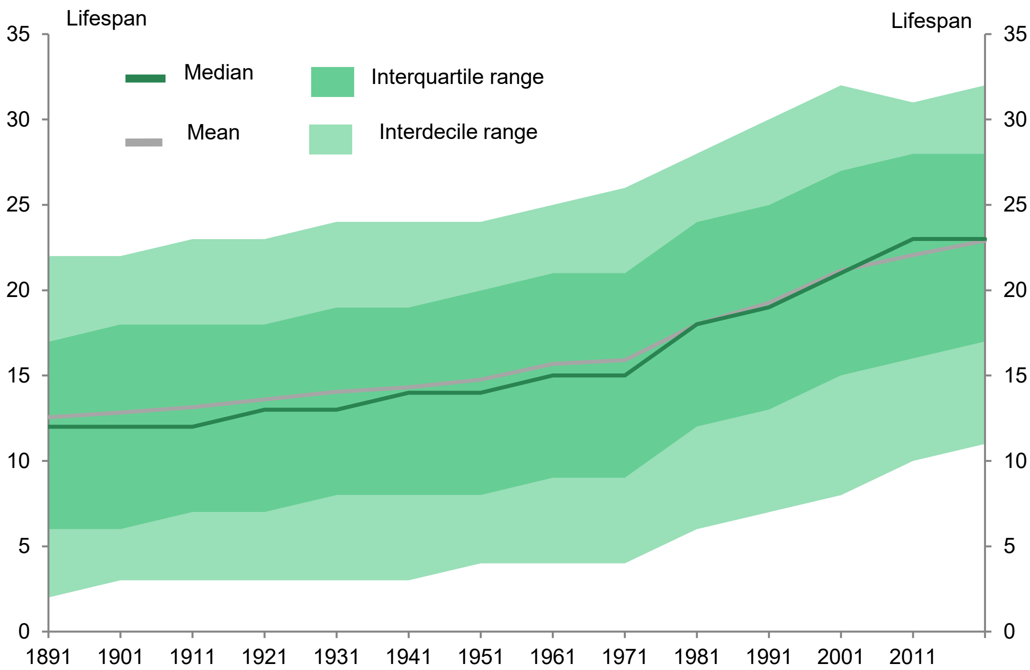
Figure 12 reproduces the distribution of lifespan charts based on the expected outcomes at age 65 rather than birth.

Figure 12: Distribution of lifespan at age 65

Males



Females



A number of differences are apparent compared with the former graphs. Firstly, the lifespan distribution is relatively symmetrical at this age and as a result the mean and median are more closely aligned. Secondly, while the interdecile range is significantly less at age 65 than at birth, it has increased slightly over time rather than narrowing. In other words, outcomes at retirement are no more predictable today than they were 120 years ago.

1.6 Allowing for future improvements in mortality

The figures reported in section 1.5 are all based on cross-sectional mortality rates from a single set of Life Tables. Section 1.4 also highlighted the substantial changes in mortality that could be expected to occur over an individual's lifetime. By way of illustrating the interaction between these two elements, the life expectancy of a boy born in 1886, as reported in the 1881–90 Tables, was 47.2 years, based on the rates in those Tables persisting throughout his life. However, his actual life expectancy would have been some six years higher. This estimate can be obtained by applying the rates reported in subsequent Tables that would be appropriate given his age and the year.

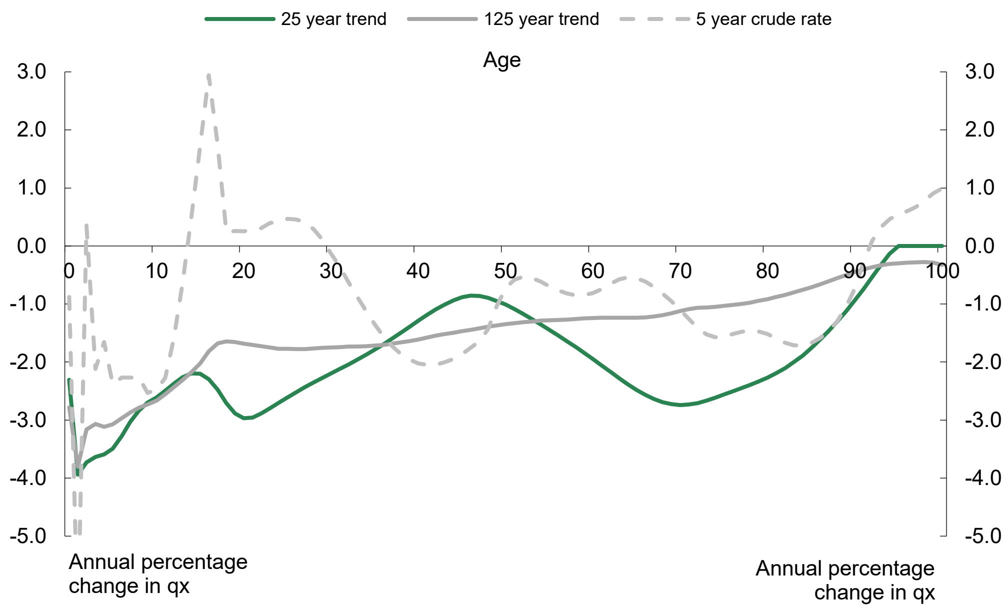
As a result, any realistic measure of longevity needs to consider the possible improvements in mortality that may occur in the future. This section focuses on life expectancy, considering the impacts of future mortality improvement. The limitations outlined in the previous section of any summary measure such as life expectancy which obscure the diversity of outcomes should continue to be borne in mind.

The issues associated with attempting to estimate more realistic life expectances by allowing for future mortality improvements were discussed in some detail in the 1995–97 Tables. Those Tables included improvement factors derived from the ratio of the mortality rates in the Tables to those reported in the Tables from 25 and 100 years previously. The current Tables continue the practice of reporting two sets of factors, one based on experience over the last 25 years and the other using the improvement in mortality over 125 years. Details on the methodology used is provided in Section 2.4 and the resulting rates set out in Appendix E.

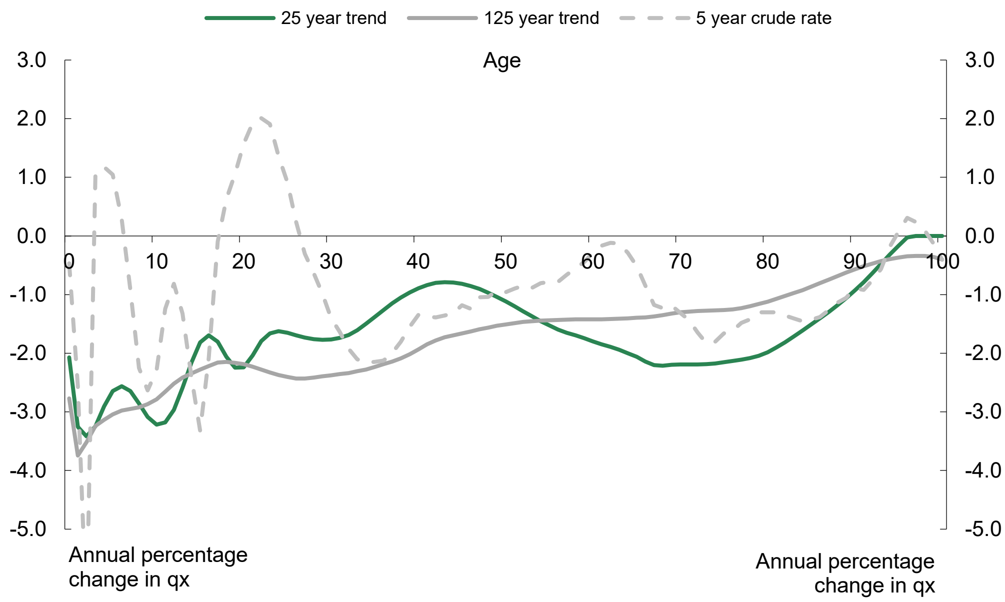
Figure 13 presents the historical rates of improvement expressed as an annual percentage change in the probability of death at a given age. Note that the lower the value, the higher the improvement in mortality has been. It can be seen that the improvements over the 125 year period have generally been less than the improvements over the past 25 years for ages between 55 and the mid-nineties. On the other hand, for ages from 35 to 55 (males) and ages 20 to 55 (females) the rates of improvement over the past 25 years have generally been less than over the preceding 100 years.

Figure 13: Historical mortality improvement factors derived from the Australian Life Tables

Males



Females



The 25 year improvement factors for the oldest ages (95 and above for males, and 97 and above for females) have been constrained to be zero. The actual trends for mortality improvement for very old ages remain unclear as there is a paucity of data;

I have therefore decided to set the factors to zero for these advanced ages until further evidence emerges.

Period life expectancy

There are two ways of taking account of mortality improvement in projecting future life expectancies. The first is to apply the same number of years of improvement to the mortality rates at all ages, effectively estimating what future Life Tables might report as life expectancy. This provides for improvement to the date of the calculation, but no further improvement thereafter. This measure is known as the period or cross-sectional life expectancy. It makes no allowance for improvements over an individual's future lifetime and was discussed in the previous section. For example, when calculating a period life expectancy for the year 2030 based on the 2020–22 Tables, nine years of improvement would be allowed for at all ages (but no improvement beyond the year 2030). The following tables show the projected period life expectancies at ages 0, 30 and 65 using the historic 25 and 125 year improvement factors.

Projected period life expectancies at selected ages under two improvement scenarios

Males

	Age 0		Age 30		Age 65	
	25 year	125 year	25 year	125 year	25 year	125 year
2021	81.3	81.3	82.2	82.2	85.3	85.3
2026	82.3	81.9	83.1	82.7	86.0	85.6
2030	83.1	82.3	83.8	83.0	86.6	85.8
2040	84.8	83.3	85.4	83.9	87.9	86.4
2050	86.4	84.2	86.8	84.7	89.0	87.0
2060	87.7	85.1	88.1	85.5	90.1	87.5
2070	88.9	85.9	89.2	86.2	91.0	88.0

Females

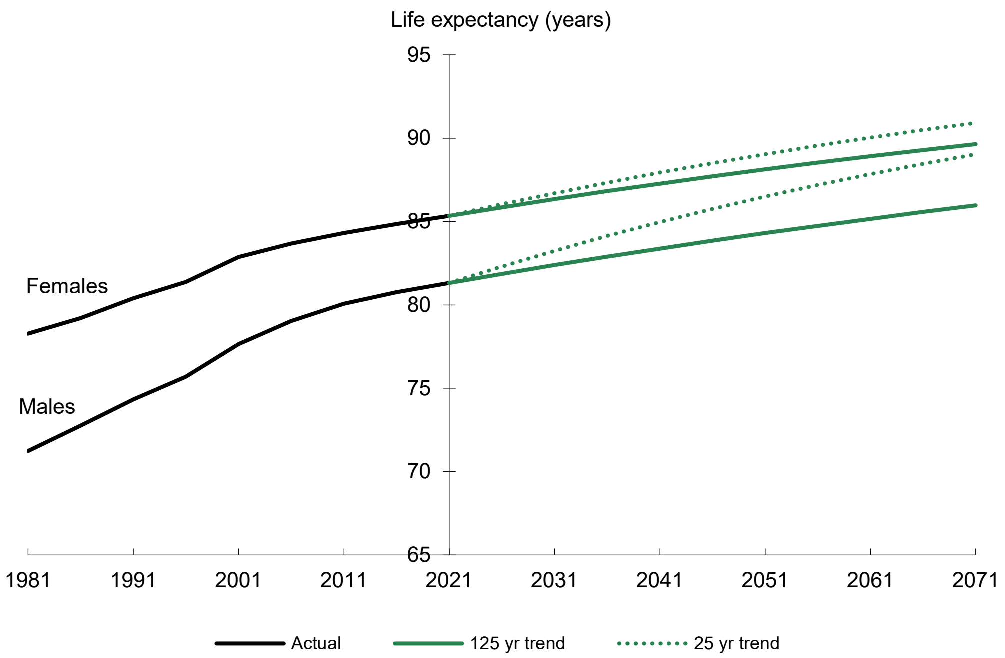
	Age 0		Age 30		Age 65	
	25 year	125 year	25 year	125 year	25 year	125 year
2021	85.3	85.3	85.9	85.9	87.9	87.9
2026	86.0	85.9	86.6	86.4	88.4	88.2
2030	86.6	86.3	87.0	86.7	88.8	88.5
2040	87.8	87.2	88.2	87.5	89.8	89.1
2050	88.9	88.0	89.3	88.3	90.7	89.7
2060	89.9	88.8	90.2	89.0	91.5	90.2
2070	90.8	89.6	91.0	89.7	92.2	90.8

The 2015–17 Tables projected a period life expectancy at birth for a boy born in 2021 of 81.9 years under the 25 year improvement scenario and 81.4 years under the 125 year improvement scenario. The current Tables estimate a male life expectancy of 81.3 years, closer to that expected under the 125 year improvement scenario. For a girl born in 2021, the equivalent estimates from the 2015–17 Tables were 85.6 and 85.4 years respectively. The current estimate of 85.3 years is also more consistent with the 125 year improvement factors reported in the 2015–17 Tables.

Following on from this trend, the projected period life expectancies in these Tables, using the 25 year improvement factors, are lower than those projected in the previous Tables. Under this scenario, the experience of the last 5 years carries greater weight. The rate of improvement in mortality over the five years to 2021 was, on average, slightly lower than over the 5 years to 1996 (the period that has dropped out of the 25 year improvement calculation). Whilst this is not uniform at all ages, this continues the observed general trend of slowing mortality improvement observed over the last three decades and will also reflect the impact of the COVID-19 pandemic on the mortality of 2022 in particular.

Figure 14 shows how the period life expectancy at birth would change over time under these two improvement scenarios.

Figure 14: Actual and projected period life expectancy at birth — 1981 to 2071



Cohort life expectancy

The second measure of life expectancy is what is termed cohort life expectancy. This measure takes into account the improvements that could be experienced over the future lifetime of the individual. For example, when calculating the cohort life expectancy of a child born in 2030 based on the 2020–22 tables, 9 years of mortality improvement will be applied to the mortality rate at age 0, 10 years at age one and so on. In the example provided at the beginning of this section, the life expectancy for a child born in 1886 calculated using the mortality rates as they changed over his lifetime is a cohort life expectancy. Cohort life expectancies can be thought of as being a more realistic representation of the unfolding mortality experience of the Australian population. Regardless, the uncertainties around future rates of mortality improvement need to be kept in mind with any projection of future mortality.

The following tables show the cohort life expectancies at ages 0, 30 and 65 using the historic 125 year improvement factors.

Projected cohort expectation of life at selected ages under the 125 year improvement scenario

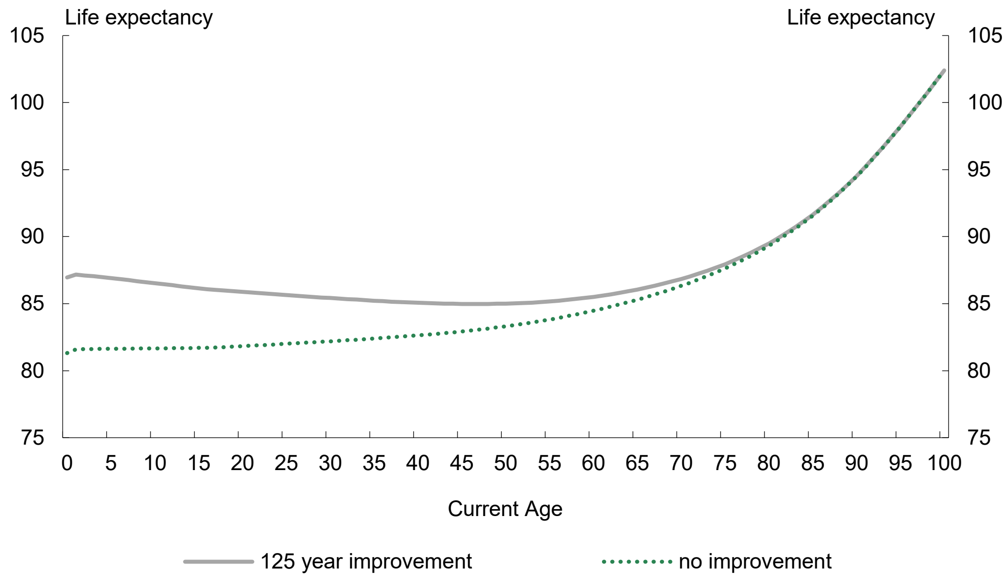
	Age 0		Age 30		Age 65	
	Males 125 year	Females 125 year	Males 125 year	Females 125 year	Males 125 year	Females 125 year
2021	87.0	90.9	85.4	89.3	86.1	88.8
2026	87.4	91.2	85.8	89.7	86.4	89.1
2030	87.7	91.5	86.1	90.0	86.6	89.4
2040	88.5	92.2	86.9	90.7	87.2	90.0
2050	89.2	92.8	87.6	91.3	87.7	90.6
2060	89.8	93.3	88.3	91.9	88.3	91.1
2070	90.4	93.8	89.0	92.5	88.8	91.6

Male mortality rates have improved at a faster rate than female rates over the last three decades. However, using short term mortality improvement factors (for example, over 25 years) to project cohort life expectancy (which is inherently a long term projection) may not be appropriate. Therefore, in this report, cohort life expectancies were calculated only under a 125 year mortality improvement scenario. A comparison with the cohort life expectancies reported in the 2015–17 Tables shows that, on these improvement assumptions, female cohort life expectancies show a marginal increase. Projected male cohort life expectancies are generally lower than in the previous report, whilst females have remained largely the same.

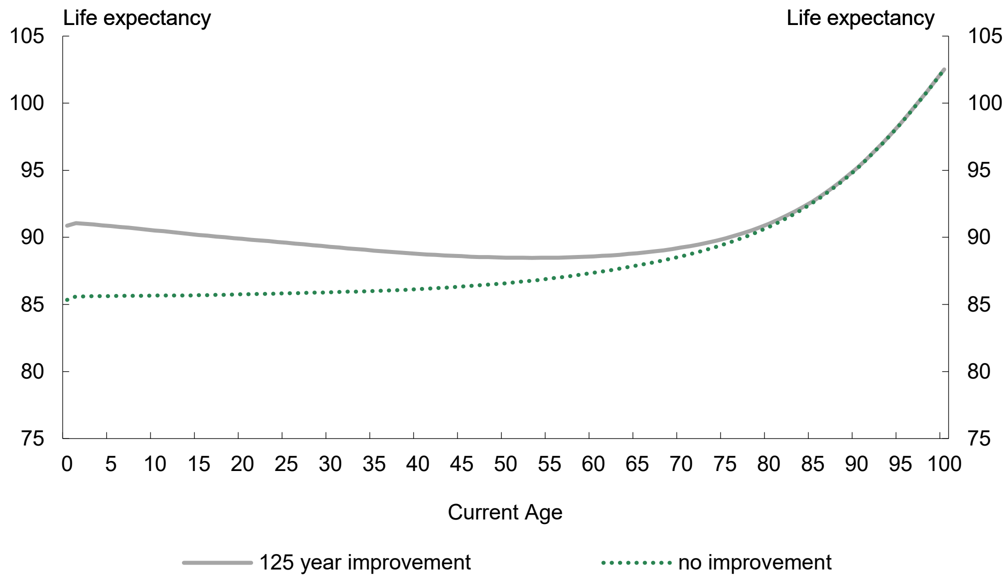
Figure 15 shows the cohort life expectancies for those currently alive in the Australian population. It highlights the considerable gap between the period life expectancies reported in these Tables and the outcomes that would arise if the rates of mortality improvement observed in the past are maintained in the future. The additional life expectancy (the gap between the 'no improvement' curve and historic 125 year improvement curve) reduces with increasing age, reflecting the shorter period for improvements to have an impact. At very old ages, the gap has disappeared but the curve rises, reflecting the fact that these people have already reached an advanced age.

Figure 15: Cohort life expectancies by current age

Males



Females



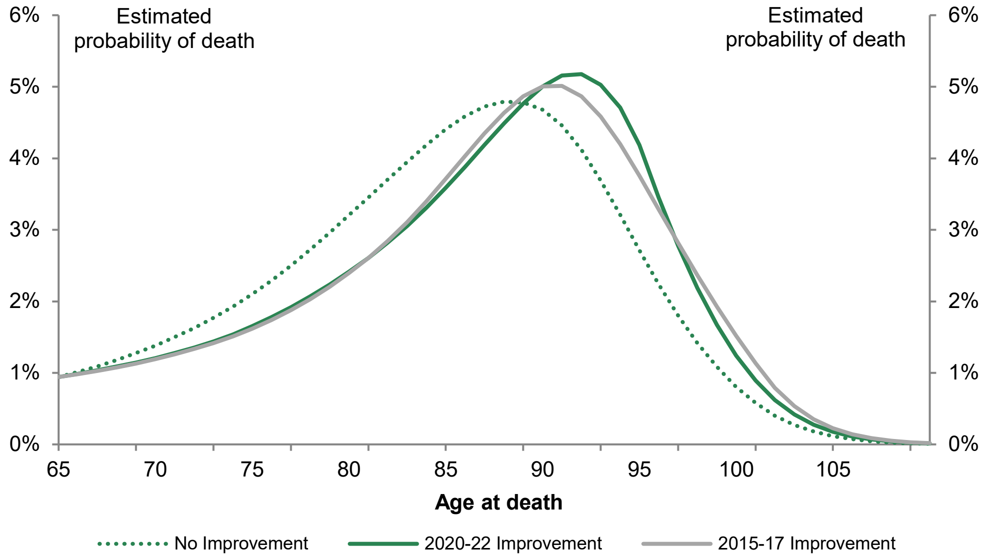
The period and cohort life expectancies set out above illustrate what would occur if mortality continued to improve at the rates observed in the past. Actual mortality improvement can change appreciably between successive Tables. This can particularly affect the improvement factors derived from the most recent 25 years of experience where the earliest period is removed from the calculation and the experience from the most recent five years incorporated. So, for example, at age 55 for males, the historic 25 year improvement factor has reduced from 2.05 per cent per annum to 1.45 per cent per annum, reflecting the fact that mortality at this age improved by 17 per cent between the 1990–92 and the 1995–97 Tables but only improved by 3.5 per cent between 2015–17 and 2020–22 Tables.

Furthermore, the effects of these movements are magnified in mortality projections because the projections assume that mortality improvement will be constant for a particular age. This is not a major issue in the short term. One year into the future, for example, the difference in mortality rates for a male aged 55 under the two assumptions is less than 1 per cent. However, when considering cohort life expectancy at birth, the projected mortality rate to be used at age 55 will include 55 years of mortality improvement and, due to compounding, the mortality rate under the 2020–22 assumption is about 22 per cent higher than it would have been under the 2015–17 assumption.

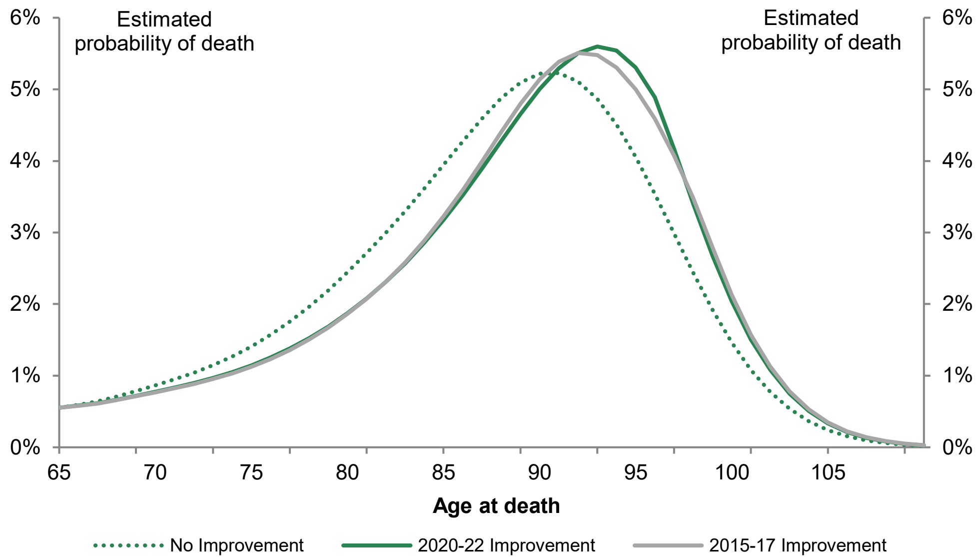
The sensitivity to changes in mortality improvement is also evident in the projected distribution of deaths, as illustrated in Figure 16. The two improvement scenarios presented are both based on the historic 25 year improvement factors.

Figure 16: Distribution of deaths for those age 65 allowing for cohort mortality improvement

Males



Females



These charts also suggest that the range of lifespans under credible mortality improvement scenarios is at least as wide as the range where no allowance for mortality improvement was made. In other words, making an allowance for future improvements in mortality does not decrease the challenges individuals face in dealing with longevity risk in retirement.

History demonstrates that mortality improvement is not constant at a particular age and, indeed, can vary within a quite considerable range. The choice of the period over which mortality is measured will also affect the estimates of mortality improvement. Thus, the estimates of cohort mortality included here must be accepted as projections of outcomes under assumptions which have a certain historical basis. They should be regarded as indicative rather than firm forecasts of life expectancy.

Australian Life Tables 2020–22: Males

Age	l_x	d_x	p_x	q_x	μ_x	$\mathring{e}_x$	L_x	T_x
0	100,000	339	0.996606	0.003394	0.000000	81.31	99,832	8,131,434
1	99,661	20	0.999801	0.000199	0.000207	80.59	99,651	8,031,602
2	99,641	17	0.999829	0.000171	0.000188	79.61	99,632	7,931,952
3	99,624	12	0.999876	0.000124	0.000148	78.62	99,617	7,832,320
4	99,611	9	0.999908	0.000092	0.000105	77.63	99,607	7,732,703
5	99,602	8	0.999922	0.000078	0.000083	76.64	99,598	7,633,096
6	99,594	7	0.999926	0.000074	0.000075	75.64	99,591	7,533,498
7	99,587	7	0.999926	0.000074	0.000074	74.65	99,583	7,433,907
8	99,580	7	0.999926	0.000074	0.000074	73.65	99,576	7,334,324
9	99,572	7	0.999927	0.000073	0.000073	72.66	99,569	7,234,748
10	99,565	7	0.999925	0.000075	0.000073	71.66	99,561	7,135,179
11	99,558	8	0.999918	0.000082	0.000078	70.67	99,554	7,035,618
12	99,549	10	0.999904	0.000096	0.000088	69.67	99,545	6,936,064
13	99,540	12	0.999879	0.000121	0.000107	68.68	99,534	6,836,519
14	99,528	16	0.999841	0.000159	0.000137	67.69	99,520	6,736,985
15	99,512	22	0.999780	0.000220	0.000184	66.70	99,502	6,637,465
16	99,490	32	0.999674	0.000326	0.000269	65.71	99,475	6,537,963
17	99,458	44	0.999562	0.000438	0.000385	64.74	99,437	6,438,488
18	99,414	51	0.999492	0.000508	0.000480	63.76	99,389	6,339,052
19	99,364	54	0.999458	0.000542	0.000530	62.80	99,337	6,239,662
20	99,310	56	0.999441	0.000559	0.000552	61.83	99,282	6,140,325
21	99,254	57	0.999425	0.000575	0.000567	60.86	99,226	6,041,043
22	99,197	59	0.999408	0.000592	0.000584	59.90	99,168	5,941,817
23	99,138	60	0.999390	0.000610	0.000601	58.93	99,108	5,842,649
24	99,078	62	0.999372	0.000628	0.000619	57.97	99,047	5,743,541
25	99,016	64	0.999352	0.000648	0.000638	57.01	98,984	5,644,494
26	98,952	66	0.999332	0.000668	0.000658	56.04	98,919	5,545,510
27	98,885	68	0.999311	0.000689	0.000679	55.08	98,852	5,446,592
28	98,817	70	0.999290	0.000710	0.000700	54.12	98,782	5,347,740
29	98,747	72	0.999268	0.000732	0.000721	53.16	98,711	5,248,958
30	98,675	74	0.999245	0.000755	0.000743	52.19	98,638	5,150,246
31	98,600	77	0.999218	0.000782	0.000768	51.23	98,562	5,051,608
32	98,523	80	0.999189	0.000811	0.000796	50.27	98,484	4,953,046
33	98,443	83	0.999155	0.000845	0.000828	49.31	98,402	4,854,563
34	98,360	87	0.999117	0.000883	0.000864	48.35	98,317	4,756,161
35	98,273	91	0.999073	0.000927	0.000904	47.40	98,228	4,657,843
36	98,182	96	0.999023	0.000977	0.000951	46.44	98,135	4,559,615
37	98,086	101	0.998966	0.001034	0.001005	45.49	98,036	4,461,481
38	97,985	108	0.998901	0.001099	0.001066	44.53	97,932	4,363,444
39	97,877	115	0.998827	0.001173	0.001135	43.58	97,820	4,265,513
40	97,762	123	0.998745	0.001255	0.001213	42.63	97,702	4,167,692
41	97,640	132	0.998652	0.001348	0.001301	41.68	97,575	4,069,990
42	97,508	142	0.998548	0.001452	0.001399	40.74	97,438	3,972,416
43	97,367	153	0.998433	0.001567	0.001509	39.80	97,291	3,874,978
44	97,214	165	0.998306	0.001694	0.001630	38.86	97,133	3,777,686
45	97,049	178	0.998166	0.001834	0.001763	37.92	96,961	3,680,554
46	96,871	193	0.998012	0.001988	0.001910	36.99	96,776	3,583,592
47	96,679	208	0.997844	0.002156	0.002072	36.07	96,576	3,486,816
48	96,470	226	0.997660	0.002340	0.002248	35.14	96,359	3,390,240
49	96,245	244	0.997460	0.002540	0.002440	34.22	96,124	3,293,881
50	96,000	265	0.997244	0.002756	0.002649	33.31	95,870	3,197,757
51	95,736	286	0.997010	0.002990	0.002874	32.40	95,594	3,101,888
52	95,449	310	0.996756	0.003244	0.003118	31.50	95,296	3,006,293
53	95,140	335	0.996480	0.003520	0.003384	30.60	94,974	2,910,997
54	94,805	362	0.996179	0.003821	0.003673	29.70	94,626	2,816,023

AUSTRALIAN LIFE TABLES 2020–22: MALES (CONTINUED)

Age	l_x	d_x	p_x	q_x	μ_x	$\mathring{e}_x$	L_x	T_x
55	94,442	392	0.995853	0.004147	0.003987	28.82	94,249	2,721,397
56	94,051	424	0.995497	0.004503	0.004329	27.93	93,842	2,627,147
57	93,627	458	0.995109	0.004891	0.004703	27.06	93,401	2,533,306
58	93,169	495	0.994689	0.005311	0.005108	26.19	92,925	2,439,904
59	92,675	535	0.994232	0.005768	0.005549	25.32	92,411	2,346,979
60	92,140	577	0.993738	0.006262	0.006027	24.47	91,855	2,254,568
61	91,563	622	0.993203	0.006797	0.006544	23.62	91,256	2,162,713
62	90,941	671	0.992626	0.007374	0.007103	22.78	90,610	2,071,457
63	90,270	722	0.992004	0.007996	0.007707	21.94	89,914	1,980,848
64	89,548	776	0.991332	0.008668	0.008357	21.12	89,165	1,890,934
65	88,772	835	0.990597	0.009403	0.009064	20.30	88,360	1,801,770
66	87,937	899	0.989780	0.010220	0.009845	19.48	87,494	1,713,410
67	87,039	969	0.988866	0.011134	0.010717	18.68	86,560	1,625,916
68	86,070	1,047	0.987837	0.012163	0.011696	17.89	85,553	1,539,356
69	85,023	1,133	0.986677	0.013323	0.012801	17.10	84,464	1,453,803
70	83,890	1,227	0.985370	0.014630	0.014049	16.32	83,285	1,369,339
71	82,663	1,331	0.983898	0.016102	0.015456	15.56	82,006	1,286,055
72	81,332	1,444	0.982241	0.017759	0.017040	14.80	80,619	1,204,049
73	79,887	1,570	0.980352	0.019648	0.018837	14.06	79,113	1,123,429
74	78,318	1,709	0.978181	0.021819	0.020899	13.33	77,475	1,044,316
75	76,609	1,863	0.975679	0.024321	0.023280	12.62	75,691	966,840
76	74,746	2,033	0.972796	0.027204	0.026031	11.92	73,744	891,150
77	72,712	2,219	0.969485	0.030515	0.029207	11.24	71,619	817,406
78	70,493	2,418	0.965699	0.034301	0.032859	10.58	69,301	745,787
79	68,075	2,628	0.961392	0.038608	0.037041	9.94	66,779	676,486
80	65,447	2,846	0.956520	0.043480	0.041807	9.32	64,043	609,707
81	62,601	3,066	0.951026	0.048974	0.047210	8.72	61,087	545,664
82	59,536	3,287	0.944784	0.055216	0.053357	8.14	57,910	484,577
83	56,248	3,507	0.937659	0.062341	0.060408	7.59	54,513	426,666
84	52,742	3,717	0.929521	0.070479	0.068525	7.06	50,900	372,153
85	49,025	3,910	0.920250	0.079750	0.077868	6.55	47,085	321,253
86	45,115	4,072	0.909735	0.090265	0.088599	6.08	43,091	274,169
87	41,043	4,192	0.897874	0.102126	0.100878	5.63	38,955	231,078
88	36,851	4,253	0.884580	0.115420	0.114870	5.21	34,727	192,123
89	32,598	4,245	0.869781	0.130219	0.130744	4.83	30,471	157,397
90	28,353	4,152	0.853554	0.146446	0.148630	4.48	26,265	126,925
91	24,201	3,957	0.836505	0.163495	0.168244	4.16	22,202	100,660
92	20,244	3,658	0.819325	0.180675	0.188830	3.88	18,386	78,459
93	16,586	3,276	0.802515	0.197485	0.209644	3.62	14,914	60,072
94	13,311	2,848	0.786004	0.213996	0.230390	3.39	11,850	45,158
95	10,462	2,411	0.769603	0.230397	0.251294	3.18	9,221	33,308
96	8,052	1,988	0.753144	0.246856	0.272595	2.99	7,024	24,087
97	6,064	1,600	0.736196	0.263804	0.294676	2.81	5,234	17,063
98	4,464	1,258	0.718290	0.281710	0.318301	2.65	3,809	11,829
99	3,207	962	0.700006	0.299994	0.343652	2.50	2,703	8,020
100	2,245	714	0.681954	0.318046	0.369781	2.37	1,869	5,317
101	1,531	513	0.664796	0.335204	0.395786	2.25	1,259	3,448
102	1,018	357	0.649229	0.350771	0.420507	2.15	828	2,188
103	661	242	0.634448	0.365552	0.443615	2.06	532	1,360
104	419	159	0.620372	0.379628	0.466267	1.98	334	829
105	260	102	0.606977	0.393023	0.488306	1.90	205	495
106	158	64	0.594237	0.405763	0.509701	1.83	123	290
107	94	39	0.582126	0.417874	0.530444	1.77	73	166
108	55	23	0.570620	0.429380	0.550526	1.72	42	94
109	31	14	0.559693	0.440307	0.569939	1.67	24	52

Australian Life Tables 2020–22: Females

Age	l_x	d_x	p_x	q_x	μ_x	$\mathring{e}_x$	L_x	T_x
0	100,000	295	0.997050	0.002950	0.000000	85.34	99,855	8,533,919
1	99,705	20	0.999798	0.000202	0.000280	84.59	99,694	8,434,064
2	99,685	10	0.999895	0.000105	0.000139	83.61	99,679	8,334,370
3	99,674	10	0.999903	0.000097	0.000094	82.62	99,670	8,234,691
4	99,665	9	0.999912	0.000088	0.000093	81.62	99,660	8,135,021
5	99,656	8	0.999921	0.000079	0.000083	80.63	99,652	8,035,361
6	99,648	7	0.999929	0.000071	0.000075	79.64	99,644	7,935,709
7	99,641	6	0.999936	0.000064	0.000067	78.64	99,638	7,836,064
8	99,635	6	0.999942	0.000058	0.000061	77.65	99,632	7,736,427
9	99,629	6	0.999944	0.000056	0.000056	76.65	99,626	7,636,795
10	99,623	6	0.999943	0.000057	0.000056	75.66	99,620	7,537,169
11	99,618	6	0.999938	0.000062	0.000059	74.66	99,615	7,437,548
12	99,611	7	0.999928	0.000072	0.000066	73.67	99,608	7,337,934
13	99,604	9	0.999913	0.000087	0.000079	72.67	99,600	7,238,326
14	99,596	11	0.999892	0.000108	0.000096	71.68	99,590	7,138,726
15	99,585	14	0.999864	0.000136	0.000121	70.68	99,578	7,039,136
16	99,571	17	0.999828	0.000172	0.000153	69.69	99,563	6,939,557
17	99,554	21	0.999791	0.000209	0.000192	68.71	99,544	6,839,994
18	99,533	22	0.999774	0.000226	0.000220	67.72	99,522	6,740,450
19	99,511	23	0.999765	0.000235	0.000232	66.74	99,499	6,640,928
20	99,487	24	0.999760	0.000240	0.000238	65.75	99,476	6,541,429
21	99,464	24	0.999758	0.000242	0.000241	64.77	99,452	6,441,953
22	99,440	24	0.999757	0.000243	0.000243	63.78	99,427	6,342,502
23	99,415	24	0.999756	0.000244	0.000244	62.80	99,403	6,243,074
24	99,391	24	0.999755	0.000245	0.000244	61.81	99,379	6,143,671
25	99,367	25	0.999751	0.000249	0.000247	60.83	99,354	6,044,292
26	99,342	25	0.999745	0.000255	0.000252	59.84	99,329	5,944,938
27	99,317	26	0.999736	0.000264	0.000259	58.86	99,304	5,845,608
28	99,290	28	0.999721	0.000279	0.000271	57.87	99,277	5,746,305
29	99,263	29	0.999704	0.000296	0.000287	56.89	99,248	5,647,028
30	99,233	31	0.999685	0.000315	0.000305	55.91	99,218	5,547,780
31	99,202	34	0.999662	0.000338	0.000326	54.92	99,186	5,448,562
32	99,169	36	0.999637	0.000363	0.000350	53.94	99,151	5,349,376
33	99,133	39	0.999608	0.000392	0.000377	52.96	99,113	5,250,225
34	99,094	42	0.999575	0.000425	0.000408	51.98	99,073	5,151,112
35	99,052	46	0.999538	0.000462	0.000443	51.00	99,029	5,052,039
36	99,006	50	0.999497	0.000503	0.000482	50.03	98,981	4,953,010
37	98,956	54	0.999452	0.000548	0.000525	49.05	98,929	4,854,029
38	98,902	59	0.999401	0.000599	0.000573	48.08	98,873	4,755,099
39	98,843	65	0.999346	0.000654	0.000626	47.11	98,811	4,656,227
40	98,778	71	0.999285	0.000715	0.000684	46.14	98,743	4,557,416
41	98,707	77	0.999218	0.000782	0.000748	45.17	98,669	4,458,673
42	98,630	84	0.999145	0.000855	0.000818	44.21	98,589	4,360,004
43	98,546	92	0.999066	0.000934	0.000894	43.24	98,500	4,261,415
44	98,454	100	0.998981	0.001019	0.000976	42.28	98,404	4,162,915
45	98,353	109	0.998889	0.001111	0.001064	41.33	98,300	4,064,510
46	98,244	119	0.998789	0.001211	0.001160	40.37	98,186	3,966,211
47	98,125	129	0.998682	0.001318	0.001264	39.42	98,061	3,868,025
48	97,996	140	0.998568	0.001432	0.001375	38.47	97,927	3,769,964
49	97,856	152	0.998446	0.001554	0.001493	37.53	97,780	3,672,037
50	97,703	165	0.998315	0.001685	0.001619	36.58	97,622	3,574,257
51	97,539	178	0.998176	0.001824	0.001755	35.64	97,451	3,476,634
52	97,361	192	0.998028	0.001972	0.001898	34.71	97,266	3,379,183
53	97,169	207	0.997869	0.002131	0.002052	33.78	97,067	3,281,917
54	96,962	223	0.997698	0.002302	0.002217	32.85	96,852	3,184,851

Australian Life Tables 2020–22: Females (continued)

Age	l_x	d_x	p_x	q_x	μ_x	$\mathring{e}_x$	L_x	T_x
55	96,739	241	0.997513	0.002487	0.002395	31.92	96,620	3,087,999
56	96,498	259	0.997312	0.002688	0.002588	31.00	96,370	2,991,379
57	96,239	280	0.997092	0.002908	0.002799	30.08	96,101	2,895,009
58	95,959	302	0.996853	0.003147	0.003029	29.17	95,810	2,798,909
59	95,657	326	0.996593	0.003407	0.003279	28.26	95,496	2,703,099
60	95,331	352	0.996310	0.003690	0.003551	27.35	95,157	2,607,603
61	94,979	380	0.996001	0.003999	0.003847	26.45	94,792	2,512,446
62	94,599	410	0.995665	0.004335	0.004171	25.56	94,397	2,417,654
63	94,189	443	0.995301	0.004699	0.004522	24.67	93,971	2,323,257
64	93,747	477	0.994907	0.005093	0.004903	23.78	93,511	2,229,286
65	93,269	515	0.994480	0.005520	0.005315	22.90	93,015	2,135,775
66	92,754	555	0.994019	0.005981	0.005759	22.02	92,480	2,042,760
67	92,200	600	0.993490	0.006510	0.006244	21.15	91,904	1,950,280
68	91,599	661	0.992780	0.007220	0.006863	20.29	91,274	1,858,376
69	90,938	733	0.991942	0.008058	0.007653	19.43	90,578	1,767,102
70	90,205	807	0.991056	0.008944	0.008527	18.59	89,808	1,676,524
71	89,398	885	0.990098	0.009902	0.009452	17.75	88,963	1,586,716
72	88,513	972	0.989020	0.010980	0.010472	16.92	88,035	1,497,753
73	87,541	1,070	0.987774	0.012226	0.011639	16.10	87,015	1,409,718
74	86,471	1,184	0.986313	0.013687	0.013001	15.30	85,889	1,322,703
75	85,288	1,314	0.984588	0.015412	0.014608	14.50	84,642	1,236,814
76	83,973	1,465	0.982553	0.017447	0.016510	13.72	83,254	1,152,172
77	82,508	1,637	0.980162	0.019838	0.018754	12.96	81,705	1,068,918
78	80,871	1,830	0.977370	0.022630	0.021391	12.21	79,973	987,213
79	79,041	2,045	0.974131	0.025869	0.024468	11.48	78,037	907,240
80	76,996	2,279	0.970403	0.029597	0.028037	10.77	75,877	829,203
81	74,718	2,530	0.966145	0.033855	0.032143	10.08	73,474	753,325
82	72,188	2,794	0.961292	0.038708	0.036840	9.42	70,814	679,851
83	69,394	3,075	0.955691	0.044309	0.042250	8.78	67,880	609,038
84	66,319	3,371	0.949171	0.050829	0.048563	8.16	64,659	541,157
85	62,948	3,678	0.941568	0.058432	0.055974	7.57	61,135	476,499
86	59,270	3,987	0.932727	0.067273	0.064680	7.01	57,302	415,364
87	55,283	4,284	0.922504	0.077496	0.074878	6.48	53,164	358,062
88	50,998	4,549	0.910805	0.089195	0.086753	5.98	48,744	304,898
89	46,450	4,752	0.897689	0.102311	0.100388	5.51	44,087	256,154
90	41,697	4,868	0.883256	0.116744	0.115749	5.09	39,269	212,067
91	36,829	4,876	0.867609	0.132391	0.132794	4.69	34,387	172,798
92	31,954	4,766	0.850854	0.149146	0.151485	4.33	29,556	138,411
93	27,188	4,538	0.833101	0.166899	0.171784	4.00	24,895	108,854
94	22,650	4,203	0.814458	0.185542	0.193648	3.71	20,517	83,959
95	18,448	3,781	0.795019	0.204981	0.217058	3.44	16,519	63,442
96	14,666	3,300	0.775017	0.224983	0.241938	3.20	12,974	46,923
97	11,367	2,785	0.754977	0.245023	0.267891	2.99	9,931	33,949
98	8,581	2,272	0.735287	0.264713	0.294302	2.80	7,404	24,018
99	6,310	1,791	0.716218	0.283782	0.320737	2.63	5,377	16,614
100	4,519	1,365	0.697936	0.302064	0.346864	2.49	3,804	11,238
101	3,154	1,008	0.680515	0.319485	0.372464	2.36	2,623	7,434
102	2,146	721	0.663943	0.336057	0.397427	2.24	1,765	4,810
103	1,425	501	0.648141	0.351859	0.421758	2.14	1,159	3,046
104	924	339	0.632965	0.367035	0.445565	2.04	743	1,887
105	585	223	0.618217	0.381783	0.469090	1.96	465	1,144
106	361	143	0.604024	0.395976	0.492447	1.88	284	679
107	218	89	0.590444	0.409556	0.515329	1.81	170	395
108	129	54	0.577462	0.422538	0.537651	1.74	99	225
109	74	32	0.565070	0.434930	0.559408	1.68	57	125

2 CONSTRUCTION OF THE AUSTRALIAN LIFE TABLES 2020–22

There are three main elements in the process of constructing the Australian Life Tables. The first is the derivation of the exposed-to-risk and crude mortality rates from the information provided by the Australian Bureau of Statistics (ABS). The second is the graduation of the crude rates and associated statistical testing of the quality of the graduation. The final task is the calculation of the Life Table functions. This chapter discusses each of these steps in turn and concludes with a discussion of the methodology used to estimate the mortality improvement factors.

2.1 Calculation of exposed-to-risk and crude mortality rates

The calculation of mortality rates requires a measure of both the number of deaths and the population which was at risk of dying — the exposed-to-risk — over the same period. The raw data used for these calculations was provided by the ABS and comprised the following:

(a) Estimates of the numbers of males and females resident in Australia at each age last birthday up to 115 years and over, as at 30 June 2021. These estimates are based on the 2021 Census of Population and Housing adjusted for under-enumeration and the lapse of time between 30 June 2021 and 10 August 2021 (the night on which the Census was taken). They differ from the published official estimates of Australian resident population which contain further adjustments to exclude overseas visitors temporarily in Australia and include Australian residents who are temporarily absent.

(b) The numbers of deaths occurring inside Australia for each month from January 2020 to December 2022, classified by sex and age last birthday at the time of death. This data covers all registrations received by the ABS of deaths to April 2024 and is considered to be effectively a complete record of all deaths occurring over the three year period.

(c) The number of registered births classified by sex in each month from January 2015 to December 2022.

(d) The number of deaths of those aged 3 years or less in each month from January 2015 to December 2022, classified by sex and age last birthday, with deaths of those aged less than one year classified by detailed duration.

(e) The numbers of persons moving into and out of Australia in each month from January 2020 to December 2022 for those aged 4 or more, and from January 2015 to December 2022 for those aged less than 4, grouped by age last birthday and sex.

Appendix B includes summary information on the population, number of deaths and population movements. Appendix C provides detailed estimates of the population at each age last birthday at 30 June 2021, and the number of deaths at each age occurring over the three calendar years 2020 to 2022.

The ABS conducts a five yearly Census of Population and Housing. Adjusted population estimates based on a particular Census will usually differ from those produced by updating the results of the previous Census for population change (that is, for births, deaths and migration) during the following 5 years. The difference between an estimate based on the results of a particular Census and that produced by updating results from the previous Census is called intercensal discrepancy. It is caused by unattributable errors in either or both of the starting and finishing population estimates, together with any errors in the estimates of births, deaths or migration in the intervening period.

The Australian Life Tables are based on the most recent Census population estimates. This is consistent with the view of the ABS that the best available estimate of the population at 30 June of the Census year is the one based on that year's Census, not the one carried forward from the previous period. Intercensal discrepancy can, however, affect the comparability of reported mortality rates, and consequently life expectancies and improvement factors.

The crude mortality rates are calculated by dividing the number of deaths at a particular age by the exposed to risk for that age. It is essential, then, that the measure of 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 denominator (that is, counted in the exposed to risk) only if their death would have been included in the numerator had they died.

The deaths used in deriving these Tables are those which occurred in Australia during 2020–22, regardless of usual place of residence. The appropriate exposed to risk is, therefore, exposure of people actually present in Australia at any time during the 3 year period. The official population estimates published by the ABS (Australian Bureau of Statistics (March 2024), National, state and territory population) are intended to measure the population usually resident in Australia and accordingly include adjustments to remove the effect of short term movements, which are not appropriate for these Tables. Adjustment does, however, need to be made to the exposed to risk to take account of those persons who, as a result of death or international movement, are not present in Australia for the full 3 year period.

The base estimate of the exposed to risk at age x, which assumes that all those present on Census night contribute a full three years to the exposed to risk, was taken to be:

$$\frac{1}{8}P_{x-2} + \frac{7}{8}P_{x-1} + P_x + \frac{7}{8}P_{x+1} + \frac{1}{8}P_{x+2}$$

where P_x is the population inside Australia aged x last birthday as measured in the 2021 Census adjusted only for under-enumeration and the lapse of time from 30 June to Census night.

This estimate was then modified to reduce exposure for those who arrived in Australia between January 2020 and June 2021, or who died or left Australia between July 2021 and December 2022. Similarly, exposure was increased to take account of those who arrived between July 2021 and December 2022 or who died or left Australia between January 2020 and June 2021.

Figure 17 compares the Census population count with the exposed-to-risk after all adjustments have been made. It can be seen that the exposed-to-risk formula smooths to some extent the fluctuations from age to age apparent in the unadjusted population count. The impact of net inward migration over the years of the investigation can be seen in the fact that the exposed-to-risk sits above the Census population count, particularly for student and working ages (noting that the margin is not as high as in previous investigations due to low net migration in 2020 and 2021 due to pandemic-related border closures).

Figure 17: Comparison of census population count and exposed-to-risk

Males

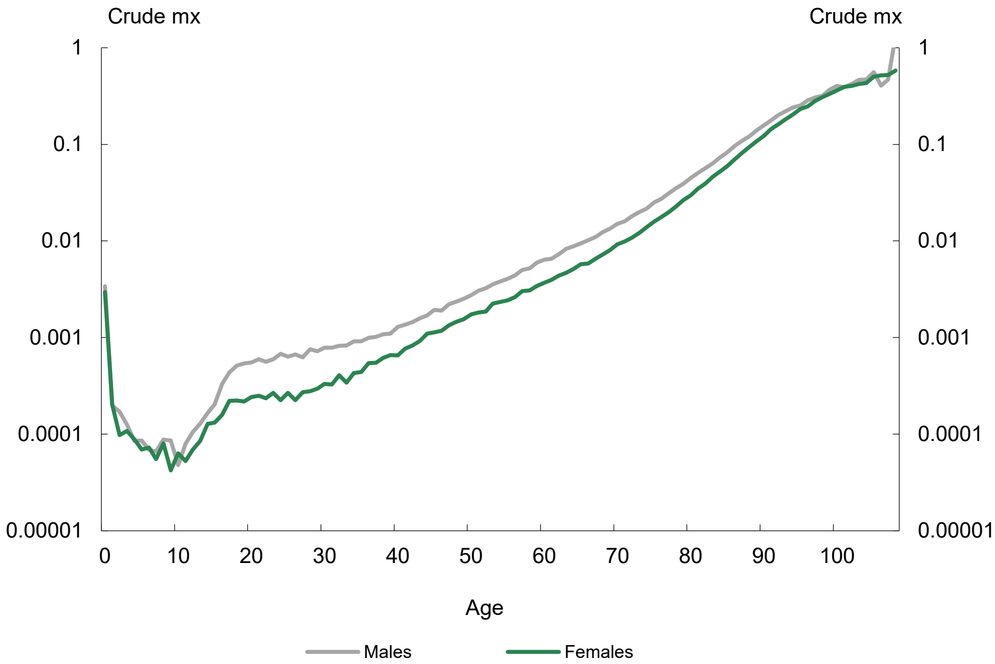
Females

For ages two and above, the crude central rate of mortality at age x, m_x, was calculated by dividing the deaths at age x during 2020, 2021 and 2022 by the relevant exposed-to-risk. The exposed-to-risk for ages 0 and 1 was derived more directly by keeping a count of those at each age for each month of the three year period using monthly birth, death and movement records from 2015 to 2022. Because of the rapid fall in the force of mortality, μ_x, over the first few weeks of life, q_x, rather than m_x, was calculated for age 0. The formulae used are available on request.

2.2 Graduation of the crude mortality rates

Figure 18 shows the crude mortality rates. The crude central rates of mortality, even when calculated over three years of experience, exhibit considerable fluctuation from one age to the next, particularly among the very young and very old where the number of deaths is typically low. From a first principles perspective, however, there is no reason to suppose that these fluctuations are anything other than a reflection of the random nature of the underlying mortality process. Hence, when constructing a life table to represent the mortality experience of a population, it is customary to graduate the crude rates to obtain a curve that progresses smoothly with age.

Figure 18: Crude central mortality rates



As with previous Life Tables, a combination of manual graduation and fitted cubic splines was used. Cubic splines were fitted over all but the youngest ages and the very top of the age distribution. At the oldest ages, there is little exposure and few deaths, so a different approach is required. This is discussed below.

The method of cubic splines involves fitting a series of cubic polynomials to the crude rates of mortality. These polynomials are constrained to be not only continuous at the 'knots' where they join, but also to have equal first and second derivatives at those points. This constraint, of itself, is insufficient to ensure that the fitted curve is smooth in the sense of having a low rate of change of curvature. A large number of knots or closely spaced knots would allow the curve to follow the random fluctuations in the crude rates. At the same time, large intervals between the knots can reduce the fitted curve's fidelity to the observed results. The choice of the number and location of knots, therefore, involves a balance between achieving a smooth curve and deriving fitted rates that are reasonably consistent with the observed mortality rates.

For a given choice of knots, the criterion used to arrive at the cubic spline was that the following weighted residual sum of squares (an approximate χ^2 variable) should be minimised:

$$\sum_{x=x_{min}}^{x_{max}} w_x(m_x - \hat{m}_x)^2$$

where:

m_x is the crude central mortality rate at age x;

$\hat{m}_x$ is the graduated value of the central mortality rate at age x, produced by the cubic spline;

w_x is a weight for each age, which gives more weight to those observations with higher exposure to risk and which accounts for non-constant variance in the data (in particular, $w_x = \frac{E_x}{m_x^1(1-m_x^1)}$, where E_x is the central exposed-to-risk at age x);

m_x^1 is a preliminary value of $\hat{m}_x$, obtained by minimising the above sum of squares with weights given by $w_x = \frac{E_x}{m_x(1-m_x)}$;

x_{min} is the lowest age of the range to which the cubic spline is to be fitted; and

x_{max} is the highest age of the range to which the cubic spline is to be fitted.

An initial choice of knots was based on observation of the crude data and the knots selected in the previous report. This choice of knots was then iteratively improved upon, with the objective of reducing the χ^2 value above. A series of statistical tests were also performed to assess the adequacy of the graduated rates. This is necessary as a singular focus on the χ^2 variable can exhibit a tendency to overfit the graduated rates to the crude rates at some ages. The final ages selected for the knots used in the graduation are shown below.

Males:	7	14	15	17	20	27	50	63	71	80	89	92
Females:	16	17	18	27	28	51	66	67	69	81	87	94

The cubic splines were fitted from ages 3 to 105 for males and 2 to 108 for females. In general, a larger number of knots is required at and near the ages where mortality undergoes a marked transition. For males, knots at ages 14, 15, 17 and 20 enabled the construction of a graduated curve that captured the behaviour of mortality rates at the edge of the accident 'cliff'. Similarly, for females, knots were needed at ages 16,17, 18 and 27 to capture the sharp increase and subsequent flattening in mortality rates over this age range.

The 2006 Census was the first to record individual ages for those aged 100 or more. It also asked for date of birth which allowed the internal consistency of the records to be checked. As result, both the quality and volume of data at very old ages improved and this process has continued in each subsequent Census where a high priority was placed on data integrity for centenarians. Nonetheless, the data remains sparse and an alternative approach is required for graduation at the very oldest ages.

The rates for these ages were constructed by extrapolating the trend of the crude rates from ages where there were sufficient deaths to make the crude rates meaningful. The trend result was determined by fitting a Makeham curve of the form:

$$q_x = 1 - exp[-A - B \times C^x (C - 1)/\ln(C)]$$

where *A*, *B* and *C* are constants.

The Makeham curve was fitted to the data using nonlinear least squares. The shape of the resulting curve is highly sensitive to the age range over which the fit is performed. The resulting graduated rates were therefore tested over a range of minimum ages (ranging from 80 to 95) and maximum ages (ranging from 104 to 108). This process involves a necessary degree of judgment. The fitted Makeham curve was used to extrapolate the graduated rates from age 102 for males and age 105 for females. These ages are higher than those used in the 2015–17 Table and reflect the improved fit of the cubic spline up to these ages. This may be a reflection of the increasing exposure up to these ages as the population ages.

As has been the case for the last seven Tables, the crude central mortality rates for males and females cross at a very old age. The 1990–92 Tables maintained the apparent crossover as a genuine feature, resulting in male mortality rates falling below the female rates from age 103. Since that time, the crossover in both the crude and graduated rates has varied within a fairly narrow range up to the 2015–17 Table. In this Table, the convergence of male and female mortality at advanced ages resulted in the graduated rates crossing over at an older age. The following table summarises the experience.

Life Tables	Crossover in crude rates	Crossover in graduated rates
1990-92	100	103
1995-97	96	98
2000-02	96	103
2005-07	99	100
2010-12	100[1]	103
2015-17	99	100
2020-22[2]	101	114

1 The male crude rates cross below female rates for the first time at age 100, but female rates are lower at ages 104 and 105. Male rates are lower at all subsequent ages.

2 Males are not consistently lower above age 101. They are first lower at 101, then at 106 and 107. Males are higher at ages 102 to 105 and age 108. The crossover in the graduated rates at age 114 is somewhat artificial and is due to the inconsistent pattern of male vs female crude mortality rates. These numbers differ slightly to those in Section 1.1 as these numbers refer to the crude central rate of mortality m_x instead of the rate of mortality q_x of a person aged exactly x.

A negligible percentage of death registrations in 2020–22 did not include the age at death (less than 0.005 per cent for all ages), and consequently no adjustments were considered necessary to the graduated rates.

A number of tests were applied to the graduated rates to assess the suitability of the graduation. 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. Appendix D provides a comparison between the actual and expected number of deaths at each age.

2.3 Calculation of life table functions

As noted above, the function graduated over all but the very youngest ages was the central rate of mortality, m_x. The formulae adopted for calculating the functions included in the Life Tables were as follows:

$$q_x = \frac{m_x \left[1 - \frac{1}{12}\frac{q_{x-1}}{p_{x-1}}\right]}{1 + \frac{5}{12}m_x}$$

$$d_x = l_x q_x$$

$$l_{x+1} = l_x - d_x$$

$$p_x = 1 - q_x$$

$$\mu_x = \frac{1}{12 l_x}\left[7(d_{x-1} + d_x) - (d_{x-2} + d_{x+1})\right]$$

$$\mathring{e}_x = \frac{1}{l_x}\sum_{t=1}^{120} l_{x+t} + \frac{1}{2} - \frac{1}{12}\mu_x$$

$$L_x = T_x - T_{x+1}$$

$$T_x = l_x \mathring{e}_x$$

l_0, the radix of the Life Table, was chosen to be 100,000.

All of the Life Table entries can be calculated from q_x using the formulae above with the exception of L_0, $\mathring{e}_0$, μ_0, μ_1 and μ_2. These figures cannot be calculated using the standard formulae because of the rapid decline in mortality over the first year of life. Details of the calculations of L_0, $\mathring{e}_0$, μ_0, μ_1 and μ_2 can be provided on request.

2.4 Estimation of mortality improvement factors

In the life tables up to and including 2005–07, the improvement factor at any given age was calculated using the following formula:

$$I_x = \left[\left(\frac{q_x(t)}{q_x(t-n)}\right)^{\frac{1}{n}} - 1\right] \times 100$$

where

I_x	is the rate of improvement at age x;
$q_x(t)$	is the mortality rate at age x in the current Tables; and
$q_x(t-n)$	is the mortality rate reported for age x in the Tables n years previously.

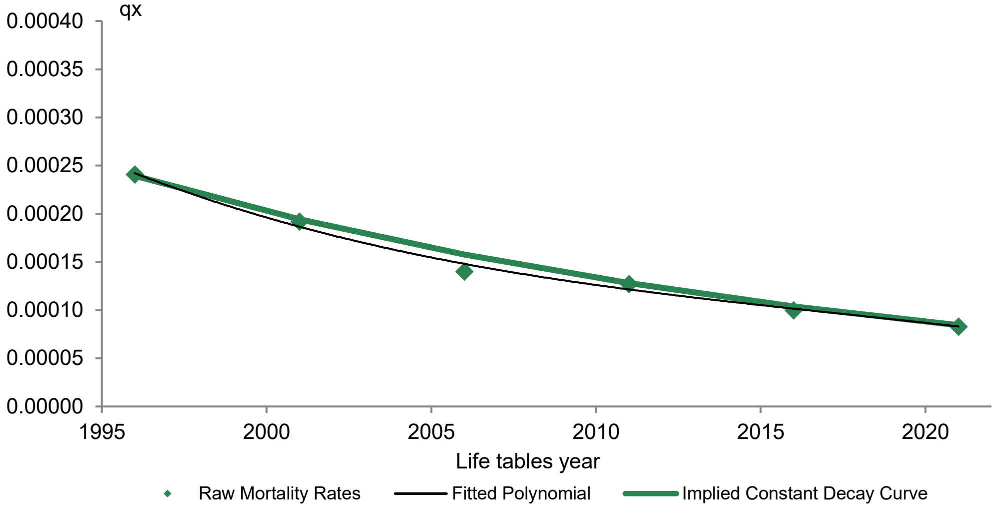
Whilst this approach was intuitive, this measure depended only upon the mortality rates at the beginning and end of the period and gave no weight to the experience over the intervening period. As a result, this methodology could yield results that did not reflect the general pattern of mortality improvement over the period.

Since 2010–12, the methodology which has been adopted has been to fit a polynomial to the mortality rates for each age over the period of interest (either 25 years or 125 years) and use the fitted values at the beginning and end of the period for estimating the mortality improvement.

For this iteration of the Life Tables, we have retained the polynomial method for the 25 year time period. However, the process was producing unreasonable results for the 125 year time period, and so the methodology was changed to the prior method, thus depending only upon the mortality rates at the beginning and end of the period.

Figure 19 illustrates this process for a male aged 4 looking at improvement over the last 25 years. In this case, a polynomial has been fitted to the six data points and the values from the fitted function are used to estimate the constant annual improvement that would give rise to the same results.

Figure 19: Estimating mortality improvement for a male aged 4



3 USE OF LIFE TABLES FOR PROBABILITY CALCULATIONS

As well as being the most recent actuarially determined record of mortality rates, the 2020–22 Tables can be used to project the probabilities of persons living or dying at some time in the future. This does, however, require an assumption on what will happen to mortality rates over the intervening period.

The simplest assumption is that mortality rates remain unchanged at the 2020–22 level. However, the continuing improvement in mortality exhibited in these Tables suggests that this assumption will tend to underestimate survival probabilities.

A range of assumptions can be made about future mortality improvements. Appendix E contains the two series of improvement factors derived from the historical trends in Australian mortality improvement over the last 25 years and 125 years. These factors (or any alternative set of improvement assumptions) can be applied to the mortality rates included in the current Life Tables to obtain projections of future mortality and life expectancy scenarios.

The process for incorporating future improvements can be expressed in the following mathematical form:

$$q_x(t) = q_x \times \left(1 + \frac{I_x}{100}\right)^{(t-2021)}$$

where

$q_x(t)$	is the mortality rate at age x in year *t*;
q_x	is the mortality rate reported for age x in the current Tables; and
I_x	is the assumed rate of improvement at age x.

Other mortality functions can then be calculated using the formulae given in section 2.3.

An example of how to apply this formula is given below:

Consider a 35 year old female. Her mortality rate in 2021 is given in the current Life Tables as 0.000462. That is, $q_{35}(2021)$ = 0.000462.

The table below sets out the calculation of the projected mortality rate for a 35 year old female in future years — $q_{35}(t)$ for *t* = 2022, 2030 and 2060 — using the two historical sets of improvement factors as scenarios.

	25 year improvement factors	125 year improvement factors
$q_{35}(2021)$	0.000462	0.000462
$q_{35}(2022)$	$q_{35}(2021) \times \left(1 + \frac{-1.3821}{100}\right)^{1} = 0.000456$	$q_{35}(2021) \times \left(1 + \frac{-2.2358}{100}\right)^{1} = 0.000452$
$q_{35}(2030)$	$q_{35}(2021) \times \left(1 + \frac{-1.3821}{100}\right)^{9} = 0.000408$	$q_{35}(2021) \times \left(1 + \frac{-2.2358}{100}\right)^{9} = 0.000377$
$q_{35}(2060)$	$q_{35}(2021) \times \left(1 + \frac{-1.3821}{100}\right)^{39} = 0.000268$	$q_{35}(2021) \times \left(1 + \frac{-2.2358}{100}\right)^{39} = 0.000191$

The two sets of improvement factors given in Appendix E should be treated as illustrative rather than forecasts. What the future will bring cannot be known. Using a particular set of factors allows the impact of a given scenario on mortality rates and associated life table functions to be quantified. It cannot say anything about what mortality rates will actually be. The differences in the projected rates under the two scenarios presented here highlight the uncertainty associated with modelling future mortality.

The importance of allowing for future improvements in mortality rates depends on the purpose of the calculations being carried out, the ages involved and the time span that is being considered. Clearly, the longer the time span being considered, the more significant will be the effect of mortality improvements. At the same time, the longer the time span being considered, the greater will be the uncertainty surrounding the projected rates. Similarly, the higher the improvement factors the more quickly the projected rates will diverge from the current rates.

Appendices

APPENDIX A: HISTORICAL SUMMARIES

The comparisons made in this Appendix are based on the published Australian Life Tables for the relevant years except that revised estimates for the 1970–72 Tables have been preferred to the published Tables, the latter having been based on an under-enumerated population.

Historical summary of mortality rates — males

	Age					
Life Tables	0	15	30	45	65	85
1881-90	0.13248	0.00372	0.00867	0.01424	0.04582	0.18895
1891-00	0.11840	0.00290	0.00698	0.01183	0.04496	0.19629
1901-10	0.09510	0.00255	0.00519	0.01083	0.03859	0.19701
1920-22	0.07132	0.00184	0.00390	0.00844	0.03552	0.19580
1932-34	0.04543	0.00149	0.00271	0.00659	0.03311	0.18864
1946-48	0.03199	0.00115	0.00186	0.00554	0.03525	0.18332
1953-55	0.02521	0.00109	0.00170	0.00478	0.03412	0.17692
1960-62	0.02239	0.00075	0.00157	0.00485	0.03454	0.17363
1965-67	0.02093	0.00079	0.00150	0.00500	0.03603	0.17617
1970-72	0.01949	0.00080	0.00142	0.00479	0.03471	0.16778
1975-77	0.01501	0.00070	0.00128	0.00453	0.03067	0.16043
1980-82	0.01147	0.00057	0.00126	0.00370	0.02671	0.14848
1985-87	0.01030	0.00050	0.00129	0.00291	0.02351	0.14276
1990-92	0.00814	0.00044	0.00131	0.00256	0.02061	0.12975
1995-97	0.00610	0.00039	0.00131	0.00231	0.01763	0.12443
2000-02	0.00567	0.00030	0.00119	0.00218	0.01420	0.10556
2005-07	0.00523	0.00022	0.00095	0.00204	0.01200	0.09907
2010-12	0.004121	0.000215	0.000826	0.001898	0.010505	0.093419
2015-17	0.003547	0.000202	0.000760	0.002015	0.009670	0.086771
2020-22	0.003394	0.000220	0.000755	0.001834	0.009403	0.079750

Historical summary of mortality rates — females

	Age					
Life Tables	**0**	**15**	**30**	**45**	**65**	**85**
1881-90	0.11572	0.00299	0.00828	0.01167	0.03550	0.18779
1891-00	0.10139	0.00248	0.00652	0.00917	0.03239	0.17463
1901-10	0.07953	0.00219	0.00519	0.00807	0.02998	0.16459
1920-22	0.05568	0.00144	0.00387	0.00606	0.02426	0.17200
1932-34	0.03642	0.00113	0.00279	0.00523	0.02365	0.15837
1946-48	0.02519	0.00061	0.00165	0.00411	0.02133	0.15818
1953-55	0.01989	0.00048	0.00096	0.00341	0.01943	0.15018
1960-62	0.01757	0.00038	0.00082	0.00300	0.01769	0.13927
1965-67	0.01639	0.00041	0.00085	0.00313	0.01774	0.13782
1970-72	0.01501	0.00042	0.00077	0.00299	0.01684	0.12986
1975-77	0.01184	0.00037	0.00062	0.00264	0.01493	0.11644
1980-82	0.00905	0.00031	0.00052	0.00207	0.01283	0.10656
1985-87	0.00794	0.00026	0.00053	0.00180	0.01179	0.09781
1990-92	0.00634	0.00025	0.00051	0.00152	0.01049	0.09021
1995-97	0.00502	0.00022	0.00049	0.00137	0.00929	0.08553
2000-02	0.00466	0.00020	0.00045	0.00130	0.00789	0.07528
2005-07	0.00440	0.00018	0.00038	0.00124	0.00679	0.07088
2010-12	0.003352	0.000162	0.000349	0.001188	0.006203	0.066375
2015-17	0.003020	0.000161	0.000338	0.001179	0.005664	0.062792
2020-22	0.002950	0.000136	0.000315	0.001111	0.005520	0.058432

Complete expectation of life at selected ages — males

	Age			
Life Tables	0	30	65	85
1881-90	47.20	33.64	11.06	3.86
1891-00	51.08	35.11	11.25	3.79
1901-10	55.20	36.52	11.31	3.65
1920-22	59.15	38.44	12.01	3.62
1932-34	63.48	39.90	12.40	3.90
1946-48	66.07	40.40	12.25	3.84
1953-55	67.14	40.90	12.33	4.01
1960-62	67.92	41.12	12.47	4.08
1965-67	67.63	40.72	12.16	4.07
1970-72	67.81	40.94	12.21	4.13
1975-77	69.56	42.18	13.13	4.45
1980-82	71.23	43.51	13.80	4.67
1985-87	72.74	44.84	14.60	4.89
1990-92	74.32	46.07	15.41	5.23
1995-97	75.69	47.26	16.21	5.40
2000-02	77.64	49.07	17.70	6.11
2005-07	79.02	50.20	18.54	6.03
2010-12	80.06	51.04	19.22	6.06
2015-17	80.76	51.65	19.86	6.40
2020-22	81.31	52.19	20.30	6.55

Complete expectation of life at selected ages — females

Life Tables	Age			
	0	30	65	85
1881-90	50.84	36.13	12.27	3.90
1891-00	54.76	37.86	12.75	4.12
1901-10	58.84	39.33	12.88	4.19
1920-22	63.31	41.48	13.60	4.06
1932-34	67.14	42.77	14.15	4.30
1946-48	70.63	44.08	14.44	4.32
1953-55	72.75	45.43	15.02	4.52
1960-62	74.18	46.49	15.68	4.79
1965-67	74.15	46.34	15.70	4.85
1970-72	74.80	46.86	16.09	5.03
1975-77	76.56	48.26	17.13	5.49
1980-82	78.27	49.67	18.00	5.74
1985-87	79.20	50.49	18.56	6.09
1990-92	80.39	51.48	19.26	6.40
1995-97	81.37	52.30	19.88	6.53
2000-02	82.87	53.72	21.15	7.28
2005-07	83.67	54.44	21.62	7.08
2010-12	84.31	54.96	22.05	7.14
2015-17	84.85	55.42	22.47	7.37
2020-22	85.34	55.91	22.90	7.57

APPENDIX B: POPULATION, DEATHS, AND MOVEMENTS BY YEAR

Population

The Australian population as shown by the last fourteen Censuses was:

Year	Males	Females	Total
1954	4,546,118	4,440,412	8,986,530
1961	5,312,252	5,195,934	10,508,186
1966	5,841,588	5,757,910	11,599,498
1971	6,506,224	6,431,023	12,937,247
1976	6,979,380	6,936,129	13,915,509
1981	7,416,090	7,440,684	14,856,774
1986	7,940,110	7,959,691	15,899,801
1991	8,518,397	8,584,208	17,102,605
1996	9,048,337	9,172,939	18,221,276
2001	9,533,996	9,670,962	19,204,958
2006	10,123,089	10,247,880	20,370,969
2011	10,972,862	11,085,920	22,058,782
2016	11,813,095	12,006,320	23,819,415
2021	12,746,627	12,933,154	25,679,781

Figures shown for Censuses before 1966 exclude Aboriginal and Torres Strait Islander peoples. Figures shown for Censuses from 1971 onwards have been adjusted by the Statistician to allow for under enumeration. Since 1991, the Census has been held in August. Figures for these years are given at 30 June of the relevant year and have been adjusted for the length of time between 30 June and Census night

Deaths

Year	Males	Females	Total
2020	85,284	77,409	162,693
2021	89,840	82,302	172,142
2022	100,254	91,152	191,406
Total	**275,378**	**250,863**	**526,241**

These numbers do not include deaths of Australian residents overseas but do include deaths of overseas residents who are in Australia at the time of their death.

Movements of the population

Year	Males		Females		Total	
	Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
2020	2,516,863	2,271,545	2,432,509	2,271,749	4,949,372	4,543,294
2021	407,840	466,975	357,171	417,446	765,011	884,421
2017	4,947,569	4,847,791	4,762,622	4,658,143	9,710,191	9,505,934
Total	**7,872,272**	**7,586,311**	**7,552,302**	**7,347,338**	**15,424,574**	**14,933,649**

These numbers are not evenly distributed by age; whether arrivals exceed departures or vice-versa may vary from age to age.

Appendix C: Population and Deaths by Age

Population at 30 June 2021 and deaths in the three years 2020–22, Australia — males

Age	Population	Deaths	Age	Population	Deaths
0	153,173	1,568	52	158,736	1,537
1	151,344	91	53	152,506	1,632
2	155,002	79	54	149,454	1,719
3	156,043	59	55	148,832	1,814
4	159,778	41	56	150,321	1,999
5	164,937	42	57	154,138	2,306
6	164,382	34	58	155,610	2,415
7	166,107	33	59	154,029	2,745
8	168,141	44	60	151,685	2,890
9	167,392	43	61	145,328	2,894
10	166,690	24	62	142,365	3,106
11	168,288	40	63	138,090	3,442
12	167,262	53	64	134,221	3,582
13	166,923	64	65	131,510	3,717
14	165,731	81	66	126,347	3,891
15	158,715	97	67	122,203	4,088
16	153,646	153	68	121,042	4,484
17	150,476	199	69	117,236	4,748
18	148,222	233	70	115,322	5,189
19	150,561	254	71	112,548	5,380
20	160,230	268	72	108,610	5,981
21	165,634	299	73	108,651	6,486
22	166,622	287	74	110,156	6,712
23	169,493	311	75	90,689	7,115
24	174,834	363	76	84,484	6,946
25	179,869	346	77	78,323	7,162
26	184,535	370	78	68,532	7,459
27	184,220	349	79	66,136	7,553
28	184,271	420	80	59,127	8,055
29	184,716	404	81	55,076	8,306
30	189,123	443	82	49,948	8,493
31	190,189	445	83	45,151	8,633
32	187,694	465	84	40,761	8,824
33	186,048	464	85	35,693	8,813
34	186,519	512	86	30,576	8,886
35	188,346	513	87	26,521	8,665
36	187,160	556	88	23,104	8,350
37	185,885	565	89	19,898	8,407
38	186,027	592	90	17,391	8,146
39	179,908	590	91	14,598	7,641
40	174,515	669	92	11,461	7,021
41	165,429	680	93	8,757	5,969
42	161,492	698	94	6,576	4,968
43	157,360	750	95	5,060	3,882
44	156,835	800	96	3,496	3,140
45	158,414	912	97	2,303	2,300
46	159,648	909	98	1,454	1,548
47	162,261	1,074	99	894	1,106
48	165,818	1,172	100 and over	1,081	1,620
49	171,146	1,279			
50	172,221	1,381	Not Stated		3
51	161,322	1,492	**Total**	**12,746,627**	**275,378**

Population at 30 June 2021 and deaths in the three years 2020–22, Australia — females

Age	Population	Deaths	Age	Population	Deaths
0	145,288	1,294	52	163,668	907
1	143,343	88	53	156,848	1,065
2	145,812	43	54	153,353	1,087
3	147,273	48	55	152,955	1,129
4	150,850	40	56	154,925	1,234
5	155,753	32	57	159,291	1,445
6	154,663	34	58	161,175	1,491
7	156,969	26	59	159,878	1,658
8	158,390	38	60	159,012	1,762
9	158,825	20	61	153,854	1,844
10	157,804	30	62	150,632	1,986
11	159,712	25	63	147,495	2,092
12	157,553	33	64	143,566	2,223
13	157,653	40	65	139,834	2,428
14	155,145	59	66	136,254	2,397
15	149,421	59	67	132,134	2,635
16	143,599	69	68	129,800	2,812
17	141,301	95	69	125,544	3,051
18	140,573	96	70	123,652	3,431
19	142,192	96	71	120,935	3,581
20	148,849	110	72	116,313	3,832
21	154,517	117	73	115,089	4,225
22	156,182	113	74	116,740	4,571
23	159,849	132	75	95,958	4,784
24	166,092	114	76	90,863	4,827
25	171,260	140	77	84,622	4,968
26	177,974	120	78	75,592	5,291
27	180,822	149	79	72,602	5,696
28	184,350	155	80	66,644	5,987
29	187,877	167	81	63,338	6,579
30	192,428	190	82	59,746	6,968
31	193,257	188	83	55,007	7,588
32	191,312	234	84	50,814	7,890
33	190,665	195	85	45,952	8,179
34	189,951	245	86	41,333	8,593
35	190,685	250	87	36,788	9,017
36	190,305	309	88	33,526	9,385
37	188,198	310	89	29,981	9,719
38	187,502	342	90	27,631	9,988
39	181,617	359	91	24,200	10,277
40	177,853	346	92	20,165	9,809
41	169,901	394	93	16,896	9,138
42	166,806	413	94	13,318	8,342
43	162,411	450	95	10,765	7,546
44	161,107	530	96	8,086	6,163
45	160,180	545	97	5,777	5,129
46	162,185	571	98	4,038	3,982
47	165,037	662	99	2,788	2,969
48	169,035	743	100 and over	4,218	5,677
49	175,756	802			
50	177,867	901	Not Stated		3
51	165,610	922	**Total**	**12,933,154**	**250,863**

Appendix D: Actual and Expected Deaths

Comparison of actual and expected deaths in the three years 2020–22, Australia — males

Age	Actual Deaths	Expected Deaths	Deviation +	Deviation -	Accumulation +	Accumulation -
2	79	79	0		0	
3	59	58	1		1	
4	41	44		3		2
5	42	38	4		2	
6	34	37		3		1
7	33	37		4		5
8	44	37	7		2	
9	43	36	7		9	
10	24	37		13		5
11	40	41		1		6
12	53	48	5			1
13	64	60	4		3	
14	81	78	3		6	
15	97	105		8		2
16	153	151	2			0
17	199	199		0		0
18	233	232	1		1	
19	254	254		0	1	
20	268	272		4		3
21	299	288	11		8	
22	287	302		15		7
23	311	317		6		14
24	363	335	28		15	
25	346	354		8	7	
26	370	371		1	6	
27	349	384		35		29
28	420	396	24			5
29	404	410		6		11
30	443	428	15		4	
31	445	443	2		6	
32	465	458	7		13	
33	464	474		10	3	
34	512	495	17		20	
35	513	520		7	14	
36	556	547	9		22	
37	565	576		11	11	
38	592	604		12		1
39	590	630		40		41
40	669	652	17			23
41	680	674	6			18
42	698	702		4		22
43	750	744	6			16
44	800	799	1			15
45	912	869	43		28	
46	909	953		44		17
47	1,074	1,050	24		7	
48	1,172	1,164	8		15	
49	1,279	1,285		6	9	
50	1,381	1,387		6	2	
51	1,492	1,467	25		27	

Comparison of actual and expected deaths in the three years 2020–22, Australia — males (continued)

Age	Actual Deaths	Expected Deaths	Deviation +	Deviation -	Accumulation +	Accumulation -
52	1,537	1,535	2		29	
53	1,632	1,622	10		40	
54	1,719	1,725		6	33	
55	1,814	1,866		52		19
56	1,999	2,045		46		64
57	2,306	2,251	55			9
58	2,415	2,463		48		57
59	2,745	2,662	83		26	
60	2,890	2,836	54		80	
61	2,894	3,004		110		30
62	3,106	3,165		59		89
63	3,442	3,345	97		8	
64	3,582	3,531	51		59	
65	3,717	3,725		8	51	
66	3,891	3,928		37	14	
67	4,088	4,164		76		61
68	4,484	4,434	50			12
69	4,748	4,756		8		19
70	5,189	5,103	86		67	
71	5,380	5,481		101		34
72	5,981	5,930	51		17	
73	6,486	6,466	20		36	
74	6,712	6,808		96		59
75	7,115	7,000	115		55	
76	6,946	7,021		75		20
77	7,162	7,173		11		31
78	7,459	7,420	39		8	
79	7,553	7,638		85		77
80	8,055	7,977	78		0	
81	8,306	8,231	75		75	
82	8,493	8,504		11	64	
83	8,633	8,715		82		18
84	8,824	8,851		27		45
85	8,813	8,854		41		86
86	8,886	8,742	144		57	
87	8,665	8,612	53		111	
88	8,350	8,495		145		35
89	8,407	8,375	32			2
90	8,146	8,167		21		24
91	7,641	7,701		60		84
92	7,021	6,919	102		18	
93	5,969	5,927	42		60	
94	4,968	4,946	22		81	
95	3,882	4,008		126		44
96	3,140	3,115	25			19
97	2,300	2,291	9			10
98	1,548	1,605		57		67
99	1,106	1,072	34			33
100	728	689	39		5	
Total	**272,824**	**272,819**				

The expected deaths are the number of deaths under the assumption that the graduated rates are correct. Deviation refers to the difference between the actual and expected number of deaths. Accumulation at age x is the sum of the deviations from age 2 to age x. Note that this table does not cover ages 0 or 1, as the exposure to risk for these ages was calculated in a different way. The numbers in the table may not add up exactly due to rounding.

Comparison of actual and expected deaths in the three years 2020–22, Australia — females

Age	Actual Deaths	Expected Deaths	Deviation +	Deviation -	Accumulation +	Accumulation -
2	43	46		3		3
3	48	43	5		2	
4	40	40	0		3	
5	32	36		4		2
6	34	33	1			1
7	26	30		4		5
8	38	28	10		6	
9	20	27		7		1
10	30	27	3		2	
11	25	29		4		2
12	33	34		1		3
13	40	41		1		4
14	59	50	9		6	
15	59	61		2	4	
16	69	75		6		2
17	95	89	6		3	
18	96	97		1	2	
19	96	103		7		5
20	110	109	1			4
21	117	113	4			0
22	113	116		3		4
23	132	120	12		9	
24	114	124		10		2
25	140	130	10		8	
26	120	136		16		8
27	149	145	4			4
28	155	155	0			4
29	167	167		0		4
30	190	181	9		5	
31	188	194		6		2
32	234	209	25		24	
33	195	224		29		5
34	245	242	3			2
35	250	263		13		15
36	309	285	24		9	
37	310	309	1		10	
38	342	333	9		19	
39	359	356	3		22	
40	346	378		32		10
41	394	401		7		18
42	413	427		14		31
43	450	458		8		39
44	530	493	37			2
45	545	537	8		6	
46	571	590		19		13
47	662	654	8			6
48	743	730	13		8	
49	802	808		6	1	
50	901	873	28		29	
51	922	925		3	26	

Comparison of actual and expected deaths in the three years 2020–22, Australia — females (continued)

Age	Actual Deaths	Expected Deaths	Deviation +	Deviation -	Accumulation +	Accumulation -
52	907	963		56		30
53	1,065	1,014	51		21	
54	1,087	1,073	14		36	
55	1,129	1,157		28	8	
56	1,234	1,266		32		25
57	1,445	1,394	51		26	
58	1,491	1,524		33		7
59	1,658	1,648	10		4	
60	1,762	1,761	1		5	
61	1,844	1,871		27		23
62	1,986	1,981	5			17
63	2,092	2,100		8		25
64	2,223	2,219	4			21
65	2,428	2,342	86		65	
66	2,397	2,469		72		7
67	2,635	2,619	16		9	
68	2,812	2,826		14		4
69	3,051	3,079		28		33
70	3,431	3,339	92		59	
71	3,581	3,607		26	34	
72	3,832	3,907		75		42
73	4,225	4,267		42		84
74	4,571	4,514	57			27
75	4,784	4,701	83		56	
76	4,827	4,803	24		80	
77	4,968	5,037		69	11	
78	5,291	5,327		36		25
79	5,696	5,647	49		24	
80	5,987	6,072		85		61
81	6,579	6,528	51			10
82	6,968	7,007		39		50
83	7,588	7,476	112		62	
84	7,890	7,896		6	56	
85	8,179	8,277		98		42
86	8,593	8,600		7		49
87	9,017	8,962	55		6	
88	9,385	9,336	49		55	
89	9,719	9,773		54	1	
90	9,988	10,075		87		87
91	10,277	10,142	135		48	
92	9,809	9,828		19	29	
93	9,138	9,176		38		9
94	8,342	8,375		33		42
95	7,546	7,414	132		90	
96	6,163	6,321		158		69
97	5,129	5,113	16			53
98	3,982	3,958	24			29
99	2,969	2,964	5			24
100	2,131	2,110	21			4
Total	**245,932**	**245,936**				

The expected deaths are the number of deaths under the assumption that the graduated rates are correct. Deviation refers to the difference between the actual and expected number of deaths. Accumulation at age x is the sum of the deviations from age 2 to age x. Note that this table does not cover ages 0 or 1, as the exposure to risk for these ages was calculated in a different way. The numbers in the table may not add up exactly due to rounding.

Appendix E: Improvement Factors

Measured percentage mortality improvement factors — males

Age	25 Year	125 Year	Age	25 Year	125 Year
0	-2.3067	-2.7797	55	-1.4465	-1.2818
1	-3.9406	-3.8038	56	-1.5425	-1.2746
2	-3.7302	-3.1589	57	-1.6403	-1.2668
3	-3.6344	-3.0657	58	-1.7406	-1.2587
4	-3.5898	-3.1150	59	-1.8437	-1.2497
5	-3.4909	-3.0727	60	-1.9499	-1.2427
6	-3.2797	-2.9667	61	-2.0584	-1.2376
7	-3.0312	-2.8695	62	-2.1684	-1.2347
8	-2.8339	-2.7852	63	-2.2778	-1.2341
9	-2.7003	-2.7307	64	-2.3833	-1.2341
10	-2.6083	-2.6633	65	-2.4809	-1.2342
11	-2.4952	-2.5555	66	-2.5666	-1.2283
12	-2.3700	-2.4336	67	-2.6373	-1.2130
13	-2.2621	-2.3101	68	-2.6905	-1.1899
14	-2.1971	-2.1721	69	-2.7249	-1.1589
15	-2.2007	-2.0259	70	-2.7395	-1.1208
16	-2.2937	-1.8180	71	-2.7337	-1.0854
17	-2.4748	-1.6793	72	-2.7090	-1.0672
18	-2.7106	-1.6418	73	-2.6676	-1.0598
19	-2.8875	-1.6535	74	-2.6159	-1.0485
20	-2.9700	-1.6806	75	-2.5604	-1.0341
21	-2.9579	-1.7065	76	-2.5054	-1.0176
22	-2.8872	-1.7290	77	-2.4508	-0.9992
23	-2.7971	-1.7483	78	-2.3951	-0.9752
24	-2.7025	-1.7688	79	-2.3353	-0.9467
25	-2.6087	-1.7726	80	-2.2686	-0.9147
26	-2.5190	-1.7750	81	-2.1928	-0.8795
27	-2.4335	-1.7762	82	-2.1058	-0.8434
28	-2.3520	-1.7680	83	-2.0052	-0.8031
29	-2.2742	-1.7557	84	-1.8900	-0.7591
30	-2.1980	-1.7497	85	-1.7605	-0.7123
31	-2.1212	-1.7443	86	-1.6180	-0.6611
32	-2.0424	-1.7352	87	-1.4639	-0.6086
33	-1.9609	-1.7302	88	-1.2996	-0.5551
34	-1.8758	-1.7251	89	-1.1248	-0.5013
35	-1.7868	-1.7162	90	-0.9381	-0.4496
36	-1.6934	-1.7032	91	-0.7390	-0.4031
37	-1.5958	-1.6851	92	-0.5315	-0.3639
38	-1.4949	-1.6637	93	-0.3265	-0.3334
39	-1.3916	-1.6381	94	-0.1346	-0.3114
40	-1.2878	-1.6091	95	0.0000	-0.2962
41	-1.1867	-1.5771	96	0.0000	-0.2867
42	-1.0920	-1.5452	97	0.0000	-0.2810
43	-1.0076	-1.5196	98	0.0000	-0.2764
44	-0.9371	-1.4941	99	0.0000	-0.2886
45	-0.8838	-1.4686	100	0.0000	-0.3280
46	-0.8568	-1.4442	101	0.0000	0.0000
47	-0.8633	-1.4170	102	0.0000	0.0000
48	-0.8963	-1.3899	103	0.0000	0.0000
49	-0.9469	-1.3665	104	0.0000	0.0000
50	-1.0116	-1.3471	105	0.0000	0.0000
51	-1.0872	-1.3307	106	0.0000	0.0000
52	-1.1706	-1.3147	107	0.0000	0.0000
53	-1.2596	-1.3006	108	0.0000	0.0000
54	-1.3521	-1.2885	109	0.0000	0.0000

Measured percentage mortality improvement factors — females

Age	25 Year	125 Year	Age	25 Year	125 Year
0	-2.0733	-2.7682	55	-1.5275	-1.4377
1	-3.2556	-3.7445	56	-1.5940	-1.4326
2	-3.4173	-3.5187	57	-1.6497	-1.4267
3	-3.2458	-3.2396	58	-1.6970	-1.4234
4	-2.9037	-3.1351	59	-1.7438	-1.4222
5	-2.6432	-3.0433	60	-1.7962	-1.4228
6	-2.5601	-2.9772	61	-1.8466	-1.4203
7	-2.6464	-2.9488	62	-1.8901	-1.4162
8	-2.8594	-2.9241	63	-1.9404	-1.4107
9	-3.0877	-2.8678	64	-1.9976	-1.4035
10	-3.2146	-2.7842	65	-2.0621	-1.3945
11	-3.1805	-2.6549	66	-2.1417	-1.3863
12	-2.9684	-2.5180	67	-2.2028	-1.3740
13	-2.5914	-2.4136	68	-2.2138	-1.3496
14	-2.1576	-2.3423	69	-2.1989	-1.3231
15	-1.8171	-2.2779	70	-2.1899	-1.3035
16	-1.6956	-2.2171	71	-2.1910	-1.2900
17	-1.8015	-2.1567	72	-2.1931	-1.2805
18	-2.0622	-2.1489	73	-2.1872	-1.2738
19	-2.2432	-2.1639	74	-2.1730	-1.2683
20	-2.2398	-2.1845	75	-2.1532	-1.2614
21	-2.0364	-2.2284	76	-2.1322	-1.2501
22	-1.7909	-2.2777	77	-2.1101	-1.2293
23	-1.6596	-2.3253	78	-2.0837	-1.1973
24	-1.6251	-2.3698	79	-2.0425	-1.1605
25	-1.6481	-2.4021	80	-1.9826	-1.1200
26	-1.6942	-2.4289	81	-1.9038	-1.0736
27	-1.7326	-2.4329	82	-1.8126	-1.0252
28	-1.7580	-2.4160	83	-1.7155	-0.9761
29	-1.7707	-2.3940	84	-1.6137	-0.9227
30	-1.7663	-2.3761	85	-1.5094	-0.8651
31	-1.7397	-2.3564	86	-1.4046	-0.8060
32	-1.6866	-2.3366	87	-1.2970	-0.7458
33	-1.6061	-2.3079	88	-1.1833	-0.6853
34	-1.5005	-2.2759	89	-1.0613	-0.6263
35	-1.3821	-2.2358	90	-0.9303	-0.5703
36	-1.2636	-2.1872	91	-0.7889	-0.5177
37	-1.1510	-2.1404	92	-0.6359	-0.4702
38	-1.0490	-2.0859	93	-0.4764	-0.4283
39	-0.9615	-2.0177	94	-0.3175	-0.3933
40	-0.8898	-1.9335	95	-0.1651	-0.3668
41	-0.8358	-1.8488	96	-0.0241	-0.3489
42	-0.8013	-1.7792	97	0.0000	-0.3403
43	-0.7873	-1.7272	98	0.0000	-0.3405
44	-0.7935	-1.6929	99	0.0000	-0.3593
45	-0.8160	-1.6612	100	0.0000	-0.4022
46	-0.8532	-1.6264	101	0.0000	0.0000
47	-0.9039	-1.5907	102	0.0000	0.0000
48	-0.9660	-1.5613	103	0.0000	0.0000
49	-1.0373	-1.5327	104	0.0000	0.0000
50	-1.1150	-1.5073	105	0.0000	0.0000
51	-1.1975	-1.4853	106	0.0000	0.0000
52	-1.2832	-1.4643	107	0.0000	0.0000
53	-1.3691	-1.4516	108	0.0000	0.0000
54	-1.4516	-1.4435	109	0.0000	0.0000