



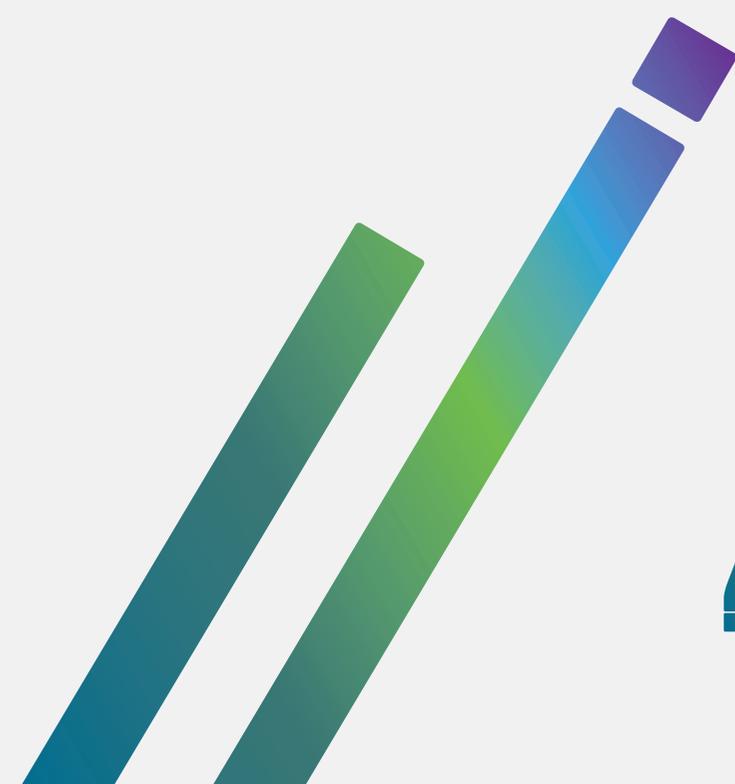
Australian Government

Australian Institute of  
Health and Welfare



# Trends in Indigenous mortality and life expectancy 2001–2015

Evidence from the Enhanced Mortality Database



**AIHW**





**Australian Government**  
**Australian Institute of  
Health and Welfare**

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Australian Institute of Health and Welfare  
Canberra

Cat. no. IHW 174

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- the former Department of Health and Ageing (now the Department of Health) for providing access to the Residential Aged Care Database
- health departments of the various jurisdictions for providing access to the National Hospital Morbidity Database and their respective jurisdictional perinatal/midwives data collections.

# Abbreviations

ABS	Australian Bureau of Statistics
ACAT	Aged Care Assessment Team
ACT	Australian Capital Territory
AIHW	Australian Institute of Health and Welfare
COAG	Council of Australian Governments
EMD	Enhanced Mortality Database
ERP	estimated resident population
MCCOD	Medical Certificate of Cause of Death
MED	Mortality Extract Data Set
NDI	National Death Index
NHMD	National Hospital Morbidity Database
NNAPECD	National Non-admitted Patient Episode of Care Database
NMD	National Mortality Database
NSW	New South Wales
NT	Northern Territory
NTSCORP	Native Title Services Corporation (of New South Wales)
PDC	Perinatal Data Collection
Qld	Queensland
RAC	Residential Aged Care
SA	South Australia
SLA	Statistical Local Area
Vic	Victoria
WA	Western Australia

# Summary

The Enhanced Mortality Database (EMD) was developed in 2010 by the Australian Institute of Health and Welfare to explore the feasibility of creating an ongoing enhanced mortality data set that allows analysis of key mortality indicators including life expectancy and causes of death, to assist with monitoring 'Closing the Gap' health targets. The method involves using data linkage to enhance the identification of Aboriginal and Torres Strait Islander people in death registrations. Current official mortality statistics for Indigenous Australians include only those 5 jurisdictions which are considered to have adequate levels of Indigenous identification in death registrations data. The EMD method allows for the production of national mortality estimates that include data from all jurisdictions, and which have been adjusted for under-identification.

Official life expectancy estimates for Indigenous Australians are produced every 5 years by the Australian Bureau of Statistics. The EMD method provides estimates that complement those of the ABS, as well as allowing estimates of Indigenous life expectancy to be made for the jurisdictions with small Indigenous populations, such as Victoria and South Australia, for which official life expectancy estimates are currently not available. It is expected that in the future, the method will enable separate life tables to be prepared also for Tasmania and the Australian Capital Territory.

The enhancement method employed in this study enables the Indigenous status recorded on death records to be compared across a wide range of independent and comparative data sets, thereby improving the prospect of deriving a consistent and more robust Indigenous status for all death records. Because both the registered death records and comparative data sets used in enhancing the Indigenous status of the death records are available on a yearly basis, the method is able to produce life tables for all jurisdictions on a yearly basis, if required.

In developing the EMD, the AIHW created a base mortality data set, the Mortality Extract Data Set, by validating extracts of death records from the National Death Index against extracts of death records from the National Mortality Database. The Mortality Extract Data Set was then linked to three independent comparative data sets: the National Hospital Morbidity Database, the Perinatal Data Collections of each jurisdiction and the national Residential Aged Care Database.

Analysis of the EMD shows that mortality—as assessed by measures such as the median age at death, age-specific death rates, the cumulative proportions of deaths occurring by specified ages, and age-standardised death rates—has declined for both Indigenous males and females nationally and in most jurisdictions.

Consistent with the observed decline in mortality, life expectancy at birth increased for both Indigenous males and females during the reference period (2001–2005 to 2011–2015). However, greater increases in life expectancy at birth occurred for non-Indigenous males and females, meaning that the gap in life expectancy between Indigenous and non-Indigenous Australians widened during the reference period.

Much of the gap in life expectancy between Indigenous and non-Indigenous Australians is due to the earlier age at death of Indigenous males and females. Deaths of Indigenous males aged under 45 contributed up to one-third (29%–36%) of the gap between Indigenous and non-Indigenous males, while deaths of Indigenous females aged under 45 contributed just over one-fifth (21%–22%) of the gap between Indigenous and non-Indigenous females.

On the whole, deaths of Indigenous males aged 60–74 made the biggest contribution to the male life expectancy gap, while higher death rates of Indigenous females aged 65 and over made the biggest contribution to the life expectancy gap between Indigenous and non-Indigenous females.

# 1 Introduction

This report covers Phase 4 of the Enhanced Mortality Database (EMD) project. It updates the first EMD report, which was published in 2012 (AIHW 2012a). The 2012 report covered the period from 2001 to 2006; this report uses an improved methodology to re-examine Indigenous life expectancy estimates for 2001–2006 as well as presenting mortality and life expectancy estimates for 2006–2010 and 2011–2015.

The purpose of this report is to present key indicators of mortality for Aboriginal and Torres Strait Islander people, including an alternative method of estimating life expectancy that complements the existing method used by the Australian Bureau of Statistics (ABS). The current ABS method is based on linking Census records with registrations of all deaths occurring during the following 13 months (ABS 2013c). The EMD method is based on linking all death registrations for a specified 5-year period with other administrative data sets that contain information on fact of death and Indigenous status. As well as providing Indigenous life expectancy estimates that complement the official ABS estimates, the EMD method enables estimates to be made for jurisdictions such as Victoria and South Australia with small Indigenous populations, for which official life expectancy estimates are currently not available.

The report examines the levels, age-sex patterns and trends in Indigenous mortality and life expectancy based on the enhanced deaths data created using the EMD method. It also assesses the robustness of the estimates and the importance of population denominators and changing Indigenous identification on the estimation of Indigenous mortality and life expectancy measures. The report also compares Indigenous and non-Indigenous mortality and life expectancy and how they are changing over time.

## 1.1 Background

In 2008, the Council of Australian Governments (COAG) committed to six ‘Closing the Gap in Indigenous disadvantage’ targets (COAG 2008). These were revised to seven targets with the addition of a school attendance target in 2014 and a further revision to the early childhood education target in 2015 (Commonwealth of Australia 2015, 2016). Two key health targets within the COAG ‘Closing the Gap’ are:

- closing the life expectancy gap within a generation (by 2031)
- halving the gap in death rates for Indigenous children under 5 within a decade (by 2018).

Assessing progress against these two ‘Closing the Gap’ targets requires robust measures of mortality and life expectancy, in particular, the levels, patterns and trends of mortality to assess whether efforts are on track to meet the targets. Official mortality and life expectancy estimates are produced by the ABS on a regular basis. ABS estimates of life expectancy for Indigenous Australians are based on linking Census data with mortality records for the 13 months following the Census, and are produced at the national level as well as for four individual jurisdictions (New South Wales, Queensland, Western Australia and the Northern Territory).

In Australia, all deaths are likely to be registered, however not all Indigenous deaths are recorded as Indigenous during the registration process. Information on a deceased person’s Indigenous status is provided to jurisdictional registrars of births, deaths and marriages from a variety of sources, including the family and friends of the deceased person, the funeral director, the doctor certifying the death, the coroner or a health worker. There is no consistency in how Indigenous status is reported by these sources.

The quality of Indigenous identification in death data therefore reflects the quality of the information provided by these various sources. The quality of Indigenous identification on death records often varies between jurisdictions, and can affect not only the reliable estimation of the true levels, patterns and trends in Indigenous mortality and life expectancy, but also the reliable estimation of the gap in mortality and life expectancy between Indigenous and non-Indigenous Australians. Robust estimates of Indigenous mortality and life expectancy cannot therefore be reliably estimated without adjustments to Indigenous status information on the death data.

This means that the effectiveness of 'Closing the Gap' initiatives to improve Indigenous mortality and life expectancy cannot be reliably determined while there are inconsistencies in Indigenous identification in death data across jurisdictions. To find solutions to meet these challenges, AIHW developed the EMD project which was later endorsed and supported by the COAG to add to similar efforts being made by Australian, state and territory statistical agencies and departments, and the research community.

The difference in life expectancy between two populations is the result of differences between the two populations in their age-specific death rates. Understanding the factors that contribute to Indigenous life expectancy is important in understanding the life expectancy gap. These components include the levels, patterns and trends in Indigenous death rates, including the distribution of Indigenous deaths by age and sex.

Equally important is knowledge of the levels, trends and components of non-Indigenous life expectancy, including the levels, age-sex patterns and trends in non-Indigenous mortality, and how these components are changing in relation to Indigenous mortality.

The focus of this report is therefore not only on the levels, patterns, trends and the gap in mortality and life expectancy between Indigenous and non-Indigenous Australians, but also on the various contributors to the life expectancy gap.

## 1.2 Objectives

The aims of the EMD project are:

1. to enhance the quality of Indigenous status information on death data by linking registered death data with comparative data sets that contain information on deaths and Indigenous identification, comparing Indigenous status information across the linked data sets, and using the result of the comparison to develop algorithms for enhancing Indigenous status on death data
2. to use the enhanced death data to develop life tables for jurisdictions with small Indigenous populations for which official life expectancy estimates are currently unavailable
3. to explore the mortality patterns underlying the trends and the gap in life expectancy between Indigenous and non-Indigenous Australians, to assist with monitoring the 'Closing the Gap' key health targets.

This report contains Indigenous mortality and life expectancy estimates for the periods 2001–2005, 2006–2010 and 2011–2015 (referred to as the reference period), based on enhanced death data (see sections 1.4.2 and 1.4.3). Indigenous mortality and life expectancy estimates for 2001–2005 and 2006–2010 are based on enhanced death data derived from linked data for the respective periods. Indigenous mortality and life expectancy estimates for 2011–2015 are preliminary; they are based on death data for 2011–2015, which have been enhanced by applying Indigenous status reclassification rates for 2006–2010 to the 2011–2015 death data.

In addition to developing mortality and life expectancy estimates at the national level, mortality and life expectancy estimates were prepared for 6 jurisdictions—see Box 1.1 for further details. The large scale of the EMD study, obtained by combining several years of deaths data, enables life expectancy estimates to be produced for South Australia and Victoria, which due to their smaller Indigenous population do not generally have a large enough sample size to allow reliable estimates to be made using the Census-based methodology. These estimates however are still less robust than those for the larger jurisdictions, and should be interpreted with caution.

Much of the focus of this report is on understanding how Indigenous life expectancy is changing in relation to non-Indigenous life expectancy, the mortality patterns underlying the life expectancy changes, and how the levels and patterns of Indigenous mortality are changing relative to non-Indigenous mortality.

The estimates presented here are based on methods and data sources that are different from those used by the ABS, with the exception of death registration records which are the base data used in both methods (see Box 1.1). The ABS Indigenous life expectancy estimates are based on persons who were counted in the Census and died within 13 months of the Census. For persons counted in the Census who subsequently died during the reference period, their Indigenous status on their Census records is compared with the Indigenous status on their death records. The result of the comparison, together with Indigenous identification propensities obtained from the Post-Enumeration Survey, are used to develop adjustment factors which are then applied to the death records (ABS 2013b).

**Box 1.1: The AIHW and ABS approaches to enhancing Indigenous status information on death data**

The base data for both the AIHW and ABS life expectancy estimates are death registrations provided by jurisdictional Registrars of Births, Deaths and Marriages.

The ABS method uses all Indigenous deaths registered in the reference period. The ABS recognises that all Indigenous deaths are registered but some are not identified and recorded as such when registered. Therefore, registration data underestimates the actual number of deaths and death rates, and consequently their application can result in overestimates of life expectancy. Hence the number of registered deaths needs to be adjusted before compiling life tables. The ABS derives the adjustment factor by linking Census records with all deaths that are registered within a year following the Census. The ABS method uses Aboriginal and Torres Strait Islander identification consistently in numerator (deaths) and denominator (population). This is a unique feature of the ABS method and reduces errors in life expectancy estimates (ABS 2013b).

The starting point for the AIHW approach is all deaths that were registered in a specified period (for example, 2011–2015). The AIHW then links the death registration records with their corresponding records on specified administrative data sets that contain information on Indigenous status and fact of death. For this report, death records were linked to their corresponding records on the National Hospital Morbidity Data Set, the Residential Aged Care Data Set and jurisdictional perinatal data collections. The Indigenous status of corresponding records is compared across the linked data sets, and the result of the comparison is used to develop adjustment factors, which are then applied to the death registration records to enhance them. Although this report also produces life expectancy estimates for jurisdictions with large Indigenous populations, the purpose is not to replace the life expectancy estimates produced by the ABS, but to complement those estimates and contribute to the ongoing search for methods for producing robust estimates of Indigenous mortality and life expectancy.

## 1.3 Phases of Enhanced Mortality Database project

The EMD project has four phases.

### Phases 1 and 2: Feasibility study covering the period 2001–2005

The aim of phases 1 and 2, which covered deaths registered for the period 2001–2005, was to test the feasibility of using linked data to enhance Indigenous status information on the AIHW Mortality Extract Data Set (MED). The MED was created by validating the fact of death information on the AIHW National Death Index (NDI) against extracts of corresponding information on the AIHW National Mortality Database (NMD) for completeness as well as for accuracy and consistency of information (such as, sex, date of birth, date of death, age, place of usual residence, place of death and Indigenous status), as well as to check for duplicate and missing records. The MED was then linked to independent and comparative data sets that also contained information on deaths and Indigenous status.

By comparing Indigenous status information across the linked data sets, an enhanced Indigenous mortality database was created. This enhanced database enabled the AIHW to develop a time series of reliable and robust yearly mortality data to calculate mortality and life expectancy estimates. The data sets linked to the MED were the National Hospital Morbidity Database (NHMD), Residential Aged Care (RAC) database and jurisdictional perinatal/midwives' data collections (PDC). These data sets are described at Appendix B.

The AIHW published a report in July 2012 detailing the objectives, methods, data and results of phases 1 and 2 of the EMD project (AIHW 2012a). The report showed that the enhanced mortality database method was feasible. About 95% of death records identified as Indigenous on the NHMD were able to be linked to the MED. As well, 99% and 60%, respectively, of death records identified as Indigenous on the RAC database and the jurisdictional PDCs were linked to the MED. Overall, about 86% of records on the comparative data sets were able to be linked to a corresponding record on the MED.

Linkage of the MED to the comparative data sets identified 532 Indigenous male and 549 Indigenous female death records on the MED that were not originally identified as Indigenous. These records are referred to in this report as 'misclassified' records. The term 'misclassified' is used here to refer to death records that were not originally classified as 'Indigenous' on the MED but were deemed to be Indigenous after comparing the Indigenous status of these records with the Indigenous status of corresponding records on the linked data sets. As Indigenous identification is determined through self-identification, the term 'misclassified' is not intended to convey the impression that the Indigenous classification on the NDI or NMD was incorrectly recorded.

Records found to have been 'misclassified' were reclassified as 'Indigenous' and added to the number of death records originally identified as Indigenous on the MED. The reclassified death records, together with the death records originally identified as Indigenous on the MED, are referred to as 'enhanced' death records.

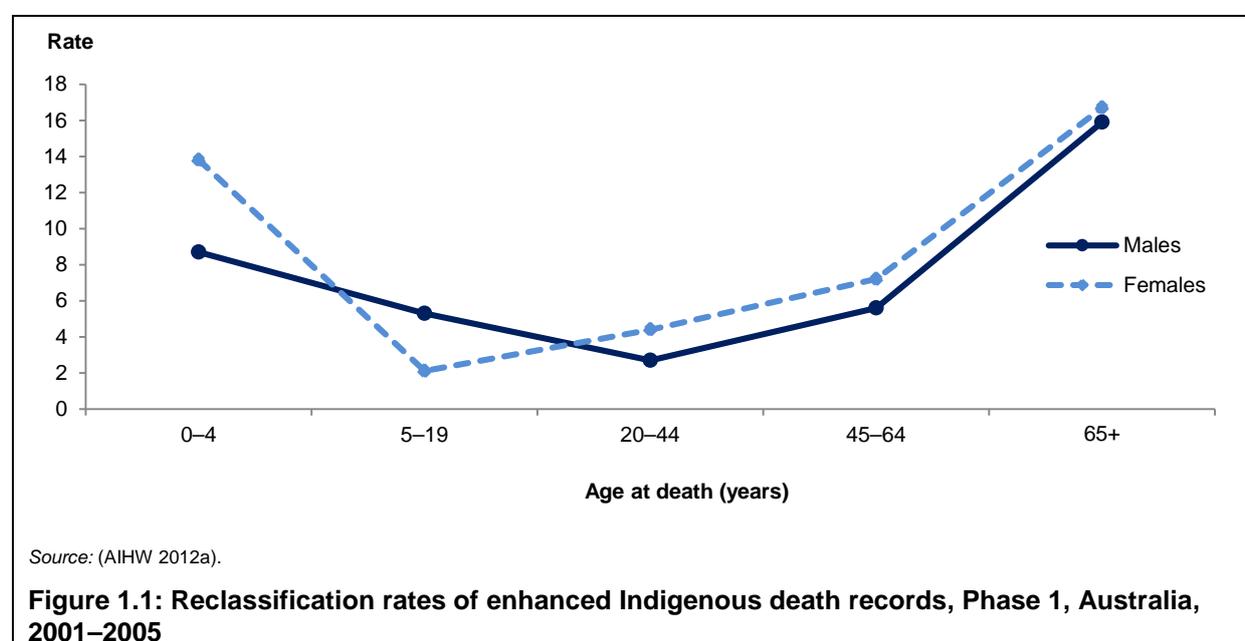
The number and proportion of Indigenous death records deemed to have been misclassified varied by age and sex (Table 1.1 and Figure 1.1). For both sexes, the greatest number and proportions of misclassified records related to deceased persons aged 65 and over, while the smallest number were for deceased persons aged 5–19.

Reclassification rates (the number of reclassified deaths as a proportion of the total number of enhanced deaths) were highest at ages 0–4 years and 65 years and over for both sexes.

**Table 1.1: Number of records reclassified as Indigenous after data linkage, by age and sex, Australia, Phase 1, 2001–2005**

Age at death (years)	Males				Females			
	Indigenous on MED	Re-classified	Enhanced Indigenous deaths	Re-classified as % of enhanced	Indigenous on MED	Re-classified	Enhanced Indigenous deaths	Re-classified as % of enhanced
0–4	430	41	471	8.7	301	48	349	13.8
5–19	233	13	246	5.3	138	3	141	2.1
20–44	1,771	49	1,820	2.7	934	43	977	4.4
45–64	1,980	117	2,097	5.6	1,405	109	1,514	7.2
65+	1,654	312	1,966	15.9	1,728	346	2,074	16.7
<b>All ages</b>	<b>6,068</b>	<b>532</b>	<b>6,600</b>	<b>8.1</b>	<b>4,506</b>	<b>549</b>	<b>5,055</b>	<b>10.9</b>

Source: Enhanced Mortality Database.



Source: (AIHW 2012a).

**Figure 1.1: Reclassification rates of enhanced Indigenous death records, Phase 1, Australia, 2001–2005**

Phases 1 and 2 of the EMD study yielded an estimate of life expectancy at birth of 66.8 years and 72.9 years, respectively, for Indigenous males and females in Australia for 2001–2005. These compare very closely with ABS estimates of 67.2 and 72.9 years, respectively, for Indigenous males and females for 2005–2007 (ABS 2009b; AIHW 2012a) (see Table 1.2).

**Table 1.2: Estimates of Indigenous life expectancy at birth, phases 1 and 2, 2001–2005**

Sex	AIHW (EMD) estimates 2001–2005 <sup>(a)</sup>		ABS estimates 2005–2007 <sup>(a)</sup>
	Linked records only	Including unlinked records	Including unlinked records
Males	66.8	66.6	67.2
Females	72.9	72.7	72.9

(a) The population denominators used in calculating the death rates used in preparing these life expectancies were based on back-cast Indigenous population estimates derived from the 2006 Census. These estimates are different from those presented in subsequent tables which are based on population estimates derived from the 2011 Census.

Sources: (ABS 2009b; AIHW 2012a).

### **Phase 3: Validation of Indigenous status information on the EMD project**

The aim of phase 3 of the EMD project was to test the validity of the enhanced Indigenous status information by linking the EMD with a 'gold standard' data set, namely the New South Wales Native Title Services Corporation (NTSCORP) research database. The NTSCORP research database contains verified Indigenous status information for people in New South Wales derived from official birth, death and marriage records, genealogical histories, archival records, historical documents, oral histories and personal interviews.

The validation was carried out in two stages. Stage 1 tested the feasibility of linking the New South Wales component of the EMD to the NTSCORP research database to validate the derived Indigenous status information on the EMD. Stage 2 involved implementing the validation methodology developed in the feasibility stage. The results showed that linkage of the EMD to the NTSCORP research database was feasible but that it should be redone using a method that accounted for the different structures and formats of the two data sets and to take advantage of additional variables not previously used for linkage purposes.

### **Phase 4: 2006–2010**

The objective of phase 4 was to broaden the time series of enhanced mortality data by extending the linkage to cover deaths registered for the period 2006–2010, to refine the methodology, and (if possible) to explore other algorithms for deriving Indigenous status.

Phase 4 was extended to cover the entire period 2001–2010, including the 2001–2005 period originally covered by phases 1 and 2:

- In phases 1 and 2, the MED was linked only to death records identified as Indigenous on the NHMD, RACD and jurisdictional Perinatal Data Collections. In phase 4, all records, rather than only Indigenous records from the three comparative data sets were linked to the MED. This approach was expected to lead to more accurate linkage results and to minimise the risk of false links and missing links.
- In phase 4, records for the whole period 2001–2010, rather than just for 2006–2010, were linked. This enabled any revisions to any of the data sets since the initial linkage to be reflected in the new linked data.

## **1.4 Data and methods**

The methods used to develop the Indigenous mortality and life expectancy estimates presented in this report are:

- data linkage to link records on the MED with corresponding records on the NHMD, RACD and jurisdictional perinatal data collections
- comparison of Indigenous status information across the linked data sets and using the results of the comparison to develop algorithms with which to derive reclassification rates of Indigenous status (see section 1.4.2)
- enhancement of Indigenous status information on the linked data sets to create the EMD
- use of standard demographic and statistical methods to prepare the Indigenous mortality estimates and life tables.

### **1.4.1 Data linkage**

The MED was linked sequentially to the comparative data sets using probabilistic methods. The MED was first linked to the RACD. The two databases were then linked to the NHMD. Lastly, the MED and the NHMD were linked to the jurisdictional perinatal data collections.

Linkage of the MED to each of the three data sets took a different approach because the variables available for linkage were different for each data set. Table 1.3 shows the list of variables available for linkage and clerical review across the MED and the three comparative data sets. While all four data sets had a sufficient number of demographic and geographic variables for linkage, only the MED and the RACD had name information.

**Table 1.3: Full list of linkage variables available on data sets for linkage and clerical review**

Linkage variable	MED	RAC database	NHMD	PDC
<b>Personal variables</b>				
Surname	✓	✓		
First name 1	✓	✓		
First name 2/middle name	✓	✓		
Other names	✓			
Maiden name	✓			
<b>Demographic variables</b>				
Date of birth				
Sex	✓	✓	✓	✓
Birth day	✓	✓	✓	✓
Birth month	✓	✓	✓	✓
Birth year	✓	✓	✓	✓
Country of birth	✓	✓	✓	
<b>Date of death/date of separation/date of discharge</b>				
Death day	✓	✓	✓	✓
Death month	✓	✓	✓	✓
Death year	✓	✓	✓	✓
Reason for discharge		✓		
Mode of separation			✓	
Death indicator		✓		✓
Age	✓	✓	✓	
<b>Geographic variables</b>				
Address				
State or territory of usual residence	✓	✓	✓	✓
Statistical Local Area	✓	✓	✓	✓
Postcode		✓		✓
Suburb	✓	✓		

Linkage of the MED to the NHMD and RACD occurred over several iterations or ‘passes’. In each pass, a set of blocking and linkage variables was used to link each data set to the MED. The linkage variables, which are shown in Table 1.3, comprised:

- personal variables such as name
- demographic variables such as sex, date of birth, date of death, age at death and country of birth
- geographic variables such as Statistical Local Area and state of usual residence.

Death records on the MED and on the comparative data sets were linked using year of death as a linking variable. However, for compiling death statistics and life expectancy estimates, death records on the MED were compiled on the basis of year of registration of death.

### **Classification of deaths by year of registration**

The analysis in this report is based on deaths classified by year of registration rather than by the year in which the death occurred. This is consistent with the type of death data used by the AIHW and the ABS to produce mortality and life expectancy estimates. Registered deaths classified by year of registration rather than year of death are preferred due to delays that can occur in death registration. While up to 95% of deaths are registered in the year in which they occur, the remainder may not be registered for several years after the death.

In the long term, the number of deaths classified by year of registration is nearly the same as the number of deaths classified by year of occurrence. In the short term, however, there will be a shortfall in the number of deaths classified by year of occurrence compared with the number classified by year of registration. Deaths classified by year of occurrence will tend to underestimate mortality and overestimate life expectancy. If mortality and life expectancy estimates are based on death data classified by year of occurrence, then estimates would need to be updated for several years until all deaths occurring in a given year are registered. See Appendix B2.1 for further information.

### **State or territory of usual residence**

Death data for the jurisdictions were compiled on the basis of state or territory of usual residence of the deceased rather than on the state or territory where the death was registered. This is important because the population denominators used to derive mortality and life expectancy estimates are constructed on the basis of state and territory of usual residence. Basing the registered deaths on state or territory of usual residence therefore aligns the death data with the population data.

### **Queensland death data**

Deaths registered in Queensland were adjusted to take account of the 'extra' deaths that were discovered and registered in Queensland in 2010. These deaths occurred over many years before 2010 but were registered only in 2010. Many of these extra deaths were Indigenous. To ensure that estimates of Indigenous mortality in Queensland for 2010 were not overestimated, deaths registered in Queensland in 2010 were included in the estimates only if they occurred within 3 years of the date of registration.

## **1.4.2 Algorithm for enhancing Indigenous status**

An 'ever-Indigenous' approach was adopted to enhance the Indigenous status of records on the MED. It was originally intended that phase 4 would explore algorithms other than the 'ever-Indigenous' algorithm, but because of the age-based nature of two of the comparative data sets (for example, RACD and perinatal data sets), most of the registered death records could potentially only link to the NHMD and one other data set. For example, while the NHMD covers deaths across all ages, the RACD only covers deaths of older persons, and the jurisdictional perinatal/midwives' collections only cover perinatal deaths.

In effect, while 75% to 78% of MED records linked to at least one other data set in 2001–2005 and 2006–2010, only 10% of MED records linked to two or more data sets (see Table C4). As a result, the use of algorithms other than the 'ever-Indigenous' algorithm was not feasible.

If the unadjusted registration data represent a ‘minimum estimate’ of the true number of Indigenous deaths, then using the ‘ever-Indigenous’ algorithm to enhance death records produces a ‘maximum estimate’ of possible Indigenous deaths, in which there may be some degree of over-identification, given the sources of Indigenous identification used in this study. The true number of Indigenous deaths will lie somewhere between the two.

The risk of over-identification, if any, will depend on the extent to which Indigenous people are likely to be reported as ‘non-Indigenous’ or the Indigenous status of Indigenous people reported as ‘unknown’, ‘missing’ or ‘not stated’, on the one hand, compared to the extent to which non-Indigenous persons are likely to be recorded as ‘Indigenous’, on the other. Unless the risk of non-Indigenous people being recorded as ‘Indigenous’ is greater than the risk of Indigenous people being recorded as ‘non-Indigenous’, then the risk of over-identification will be very low even, with the use of the ‘ever-Indigenous’ algorithm.

Alternative algorithms will be explored in future work if appropriate additional data sets can be linked to the EMD.

### **1.4.3 Method of enhancing Indigenous status on the MED**

This section describes the enhancement process, which is detailed more fully at Appendix C.

Linkage of the MED to the comparative data sets returned two sets of results:

- records on the MED that linked to a corresponding record on one or more of the comparative data sets
- records on the MED that did not link to a corresponding record on any of the comparative data sets.

#### **Treatment of linked MED records**

After the linkage of the MED to the comparative data sets, the Indigenous status of linked records was compared across the linked data sets. From the comparison, a number of determinations were made:

- Linked MED records that were labelled as Indigenous on the MED were accepted as Indigenous, irrespective of their status on the comparative data sets.
- Misclassified linked MED records—that is, MED records that were labelled as non-Indigenous on the MED but as Indigenous on any of the comparative data sets—were reclassified as Indigenous.
- Linked MED records with ‘missing’, ‘unknown’ or ‘not stated’ Indigenous status information on the MED but that were identified as Indigenous on any of the comparative data sets were reclassified as Indigenous.

By comparing the Indigenous status of linked records on the MED with that on the comparative data sets, an estimate of Indigenous misclassification among linked MED records can be made. This estimate is derived in terms of the number and proportion of non-Indigenous records and records with ‘missing’, ‘unknown’ or ‘not stated’ Indigenous status information on the MED that have been identified as Indigenous on one or more of the comparative data sets.

This measure of Indigenous status misclassification was estimated by age, sex and state of usual residence.

Based on this measure of misclassification, a measure of reclassification was estimated, which can be applied to unlinked MED records with ‘non-Indigenous’, ‘missing’ or ‘unknown’ Indigenous status information.

For each age and sex group, a measure of reclassification can be estimated as one (1) plus the proportion of misclassified records in that age–sex category. Thus, if in a particular age–sex group, 15% of MED records were deemed to have been misclassified, the reclassification rate for that age–sex category would be 1.15 (that is,  $1 + .15$ ). The reclassification rate (sometimes referred to as an adjustment factor) shows by how much linked MED death records in that age–sex category was adjusted to account for the observed misclassification.

The measures of misclassification and reclassification are particularly useful when enhancing the Indigenous status of unlinked MED records not classified as ‘Indigenous’.

### **Treatment of unlinked MED records**

Some MED records did not link to a corresponding record on any of the comparative data sets for a range of reasons:

- the unlinked MED record did not have a corresponding record on any of the comparative data sets (for example, the record related to a death that occurred outside a hospital or residential aged care facility)
- the unlinked MED record related to a delayed registered death; that is, a death that occurred before the reference period but was registered during the reference period
- there were missing, incomplete, erroneous or poor-quality linkage variables either on the MED or on one or more of the comparative data sets.

Unlinked MED records have no identified corresponding records on the comparative data sets against which to compare their Indigenous status from the MED. However, just as was observed among linked records, it was assumed that a certain proportion of unlinked MED records with ‘non-Indigenous’ ‘unknown’ or ‘missing’ Indigenous status information could have been misclassified, and could, indeed, be Indigenous. This cannot, however, be directly ascertained from the unlinked records as they have no corresponding records on any of the comparative data sets to allow this assumption to be verified.

Having no identified corresponding records on any of the comparative data sets, a possible approach to enhancing the Indigenous status information of unlinked MED records may be to assume that the pattern of misclassification observed among linked MED records will be similar to that for unlinked MED records.

Given this assumption, the age–sex reclassification rates observed among linked MED records can be applied to the unlinked MED records with ‘non-Indigenous’, ‘missing’, ‘not stated’ or ‘unknown’ Indigenous status information. This application yielded an estimate of reclassified Indigenous deaths, by age and sex, among unlinked MED records.

The estimated reclassified deaths among unlinked MED records was added to the number of linked and unlinked records originally labelled as ‘Indigenous’ on the MED, as well as to linked MED records that were reclassified as Indigenous. This yielded an overall estimate of the number of enhanced Indigenous death records on the MED.

The total number of enhanced Indigenous death records is therefore equivalent to:

1. linked MED records labelled as ‘Indigenous’ on the MED
2. linked MED records with ‘non-Indigenous’, ‘missing’ or ‘unknown’ Indigenous status information on the MED that were reclassified as ‘Indigenous’ using the ever-Indigenous algorithm
3. unlinked MED records labelled as ‘Indigenous’ on the MED
4. unlinked MED records with ‘non-Indigenous’, ‘missing’ or ‘unknown’ Indigenous status information on the MED that were reclassified as ‘Indigenous’
5. net gains and losses as a result of lags in death registration (see Appendix A).

Further details are provided at Appendix C.

### **Enhancement of death data for 2011–2015**

Linkage of data for 2001–2010 was carried out after the AIHW and jurisdictional ethics bodies granted approval to implement the EMD project. The project has since been granted ethics approval by the AIHW Ethics Committee as well as approval human research ethics committees (HREC) from New South Wales, Victoria, South Australia, Western Australia, the Northern Territory and the Australian Capital Territory for the EMD to become an ongoing data collection. Ethics approval from the University of Tasmania HREC, as well as approval from Queensland Health under the *Public Health Act* (2005) and from jurisdictional data custodians to access and link their respective jurisdictional data sets to death registration data, is now being sought (see Box 1.2).

As linked data for 2011–2015 are not yet available, the Indigenous status of records on the MED for 2011–2015 was enhanced by assuming that the level and pattern of Indigenous status ‘misclassification’ observed on 2006–2010 death records would not have changed substantially between 2006–2010 and 2011–2015.

Based on this assumption, MED death records for 2011–2015 were enhanced by applying to those records the age–sex Indigenous status reclassification rates estimated from the 2006–2010 linked data. The following procedures were adopted:

- A Mortality Extract Database for 2011–2015 (MED 2011–2015) was created by validating extracts of death records on the NDI registered 2011, 2012, 2013, 2014 and 2015 against extracts of death records from the NMD registered during the same period. This was done to check for completeness, accuracy and consistency of data, and to correct for missing and duplicate records.
- MED 2011–2015 records coded as Indigenous were accepted as ‘Indigenous’.
- MED 2011–2015 records with ‘non-Indigenous’, ‘missing’, ‘not stated’ or ‘unknown’ Indigenous status information were enhanced by applying to these records the age–sex-specific reclassification rates obtained for linked records for 2006–2010.

The total number of enhanced Indigenous records for 2011–2015 was therefore estimated by summing:

1. MED 2011–2015 records labelled as ‘Indigenous’ on the MED 2011–2015
2. MED 2011–2015 records with ‘non-Indigenous’, ‘missing’ or ‘unknown’ Indigenous status information on the MED that were reclassified as ‘Indigenous’.

Simulations were carried out to estimate the impact of changes on estimates of life expectancy for 2011–2015 if the rates of Indigenous status misclassification observed on death data for 2006–2010 improved or deteriorated within a 40% margin. The results are shown in appendix figures C1 and C2, and discussed at Appendix C3.

The results show that, for both sexes, Indigenous life expectancy for 2011–2015 could be underestimated by up to 0.4 of a year if Indigenous status misclassification had declined by up to 20% since 2006–2010, but the 2006–2010 reclassification rates were applied to the 2011–2015 death data. Similarly, Indigenous life expectancy could be overestimated by up to 0.4 of a year if Indigenous status misclassification had increased by up to 20% since 2006–2010, but the 2006–2010 reclassification rates were applied to the 2011–2015 death data.

Thus, even if Indigenous status misclassification rates observed in 2006–2010 were to change by up to 40%, the impact on estimates of Indigenous life expectancy of applying the 2006–2010 reclassification rates to 2011–2015 death data would be less than 1 year.

Based on these results, Indigenous status reclassification rates estimated for 2006–2010 were applied to death data for 2011–2015 to produce the enhanced death data used to prepare the preliminary 2011–2015 mortality and life expectancy estimates presented in this report. Final mortality and life expectancy estimates will be prepared for 2011–2015 when all ethics and data custodian approvals are received, and data are linked and analysed for that period.

#### 1.4.4 Development of mortality estimates and life tables

Two types of data are required to estimate Indigenous period life tables. These are:

- the number of Indigenous deaths registered during the reference period, and classified by age and sex
- the population from which those deaths occurred (population at risk) during the specified period, classified into the same age and sex categories.

For this study, age-specific death rates were computed from enhanced death data. The distribution of enhanced Indigenous deaths by age and sex was used to calculate age–sex-specific death rates. These rates are ratios of the number of enhanced Indigenous deaths (classified by age and sex) to the population at risk, also classified by the same age and sex categories. The population at risk in this report is the Indigenous back-cast and projected population estimates based on the 2011 Census (ABS 2014a).

##### **Box 1.2: Calculating jurisdiction-specific mortality and life expectancy estimates**

Although death data were available for all jurisdictions, jurisdiction-specific mortality and life expectancy estimates were prepared for only New South Wales, Victoria, Queensland, South Australia, Western Australia and the Northern Territory. The life expectancy estimates for Victoria and South Australia should be interpreted with caution. Jurisdiction-specific estimates were not prepared for Tasmania and the Australian Capital Territory because of the small size of the Indigenous population and the very few Indigenous deaths in those jurisdictions.

Estimates based on jurisdictions with very few Indigenous deaths could result in estimates with high standard errors, especially where the deaths have to be distributed across several age-sex groups in order to prepare Indigenous life tables. In the future, separate processes may be developed to enable estimates to be prepared for these jurisdictions.

Estimates for Australia as a whole, however, included death data from all jurisdictions.

#### **Choice of denominator population**

Of critical importance to the mortality and life expectancy estimates presented in this report is the choice of denominator population. An appropriate denominator population is required to prepare the mortality measures shown in Chapter 2 and the age-specific death rates that served as input data for the life tables and life expectancy estimates shown in Chapter 3.

The AIHW had a choice of two denominator populations:

- the official ABS back-cast and projected Indigenous population estimates based on the 2011 Census
- cohort-interpolated population estimates based on the 2001, 2006 and 2011 Censuses.

There are strengths and weaknesses associated with using either of these two populations as denominator populations. The appropriate choice is not clear cut; however, the impact on the magnitude of key estimates such as life expectancy can be very substantial, often larger

than other sources of variation captured in the width of confidence intervals. Appendix C5 provides further details on the impact on Indigenous life expectancy estimates of choosing either the cohort-interpolated population or the back-cast and projected Indigenous population as a population denominator.

The advantage of the back-cast and projected Indigenous populations is that they represent a demographically-consistent population. The ABS believes them to be the most accurate and up-to-date series and advises that, wherever possible, they should be used (ABS 2014a). On the other hand, a key advantage of the cohort-interpolated population is that its Indigenous identification aligns more closely to the date of the events in the numerator, which the ABS also recognises as an important consideration.

### **Back-cast and projected Indigenous population estimates**

After each Census, the ABS prepares an Indigenous estimated resident population (ERP) as at 30 June of the Census year, based on the latest Census. For the 2011 Census, this was the Indigenous population as at 30 June 2011. In preparing the 30 June 2011 Indigenous ERP, the Census count was adjusted for Census undercount, records with missing Indigenous status information as well as for the number of births, and the age and sex distribution of deaths between 30 June 2011 and the Census date of 9 August 2011 (ABS 2012a, 2014a).

From the 30 June Indigenous ERP, the ABS prepared 'back-cast' estimates of the Indigenous ERP to 30 June 2000, as well as forward estimates or projections of the Indigenous population from 30 June 2011 to 30 June 2026, using assumptions about future fertility, paternity, life expectancy and migration (ABS 2014a).

Following the release of new back-cast and projected Indigenous population estimates after each Census, Indigenous measures and indicators (based on population denominators calculated from the previous Census) need to be revised, based on the new set of population denominators calculated from the current Census. Because the new sets of measures do not involve a change to the numerator—only to the denominator population—the level of any resulting Indigenous measures or indicators will depend on the population denominator used to prepare the measures or indicators.

For example, after the 2006 Census, the Indigenous ERP as at 30 June 2006 was estimated at 517,043. After the 2011 Census, the 30 June 2006 Indigenous ERP was revised to 601,450, an increase of 16.3%. Similarly, the Indigenous ERP as at 30 June 2011 was revised from 575,552, based on projecting the 2006 Census, to 669,881, based on the 2011 Census—an increase of 16.4% (ABS 2012a, 2012b, 2014a).

A comparison of estimates of the Indigenous population as at 30 June 2006 and 30 June 2011, based on the 2006 and 2011 Censuses, is presented in Table 1.4. The table shows that if the Indigenous population as at 30 June 2006 and 30 June 2011 were based on the 2006 and 2011 Censuses, respectively, the Indigenous population would have increased by 29.7% for males and 29.4% for females during the 5-year period from 30 June 2006 to 30 June 2011. This is equivalent to an average annual increase of 5.9% for both males and females. This increase is more than twice the rate of natural increase, with the additional increase most likely due to improvements in Census methodology, as well as to an increased likelihood that individuals identified themselves and their children as Indigenous (ABS 2012a, 2012b, 2014a).

**Table 1.4: Projected Indigenous population and Indigenous ERP for 30 June 2006 and 30 June 2011, based on the 2006 and 2011 Censuses**

Estimate	Males	Females	Total
30 June 2011 projected Indigenous population based on 2006 Census (a)	286,738	288,814	575,552
30 June 2011 Indigenous ERP based on 2011 Census (b)	333,683	336,198	669,881
Percentage difference of (a) from (b) (%)	16.4	16.4	16.4
30 June 2006 Indigenous ERP based on 2006 Census (c)	257,309	259,734	517,043
30 June 2006 Indigenous ERP based on 2011 Census (d)	299,637	301,813	601,450
Percentage change from (c) to (d)	16.5	16.2	16.3
Percentage change from (c) to (b) (%)	29.7	29.4	29.6
Annual percentage increase (c) to (b) (%)	5.9	5.9	5.9

Sources: (ABS 2009c, 2012c, 2012d).

Figure 1.2 compares the total Indigenous back-cast and projected population for the period 2000 to 2021, based on the 2001, 2006 and 2011 Censuses. While each year, the population estimates vary between Censuses, the differences are largest for estimates based on the 2006 and 2011 Censuses. This observation is important. If, after each Census, estimates based on the previous Census are re-estimated using population denominators based on the current Census, then the new estimates could vary substantially from the previous estimates, depending on differences between the two Census-based population denominators in size and age distribution.

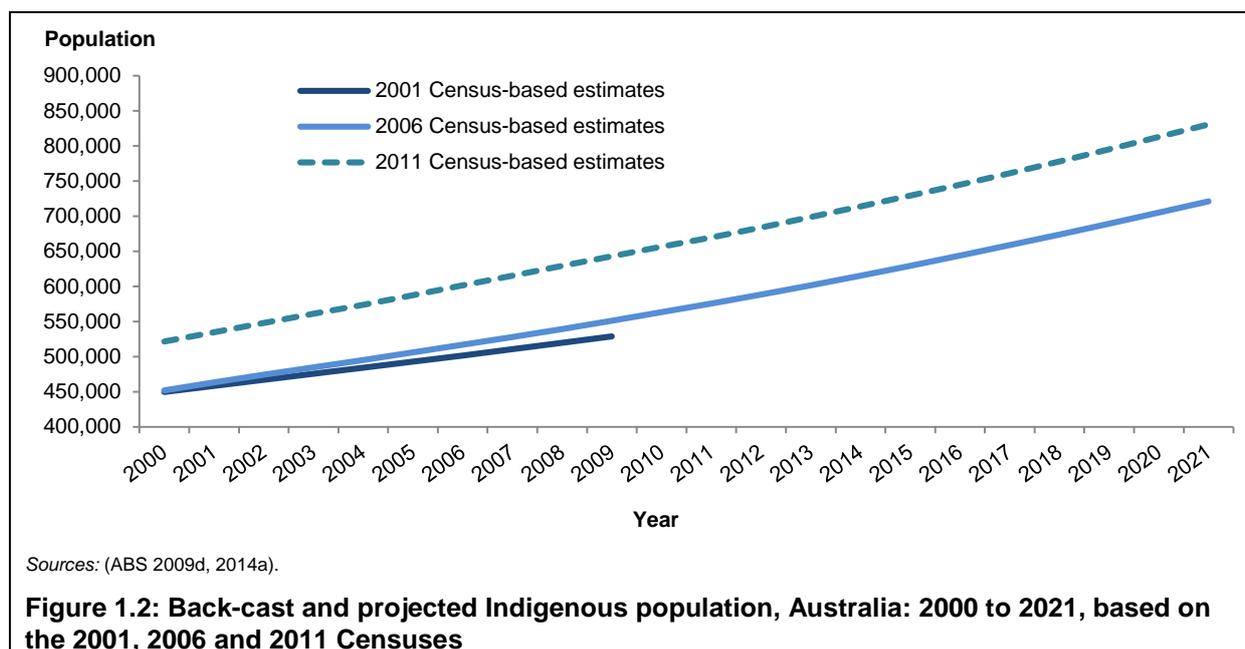
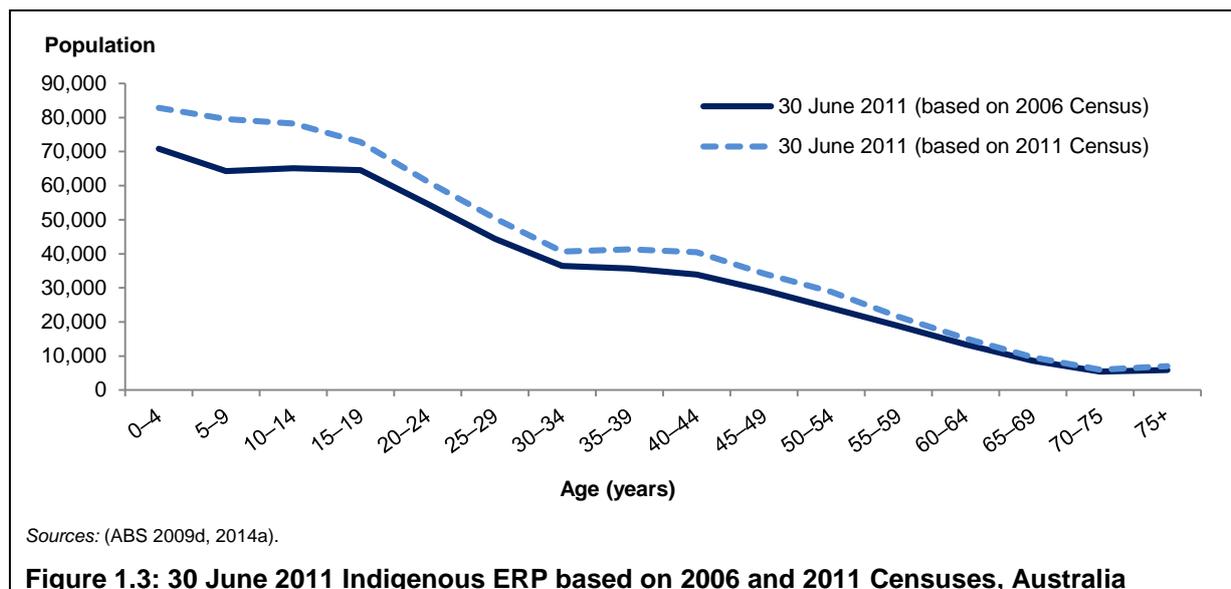


Figure 1.3 compares the age distribution of the Indigenous ERP as at 30 June 2011, based on the 2006 and 2011 Censuses. At each age, the Indigenous ERP based on the 2011 Census is larger than that based on the 2006 Census. The differences between the two estimates are largest at the youngest ages (0–14), and reduce towards the oldest ages. Any estimates based on population denominators derived from the two Censuses will be affected not only by the different sizes of the two populations, but also by their different age structures.



As an example, for the period 2001–2005, AIHW estimates show Indigenous male life expectancy to be 66.6 (2006) or 68.3 (2011) years, and female life expectancy, 72.7 (2006) or 73.9 (2011) years, depending on whether the population denominator used in calculating the life table age-specific death rates was based on the 2006 or the 2011 Census (see Table C6).

### Cohort-interpolated Indigenous population estimates

While ABS Indigenous back-cast estimates and projected populations are based on a single Census, cohort-interpolated population estimates are based on multiple Censuses. They are based on the Censuses that straddle the years for which the estimates are being sought. Thus, measures covering the period 2001–2006 are based on the 2001 and 2006 Census population estimates, while estimates covering the period 2006–2011 are based on the 2006 and 2011 Census population estimates.

For example, the population aged 20 at the 2006 Census are survivors of the birth cohort aged 15 at the 2001 Census. This cohort will be aged 25 at the 2011 Census. Thus, to obtain population denominators for the age group 20–24—for instance, for the preparation of measures covering the period 2006 to 2010—one has to interpolate between the population aged 15 at the 2001 Census and the population aged 20 at the 2006 Census to obtain the populations aged 15, 16, 17, 18 and 19. The population aged 20, 21, 22, 23 and 24 will be derived from interpolating between the population aged 20 at the 2006 Census and the population aged 25 at the 2011 Census.

One possible drawback which needs to be considered when using back-cast population denominators from a single Census is that Indigenous identification obtained from that single Census is applied to all the back-cast and projected population estimates. If Indigenous identification has changed between Censuses, and if this change is reflected in the numerator data (for example, death records), this is likely to lead to a mismatch in Indigenous identification between the numerator and denominator population.

One possible advantage of using a cohort-interpolated population denominator is that Indigenous identification in the denominator population may better reflect that in the numerator data because of the closeness in time between the dates of the Indigenous status information in the numerator and denominator.

In many cases, however, this may not be the case because Indigenous identification for the same individual may vary from one period to another, between data sets, according to who provided the information, and depending on the purpose for which the information was being collected. Indigenous identification for the same individual may also vary between Censuses and between a Census record and a death record, especially since on a death record, a person is no longer reporting on their own Indigenous status.

In explaining the factors contributing to the large increase in the Indigenous population between the 2006 and 2011 Censuses, the ABS noted that 'of the increase in the Aboriginal and Torres Strait Islander population observed between the 2006 and 2011 Censuses, the ABS estimates that 43% was attributable to demographic change. An estimated 36% of the increase was due to methodological improvements, with propensity to identify a major contributor to the remaining 21% unexplained increase' (ABS 2013c).

This means that not only have methodological improvements made the 2011 Census data better than (but probably incomparable to) population data based on other Censuses, but also up to 57% of the difference between the Indigenous populations based on the 2006 and 2011 Censuses may be due to factors that are specific to the 2011 Census (that is, methodological improvements, 36% and the propensity to identify, 21%). It may therefore not be appropriate to combine population data from the 2011 and other Censuses for estimating Indigenous measures for historical comparisons. It is therefore conceptually problematic to create cohort-interpolated Indigenous population estimates by combining population data based on the 2011 with population data based on other censuses for the purposes of estimating Indigenous measures for historical comparisons.

The ABS has stated that 'the 2011-based [population] series is the most accurate and up-to-date series currently produced by the ABS, including in terms of the methodology used in the Census collection and in the estimation/projection processes' (ABS 2013c). The ABS further advises that wherever possible, the 2011 Census-based series should be used as the denominator of rates being compared over time, especially if the time series is short. The 2011 Census-based [population] series is also recommended 'when there is a known quality issue in the data from earlier Censuses (such as the older age groups in the 2001 Census)' (ABS 2013c).

The ABS also recommends that a range of different Census-based population estimates could be considered if transitioning from one series to the next to maximise consistency of identification levels and coverage between the numerator and denominator. There is no indication that this will be the case for the 2001, 2006 and 2011 Census-based Indigenous populations, as the quality of Indigenous identification in the 2011 Census is much better than in earlier Censuses.

A case could have been made to use cohort-interpolated Indigenous population data created from the 2001, 2006 and 2011 Censuses if Indigenous identification in the 2001 Census was shown to mirror Indigenous identification on death registration data for 2001–2006, or that Indigenous identification in the 2006 Census mirrored Indigenous identification on of death registration data for 2006–2010. This could not be verified.

### **Other considerations**

The quality of Indigenous identification information in the comparative data sets used in the enhancements to the death data has considerably improved the quality of the death data. For example, hospital separations data in the NHMD was one of the comparative data sets used in enhancing Indigenous status information on death registration records.

Between 2003 and 2012, the AIHW undertook a number of audits to measure the level of correctness of Indigenous identification in hospital separations data. The audits involved

interviewing a sample of admitted patients in public hospitals in each jurisdiction throughout Australia about their Indigenous status, and comparing the patients' responses with the Indigenous status information recorded on the hospital admission records.

Analysis of the data revealed that 82%, 89% and 88%, respectively, of Indigenous patients in public hospitals in Australia in 2004–2005, 2007–2008 and 2011–2012 were correctly identified as Indigenous in hospital records (AIHW 2010b, 2013). In 2011–2012, except for Tasmania (64%) and the Australian Capital Territory (58%) where smaller proportions of Indigenous records were correctly identified as Indigenous, rates of correct Indigenous identification in other jurisdictions ranged between 78% in Victoria and 98% in the Northern Territory, with Queensland, Western Australia and South Australia also having very high rates of correct Indigenous identification of 87%, 96% and 91%, respectively.

Mindful of these considerations, it was decided to use the 2011 Census-based back-cast Indigenous population as the denominator population for preparing age-specific death rates for 2001–2005, 2006–2010 and 2011–2015, as this will provide a consistent series of estimates for historical comparisons.

### **Box 1.3: Enhanced Indigenous Mortality Data Collection**

The EMD project has hitherto been conducted as a series of *ad hoc* data linkage projects involving a number of phases covering specific periods of time. Each phase had its own scope and set of objectives. Each phase also required its own ethics approval from the AIHW Ethics Committee and jurisdictional human research ethics committees. Data custodians have also required separate jurisdictional approvals before data could be released for each phase. These processes have tended to slow down the rate of progress in the respective phases of the project.

As a result of these issues and the fact that the feasibility of the EMD methodology has already been demonstrated, the AIHW is consulting with other stakeholders to convert the EMD into an ongoing data collection—the 'Enhanced Indigenous Mortality Data Collection' (EIMDC)—for which data custodian and ethics approval from applicable jurisdictional ethics committees will be obtained. The EIMDC will provide a time series of enhanced Indigenous mortality data from 2001, on a continuous basis.

The collection will also contain information on cause of death and mortality risk factors. It will provide enhanced yearly Indigenous mortality data that can be used to produce more robust yearly estimates of mortality and life expectancy—nationally and by jurisdiction, where data quality permits.

The AIHW Ethics Committee has approved the establishment of the ongoing collection. Ethics and data custodian approvals are now being sought from jurisdictional data custodians for access to applicable ongoing data to build the collection.

The results of phase 4 of the EMD project will be incorporated into the EIMDC. Validation of the enhanced Indigenous status information in the collection will also be routinely conducted as part of the collection.

As well as working to meet its objective, as already described, the collection will also explore the use of additional algorithms to derive Indigenous status from the linked data.

## 2 Mortality levels, patterns and trends

### 2.1 Introduction

The mortality estimates presented in this report are based on death data from the EMD that have been adjusted for Indigenous under-identification. These estimates may therefore differ from Indigenous mortality measures published annually by the ABS and the AIHW that are not adjusted for Indigenous under-identification (ABS 2015; AIHW 2011a, 2012c). These publications contain Indigenous mortality estimates for the five jurisdictions (New South Wales, Queensland, South Australia, Western Australia and the Northern Territory) that were considered to have Indigenous mortality data of sufficient quality for publication.

The EMD has made possible a more robust analysis of Indigenous mortality levels, patterns and trends based on enhanced death data that have been adjusted for Indigenous under-identification across all jurisdictions. The enhanced death data also allow for a direct comparison of Indigenous and non-Indigenous mortality.

The national discourse on Indigenous disadvantage has often focused on a single measure—the gap between Indigenous and non-Indigenous life expectancy at birth—and, sometimes, on infant mortality as well. Although life expectancy is a useful summary measure, it does not provide sufficient insights into the underlying mortality levels and patterns reflected in the life expectancy gap, or where the focus of policy intervention should be to close this gap.

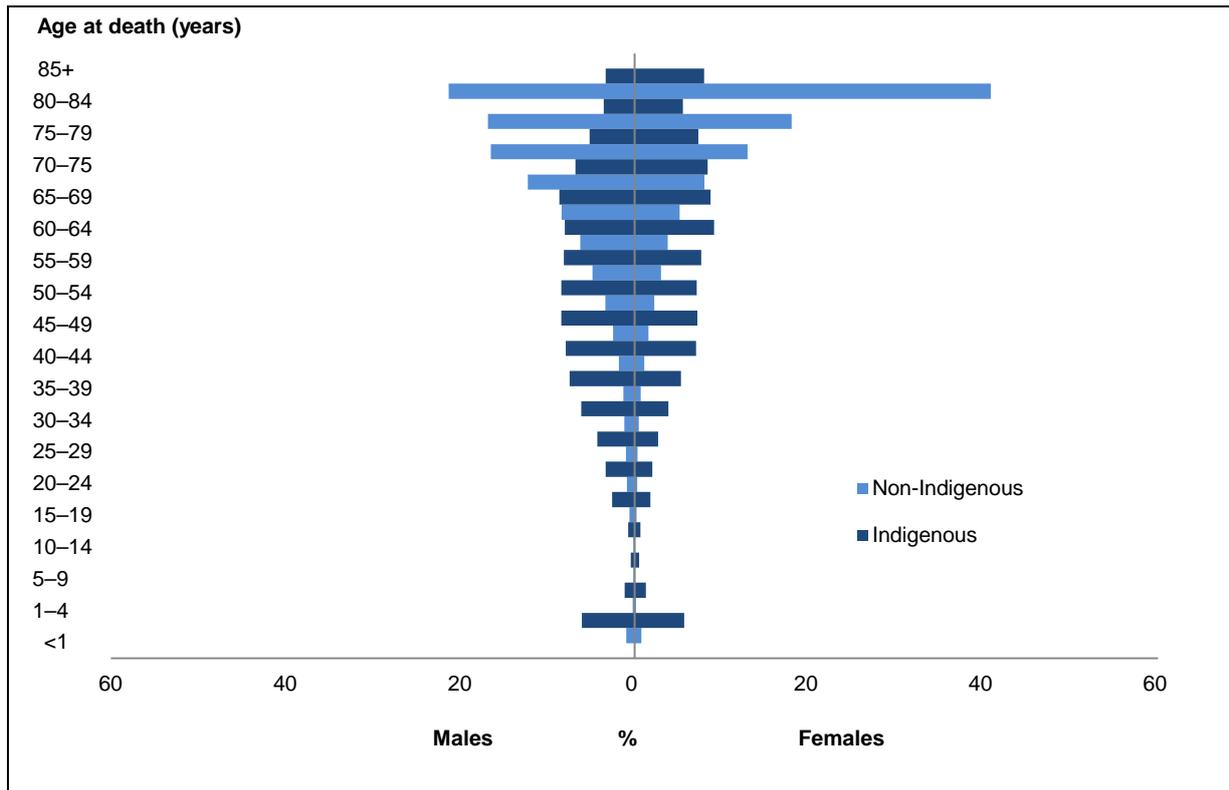
This chapter examines various mortality indicators, ranging from age-specific measures to summary measures, which, together, provide more insights into the mortality patterns underlying the difference in life expectancy between Indigenous and non-Indigenous Australians.

#### 2.1.1 Distribution of deaths by age and sex

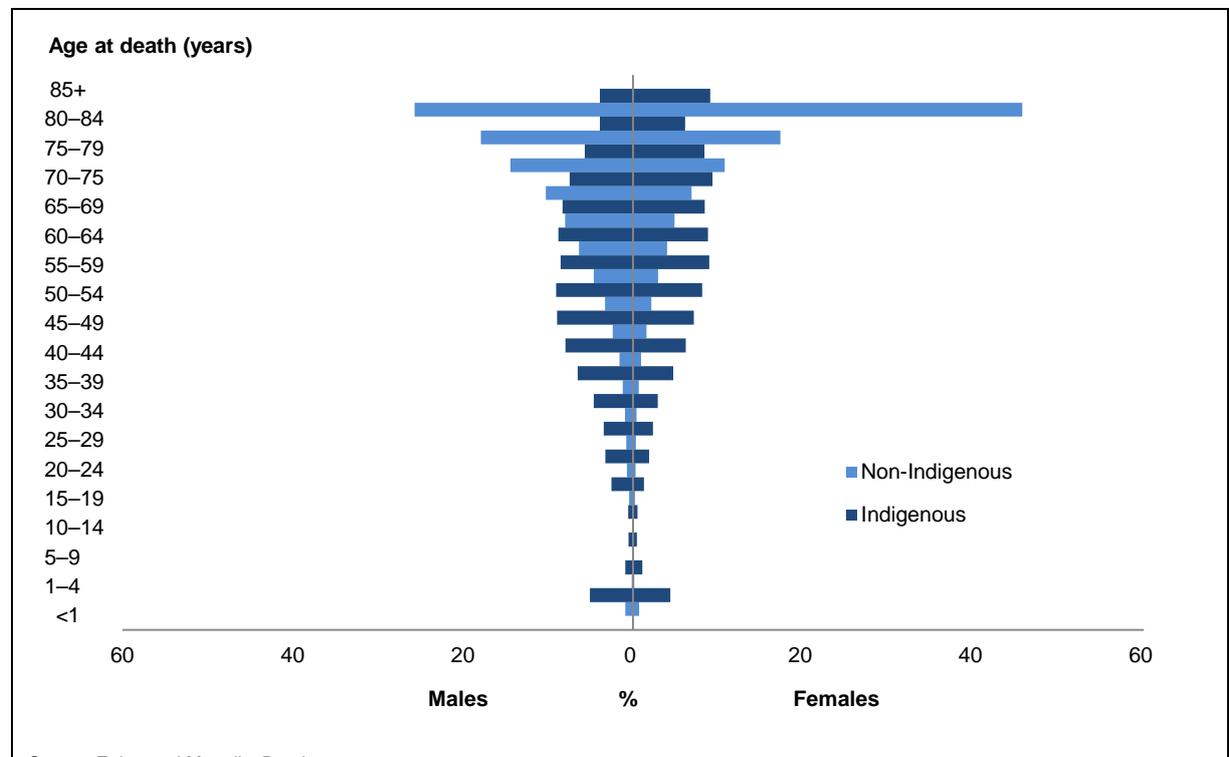
The distribution of deaths by age and sex gives an insight into the quality of age reporting of death; it is also related to the level and cause of death in the population. The quality of reporting for age at death is affected by the fact that information about a deceased person is often reported by family and friends, or by the funeral director, the doctor certifying the death, the coroner or a health worker, who may not always know the exact age or date of birth of the deceased. The reported age at death may not always be accurate, and could lead to distortions in death rates or estimates of life expectancy. For infants and young children, casual reporting of age at death, amounting to a shift in age at death of as little as a few months, could affect whether the death is classified as an infant death, a child death or a non-child death.

The age pyramids of the deceased in figures 2.1, 2.2 and 2.3 show the distribution of Indigenous and non-Indigenous deaths by age and sex for the periods 2001–2005, 2006–2010 and 2011–2015. Although these reflect the distribution of ages where deaths occur, they also reflect past fertility and the age structure of the population.

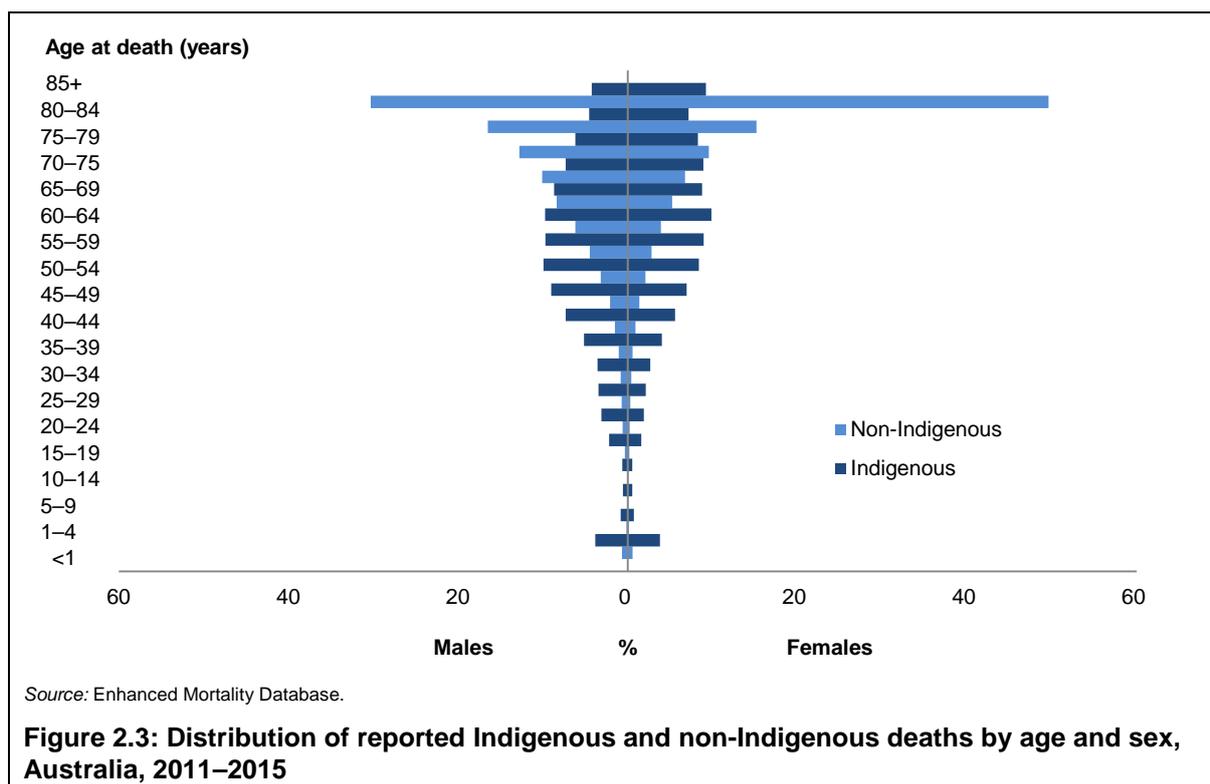
The age pyramids show the very early age at death among the Indigenous population compared to the non-Indigenous population. Among the Indigenous population, a bulge in deaths occurs from age 35, highlighting an earlier age at death and a concentration of deaths from that age. This is a reflection of the younger age profile of the Indigenous population. A bulge in deaths for the non-Indigenous population does not start till after age 64. In fact, among the non-Indigenous population, most deaths tend to occur after age 74.



**Figure 2.1: Distribution of reported Indigenous and non-Indigenous deaths, by age and sex, Australia, 2001–2005**



**Figure 2.2: Distribution of reported Indigenous and non-Indigenous deaths by age and sex, Australia, 2006–2010**



### Distribution of reported and enhanced number of deaths

Table 2.1 shows the number of reported, reclassified and enhanced Indigenous deaths for the periods 2001–2005, 2006–2010 and 2011–2015. After linking and comparing Indigenous status information across the MED and the comparative data sets, it was estimated that, during the reference period, the Indigenous status of 783, 1,208 and 1,215 male Indigenous deaths and 685, 962 and 986 female Indigenous deaths, respectively, in 2001–2005, 2006–2010 and 2011–2015, had been misclassified as ‘non-Indigenous’, ‘unknown’ or ‘missing’. The Indigenous status of these records was therefore reclassified as Indigenous.

**Table 2.1: Reported<sup>(a)</sup>, reclassified<sup>(b)</sup> and enhanced<sup>(c)</sup> number of Indigenous deaths, Australia, 2001–2005, 2006–2010 and 2011–2015**

Indigenous death records	Males			Females		
	2001–2005	2006–2010	2011–2015	2001–2005	2006–2010	2011–2015
Total number of deaths	339,686	358,477	385,577	318,080	341,293	368,763
Reported Indigenous deaths	6,074	6,686	7,648	4,482	5,458	6,343
Deaths reclassified as Indigenous	783	1,208	1,215	685	962	986
Enhanced Indigenous deaths	6,857	7,894	8,863	5,167	6,420	7,329
Reclassified deaths as % of enhanced Indigenous deaths	11.4	15.3	13.7	13.3	15.0	13.5

(a) Reported Indigenous deaths are the number of deaths originally recorded on the MED as Indigenous.

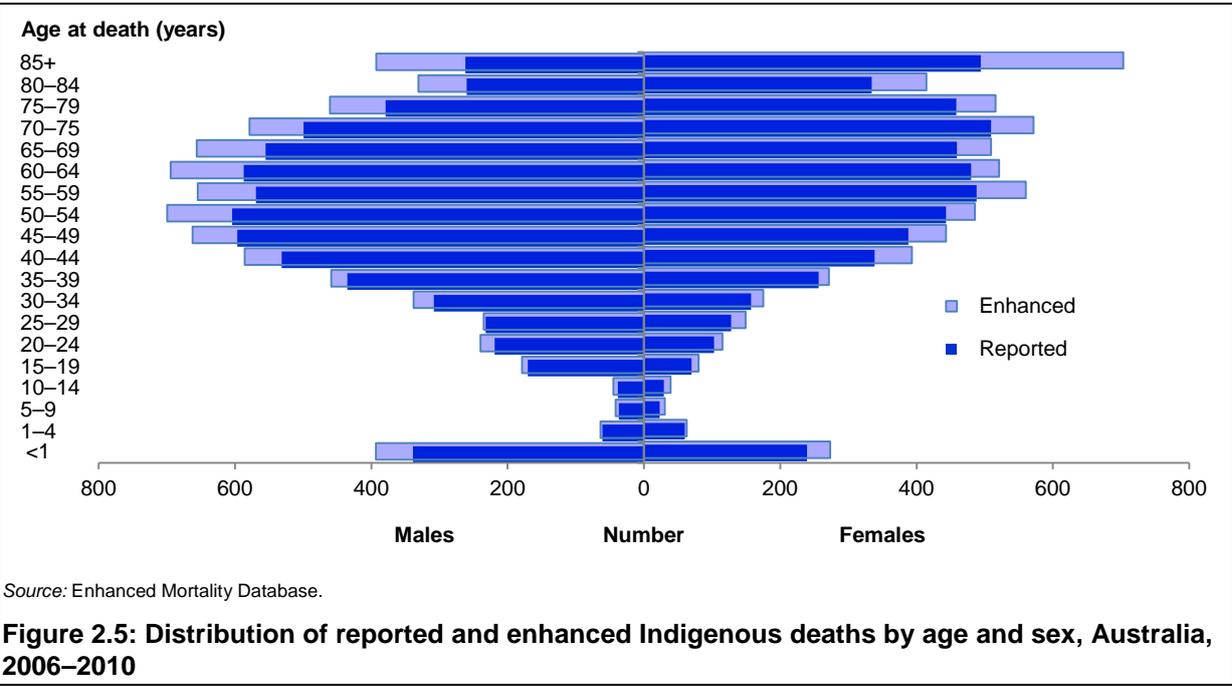
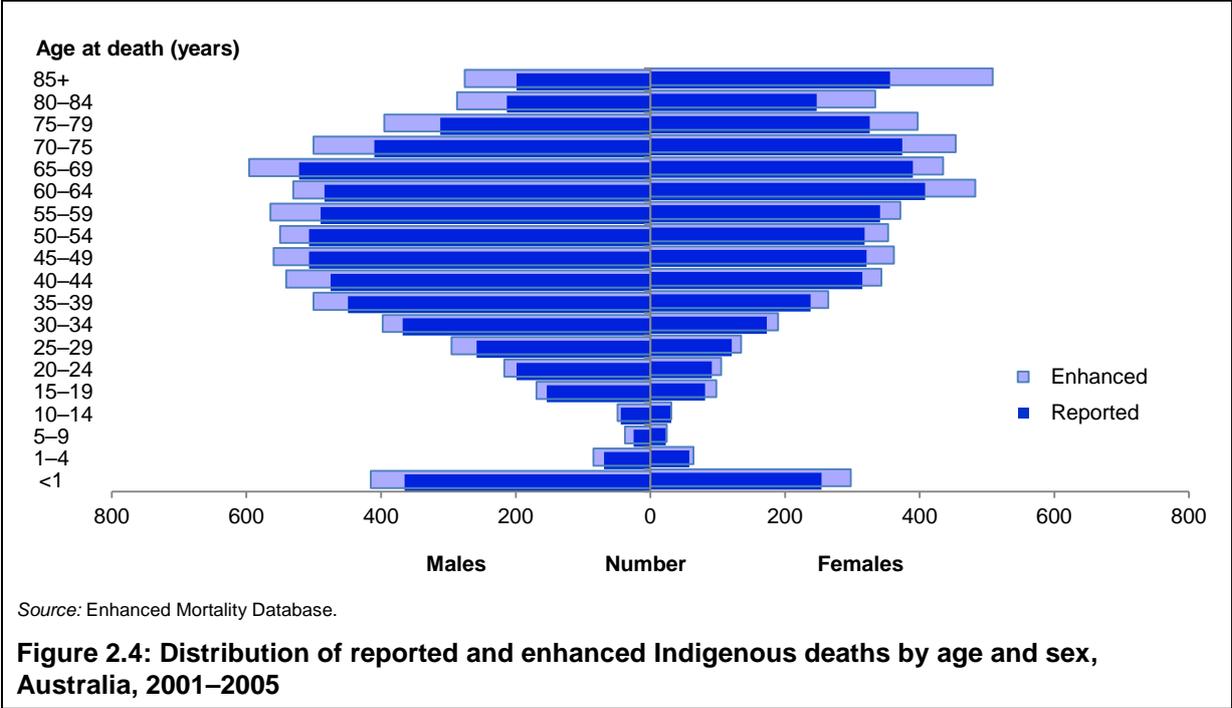
(b) Reclassified deaths are Indigenous deaths that were not classified as Indigenous on the MED but were deemed to be Indigenous after data linkage and comparison of Indigenous status across the linked data sets.

(c) Enhanced deaths comprise the sum of reported and reclassified deaths.

Source: Enhanced Mortality Database.

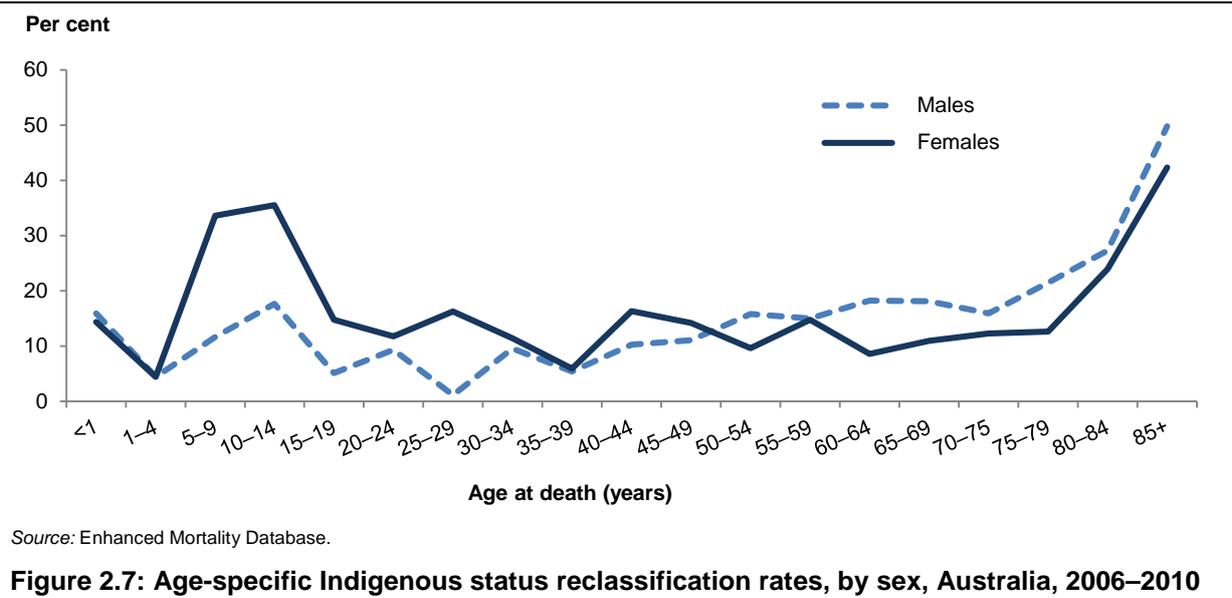
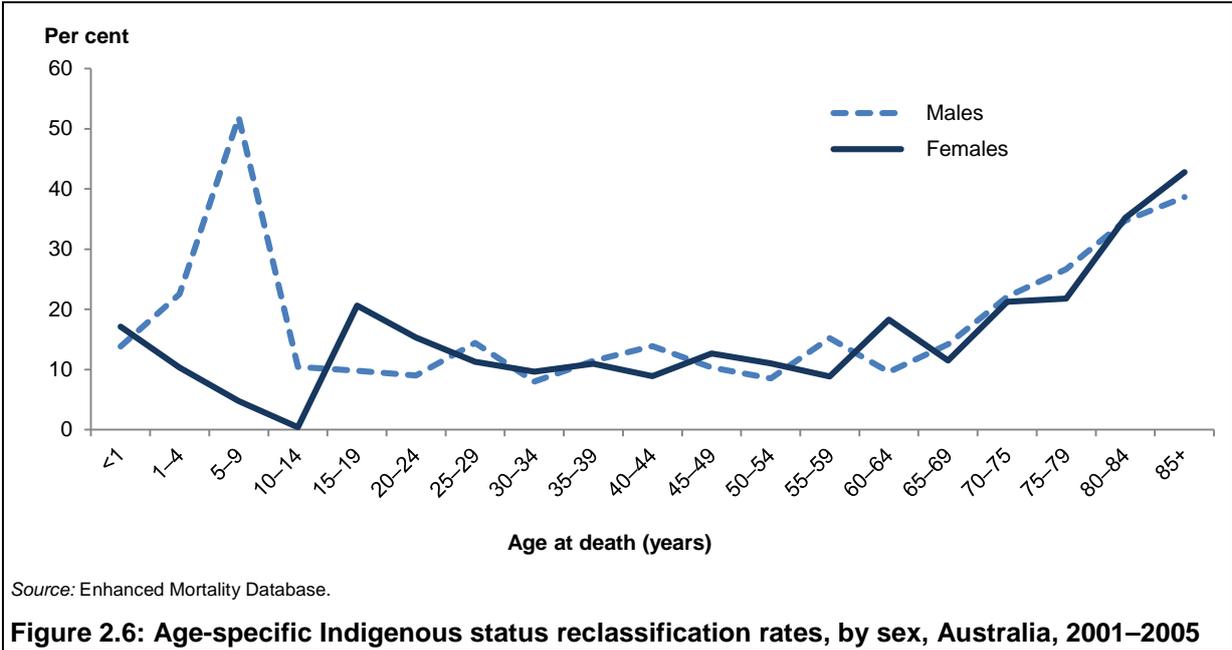
The number of deaths reclassified as Indigenous amounted to 11%–15% of the total number of enhanced Indigenous male deaths, and 13%–15% of the total number of enhanced Indigenous female deaths.

Figures 2.4, 2.5 and 2.8 are age pyramids showing the distribution by age and sex of reported and enhanced Indigenous deaths for the periods 2001–2005, 2006–2010 and 2011–2015. The darker coloured parts of these figures show the distribution of reported deaths while the lighter shaded areas show the distribution of enhanced deaths.



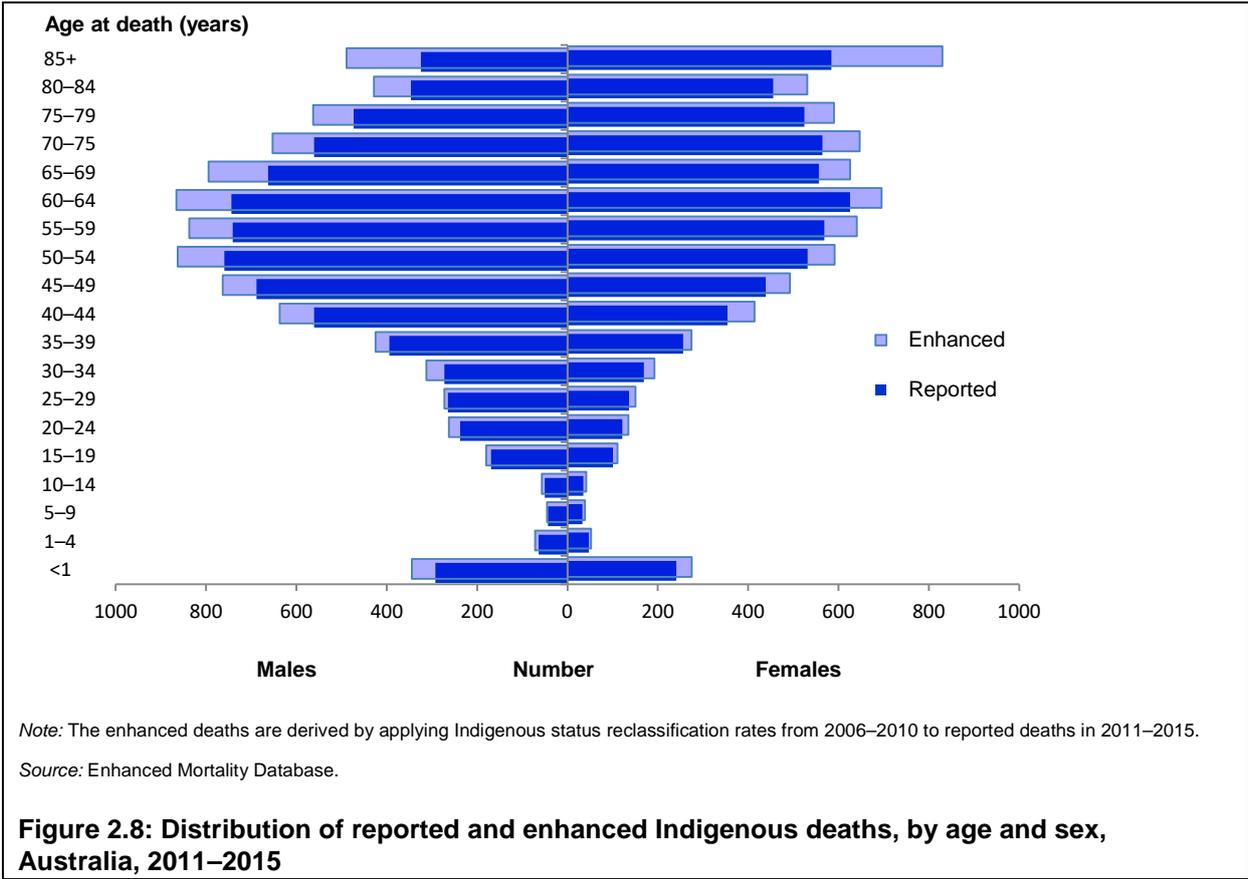
Figures 2.4 and 2.5 show that the age and sex pattern of the distribution of reported and enhanced deaths on the NDI in 2001–2005 was similar to that in 2006–2010. The figures also show that there was no drastic change in the age and sex pattern of Indigenous status reclassification on the NDI between 2001 and 2010 (as the Indigenous status reclassification rates for 2001–2005 and 2006–2010 in figures 2.6 and 2.7, respectively show; see also footnote at Table 2.1), with the exception of ages 1–4 and 5–9 years where the small number of deaths appears to have led to an erratic pattern of death rates.

During 2001–2005 (Figure 2.6) and 2006–2010 (Figure 2.7), average reclassification rates were between 10%–15% at most age groups between 15–19 and 60–64; they were variable at ages 0–14 for both Indigenous males and females. Reclassification rates were highest at ages 65 and above, reaching up to 40% or higher at ages 85 and over.



On the assumption that the misclassification rates observed in 2006–2010 apply to 2011–2015, the age and sex pattern of Indigenous reclassification rates estimated for 2006–2010 were applied to death records in 2011–2015 to yield a distribution of misclassified and enhanced Indigenous deaths on the NDI by age and sex for the period 2011–2015.

Figure 2.8 shows the effect of applying the age pattern of Indigenous identification and reclassification on death data for 2006–2010 to death data for 2011–2015. The distribution of enhanced Indigenous deaths by age and sex was used as input data for the production of preliminary mortality and life expectancy estimates for 2011–2015.



## 2.2 Summary measures of mortality

### 2.2.1 Median age at death

The median age at death is the age at which exactly one-half of all deaths registered (or occurring) in a given time period were deaths of people above that age and half were deaths below that age. It is one of the simplest measures of the level and distribution of mortality. The median age at death can also refer to a value from the life table, and can be defined as the age to which half of the initial cohort assumed in the life table survives (Shryock & Siegel 1976). The definition adopted for this analysis is the former.

The median age at death is influenced by both the age structure and the mortality level of the population. A population with a younger age structure will have a lower median age at death than an older population with the same mortality level. However, a population with a younger population is often the result of past high mortality and fertility.

The median age at death is thus a useful indicator of the level and distribution of mortality in relation to populations with a similar age structure. Table 2.2 compares the median age at death for Indigenous males and females in New South Wales, Victoria, Queensland, South Australia, Western Australia and the Northern Territory. These six jurisdictions had sufficiently large Indigenous populations and a sufficiently large number of deaths across age and sex groups to enable age-sex analysis of deaths to be reliably carried out. The median age at death for Indigenous males and females is not compared with that of non-Indigenous males and females because the two populations have different age structures.

Of the 6 jurisdictions considered, the Northern Territory had the lowest median age at death, while New South Wales and Victoria had the highest among both Indigenous males and females. Indigenous males and females in New South Wales, Victoria and Queensland had a higher median age at death than Indigenous males and females in Australia as a whole.

These differences could be partly due to lower levels of infant, child and young adult mortality in New South Wales, Victoria and Queensland than in the remaining jurisdictions; they could also be partly due to the Indigenous population in these three states having a slightly older age structure than in the remaining jurisdictions.

**Table 2.2: Median age at death in years, Indigenous males and females, states and territories, 2001–2005, 2006–2010 and 2011–2015**

Jurisdiction	Males			Females		
	2001–2005	2006–2010	2011–2015	2001–2005	2006–2010	2011–2015
NSW	57.6	59.5	59.4	64.7	66.0	65.9
Vic	55.6	54.8	58.6	60.2	62.2	66.3
Qld	52.9	54.8	56.9	59.9	61.1	62.5
WA	51.4	50.7	52.6	59.9	57.7	58.1
SA	47.3	52.4	54.2	52.6	56.6	59.5
NT	45.8	48.5	52.2	52.6	55.9	56.5
<b>Australia</b>	<b>51.9</b>	<b>54.3</b>	<b>56.2</b>	<b>59.8</b>	<b>60.8</b>	<b>61.8</b>

Note: Australia includes all states and territories.

Source: Enhanced Mortality Database.

Table 2.2 shows that, between 2001–2005 and 2011–2015, the median age at death increased in all jurisdictions for both Indigenous males and females, except in Western Australia where the median age at death for females in 2006–2010 and 2011–2015 was lower than in 2001–2005. The increases in the median age at death were larger for Indigenous males than females in all jurisdictions except in Victoria, where the increases were larger for Indigenous females than males. The increases in the median age at death were larger for South Australia and the Northern Territory than for the remaining three jurisdictions.

For Australia as a whole, the median age at death increased by 4.3 years for Indigenous males and 2.0 years for Indigenous females over the reference period. The differential increases in the median age at death observed between jurisdictions may reflect differential improvements in the level of mortality across age groups as well as differential shifts in the causes of death for Indigenous males and females across jurisdictions.

## 2.2.2 Age-standardised death rates

The age-standardised death rate is a single mortality measure that summarises the mortality experience in a population. Age-standardised rates are hypothetical rates that would have

been observed if the populations being studied had the same age distribution as the standard population, while all other factors remained unchanged (AIHW 2011b). They are particularly useful where one wants to compare death rates of a population over time, or where the objective is to compare two or more populations that have different age structures.

The Indigenous population has a relatively young age structure compared with that of the non-Indigenous population. These different age structures may confound some mortality measures based on the two populations unless the mortality rates are standardised to a common age structure.

Official Indigenous mortality estimates generally include data from the five jurisdictions for which Indigenous identification in death registrations is considered of sufficient quality to publish (New South Wales, Queensland, Western Australia, South Australia and the Northern Territory). Table 2.3 shows age-standardised death rates for Indigenous and non-Indigenous males and females for these 5 jurisdictions, based on enhanced mortality data derived from the EMD. Estimates for Victoria are also shown, and shaded to indicate that these are not normally part of the official Indigenous mortality estimates. Estimates for Australia include all jurisdictions.

**Table 2.3: Age-standardised death rates per 1,000 population, states and territories, 2001–2005, 2006–2010 and 2011–2015<sup>(a)</sup>**

Indigenous status/Jurisdiction	Males			Females		
	2001–2005	2006–2010	2011–2015	2001–2005	2006–2010	2011–2015
<b>Indigenous</b>						
NSW	12.1	12.2	12.0	11.0	9.9	10.0
Vic	10.0	10.3	9.9	6.3	8.2	8.2
Qld	14.0	14.2	14.4	11.4	10.9	10.1
WA	19.9	19.5	16.8	17.0	13.5	11.7
SA	11.5	11.9	12.6	10.2	10.3	9.2
NT	19.5	16.8	16.7	15.0	14.1	14.7
<i>Australia</i>	13.8	13.3	13.2	11.6	10.5	10.2
<b>Non-Indigenous</b>						
NSW	7.9	7.0	6.5	5.2	4.8	4.5
Vic	7.8	7.0	6.3	5.2	4.9	4.5
Qld	8.0	7.3	6.6	5.3	4.9	4.6
WA	7.5	6.9	6.2	4.9	4.6	4.2
SA	8.2	7.3	6.6	5.2	4.9	4.6
NT	9.0	9.0	7.4	6.3	4.9	4.6
<i>Australia</i>	7.9	7.1	6.5	5.2	4.8	4.5

(a) Estimates for Australia include Tasmania, the Australian Capital Territory and Other Territories.

(b) Rates have been age standardised to the age distribution of the 2001 Australian standard population (ABS 2014b).

Source: Enhanced Mortality Database.

Table 2.3 shows higher age-standardised death rates for Indigenous males and females than for non-Indigenous males and females, as well as higher age-standardised death rates for both Indigenous and non-Indigenous males than for their female counterparts, in both Australia as a whole as well as across all the six jurisdictions. For Australia as a whole in 2011–2015, there were 13.2 Indigenous male deaths and 10.2 Indigenous female deaths, for every 1,000 Indigenous males and females; these figures compare with rates of 6.5 and 4.5, for every 1,000 non-Indigenous males and females, respectively, in Australia as a whole.

Across all years and the 6 jurisdictions considered, New South Wales, Victoria and South Australia had the lowest age-standardised death rates for both Indigenous and non-Indigenous males and females. Western Australia however had the lowest age-standardised death rates for both non-Indigenous males and females.

During the reference period, age-standardised death rates declined for non-Indigenous males and females in all six jurisdictions considered, as well as in Australia as a whole. The decline for Indigenous males and females was however variable and inconsistent. There were declines in age-standardised death rates for Indigenous males in Victoria, Western Australia, South Australia, the Northern Territory and for Australia as a whole. For Indigenous females, declines were observed in New South Wales, Queensland, Western Australia and in Australia as a whole. This pattern of decline may reflect variable improvements in the social, economic, environmental and health conditions associated with mortality decline, as well as to the small number of Indigenous deaths in some jurisdictions.

Because the deaths used in the estimation of the 2011–2015 adjusted-standardised rates shown in this report have been adjusted to take account of Indigenous status under-identification, the resulting age-standardised death rates are higher than those published in the Aboriginal and Torres Strait Islander Health Performance Framework (HPF) for the same period (AIHW 2017; Australian Health Ministers' Advisory Council 2017). Further, the estimates published in this report were estimated for age groups with an upper cut-off of 85 and over. The estimates published in the HPF were estimated for age groups with an upper cut-off of 75 and over. Because of the concentration of deaths at the oldest age groups, age-standardised rates with an upper age cut-off of 75 and over will be lower than estimates with an upper cut-off age of 85 and over.

### **2.2.3 Age-standardised death rate differences and rate ratios**

Table 2.4 shows age-standardised death rate differences and rate ratios for the Indigenous and non-Indigenous populations. The rate differences show the absolute difference between the Indigenous and non-Indigenous death rates, while the rate ratios show the relative difference in the rate between the two population groups. Together, the rate difference and rate ratio show the gap in mortality that must be bridged in order to close the life expectancy gap between the Indigenous and non-Indigenous population (Ring et al. 2016).

For example, the age-standardised death rate may decline for both the Indigenous and non-Indigenous populations, but the rate difference and rate ratio may actually increase if mortality declines by larger absolute amounts among the non-Indigenous population than among the Indigenous population. It is therefore important to use both measures when comparing the gap in mortality between Indigenous and non-Indigenous Australians.

Table 2.4 shows that nationally, despite the decline in age-standardised death rates for both Indigenous males and females in Australia as a whole, the rate difference between Indigenous and non-Indigenous males actually increased from 5.9 in 2001–2005 to 6.7 in 2011–2015, while that for females declined from 6.4 in 2001–2005 to 5.7 in 2011–2015. The apparent increase in the rate difference for Indigenous males may be associated with the fact that non-Indigenous males experienced a bigger absolute mortality decline (1.4 per 1,000 males) than did Indigenous males (0.6 per 1,000 males) during the reference period. On the other hand, Indigenous females experienced a bigger absolute decline in death rates (1.4 per 1,000 females) than did non-Indigenous females (0.7 per 1,000 females).

**Table 2.4: Age-standardised death rate differences and rate ratios, Australia, 2001–2005, 2006–2010 and 2011–2015<sup>(a)</sup>**

Rate difference and rate ratio	2001–2005	2006–2010	2011–2015
<b>Rate difference</b>			
Indigenous males—non-Indigenous males	5.9	6.2	6.7
Indigenous females—non-Indigenous females	6.4	5.7	5.7
<b>Rate ratio</b>			
Indigenous males/non-Indigenous males	1.7	1.9	2.0
Indigenous females/non-Indigenous females	2.2	2.2	2.3

(a) Rates have been age standardised to the age distribution of the 2001 Australian standard population (ABS 2013a).

Source: Enhanced Mortality Database.

As a result of the much bigger decline in the age-standardised death rate for non-Indigenous males than for Indigenous males, the rate ratio between the two male population groups also increased, from 1.7 in 2001–2005 to 2.0 in 2011–2015.

Despite the decline in the rate difference between Indigenous and non-Indigenous females, the rate ratio appears to have been fairly steady during the reference period, at 2.2 in both 2001–2005 and 2006–2010, and increasing only marginally to 2.3 in 2011–2015. The source of this apparent anomaly lies in the differential absolute and relative declines in mortality experienced by Indigenous and non-Indigenous females during the reference period.

Although Indigenous females experienced a bigger absolute decline of about twice the size of the absolute decline in the age-standardised death rate experienced by non-Indigenous females between 2001–2005 and 2011–2015 (1.4 for Indigenous females and 0.7 for non-Indigenous females), the relative decline in the age-standardised death rate varied only marginally between the two female population groups (12.1% and 13.5%, respectively).

Section 2.3 and figures 2.11, 2.12, 2.13 and 2.14 provide further analysis and illustration of the relationship between rates, rate differences and rate ratios.

## 2.3 Age pattern of mortality

### 2.3.1 Age-specific death rates

Death rates vary by age and sex. For both sexes, death rates are generally higher for early childhood and the oldest ages than they are for other ages. The overall levels of mortality and life expectancy in a population are influenced by the age pattern of mortality in that population. Summary measures such as life expectancy and median age at death are important in understanding the overall level of mortality in a population, but they mask differences between age groups in their levels of mortality. Knowing the age pattern of mortality is important in developing targeted policies, programs and services to address age-related mortality. Age-specific death rates are the key mortality measures that can provide this information.

The age-specific death rate is the number of deaths in a specified age or age group per unit of population (usually 1,000 or 100,000) of the same age or age group. They can be estimated for single-year ages, 5-year age groups (as in figures 2.9 and 2.10) or for broad age groups (as in figures 2.11, 2.12, 2.13 and 2.14).

Figure 2.9 shows the age-specific death rates per 100,000 population for Indigenous and non-Indigenous males and females in Australia in 2011–2015. Because of very low age-specific death rates at early childhood, and very high age-specific death rates at the

oldest ages, the shape of the age pattern of mortality is obscured when the age-specific death rates are plotted on a standard scale. The similarities and differences between patterns of mortality for Indigenous males and females on the one hand, and non-Indigenous males and females on the other, are much clearer in Figure 2.10, which is based on a logarithmic scale.

Death rates were relatively high at age under one year, and very low from ages 1–4 to about age 25–29, and then started to rise thereafter. Although the shape of the mortality curves in figures 2.9 and 2.10 seem to be similar, there are some key differences. As Figure 2.10 shows, death rates are higher for both Indigenous males and females at each age than for non-Indigenous males and females. Death rates also seem to rise much earlier among Indigenous males and females, and to remain at much higher levels, than they do for non-Indigenous males and females.

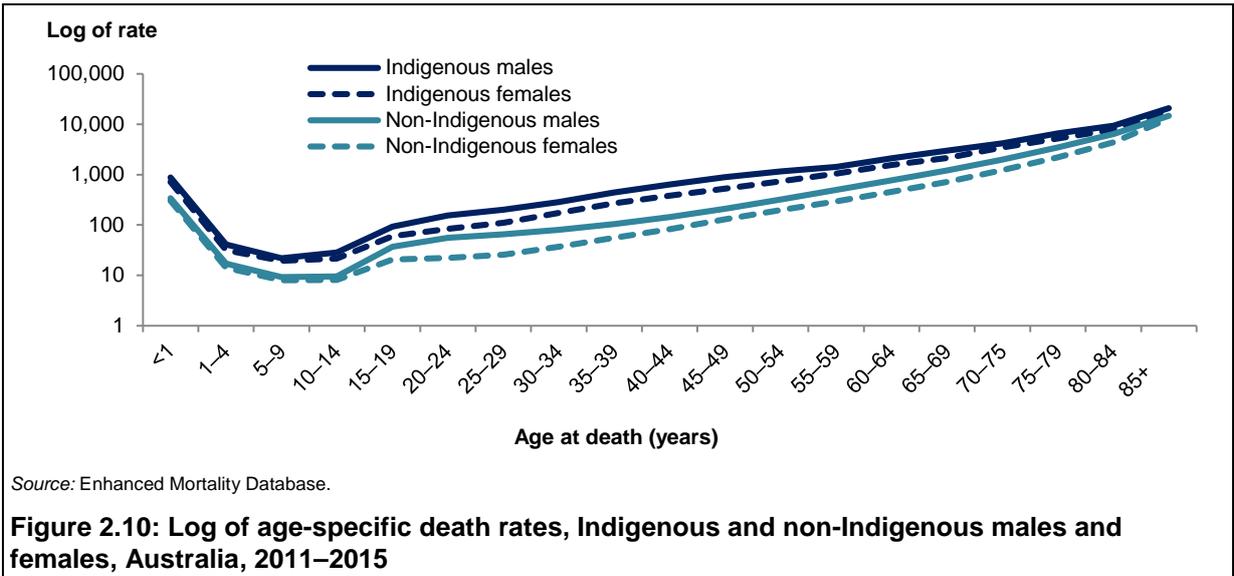
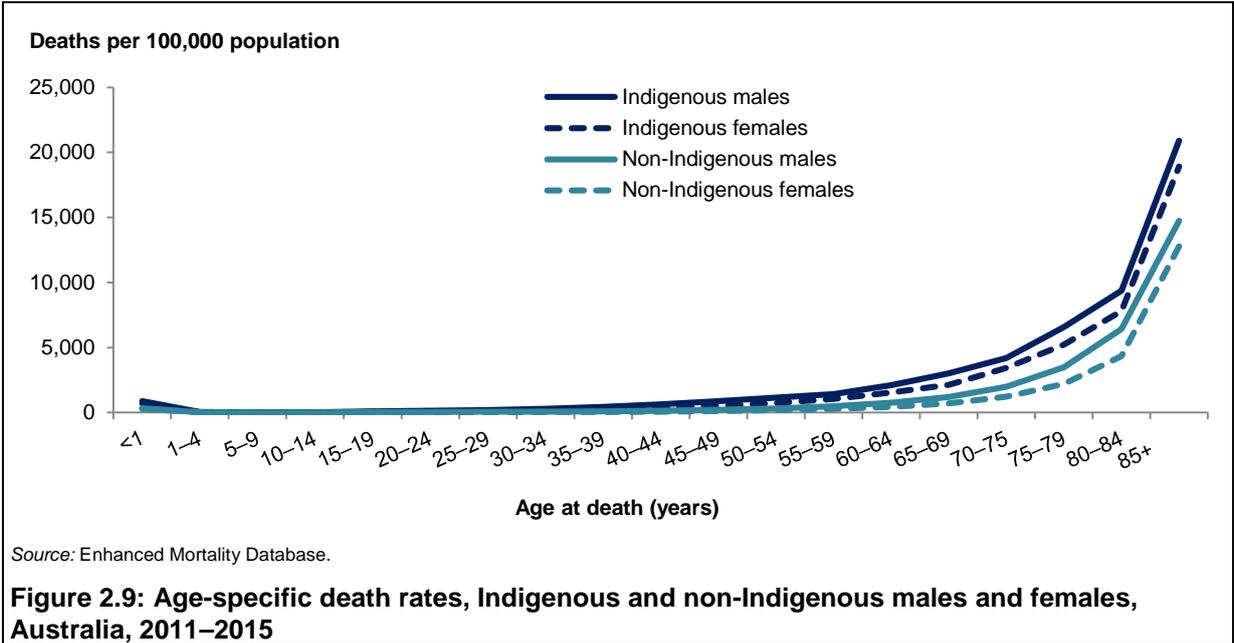
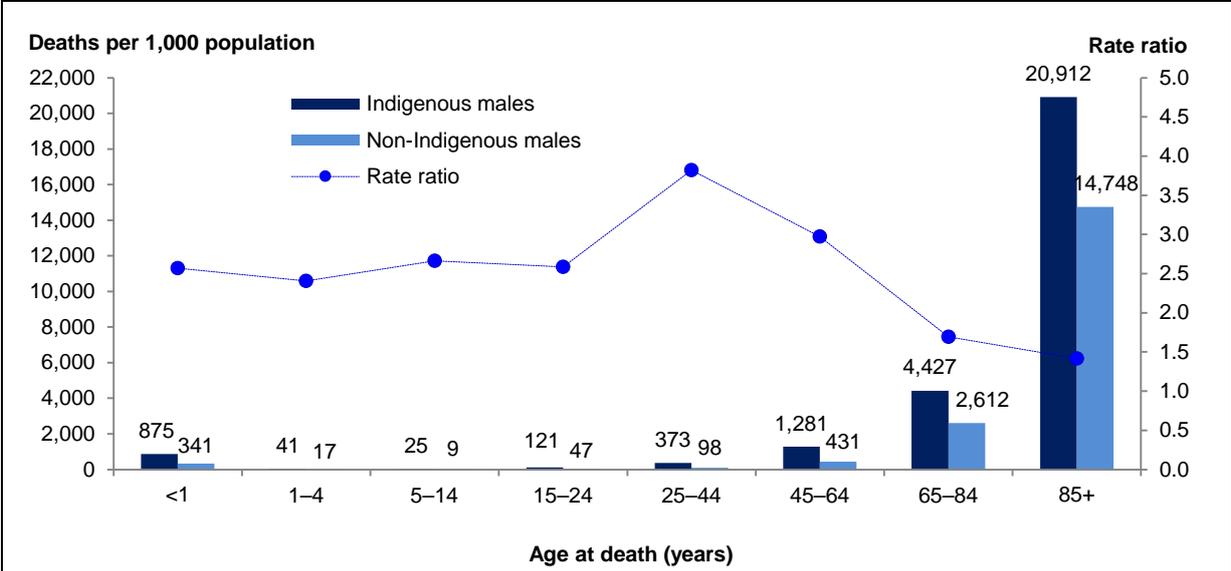
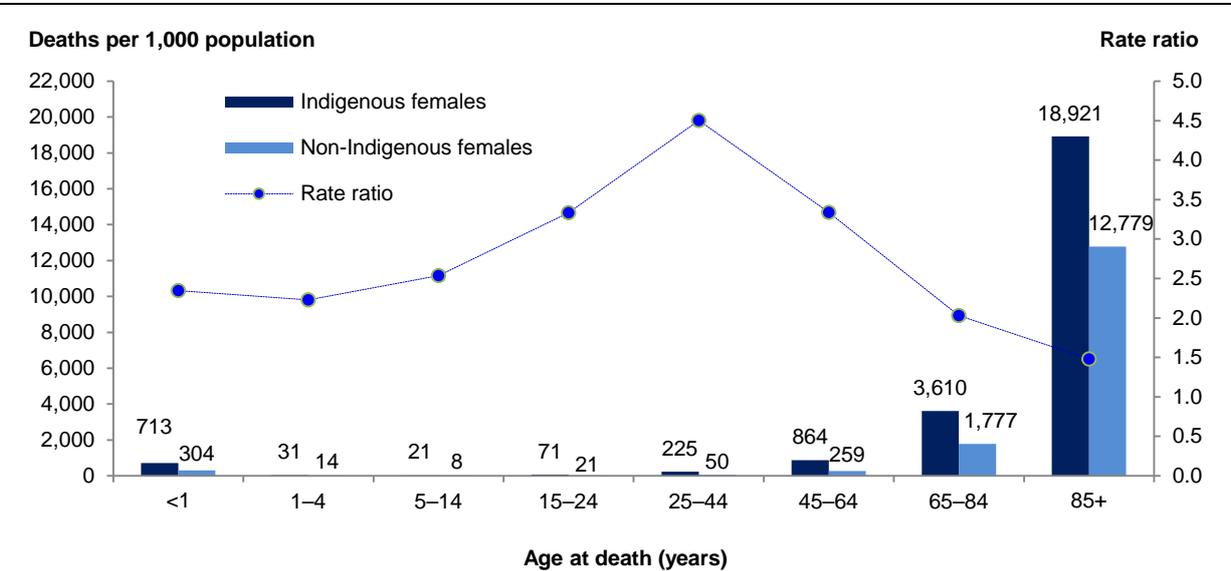


Figure 2.11 compares age-specific death rates for Indigenous males and non-Indigenous males, in broad age groups. Figure 2.12 presents equivalent information for females. For all four subpopulations, death rates were slightly higher at infancy (age under 1), and very low from late childhood to the early teenage years. The rates began to increase from age 30–34, at first slowly, and then sharply thereafter.



Source: Enhanced Mortality Database.

**Figure 2.11: Number of Indigenous and non-Indigenous male deaths per 1,000 population, Australia, 2011–2015**

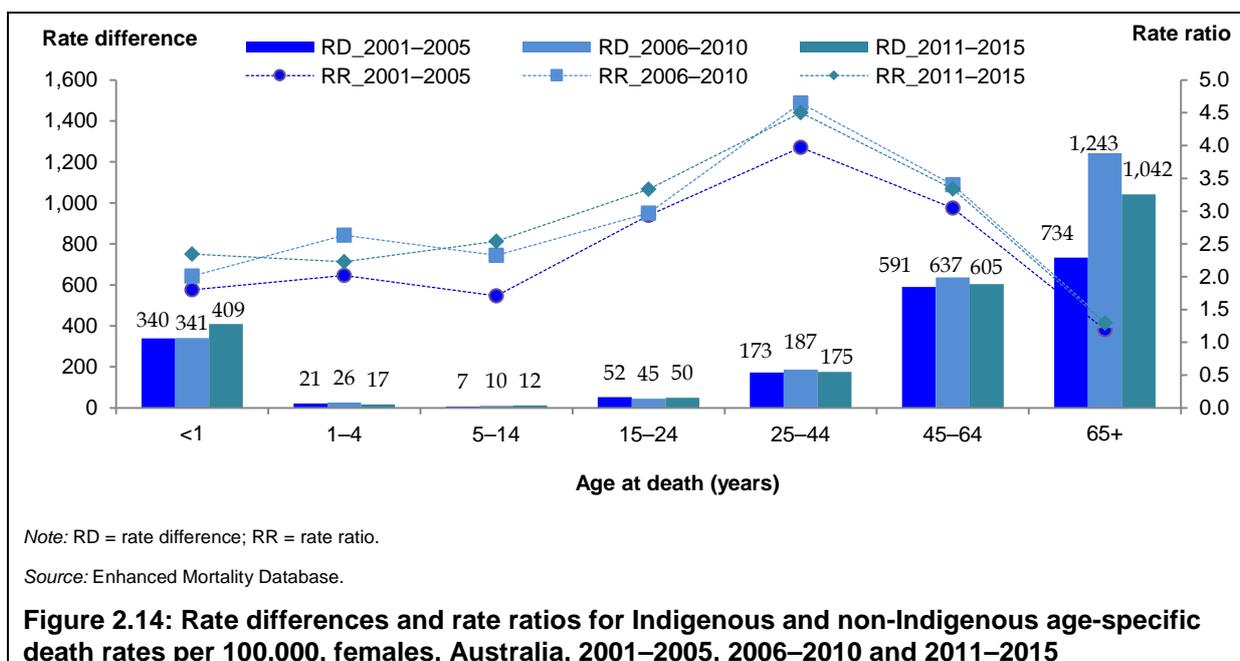
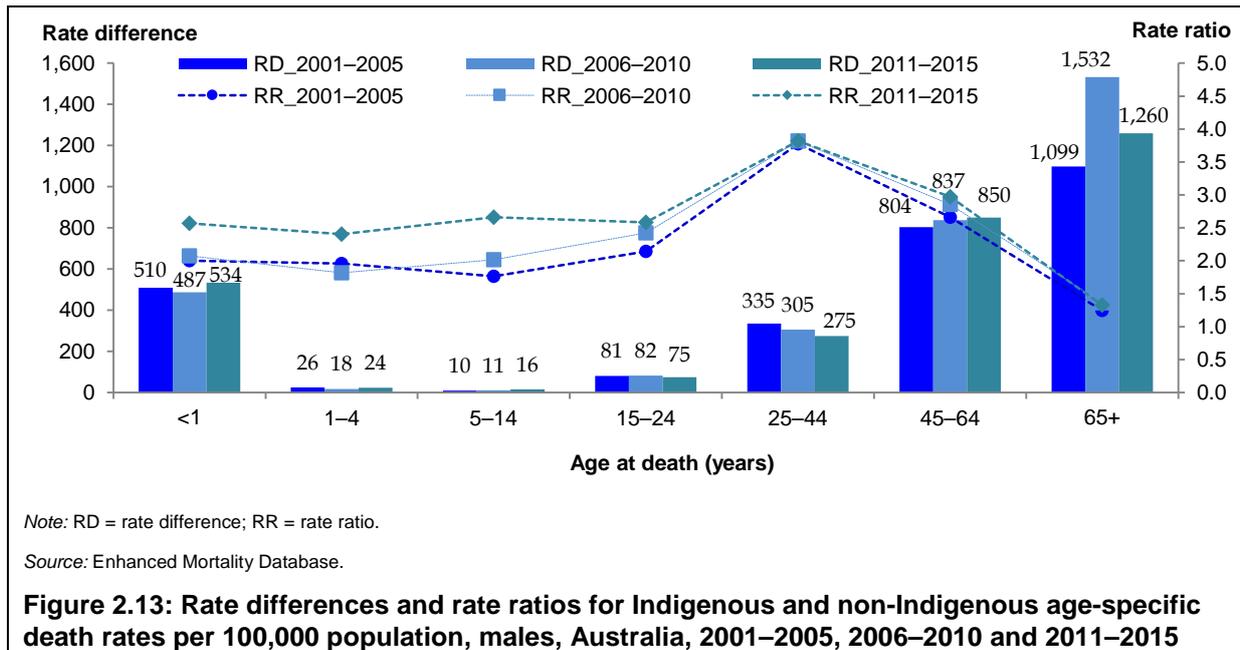


Source: Enhanced Mortality Database.

**Figure 2.12: Number of Indigenous and non-Indigenous female deaths per 1,000 population, Australia, 2011–2015**

Figures 2.13 and 2.14 show the relationship between rate differences and rate ratios. The biggest rate differences are at the oldest ages (45–64, 65–84 and 85 and over). The largest rate ratios, however, are at ages 25–44 and at the youngest ages (under 1, 1–4, 5–14 and 15–24), all of which have rate ratios of 2 or more. What this means is that at these younger ages, Indigenous death rates are 2 or more times as high as non-Indigenous death rates.

The rate difference provides an indication not only of the absolute difference in death rates between Indigenous and non-Indigenous Australians, but also of the absolute size of the mortality gap that must be closed. The rate ratio, on the other hand, provides an indication of the relative difference in mortality between Indigenous and non-Indigenous Australians.



Figures 2.13 and 2.14 fail to show any clear relationship between rate differences and rate ratios. The age group with the biggest rate differences (65 and over) is not the age group with the highest rate ratios. Similarly, the age group with the highest rate ratios for both males and females (25–44) is not the age group with the biggest rate differences.

As Ring and others (Ring et al. 2016) have observed, different perspectives of the rate ratio and the rate difference provide useful information regarding whether the gap is closing. They address different aspects of the same 'story', and both are needed to tell the complete story. To close the gap, the rate difference must be approaching zero while the rate ratio must be approaching unity or one.

### **2.3.2 Cumulative percentages of deaths occurring by specified ages**

Another way to examine the age pattern of mortality is to cumulate and plot the percentages of deaths occurring by specified ages, as shown in figures 2.15 and 2.16. The two plots show that the age pattern of death in the Indigenous population differs from that in the non-Indigenous population. The two plots also point to improvements in mortality over the period 2001–2005 to 2011–2015 for both Indigenous and non-Indigenous males and females, as depicted by consecutive small reductions in the cumulative percentage of deaths occurring at each age from one period to the next.

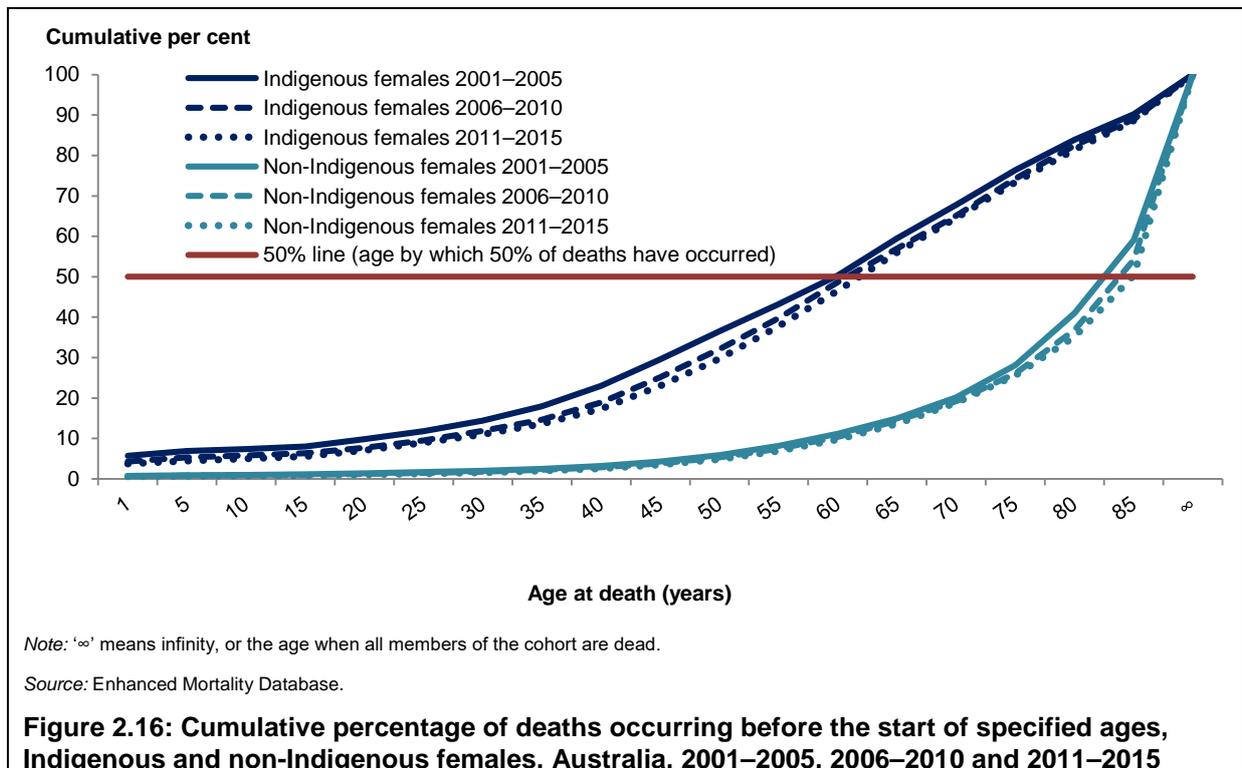
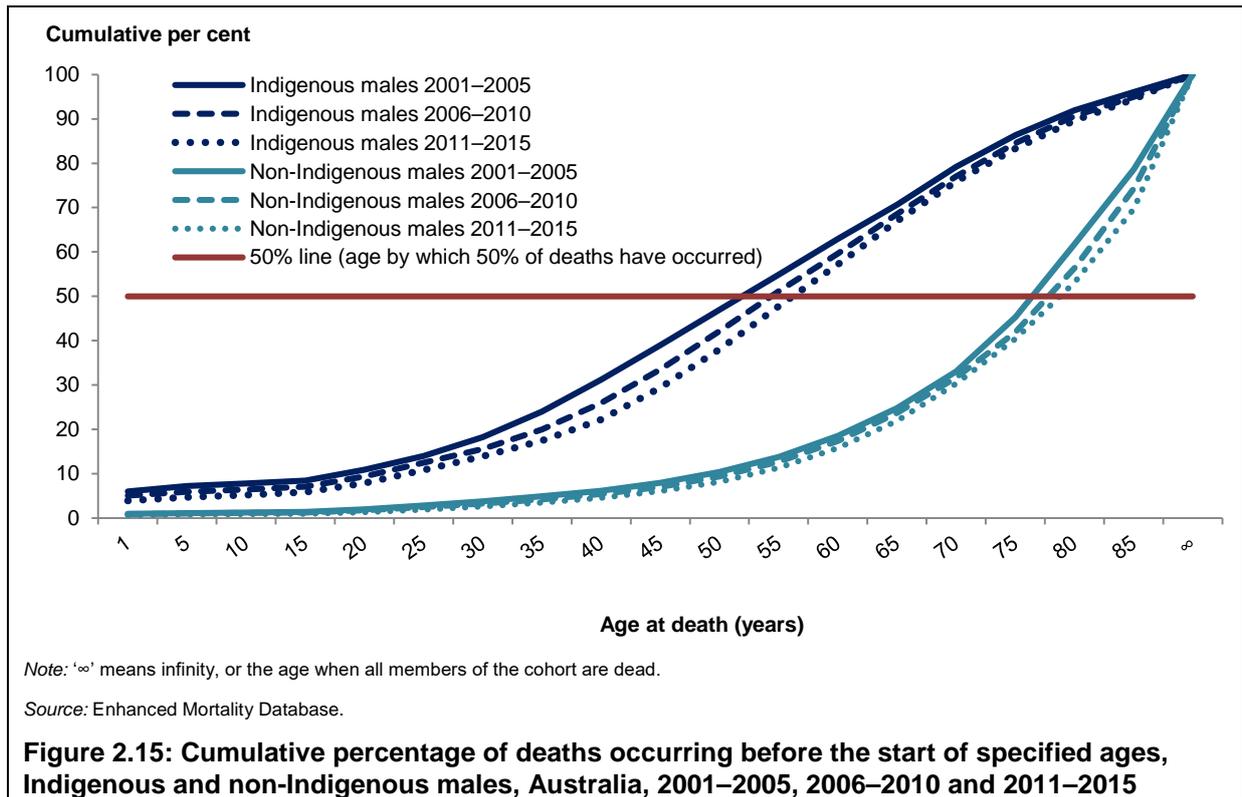
Figures 2.15 and 2.16 confirm earlier observations that Indigenous males and females die at earlier ages than non-Indigenous males and females. The differences between the Indigenous and non-Indigenous population in terms of the ages when deaths occur are very small at very young ages, but become bigger at later ages at death. The gap between the Indigenous and non-Indigenous curves represent the gap in mortality that must be bridged in order to close the gap in life expectancy between Indigenous and non-Indigenous Australians.

It is noted, however, that the Indigenous population is a much younger population than the non-Indigenous population. Thus, independent of the causes of death at younger ages in the Indigenous population, this population's younger age structure would contribute to a high proportion of deaths at younger ages. On the other hand, independent of the age-specific causes of death, the older age structure of the non-Indigenous population would contribute to a high proportion of deaths at older ages. On the whole, however, death occurs much earlier in high-mortality populations than in populations with relatively low mortality.

For all three periods (2001–2005, 2006–2010 and 2011–2015) more than 5% of all Indigenous male deaths had occurred by the start of age 10 compared to less than 1% of non-Indigenous male deaths. The age when death occurred among Indigenous males and non-Indigenous males began to diverge substantially from this point onwards. By the start of age 40, between 23% and 31% of all Indigenous male deaths had occurred, compared with less than 5% of non-Indigenous male deaths. About 50% of all Indigenous male deaths had occurred by age 55, whereas 50% of non-Indigenous male deaths did not occur till age 75.

More than 2 out of every 3 Indigenous male deaths (67–69%) had occurred by the start of age 65, whereas only 22%–24% of non-Indigenous male deaths had occurred by that age. This means that by the start of age 65, about 45% more Indigenous male deaths had occurred than non-Indigenous male deaths.

A similar pattern of age at death is observed for Indigenous and non-Indigenous females (Figure 2.14), although death occurred at a slightly later age for both Indigenous and non-Indigenous females than their male counterparts.



## 2.4 Trends in Indigenous death rates

Table 2.5 confirms observations from tables 2.2, 2.3 and 2.4 that there have been modest declines in mortality between 2001–2005 and 2011–2015 at almost all ages for both Indigenous males and females except for age 75 and over. For males, the declines appear to have occurred mostly around early childhood mortality and around the middle to late ages (<1, 25–24 and 65–74), as Table 2.5 and figures 2.17 and 2.18 show. For females, the declines occurred mostly at ages under 1 and 65–74.

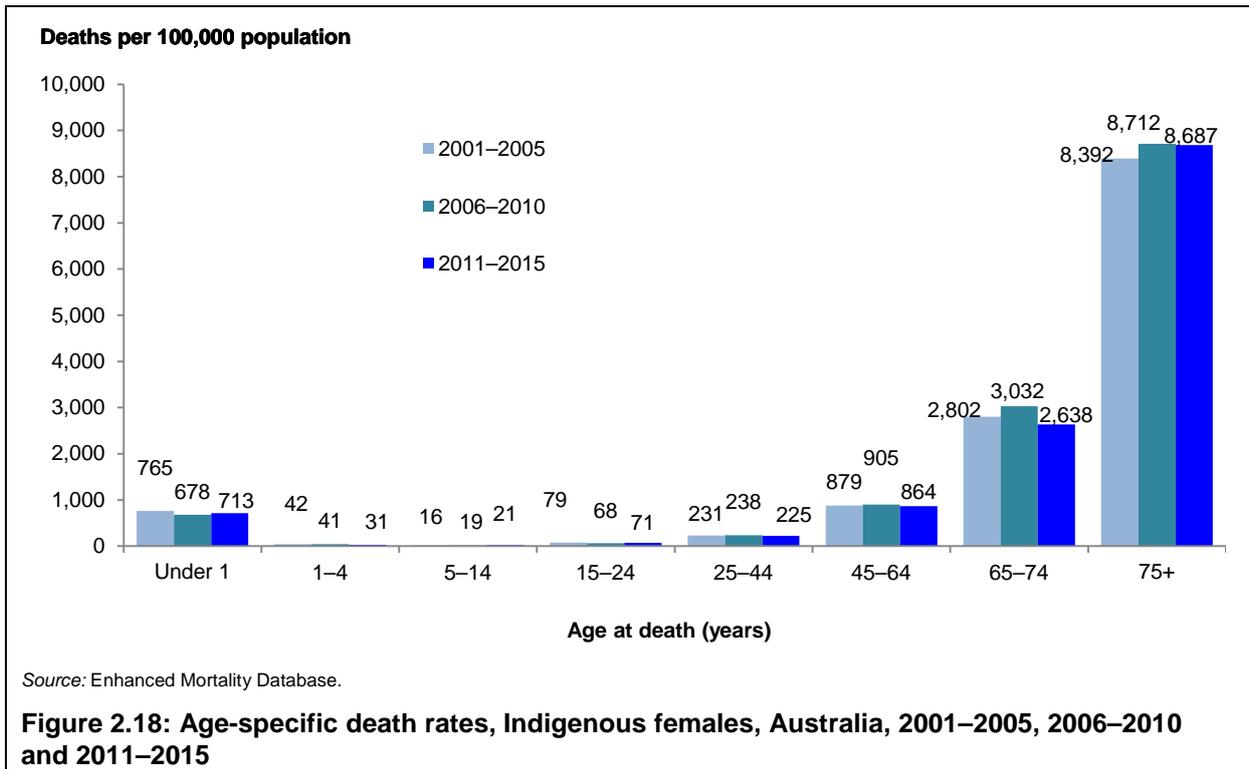
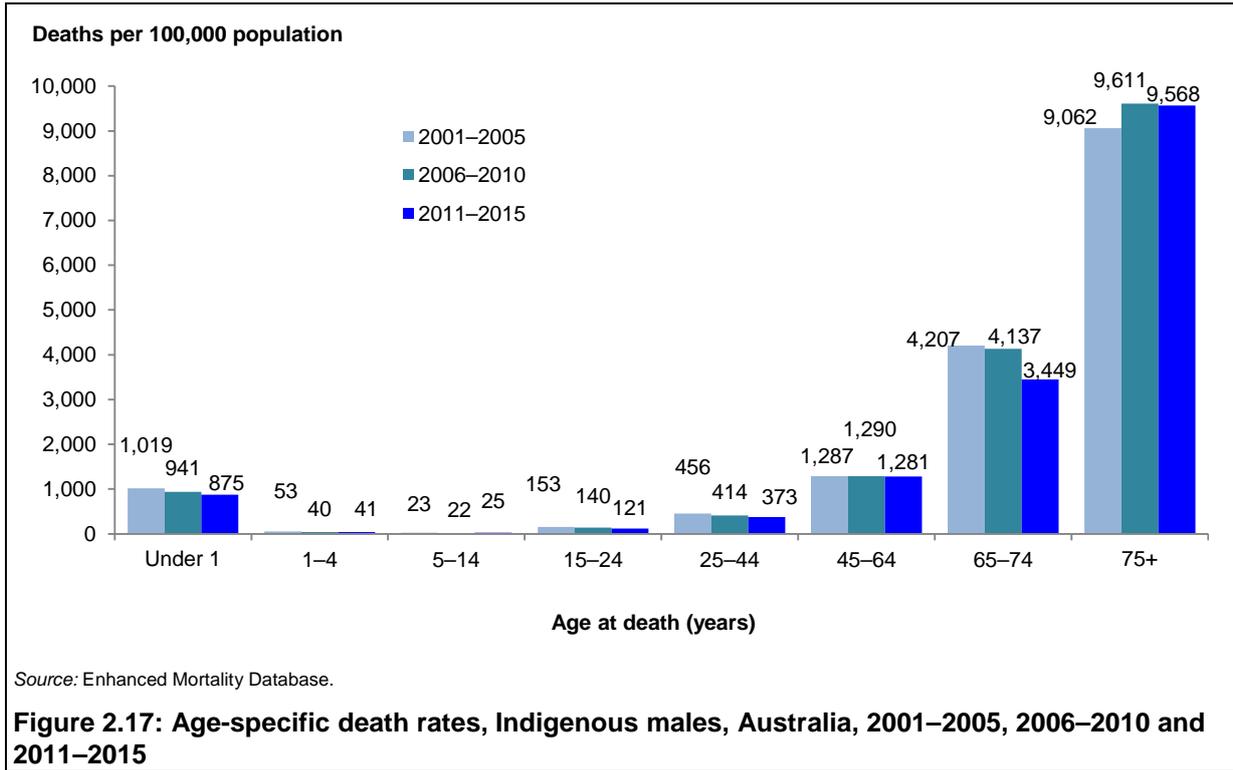
**Table 2.5: Age-specific death rates per 100,000 males and females, Australia, 2001–2005, 2006–2010 and 2011–2015**

Age group (years)	2001–2005		2006–2010		2011–2015	
	Males	Females	Males	Females	Males	Females
<b>Indigenous</b>						
Under 1	1,019	765	941	678	875	713
1–4	53	42	40	41	41	31
5–14	23	16	22	19	25	21
15–24	153	79	140	68	121	71
25–44	456	231	414	238	373	225
45–64	1,287	879	1,291	905	1,281	864
65–74	4,207	2,802	4,138	3,032	3,449	2,638
75+	9,062	8,392	9,611	8,712	9,568	8,687
<b>Non-Indigenous</b>						
Under 1	513	426	455	359	341	304
1–4	27	21	22	17	17	14
5–14	13	10	11	8	9	8
15–24	72	27	58	24	47	21
25–44	121	58	109	53	98	50
45–64	483	288	451	271	431	259
65–74	2,119	1,208	1,756	1,040	1,534	934
75+	7,800	6,404	7,508	6,417	7,174	6,364

Source: Enhanced Mortality Database.

Some of the declines in mortality implied in the preceding tables and graphs could be associated not only with actual declines in the number of deaths, but also with shifts in the ages at death as well as changes in the causes of death. A future report in this series will include an examination of causes of death, and the role played by shifts in causes of death in changing the levels, patterns and trends in Indigenous mortality.

It is noted, however, that death rates at ages 75 and over, particularly for Indigenous males, appear to have increased slightly between 2001–2005 and 2006–2010 and 2011–2015. This pattern of death rates is probably due to an increase in the number of people dying at older ages as a result of declining mortality at younger ages (for example, 25–44 and 65–74 for males). There is no such clear pattern for females.



## 2.5 Conclusion

Enhancement of Indigenous identification in the Enhanced Mortality Database has enabled the estimation of alternative mortality measures for the six jurisdictions considered, as well as for Australia as a whole. A number of mortality measures and indicators—namely, the median age at death, age-specific death rates, the cumulative proportions of deaths occurring by specified ages, and age-standardised death rates—have all shown that mortality has declined, if only slightly, in most age groups for both Indigenous males and females across the six jurisdictions considered.

The analysis also provides information on which areas of mortality must be further monitored and targeted. For instance, on average, death occurs much earlier for Indigenous males and females than non-Indigenous males and females. Some of the key findings from the study include the following:

- Mortality appeared to have declined during the reference period for both Indigenous males and females: the median age at death for both Indigenous males and females increased during the period 2001–2005 to 2011–2015, while the age-standardised death rates declined for both Indigenous males and females (tables 2.2 and 2.3).
- In terms of absolute decline in mortality, non-Indigenous males experienced a much bigger absolute decline in mortality than Indigenous males, while Indigenous females experienced a much bigger absolute decline in mortality than non-Indigenous females:
  - consequently, the rate difference between Indigenous and non-Indigenous males increased during the period 2001–2005 to 2011–2015 while the rate difference between Indigenous and Indigenous females decreased (Table 2.4).
- In terms of relative decline in mortality, non-Indigenous females experienced a slightly higher percentage decline in mortality (13.5%) than that experienced by Indigenous females (12.9%). Non-Indigenous males, however, experienced both a bigger absolute decline in mortality as well as a bigger percentage mortality decline (17.7%) compared to Indigenous males (4.3%):
  - as a result, the rate ratio between Indigenous and non-Indigenous males increased during the period 2001–2005 to 2011–2015 while the rate ratio between Indigenous and Indigenous females remained stable (Table 2.4).
- The age-standardised death rate declined marginally (4.3%) for Indigenous males, from 13.8 per 1,000 population in 2001–2005 to 13.2 in 2011–2015 and more substantially for Indigenous females (12.1%) from 11.6 in 2001–2005 to 10.2 in 2011–2015.
- On the other hand, the age-standardised death rate declined by 17.7 per cent for non-Indigenous males, from 7.9 per 1,000 population in 2001–2005 to 6.5 in 2011–2015, and by 13.5 per cent for Indigenous females, from 5.2 in 2001–2005 to 4.5 in 2011–2015.
- The age-standardised death rate also declined for Indigenous males and females in all jurisdictions, except in Queensland and South Australia where the age-standardised death rate increased for Indigenous males, and Victoria, where the age-standardised death rate increased for Indigenous females.
- The biggest gap in mortality between Indigenous males and females on the one hand, and non-Indigenous males and females on the other, occurred at two points along the age spectrum: at infancy and from about age 45 onwards.

## 3 Life expectancy

Life expectancy is a statistical measure of how long a person can expect to live, depending on the age they have already reached. It is the number of years of life remaining to a person at a particular age if current death rates do not change. Life expectancy can be determined for any age. Thus, life expectancy at age 20 or 65 refers to the probable years of life remaining for a group of people at age 20 or 65 if they experienced the prevailing mortality rates for the rest of their lives. The most commonly used estimate of life expectancy is life expectancy at birth. Life expectancy at birth reflects the mortality pattern that prevails across all age groups (Shryock & Siegel 1976).

Estimates of life expectancy are obtained from a life table. The life table is a summary measure of the age-specific death rates in a population. Because mortality differs between the two sexes, the life table is usually calculated for males and females separately. The quality of life table estimates is directly affected by the quality of the input death and population data.

The death data used to prepare the life tables in this report come from the Enhanced Mortality Database, created by linking the MED to comparative data sets that contain information on death and Indigenous status (see Appendix C on the methodology for enhancing the Indigenous status of death records).

### 3.1 Key data inputs

The key inputs into the construction of a life table are age-specific death rates, calculated separately for males and females, as described in Section 2.3.1. The age-specific death rates used in preparing the life tables presented in this report were based on enhanced deaths between 2001 and 2014, divided by the back-cast and projected Indigenous ERP as at 30 June of each year between 2001 and 2014.

The choice of denominator population can have a non-negligible impact on the estimated age-specific death rates, and hence on the life expectancy estimates (see Appendix C5 and Table C10 for a comparison of life expectancy estimates based on the back-cast Indigenous ERP, with life expectancy estimates based on an alternative population denominator).

### 3.2 Percentages of people surviving to older ages

One of the most important pieces of information that can be obtained from a life table is the survival function, or the proportions of people surviving from one age to the next among a cohort of newborn babies. This information can be estimated separately from two columns of the life table: the proportions of people alive at the start of an indicated age interval who will die before reaching the end of that age interval ( ${}_nq_x$ ), and the number of persons alive at the start of an indicated age interval ( ${}_nl_x$ ) out of a cohort of newborn babies or out of the total number of births assumed as the radix of the life table.

The life tables from which the survival functions were estimated were constructed from the enhanced death data. The life table survival function is based on the assumption that people will be exposed throughout their lifetimes according to the probabilities of dying or surviving implied in the life tables.

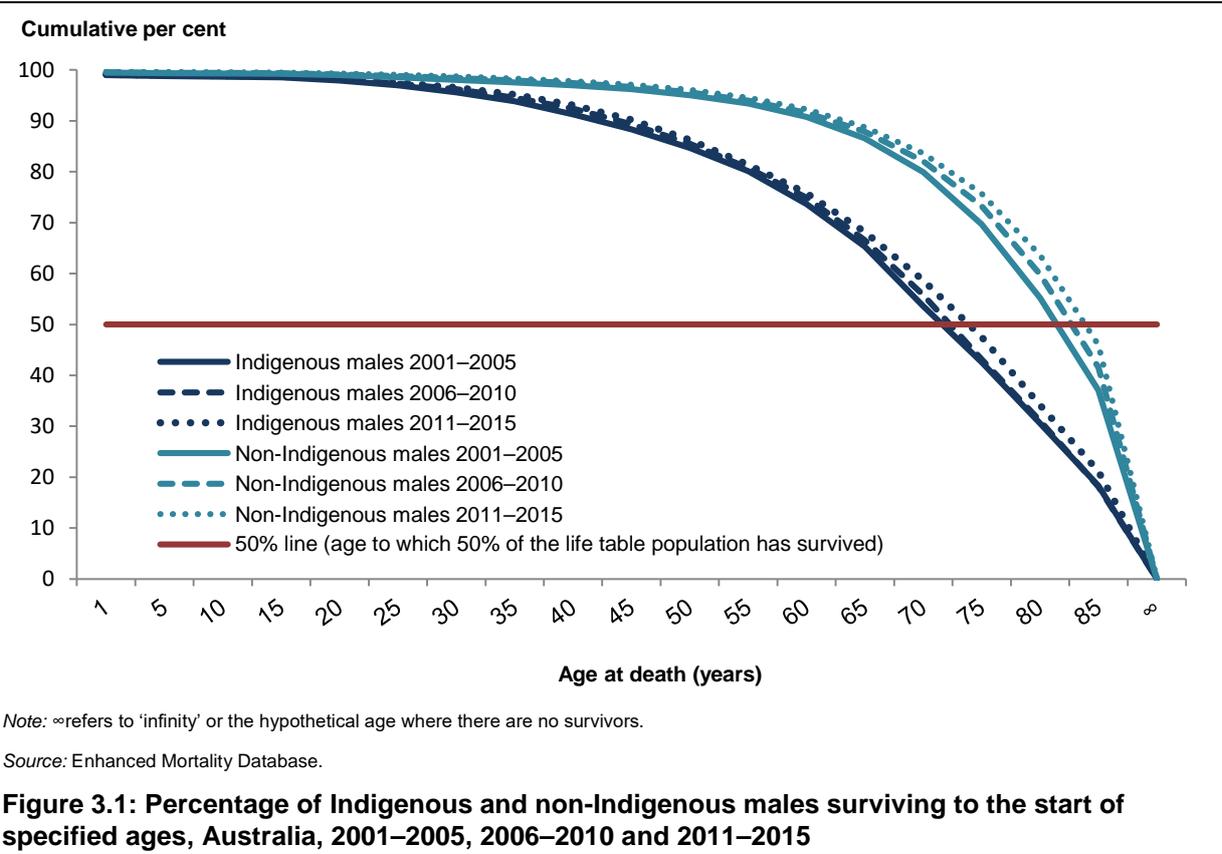
Figures 3.1 and 3.2 and Table 3.1 confirm the findings from section 2.3.2 that Indigenous males and females died at considerably younger ages than non-Indigenous males and

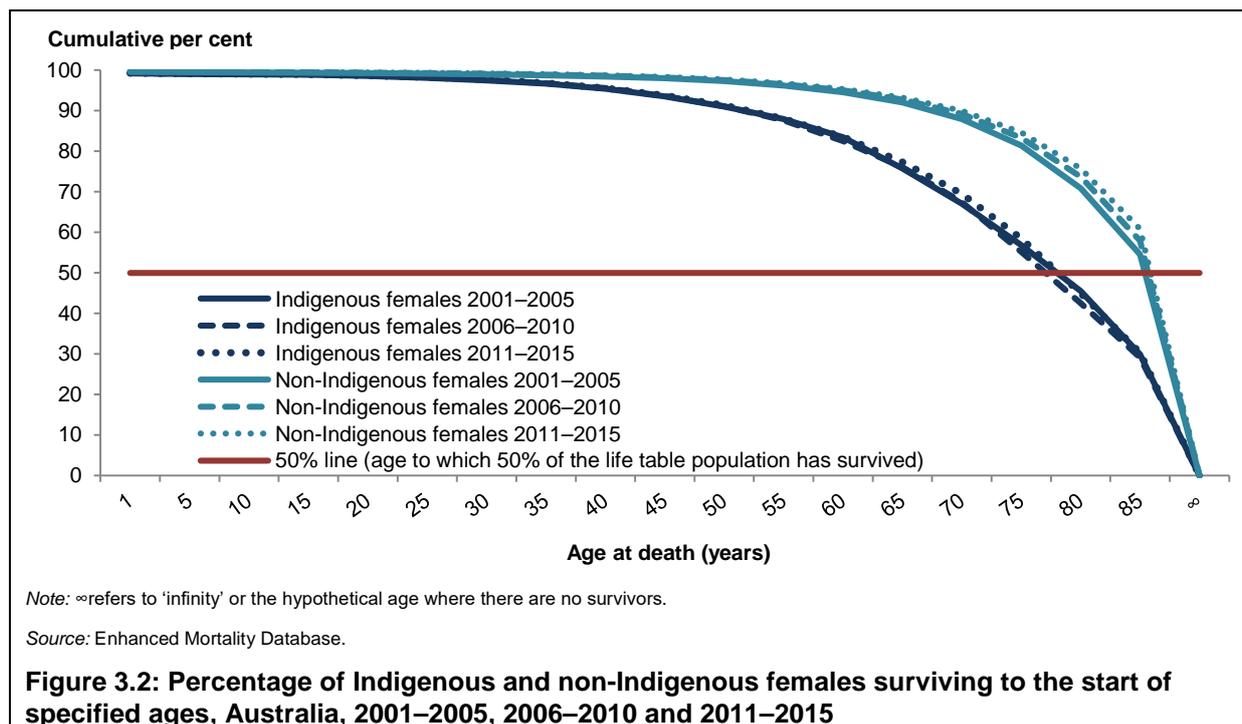
females. They show that, because of higher proportions of Indigenous than non-Indigenous deaths at younger ages, lower percentages of Indigenous males and females survived to each specified age compared with non-Indigenous males and females. The difference between the percentages of Indigenous males and females surviving to the next higher age compared with the percentages of non-Indigenous males and females surviving to the next higher age was, however, small at ages under 25.

A noticeable gap between Indigenous males and females (on the one hand) and non-Indigenous males and females (on the other) in the percentages surviving to the next higher age began to open from about age 35. By age 50, about 10% more non-Indigenous than Indigenous males were still alive; at the same age, about 6%–7% more non-Indigenous females than Indigenous females were still alive.

The survival gap began to widen rapidly from then on. By age 60, about 73%–76% of Indigenous males were still alive compared with 91%–92% of non-Indigenous males—a gap of about 16%–18%. The gap was slightly smaller for females. By age 60, about 83%–84% of Indigenous females were still alive compared with about 95% of non-Indigenous females—a gap of about 11%–12%.

While only about 47% of a cohort of Indigenous male babies born in the reference period are estimated to be likely to survive to age 75, about 75% of non-Indigenous male babies born during the same period are likely to survive to age 75. At the same time, while 58% of Indigenous female babies are likely to survive to age 75, about 84% of non-Indigenous female babies will be likely to survive to this age.





**Table 3.1: Percentage of people surviving to the start of specified ages, by Indigenous status and sex, Australia, 2001–2005, 2006–2010 and 2011–2015**

Sex/Age at death (years)	Indigenous			Non-Indigenous		
	2001–2005	2006–2010	2011–2015	2001–2005	2006–2010	2011–2015
Males						
1	99.0	99.1	99.1	99.5	99.5	99.7
5	98.8	98.9	99.0	99.4	99.5	99.6
10	98.7	98.8	98.9	99.3	99.4	99.5
15	98.5	98.7	98.7	99.3	99.3	99.5
20	97.9	98.2	98.3	99.0	99.1	99.3
25	97.0	97.3	97.5	98.5	98.8	99.0
30	95.6	96.2	96.5	98.1	98.4	98.7
35	93.8	94.5	95.2	97.6	98.0	98.3
40	91.3	92.4	93.1	97.0	97.4	97.8
45	88.3	89.3	90.2	96.2	96.7	97.1
50	84.7	85.5	86.3	95.1	95.6	96.1
55	80.1	80.7	81.4	93.4	94.0	94.6
60	73.6	74.9	75.8	90.8	91.6	92.3
65	65.3	66.6	68.2	86.6	87.9	88.8
70	53.6	55.7	58.7	80.0	82.1	83.6
75	42.6	43.1	47.5	69.7	73.3	75.7
80	30.6	31.1	34.1	55.2	59.8	63.6
85	18.3	18.2	21.2	37.1	41.6	46.0

(continued)

**Table 3.1 (continued): Percentage of people surviving to specified ages, by Indigenous status and sex, Australia, 2001–2005, 2006–2010 and 2011–2015**

Sex/Age at death (years)	Indigenous			Non-Indigenous		
	2001–2005	2006–2010	2011–2015	2001–2005	2006–2010	2011–2015
<b>Females</b>						
1	99.2	99.3	99.3	99.6	99.6	99.7
5	99.1	99.2	99.2	99.5	99.6	99.6
10	99.0	99.1	99.1	99.4	99.5	99.6
15	98.9	99.0	99.0	99.4	99.5	99.6
20	98.6	98.7	98.7	99.3	99.4	99.5
25	98.1	98.3	98.3	99.1	99.3	99.3
30	97.5	97.6	97.7	99.0	99.1	99.2
35	96.7	96.8	96.9	98.8	98.9	99.0
40	95.4	95.6	95.6	98.5	98.6	98.8
45	93.5	93.6	93.8	98.0	98.2	98.4
50	91.0	91.1	91.3	97.3	97.5	97.7
55	87.9	87.6	88.0	96.2	96.5	96.8
60	83.4	82.5	83.6	94.6	95.0	95.3
65	75.7	76.0	77.3	92.0	92.7	93.2
70	67.0	67.5	69.5	87.9	89.2	90.0
75	56.9	55.2	58.5	81.4	83.3	84.6
80	45.5	42.5	45.0	70.9	73.6	75.7
85	29.9	29.1	30.3	54.6	58.2	60.8

Source: Enhanced Mortality Database.

Table 3.1 also shows that there have been slight improvements in survival for both Indigenous and non-Indigenous males and females at most ages over the study period. At most ages, and particularly at most adult ages past 20, the proportion of both Indigenous and non-Indigenous males and females surviving to the next higher age was higher in 2011–2015 than in any of the preceding periods studied.

### 3.3 Levels and differentials in life expectancy

Table 3.2 presents estimates of life expectancy at birth and at ages 20, 45 and 65, together with their 95 per cent confidence intervals, for the periods 2001–2005, 2006–2010 and 2011–2015 (see Box 3.1). Life expectancy estimates for 2001–2005 and 2006–2010 are based on enhanced death data obtained from linking the MED to the NHMD, the RAC database and the jurisdictional perinatal data collections over the periods 2001–2005 and 2006–2010.

Life expectancy estimates for 2011–2015 are preliminary. They are based on applying 2006–2010 Indigenous status reclassification rates to 2011–2015 death records, on the assumption that Indigenous status misclassification on death records had not changed substantially between 2006–2010 and 2011–2015. The 2006–2010 Indigenous status enhancement factors were obtained by linking the MED for 2006–2010 to corresponding records on the three comparative data sets over the same period, and comparing Indigenous status across the linked data sets. Final life expectancy estimates for 2011–2015 will be produced when final MED data for 2015 become available, and MED records for 2011–2015 are linked to the three comparative data sets and to an additional data set, the NNAPECD.

Life expectancy estimates for 2001–2005 and 2006–2010 are based on single year enhanced age-specific death rates (see Section 2.2.3). Life expectancy estimates for 2011–2015 are based on 5-year age-specific death rates. These rates have been enhanced using 2006–2010 Indigenous status enhancement factors, on the assumption that Indigenous identification in 2011–2015 had not changed substantially from what it was in 2006–2010. In relation to this assumption, Appendix C3.2.3 presents simulations of the likely impact of changes in Indigenous identification on life expectancy in 2011–2015.

### **Box 3.1: Confidence intervals**

Life expectancy values presented in this report are estimates and are therefore subject to a margin of error which is determined by the level of mortality and size of population (Chiang 1984; Li & Tuljapurkar 2012). Tables in this chapter present life expectancy estimates, followed by upper and lower 95% confidence levels in square brackets. The 95% confidence intervals represent the margin of error. The width of the confidence interval represents the size of the margin of error.

For example, in Table 3.3, life expectancy at birth for Indigenous males in Victoria in 2006–2010 is given as '73.6 [72.1–75.2]'. This means that '73.6' years is the best estimate of Indigenous male life expectancy in Victoria in 2006–2010. Since this is only an estimate, the true value could be different from 73.6 years. There is 95% confidence, however, that the true value is between 72.1 and 75.2 years.

In general, confidence intervals are smaller for Australia-level estimates and biggest for those for Victoria and South Australia. These two states both have relatively small Indigenous populations and still fewer Indigenous deaths, and so there is more uncertainty about the estimates. Estimates with wide confidence intervals should be interpreted with caution.

Similarly, there are wider confidence intervals around the life expectancy estimates for Indigenous males and females, compared to corresponding estimates for non-Indigenous males and females. This is because of the much smaller Indigenous population and fewer Indigenous deaths compared with the size of the non-Indigenous population and the number of non-Indigenous deaths.

Table 3.2 shows that estimated life expectancy at birth increased significantly for both Indigenous males and females between 2001–2005 and 2011–2015, by 1.8 years for Indigenous males (from 68.3 to 70.1 years) and by 0.6 years for Indigenous females (from 73.9 to 74.5 years).

Life expectancy appears to have increased across all ages, though the changes were not significant for females.

**Table 3.2: Indigenous life expectancy at selected ages, Australia, 2001–2005, 2006–2010 and 2011–2015**<sup>(a)(b)</sup>

Period/Selected ages (years)	Males	Females
<b>2001–2005</b>		
0	68.3 [67.9–68.7]	73.9 [73.6–74.2]
20	49.6 [49.3–50.0]	54.9 [54.6–55.2]
45	28.4 [28.1–28.8]	32.1 [31.7–32.5]
65	14.5 [14.1–14.9]	16.7 [16.3–17.1]
<b>2006–2010</b>		
0	69.6 [69.3–70.0]	74.4 [74.0–74.8]
20	50.8 [50.5–51.1]	55.2 [54.9–55.5]
45	29.1 [28.8–29.4]	32.2 [31.9–32.5]
65	14.8 [14.4–15.1]	16.7 [16.4–17.0]
<b>2011–2015</b>		
0	70.1 [69.7–70.3]	74.5 [74.2–74.8]
20	51.1 [50.8–51.4]	55.3 [55.1–55.6]
45	29.3 [29.0–29.5]	32.4 [32.1–32.6]
65	15.0 [14.8–15.3]	16.7 [16.5–17.0]

(a) Estimates for 2001–2005 and 2006–2010 are based on deaths and population denominators for 2001–2005 and 2006–2010, respectively.

(b) The 2011–2015 estimates are preliminary, and are based on applying 2006–2010 Indigenous status adjustment factors to the enhanced death data for 2011–2015. Final life tables for 2011–2015 will be prepared when final 2011–2015 NMD data become available, and a Mortality Data Extract for 2011–2015 is created and linked to the comparative data sets, including to the NNAPECD.

Source: Enhanced Mortality Database.

Figure 3.3 compares life expectancy at birth between Indigenous males and females and non-Indigenous males and females in Australia. It shows increases in life expectancy for all four subpopulations during the reference period.

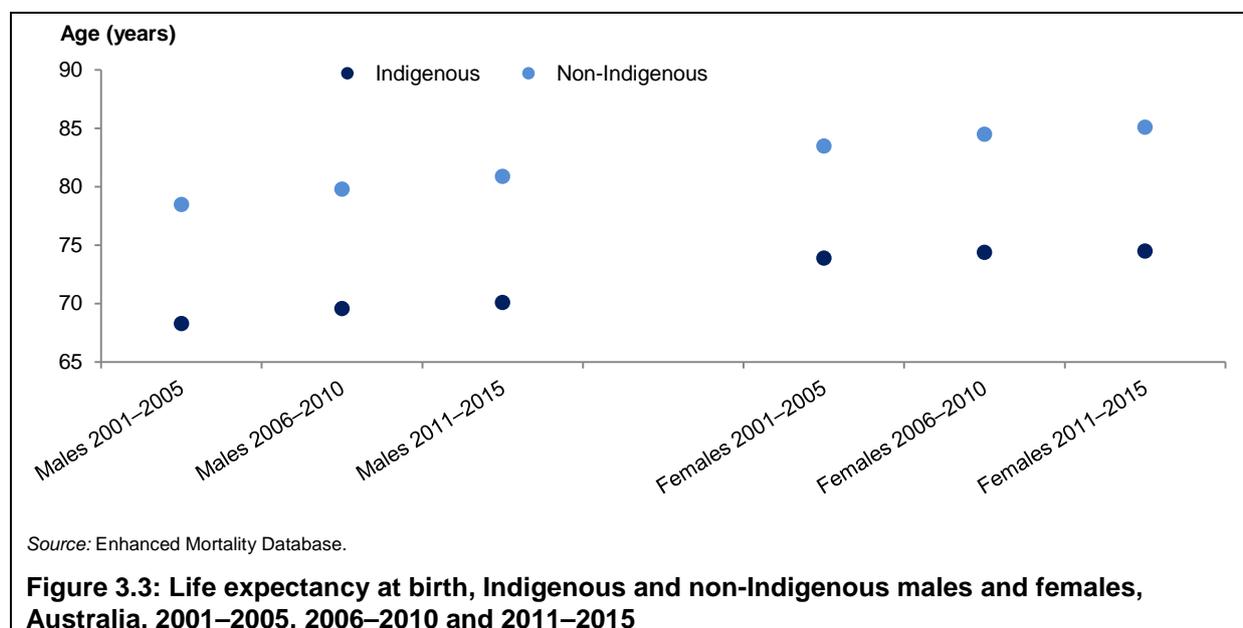


Table 3.3 presents estimates of life expectancy at birth, and 95 per cent confidence intervals, for Indigenous and non-Indigenous males and females for New South Wales, Queensland, Western Australia, and the Northern Territory for 2001–2005, 2006–2010 and 2011–2015.

Separate estimates were also prepared for Victoria and South Australia, and these must be viewed with caution because of the high standard errors around these estimates. Separate estimates were not prepared for Tasmania and the Australian Capital Territory (ACT) because of the small size of the Indigenous population and the very few Indigenous deaths in these two jurisdictions. Enhanced death data for Tasmania and the ACT were, however, included in the Australia estimates. Methods are being investigated that may allow separate estimates for these smaller jurisdictions to be prepared and incorporated in subsequent reports.

**Table 3.3: Expectation of life at birth for the Indigenous and non-Indigenous population, selected states and territories, 2001–2005<sup>(a)</sup>, 2006–2010<sup>(a)</sup> and 2011–2015<sup>(a)(b)</sup>**

Jurisdiction	Indigenous		Non-Indigenous	
	Males	Females	Males	Females
<b>New South Wales</b>				
2001–2005	71.9 [71.2–72.6]	76.4 [75.8–77.0]	78.5 [78.4–78.6]	83.6 [83.5–83.6]
2006–2010	71.7 [71.2–72.3]	76.3 [75.8–76.9]	#79.9 [79.8–80.0]	#84.3 [84.3–84.4]
2011–2015	72.1 [71.6–72.6]	75.8 [75.4–76.3]	#, *80.9 [80.8–80.9]	#, *85.1 [85.0–85.2]
<b>Queensland</b>				
2001–2005	66.8 [66.1–67.5]	73.0 [72.2–73.7]	78.3 [78.2–78.4]	83.3 [83.2–83.4]
2006–2010	#69.4 [68.8–70.1]	73.9 [73.3–74.5]	#79.5 [79.4–79.6]	#84.2 [84.1–84.2]
2011–2015	#69.8 [69.3–70.3]	#75.1 [74.6–75.6]	#, *80.6 [80.5–80.7]	#, *84.8 [84.8–85.0]
<b>Western Australia</b>				
2001–2005	63.4 [62.5–64.3]	68.9 [68.1–69.8]	79.2 [79.1–79.3]	84.3 [84.2–84.4]
2006–2010	64.8 [63.9–65.6]	70.0 [69.2–70.8]	#80.2 [80.1–80.3]	#85.0 [84.9–85.1]
2011–2015	65.8 [65.1–66.5]	#71.5 [70.7–72.3]	#, *81.5 [81.3–81.6]	#, *86.0 [85.9–86.1]
<b>Northern Territory</b>				
2001–2005	59.0 [58.1–59.9]	67.0 [65.9–68.1]	76.7 [76.1–77.3]	81.5 [80.8–82.1]
2006–2010	#63.0 [61.9–64.0]	68.2 [67.2–69.2]	77.2 [76.7–77.6]	#84.6 [84.0–85.2]
2011–2015	#63.9 [63.0–64.8]	67.0 [66.1–67.8]	#, *79.6 [79.1–80.0]	#84.9 [84.4–85.4]
<b>Victoria<sup>(a)</sup></b>				
2001–2005	72.4 [70.8–74.1]	79.8 [77.6–82.0]	78.7 [78.6–78.8]	83.5 [83.5–83.5]
2006–2010	73.6 [72.1–75.2]	#75.9 [74.5–77.3]	#80.1 [80.0–80.1]	#84.4 [84.4–84.5]
2011–2015	74.4 [73.2–75.5]	77.9 [76.9–78.9]	#, *81.4 [81.3–81.4]	#, *85.2 [85.2–85.3]
<b>South Australia<sup>(a)</sup></b>				
2001–2005	66.5 [64.7–68.3]	71.9 [70.1–73.7]	78.1 [77.9–78.2]	83.5 [83.3–83.6]
2006–2010	68.1 [66.6–69.6]	70.9 [69.4–72.4]	#79.5 [79.4–79.6]	#84.2 [84.1–84.3]
2011–2015	69.5 [68.3–70.8]	74.8 [73.6–76.1]	#, *80.7 [80.6–80.8]	#, *84.9 [84.8–85.0]
<b>Australia (All jurisdictions)</b>				
2001–2005	68.3 [67.9–68.7]	73.9 [73.6–74.2]	78.5 [78.4–78.5]	83.5 [83.5–83.6]
2006–2010	#69.6 [69.3–70.0]	74.4 [73.6–75.1]	79.8 [79.7–79.8]	#84.4 [84.3–84.4]
2011–2015	#70.1 [69.7–70.3]	74.5 [74.2–74.8]	#, *80.9 [80.9–81.0]	#, *85.1 [85.1–85.2]

# significantly different from 2001–2005 at 95% confidence level.

\* significantly different from 2006–2010 at 95% confidence level.

(a) Estimates for 2001–2005 and 2006–2010 are based on deaths and population denominators for 2001–2005 and 2006–2010, respectively.

(b) The 2011–2015 estimates (shaded) are preliminary, and are based on applying 2006–2010 Indigenous status reclassification rates to the enhanced death data for 2011–2015. Final life tables for 2011–2015 will be prepared when final 2011–2015 NMD data become available, and a Mortality Data Extract for 2011–2015 is created and linked to the comparative data sets, including to the NNAPECD.

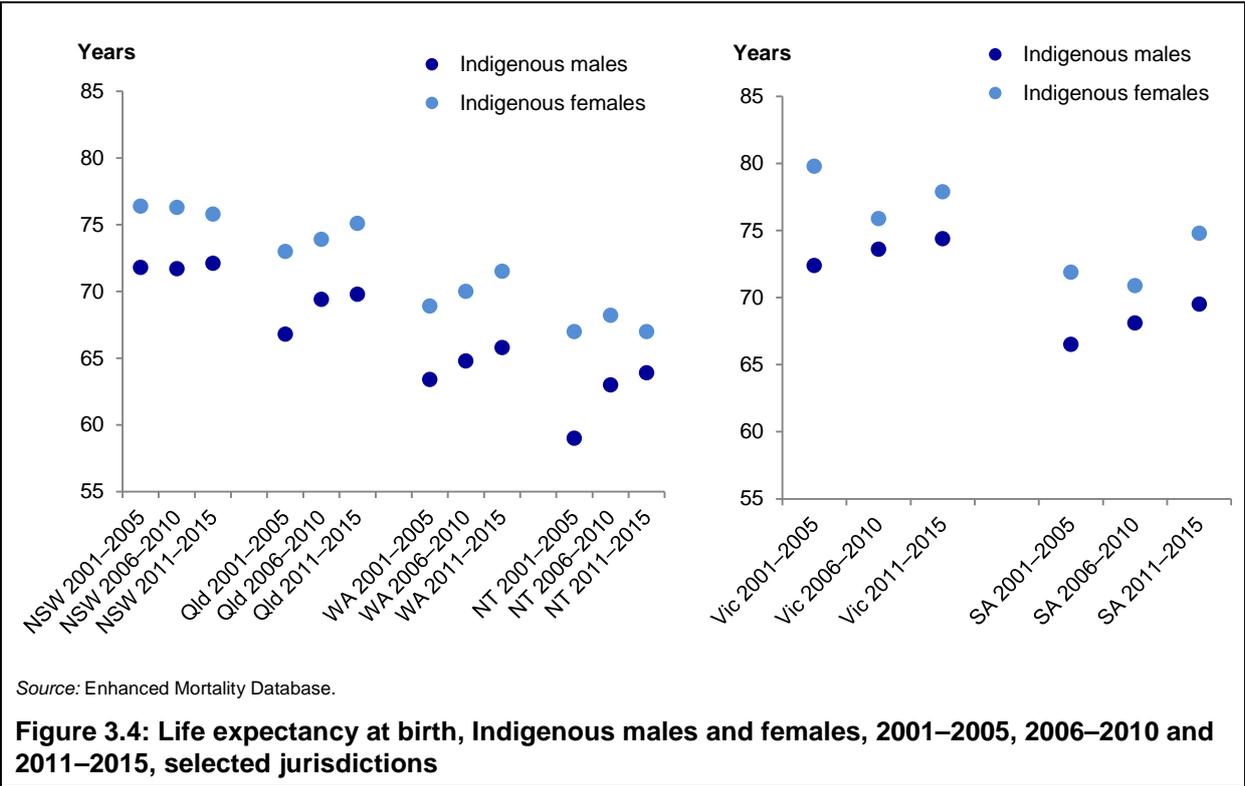
(c) Estimates for Victoria and South Australia are marked separately because of their wide confidence intervals.

Source: Enhanced Mortality Database.

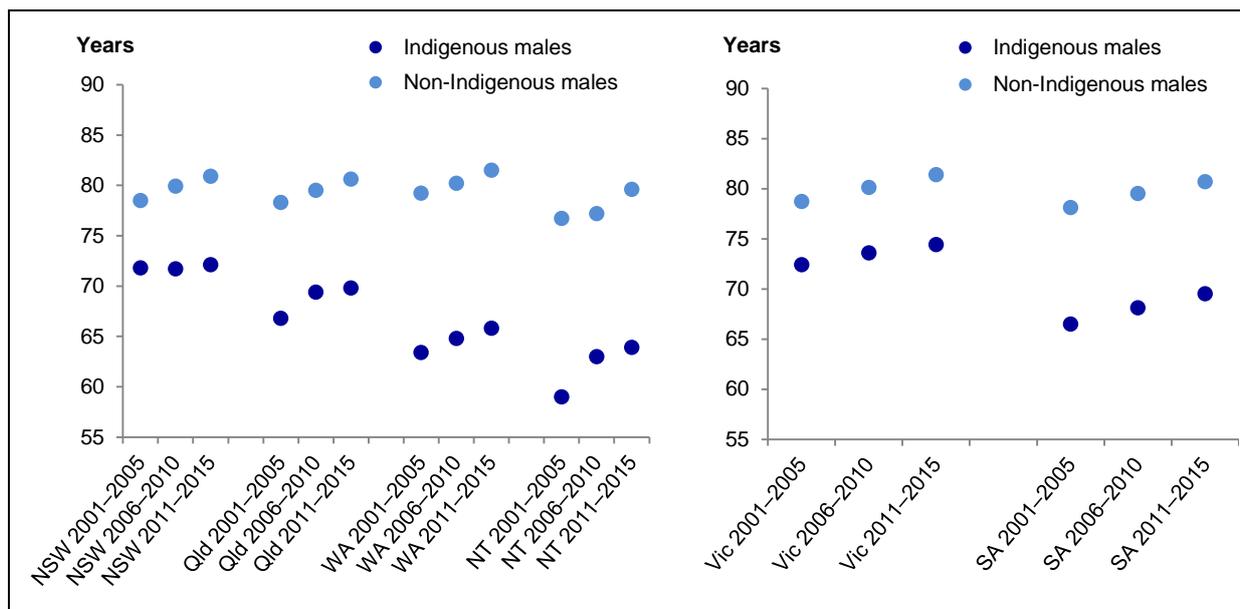
At the national level (all jurisdictions combined), Indigenous life expectancy at birth in 2001–2005 was 68.3 years for males and 73.9 years for females. For males there was a significant increase of 1.8 years between 2001–2005 and 2011–2015 (to 70.1), while for females the increase of 0.6 years (to 74.5) was not significant. For non-Indigenous males there was a significant increase of 2.4 years (from 78.5 to 80.9) over this period, and also a significant increase of 1.6 years (from 83.5 to 85.1) for non-Indigenous females.

There appear to have been modest (but often not statistically significant) increases in life expectancy at birth for Indigenous Australians across most of the six jurisdictions considered between 2001–2005 and 2011–2015. Significant increases were found for males and females in Queensland, for females in Western Australia and for males in the Northern Territory. There were slight but not significant decreases for females in New South Wales and Victoria, and no change for females in the Northern Territory.

Figure 3.4 compares life expectancy at birth for Indigenous males and females across the six jurisdictions over the reference period. Estimates for New South Wales, Queensland, Western Australia and the Northern Territory are shown separately from estimates for Victoria and South Australia because of the high standard errors for the estimates for the latter two jurisdictions. In all the six jurisdictions, life expectancy was higher for Indigenous females than for Indigenous males. Figure 3.4 also illustrates clearly the pattern of change in life expectancy across the jurisdictions. The erratic trends in Victoria and South Australia may be related to the small Indigenous population and the small number of Indigenous deaths in those jurisdictions.

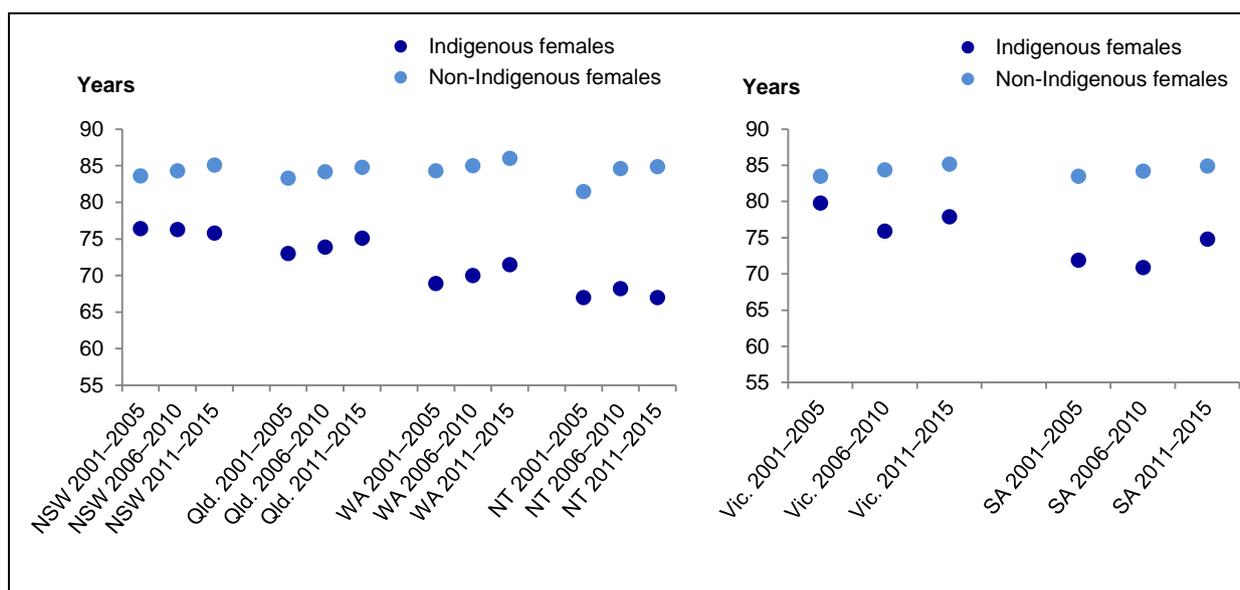


The relationship between Indigenous and non-Indigenous life expectancy across the six jurisdictions is more clearly shown in figures 3.5 and 3.6.



Source: Enhanced Mortality Database.

**Figure 3.5: Indigenous and non-Indigenous male life expectancy at birth, 2001–2005, 2006–2010 and 2011–2015, selected jurisdictions**



Source: Enhanced Mortality Database.

**Figure 3.6: Indigenous and non-Indigenous female life expectancy at birth, 2001–2005, 2006–2010 and 2011–2015, selected jurisdictions**

New South Wales and Victoria had the highest estimated life expectancy at birth for Indigenous males and females during the reference period, followed by Queensland and South Australia. The Northern Territory had the lowest life expectancy at birth for both Indigenous males and females during the period.

Figures 3.5 and 3.6 show that there was more variability between jurisdictions in Indigenous life expectancy than in non-Indigenous life expectancy. Irrespective of one's jurisdiction of usual residence (except in the Northern Territory), non-Indigenous males and females, respectively, experienced similar levels and trajectories in improvements in life expectancy.

For example, except in the Northern Territory, life expectancy at birth throughout the reference period for both non-Indigenous males and females did not vary by more than one year between the jurisdiction with the lowest life expectancy at birth and the jurisdiction with the highest life expectancy at birth. For Indigenous males and females, on the other hand, the gap between the jurisdiction with the lowest life expectancy at birth and that with the highest life expectancy at birth was up to 9 years, for males and between 6 and 11 years, for females. Such large variation in Indigenous life expectancy across jurisdictions may reflect differences in the socioeconomic, health and welfare circumstances of Indigenous people living in different jurisdictions.

## **3.4 Life expectancy gap**

### **3.4.1 Gap between Indigenous and non-Indigenous life expectancy**

The estimate of the gap between Indigenous and non-Indigenous is dependent on the resolution of a number of methodological and data quality issues, including the robustness with which Indigenous under-coverage in death data is addressed, the choice of population denominators used in preparing the mortality and life expectancy estimates, and the way Indigenous status reclassification factors are calculated and applied to enhance Indigenous identification on death records. While the AIHW has addressed these issues as carefully as possible, uncertainties still remain. The life expectancy gap could be different if a different series of population denominators were used as input data for the life tables or a different methodological approach was used in enhancing Indigenous status information on death records. Caution is therefore urged in the interpretation of these estimates.

The gap in life expectancy between two populations is a function of the difference between the two populations in their age-specific death rates. The gap between Indigenous and non-Indigenous life expectancy therefore depends not only on whether Indigenous life expectancy is increasing, but also on how non-Indigenous death rates and life expectancy are changing relative to changes in Indigenous death rates and life expectancy. The gap between Indigenous and non-Indigenous life expectancy can therefore narrow, widen or remain unchanged independent of whether or not Indigenous life expectancy is increasing.

In Australia as a whole, as well as in all the six jurisdictions considered, life expectancy at birth increased for both Indigenous males and females as well as for both non-Indigenous males and females, during the reference period. The increases in Indigenous life expectancy were variable, not only between jurisdictions, but also from one period to the other.

Table 3.4 shows the gap between Indigenous and non-Indigenous life expectancy during the reference period. In Australia as a whole, life expectancy at birth was about 10.2 to 10.8 years higher for non-Indigenous than for Indigenous males, while corresponding estimates for non-Indigenous females were about 9.6 to 10.6 years higher than for Indigenous females.

While life expectancy for Indigenous males increased by 1.8 years during the reference period, non-Indigenous males experienced an increase in life expectancy of about 2.4 years. Similarly, life expectancy for Indigenous females increased by 0.6 of a year compared with an increase of 1.6 years for non-Indigenous females during the reference period. Thus, although life expectancy improved for both Indigenous males and females, the gap between Indigenous and non-Indigenous life expectancy did not narrow because non-Indigenous life expectancy increased faster than Indigenous life expectancy.

**Table 3.4: Gap in life expectancy at birth between Indigenous and non-Indigenous Australians, 2001–2005, 2006–2010 and 2011–2015**

Jurisdiction	Gap between Indigenous and non-Indigenous males			Gap between Indigenous and non-Indigenous females		
	2001–2005	2006–2010	2011–2015	2001–2005	2006–2010	2011–2015
New South Wales	6.7	8.2	8.8	7.2	8.0	9.3
Queensland	11.5	10.1	10.8	10.3	10.3	9.7
Western Australia	15.8	15.4	15.7	15.4	15.0	14.5
Northern Territory	17.7	14.2	15.7	14.5	16.4	17.9
Victoria <sup>(a)</sup>	6.3	6.5	7.0	3.7	8.5	7.3
South Australia <sup>(a)</sup>	11.6	11.4	11.2	11.6	13.3	10.1
Australia <sup>(b)</sup>	10.2	10.2	10.8	9.6	10.0	10.6

(a) Caution should be exercised in interpreting the gap for Victoria and South Australia because of the wider confidence intervals of the life expectancy estimates on which gap estimates are based (see Table 3.3).

(b) Estimates for Australia include Tasmania, the Australian Capital Territory and Other Territories.

Source: Enhanced Mortality Database.

Table 3.4 shows that the estimated life expectancy gap was widest in Western Australia and the Northern Territory. The gap was much smaller in New South Wales and Victoria than in the remaining jurisdictions, as figures 3.5 and 3.6 show separately for males and females.

### 3.4.2 Life expectancy gap between males and females

The life expectancy gap between Indigenous males and females in 2011–2015 was 4.4 years, having narrowed from 5.6 years in 2001–2005 and 4.8 years in 2006–2010. There is no consistent pattern in the life expectancy gap between males and females in Australia as a whole and across the six jurisdictions considered. Table 3.5 shows that for Australia as a whole, as well as for most jurisdictions except New South Wales and Victoria in 2006–2010 and 2011–2015, and the Northern Territory in 2006–2010, there was a slightly bigger gap in life expectancy at birth between Indigenous males and females than between non-Indigenous males and females. The life expectancy gap between Indigenous males and females was highest in the Northern Territory. The gap was 8 years in 2001–2005, reducing to 5.2 years in 2006–2010 and to 4.1 years in 2011–2015.

The large life expectancy gap between males and females in the Northern Territory was also observed by the ABS for 2005–2007 (7.7 years), using population denominators based on the 2006 Census (ABS 2013b). This observed gap rose slightly to 7.9 years following the revision of the 2005–2007 life expectancy estimates, using population denominators based on the 2011 Census. In 2010–2012, the gap was estimated at 5.3 years (ABS 2009b, 2013b).

**Table 3.5: Gap in life expectancy at birth between males and females, Australia, 2001–2005, 2006–2010 and 2011–2015**

Jurisdiction	Gap between Indigenous males and Indigenous females			Gap between non-Indigenous males and non-Indigenous females		
	2001–2005	2006–2010	2011–2015	2001–2005	2006–2010	2011–2015
New South Wales	4.6	4.6	3.7	5.1	4.4	4.2
Queensland	6.2	4.5	5.3	5.0	4.7	4.2
Western Australia	5.5	5.2	5.7	5.1	4.8	4.5
Northern Territory	8.0	5.2	3.1	4.8	7.4	5.3
Victoria <sup>(a)</sup>	7.4	2.3	3.5	4.8	4.3	3.8
South Australia <sup>(a)</sup>	5.4	2.8	5.3	5.4	4.7	4.2
<b>Australia<sup>(b)</sup></b>	<b>5.6</b>	<b>4.8</b>	<b>4.4</b>	<b>5.0</b>	<b>4.6</b>	<b>4.2</b>

(a) Caution should be exercised in interpreting the gap for Victoria and South Australia because of the wider confidence intervals of the life expectancy estimates on which gap estimates are based (see Table 3.3).

(b) Estimates for Australia include Tasmania, the Australian Capital Territory and Other Territories.

Source: Enhanced Mortality Database.

The life expectancy gap between males and females appears to have reduced during the reference period for both Indigenous and non-Indigenous Australians across Australia and for most of the six jurisdictions considered. The exceptions are the life expectancy gap between Indigenous males and females in Western Australia in 2011–2015 compared with the gap in 2001–2005, and the life expectancy gap between non-Indigenous males and females in the Northern Territory in 2011–2015, compared with the gap in 2001–2005.

The reduction in the life expectancy gap between males and females was due to the much larger increases in life expectancy for Indigenous males (1.8 years) than Indigenous females (0.6 of a year) as well as the larger increases in life expectancy for non-Indigenous males (2.4 years) compared with non-Indigenous females (1.6 years).

## 3.5 Age decomposition of life expectancy

### 3.5.1 Contribution of age groups to the gap between Indigenous and non-Indigenous life expectancy

Age decomposition of life table mortality rates offers a very useful approach to determine the contribution of age groups to the overall difference in life expectancy between two or more populations. The age decomposition method is based on the premise that the difference in life expectancy between two populations is a function of differences in mortality between the two populations at various ages. The aim of age decomposition of life expectancy is therefore to estimate the additive contributions of various age groups to the overall difference in life expectancy between the two populations, based on their age-specific death rates (Andreev et al. 2002; Arriaga 1984; Kitagawa 1955; Pollard 1988).

Table 3.6 examines the percentage contribution of 5-year age groups to the gap in life expectancy between Indigenous males and non-Indigenous males, and between Indigenous females and non-Indigenous females, while Figure 3.9 examines the gap in broad age groups. Figures 3.10 and 3.11 present the cumulative percentage contributions of age groups to the gap in life expectancy between Indigenous and non-Indigenous Australians.

Figures 3.7 and 3.8, as well as Table 3.6, highlight the early age at death of Indigenous males and females compared with the age at death for non-Indigenous males and females, and the loss in life expectancy as a result of early age at death. Up to one-third of the gap in

life expectancy at birth between Indigenous and non-Indigenous males was contributed by the higher death rates of Indigenous males aged under 45. For example, as a result of the higher mortality rates among Indigenous children compared with non-Indigenous children, the higher death rates of Indigenous male children aged under 10 contributed between 4% and 5% to the gap in life expectancy at birth between Indigenous males and non-Indigenous males. Deaths of young males aged under 25 contributed between 8.7% (2006–2010) and 9.7% (2001–2005) to the life expectancy gap, while deaths of Indigenous males aged between 25 and 44 contributed between 20% (2011–2014) and 26% (2001–2005) to the life expectancy gap.

A similar pattern of contributions to the life expectancy gap is also observed for females. A little over one-fifth of the gap in life expectancy at birth between Indigenous and non-Indigenous females was contributed by deaths of Indigenous females aged under 45. Deaths of Indigenous female children aged under 10 contributed between 3% and 4% to the gap in life expectancy at birth between Indigenous females and non-Indigenous females. Deaths of young females aged under 25 contributed between 6% and 7% to the life expectancy gap while deaths of Indigenous females aged between 25 and 44 contributed about 15% to the life expectancy gap.

Among individual male age groups, deaths in the age groups 55–59, 60–64 and 65–69 made the single largest contribution to the gap in expectation of life at birth between Indigenous and non-Indigenous males in 2001–2005. For 2006–2010 and 2011–2015, the largest contribution in this regard had shifted to ages 60–64, 65–69 and 70–74.

Among individual female age groups, deaths in the age groups 60–64 and 65–69 made the single largest contribution to the gap in expectation of life at birth between Indigenous and non-Indigenous females in 2001–2005. In 2006–2010 and 2011–2015, deaths making the largest contributions to the life expectancy gap occurred in age groups that were 5 years older—at 65–69 and 70–74.

For both sexes, deaths in the 60–64 and 65–69 age groups alone contributed nearly one-fifth to one-quarter of the overall gap in life expectancy between Indigenous and non-Indigenous Australians. It is also important to point out that deaths of babies under 1 year contributed more to the life expectancy gap than deaths in any of the age groups 1–4, 5–9, 10–14, 15–19 and 20–24, for males, and in the age groups 1–4, 5–9, 10–14, 15–19, 20–24 and 25–29, for females. Indeed, the contribution of infant deaths to the life expectancy gap was more than the combined contribution of deaths occurring in the age groups 1–4, 5–9, 10–14 and 15–19.

The contribution of deaths in various age groups to the life expectancy gap increased with age. The contribution of infant deaths to the life expectancy gap, however, was such that it was not till ages 25–29, in some instances, and ages 30–34, in most cases, that the contribution of deaths in any age group equalled or exceeded the contribution of infant deaths to the life expectancy gap.

For both sexes, and for all three periods, the age groups 1–4, 5–9 and 10–14 made the lowest contribution to the gap. This is mostly because death rates at these ages were low compared to death rates at all other ages.

Figures 3.7 and 3.8 graphically represent the contributions of 5-year age groups to the life expectancy gap, while Figure 3.9 presents the same information for broader age groups. Figures 3.7, 3.8 and 3.9 confirm the earlier age at death of Indigenous Australians compared with non-Indigenous Australians. About one-third (36%, 31% and 29%, respectively, in 2001–2005, 2006–2010 and 2011–2015) of the gap in life expectancy at birth between Indigenous and non-Indigenous males was contributed by deaths of Indigenous males aged

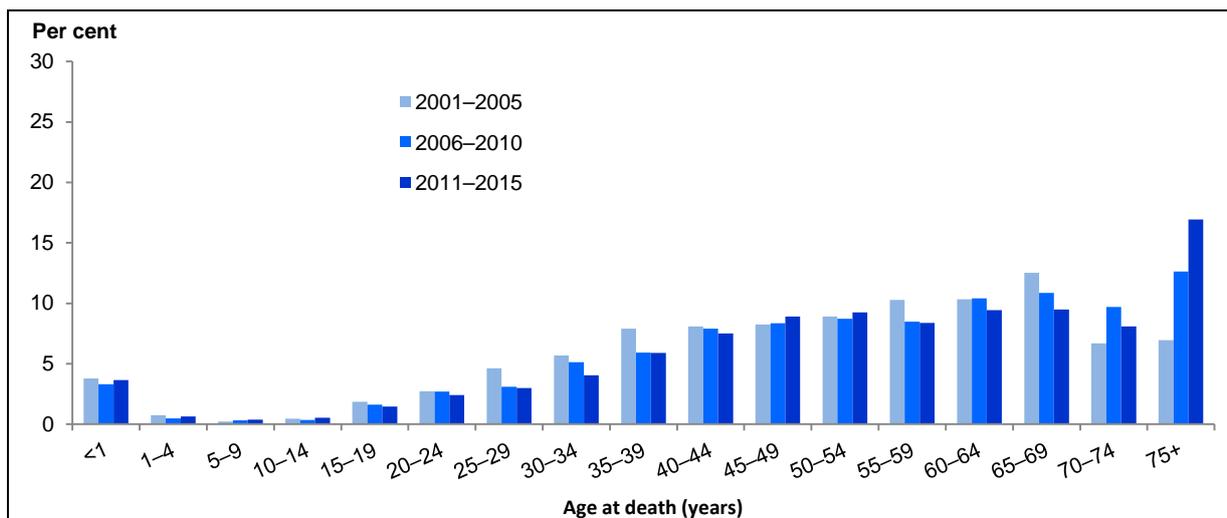
under 45. Among females, deaths of Indigenous females aged under 45 contributed more than one-fifth (23%, 22% and 22%, respectively, in 2001–2005, 2006–2010 and 2011–2015) of the gap in life expectancy at birth between Indigenous and non-Indigenous females.

**Table 3.6: Percentage contribution of deaths in various age groups to the gap between Indigenous and non-Indigenous life expectancy at birth, Australia, 2001–2005, 2006–2010 and 2011–2015**

Age at death (years)	Males			Females		
	2001–2005	2006–2010	2011–2015	2001–2005	2006–2010	2011–2015
0	3.8	3.3	3.6	2.7	2.3	2.9
1–4	0.7	0.4	0.7	0.6	0.7	0.5
5–9	0.2	0.3	0.3	0.1	0.3	0.4
10–14	0.5	0.3	0.5	0.3	0.4	0.4
15–19	1.9	1.6	1.6	1.4	0.8	1.1
20–24	2.7	2.7	2.4	1.7	1.6	1.7
25–29	4.6	3.1	2.8	2.4	2.5	2.4
30–34	5.6	5.1	4.1	2.9	2.9	3.0
35–39	7.8	6.0	5.9	4.3	3.7	4.2
40–44	8.0	7.9	7.2	5.6	5.7	5.2
45–49	8.2	8.4	8.8	6.2	6.1	5.9
50–54	8.9	8.8	8.8	6.4	7.1	6.9
55–59	10.2	8.5	8.7	7.8	9.3	8.4
60–64	10.1	10.6	9.6	12.3	9.5	9.6
65–69	12.4	11.0	9.4	10.3	10.1	9.8
70–74	6.7	9.7	8.5	8.4	11.9	10.9
75–79	4.7	5.0	6.9	5.3	8.1	9.9
80–84	2.9	3.7	3.9	5.1	4.5	6.2
85+	0.0	3.6	6.0	16.1	12.6	10.4

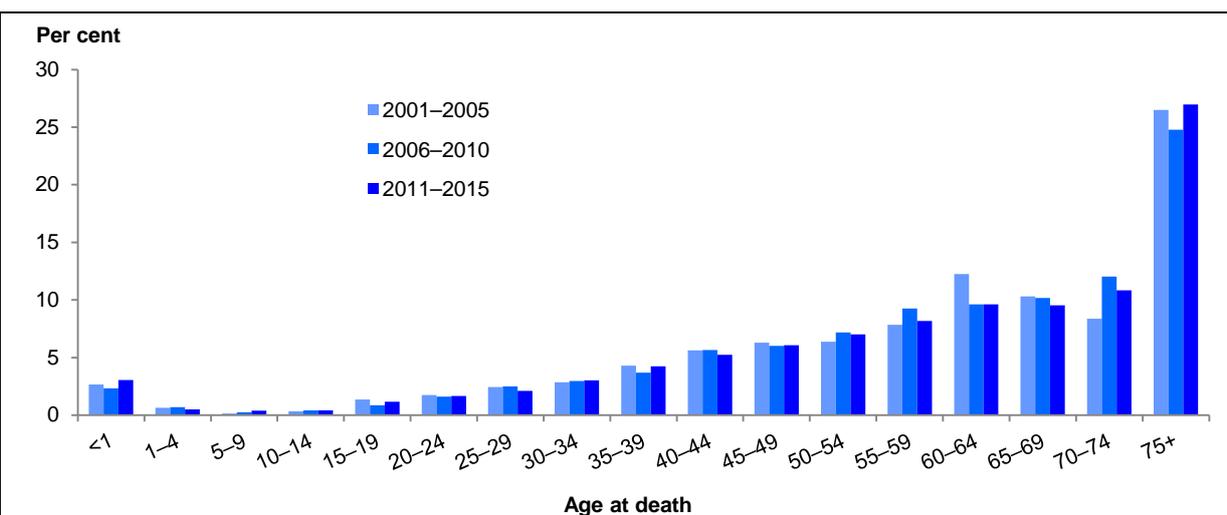
Source: Enhanced Mortality Database.

The contribution of the various age groups to the life expectancy gap is consistent with findings from the Australian Burden of Disease Study (AIHW 2010a), which showed that the age groups contributing most to ‘Years of Life Lost’ are infants and the age groups 60–79.



Source: Enhanced Mortality Database.

**Figure 3.7: Percentage contribution of age groups to the difference in expectation of life at birth between Indigenous and non-Indigenous males, Australia, 2001–2005, 2006–2010 and 2011–2015**

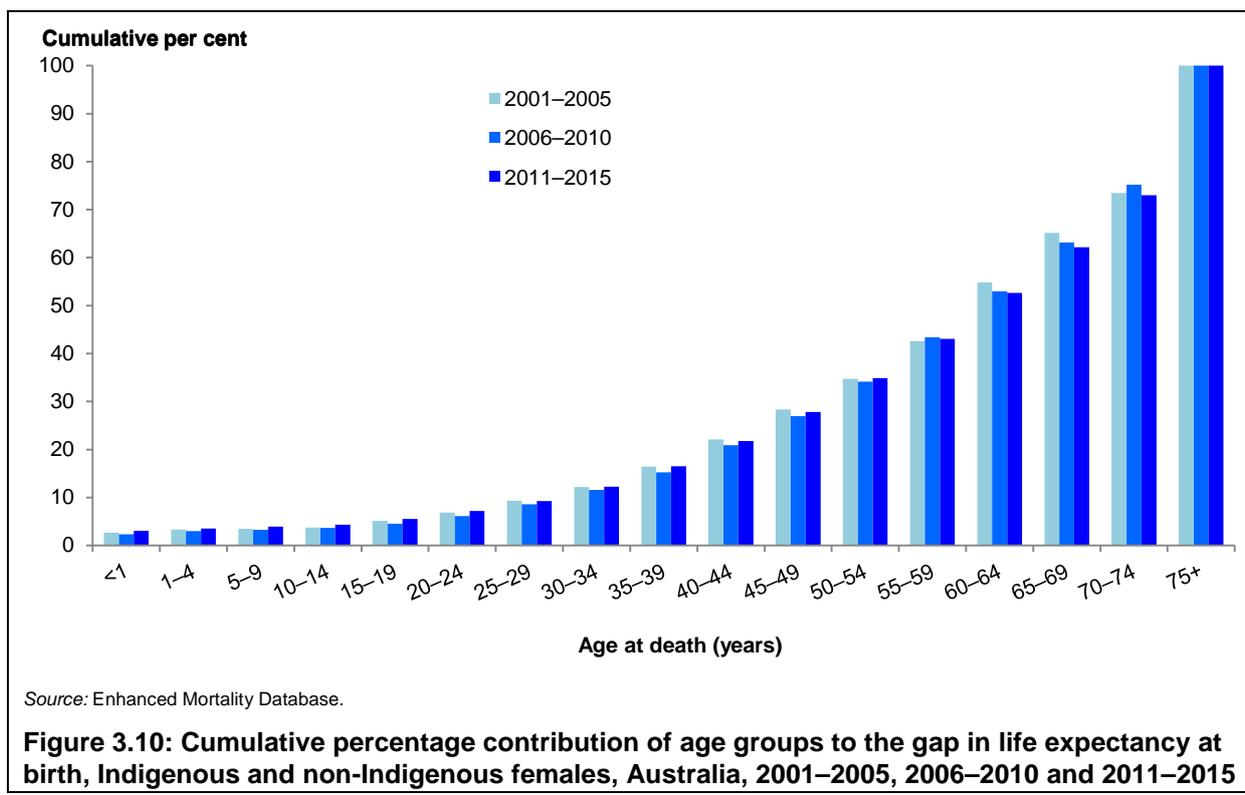
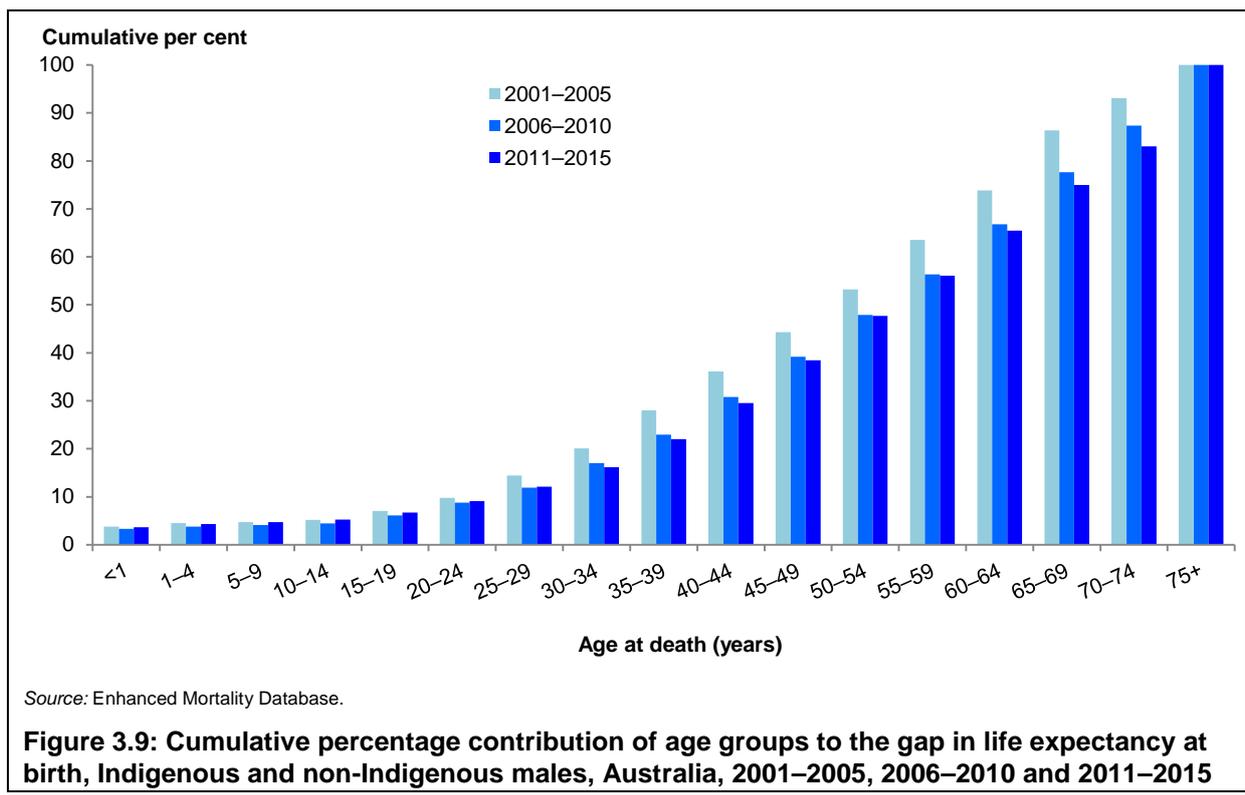


Source: Enhanced Mortality Database.

**Figure 3.8: Percentage contribution of age groups to the difference in expectation of life at birth between Indigenous and non-Indigenous females, Australia, 2001–2005, 2006–2010 and 2011–2015**

Figures 3.9, 3.10 and 3.11 emphasise the difference between Indigenous males and females in their respective age contributions to the gap in life expectancy between Indigenous males and females on the one hand, and non-Indigenous males and females on the other. The plots illustrate the much bigger concentration of Indigenous male deaths at younger ages than is the case for female deaths.

Indigenous males at every age until 65 contributed more to the life expectancy gap between Indigenous and non-Indigenous males than was the case for females at the same age. On the other hand, Indigenous females aged 65 and over contributed more to the life expectancy gap between Indigenous and non-Indigenous females than was the case between Indigenous and non-Indigenous males at the same age.



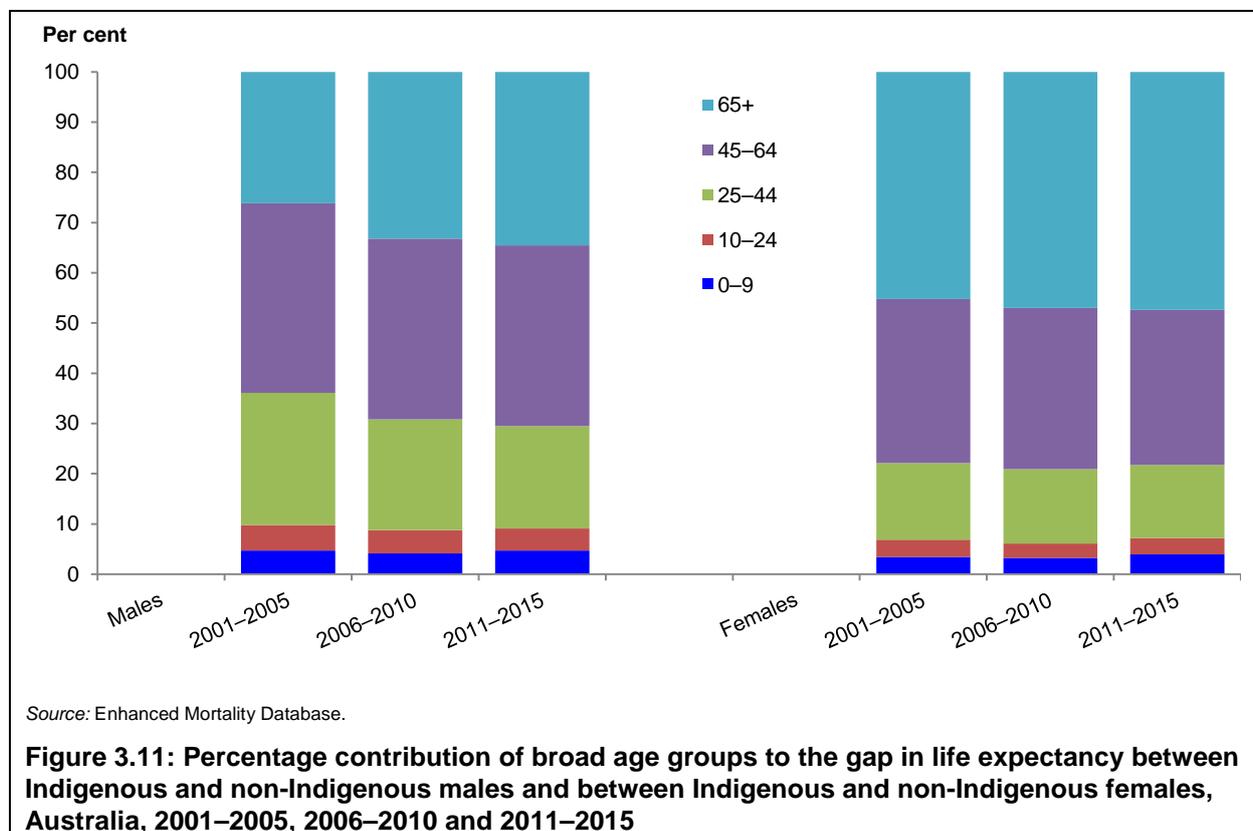
Figures 3.9 and 3.10 show that at any age, the cumulative percentage contributions of age groups to the life expectancy gap varied by only 1–2 percentage points between the three periods 2001–2005, 2006–2010 and 2011–2015.

About 42–44 and 28%–30%, respectively, of the life expectancy gap was contributed by Indigenous males and females aged up to 45–49, while about 82% to 84% and 64% to 67% of the gap, respectively, was contributed by Indigenous males and Indigenous females aged up to 65–69. Indigenous males aged 25–29 contributed about 12%–15% of the life expectancy gap, while Indigenous females of the same age contributed about 9%–10%.

Figure 3.11 presents the contribution of broad age groups to the gap in life expectancy between Indigenous males and non-Indigenous males, and between Indigenous females and non-Indigenous females in the periods 2001–2005, 2006–2010 and 2011–2015. For both males and females, the age groups 25–44, 45–64 and 65 and over made the biggest contributions to the life expectancy gap.

In the three periods considered, relatively higher Indigenous male death rates in the age groups 25–44, 45–64 and 65 and over contributed 20%–26%, 36%–38% and 26%–35%, respectively, of the Indigenous and non-Indigenous male life expectancy gap. Among females, during the same period, the age groups 25–44, 45–64 and 65 and over contributed 15%, 31%–33% and 45%–47%, respectively, of the female life expectancy gap.

Figure 3.11 also confirms the relatively higher Indigenous male death rates at younger ages. Higher death rates among Indigenous aged less than 45 contributed 36.1%, 30.8% and 29.5%, respectively, to the life expectancy gap between Indigenous and non-Indigenous males during the three periods considered. Corresponding estimates for females were 22.1%, 20.9% and 21.8%, respectively. This shows that younger Indigenous males contributed more to the Indigenous and non-Indigenous male life expectancy gap than did Indigenous females to the Indigenous and non-Indigenous female life expectancy gap.



Consistent with this observation, Indigenous males aged 65 and over contributed 26.1%, 33.2% and 34.5%, respectively, to the Indigenous and non-Indigenous male life expectancy gap, while Indigenous females aged 65 and over contributed more: 45.2%, 47.0% and 47.3%, respectively, to the Indigenous and non-Indigenous female life expectancy gap.

Figure 3.11 however shows that the contribution of younger age groups to the life expectancy gap is declining, while the contribution of older age groups is increasing. This is consistent with faster declining mortality among young Indigenous males and females relative to non-Indigenous males and females. The contribution of older age groups to the life expectancy gap will continue to increase as Indigenous mortality at young ages continues to decline, and declines much faster than the decline for non-Indigenous males and females.

### **3.5.2 Contributions of age groups to the gap in life expectancy between males and females**

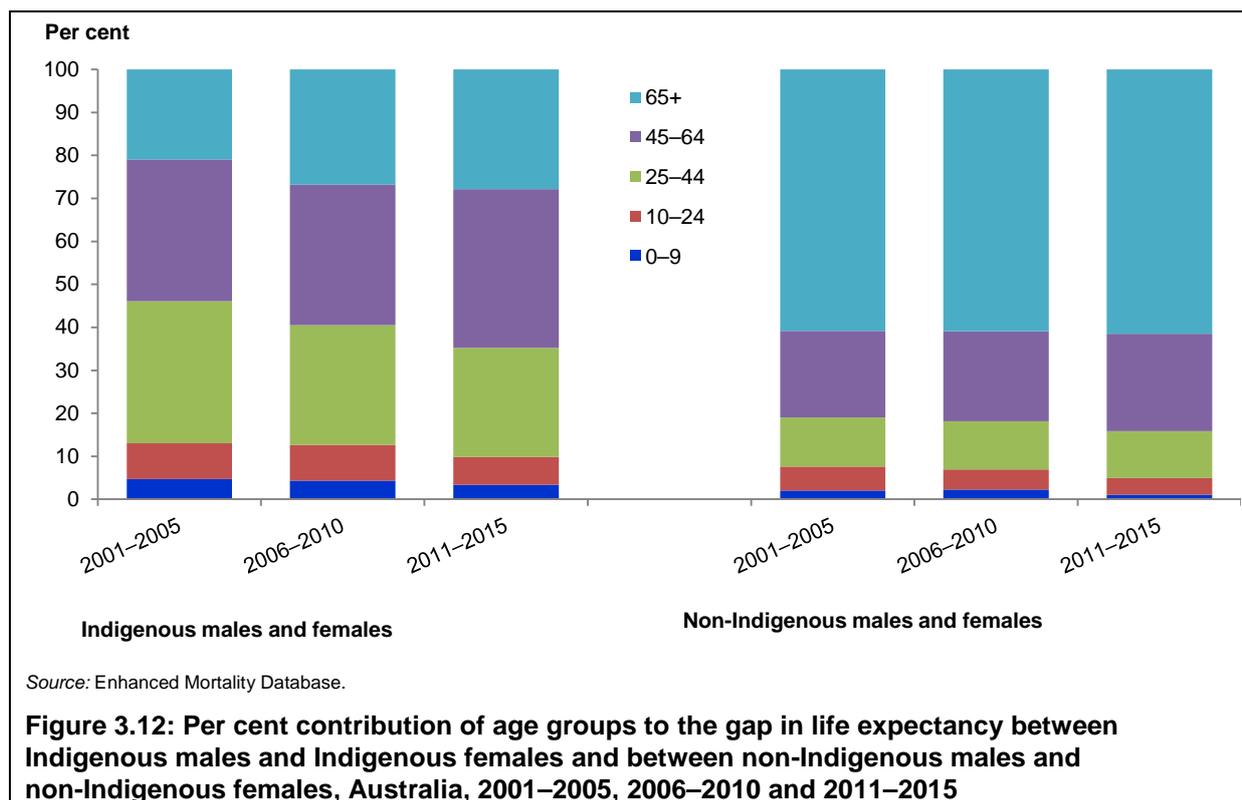
Tables 3.4 and 3.5 have shown that during the reference period, not only was there a gap in life expectancy between Indigenous and non-Indigenous Australians, but that there was also a gap in life expectancy between Indigenous males and Indigenous females as well as between non-Indigenous males and non-Indigenous females.

For example, from Table 3.5 we observed there was a gap in life expectancy of about 4.4–5.6 years between Indigenous males and Indigenous females and about 4.2–5.0 years between non-Indigenous males and non-Indigenous females. It was observed in section 3.5.1 that differences in life expectancy between two or more populations are the result of differences between the populations in their age-specific death rates. Understanding the contributions of age groups to the gap in life expectancy between Indigenous males and females compared to that between non-Indigenous males and females is important in developing policies and programmes aimed at closing the gap in life expectancy between Indigenous and non-Indigenous Australians.

This section uses age decomposition of life table age-specific death rates to explore the differences in death rates between Indigenous males and Indigenous females, on the one hand, and that between non-Indigenous males and non-Indigenous females. The results are shown in Figure 3.12.

While the gap in life expectancy between Indigenous males and Indigenous females is nearly the same as that between non-Indigenous males and non-Indigenous females, Figure 3.12 shows that the contribution of age-specific death rates to the life expectancy gap between Indigenous males and Indigenous females is different from that between non-Indigenous males and non-Indigenous females. The plot shows higher contributions to the gap by younger Indigenous males aged 45–64, 25–44 and 10–24. In the non-Indigenous population however, the plot shows that much of the gap in life expectancy between males and females is related to higher death rates among non-Indigenous males at the oldest ages (65 and over).

In the Indigenous population, higher death rates among Indigenous males, compared to Indigenous females, aged 25–44 and 45–64 contributed a combined total of nearly two-thirds of the gap in life expectancy between Indigenous males and females, whereas among the non-Indigenous population, deaths in age groups 25–44 and 45–64 contributed a total of only about one-third of the life expectancy gap between non-Indigenous males and females.

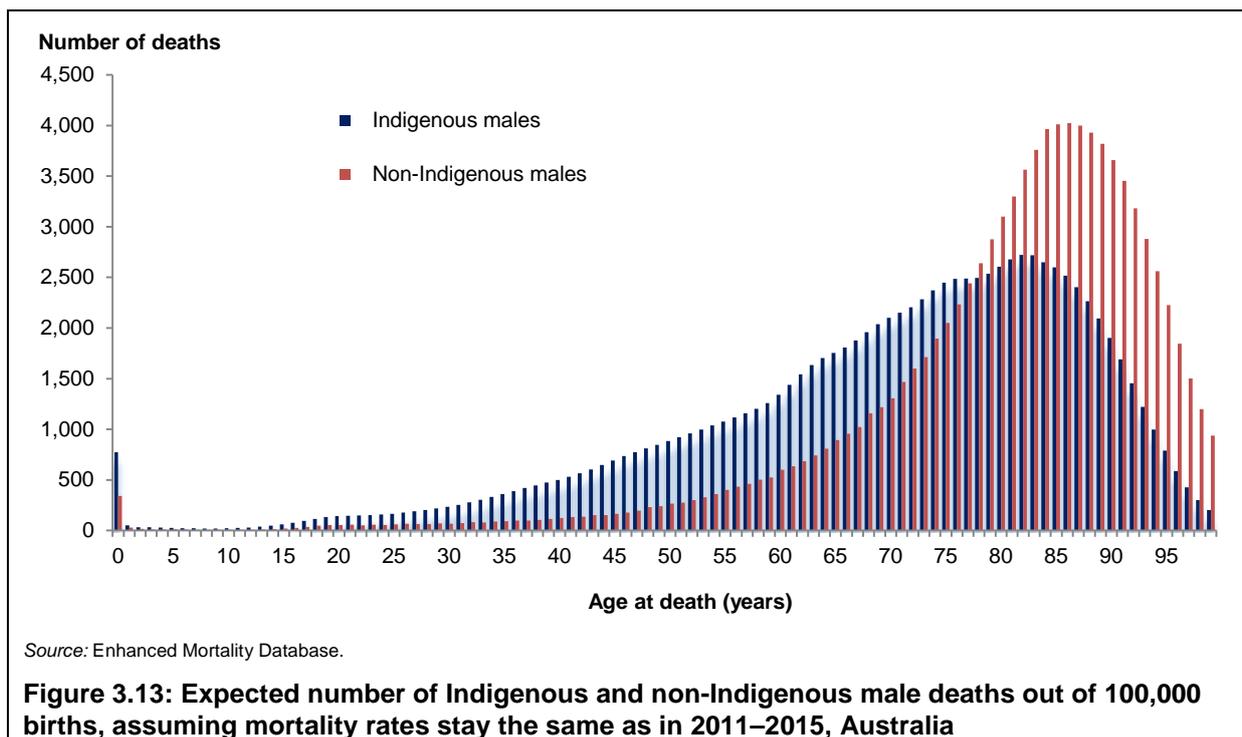


Among Indigenous males and females, deaths in the age group 65 and over contributed only about 20%–28% of the gap in life expectancy between Indigenous males and females. Among the non-Indigenous population, however, differences in death rates among males and females aged 65 and over contributed nearly 60%–62% of the gap in life expectancy between non-Indigenous males and females.

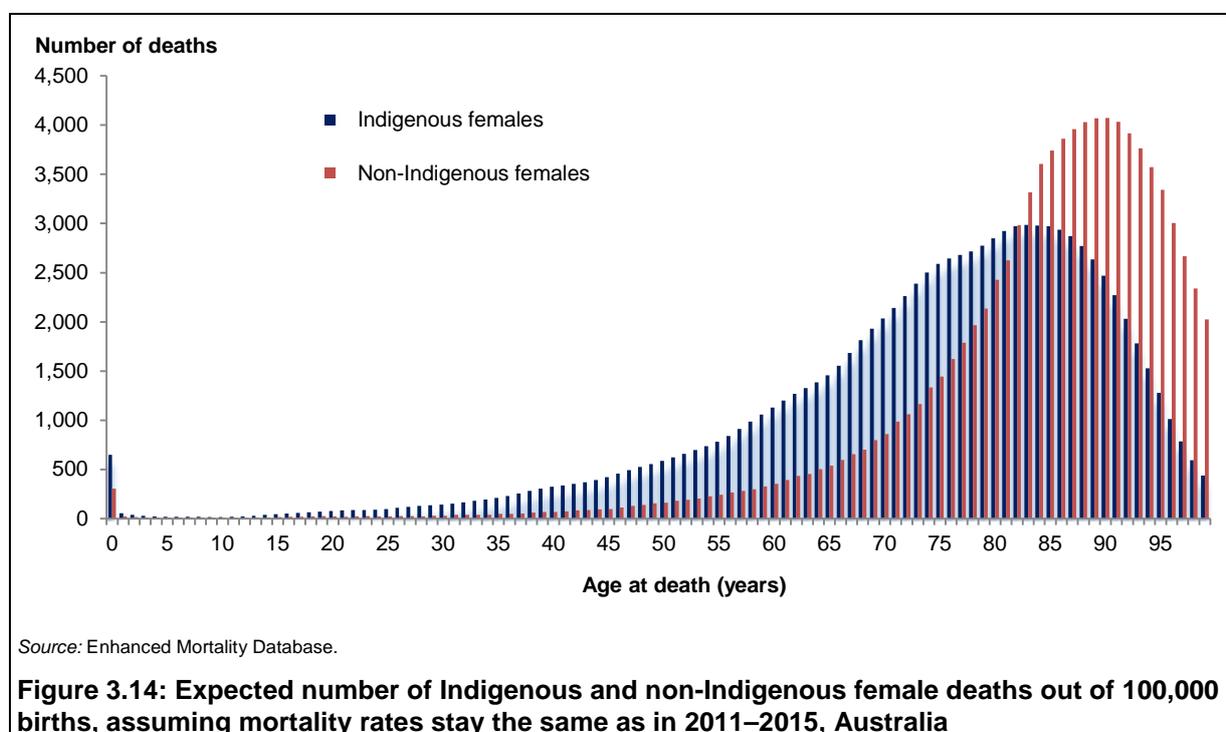
Higher death rates among non-Indigenous males aged under 45 contributed only about 15% to the life expectancy gap between non-Indigenous males and non-Indigenous females. In the Indigenous population, the contribution by males aged under 45 years to the gap in life expectancy between Indigenous males and females was about two to three times higher, at about 46% in 2001-2005, and declining to 35% in 2011-2015.

### 3.6 Probability density function for survival

The contribution of differences in age-specific death rates to the gap in life expectancy between Indigenous and non-Indigenous Australians can best be illustrated with the life table probability density function for survival, which is defined as the expected number of deaths at each age out of 100,000 births assuming the current mortality rates continue. It is calculated by multiplying the life table probability of dying from one age to the next ( $q_x$ ) by the number of survivors at that age ( $S_x$ ) out of 100,000 births. This illustration is shown in figures 3.13 and 3.14 for males and females, respectively.



Figures 3.13 and 3.14 show the expected number of Indigenous and non-Indigenous male and female deaths that will occur at each age, from 100,000 births, if mortality rates observed in 2011–2015 do not change. While the number of Indigenous deaths has been enhanced, they have not been smoothed for age-specific fluctuations in the reported number of deaths.



Figures 3.13 and 3.14 clearly show that for both Indigenous males and females the expected number of deaths is skewed more towards younger ages, and towards older ages for both non-Indigenous males and females.

Figures 3.13 and 3.14 show that there was an excess of Indigenous over non-Indigenous male deaths at age 0 and between ages 15 and 75, whereas for females, there was an excess of Indigenous over non-Indigenous deaths at age 0 as well as between ages 15 and 80. On the other hand, there was an excess of non-Indigenous over Indigenous deaths at ages 75 and over for males, and at ages 80 and over for females. Indigenous male deaths are also more skewed towards younger ages relative to non-Indigenous male deaths than was the case for Indigenous and non-Indigenous female deaths.

## 3.7 Conclusion

Robust estimates of Indigenous life expectancy require complete coverage of Indigenous identification on official death records. The life expectancy estimates used in this report are based on death data that have been enhanced to take account of possible misclassification (or lack of identification) of Indigenous deaths in death registration records.

Life expectancy estimates are affected by the population denominators which are used to estimate the age-specific death rates on which the life tables are based. They are also affected by the process of enhancing death records to account for misclassification of Indigenous status on death records.

Life expectancy at birth between jurisdictions was more variable for Indigenous males and females than for non-Indigenous male and females. Irrespective of the jurisdiction of usual residence, non-Indigenous life expectancy at birth did not vary by more than one year between jurisdictions, with the exception of the Northern Territory, where life expectancy for non-Indigenous males and females was, respectively, two or more years lower than in the remaining jurisdictions.

On the other hand, Indigenous life expectancy, excluding the Northern Territory, varied by up to 9 years for males, and between 6 and 10 years, for females. Such large differences in Indigenous life expectancy between jurisdictions may reflect data quality issues as well as differential access to health care and variations in the living conditions and socioeconomic circumstances of Indigenous males and females across jurisdictions.

Additional findings on life expectancy from the study include the following:

- Life expectancy at birth increased for both Indigenous males and females during the period 2001–2005 to 2011–2015. Life expectancy at birth in Australia during the three periods was 68.3, 69.6 and 70.1 years, respectively, for Indigenous males and 73.9, 74.4 and 74.5 years, respectively, for Indigenous females. Life expectancy at birth increased much more for Indigenous males (1.8 years) than for Indigenous females (0.6 of a year).
- Life expectancy at birth during the reference period increased slightly more for non-Indigenous males (2.4 years) than for Indigenous males (1.8 years). Life expectancy at birth also increased much more for non-Indigenous females (1.6 years) than for Indigenous females (0.6 of a year). Indigenous males also enjoyed a larger increase in life expectancy at birth (1.8 years) than Indigenous females (0.6 of a year).
- Life expectancy at birth also increased (though not always significantly) for both Indigenous males and females across most jurisdictions, although the increases were variable between males and females, across jurisdictions and over time.

- Estimates of life expectancy at birth were also more variable in jurisdictions such as Victoria and South Australia as a result of the small size of the Indigenous population and the small number of Indigenous deaths in those jurisdictions. As a result, there were wide confidence intervals around the life expectancy estimates for these two jurisdictions; these estimates should be treated with caution.
- The age decomposition of Indigenous and non-Indigenous life expectancy confirms the earlier age at death among the Indigenous population relative to the non-Indigenous population. Indigenous males and females aged under 45 contributed up to one-third and up to one-quarter, respectively, to the gap in life expectancy between Indigenous males and females on the one hand, and non-Indigenous males and females, on the other.
- The early death of young Indigenous males and females before age 50 contributed up to 44% of the life expectancy gap between Indigenous males and non-Indigenous males, and about 30% of the life expectancy gap between Indigenous females and non-Indigenous females.

While it is an important goal to reduce Indigenous death rates across all age groups, the greatest gains could be achieved by focusing on the age groups with:

- the highest death rates
- the biggest gap in mortality between Indigenous males and females on the one hand and non-Indigenous males and females on the other
- the biggest contribution to the life expectancy gap.

# Appendix A: Methodology

## A1 Enhancement of death records on the MED

### A1.1 Background

The objective of undertaking the EMD project is to adjust for the under-identification of Indigenous deaths on the MED. The MED is an extract of registered deaths from the NDI which has been validated against extracts of corresponding information on the AIHW NMD for completeness, accuracy and consistency of information (such as, sex, date of birth, date of death, age, place of usual residence, place of death and Indigenous status), and to check for duplicate and missing records. The MED was the base data linked with the comparative data sets to create the Enhanced Mortality Database (EMD).

The under-identification of Indigenous deaths on the MED may be due to two factors:

- Indigenous deaths that have been misclassified as non-Indigenous on the MED
- Indigenous deaths that have missing Indigenous status information on the MED.

Both sources of under-identification are referred to as misclassification in this analysis.

By linking the MED with additional data sets that have information on deaths and Indigenous status, it is possible to compare Indigenous status information across the linked data sets and to derive an enhanced Indigenous status for misclassified Indigenous records on the MED. The additional data sets linked to the MED were:

- the NHMD (contains about 55% of all death records on the MED) for the period in scope
- the RAC Database (contains about 32% of all deaths on the MED for the period in scope)
- jurisdictional Perinatal Data Collections (contain less than 1% of all death records on the MED for the period in scope).

### A1.2 Characteristics of data sets on which method is based

Certain characteristics of the input data sets influenced the choice of method. These are:

- The comparative data sets (NHMD, RAC Database and the jurisdictional perinatal data collections) contain up to 87% of all deaths on the MED, during the period in scope.
- All deaths on the comparative data sets are on the NDI, but as the MED is the bigger data set, not all deaths on the MED are on the comparative data sets.
- The death records of persons who did not die in hospital as admitted patients as well as the records of persons who did not die while on admission in a residential aged care facility will not be on the comparative data sets.
- Deaths that occur at home, on sporting fields, at recreational venues, as well as traffic accident deaths, may not be on the comparative data sets unless the deceased persons were receiving admitted patient episodes of care or were admitted to a residential aged care facility at the time of their death.
- In some jurisdictions, persons who die in ambulances on the way to hospital or in hospital emergency departments will not be on the admitted hospital patient database, and hence will not be on the NHMD or on the comparative data sets.

- The comparative data sets linked to the MED cover 85%–87% of all death records on the MED. This means that the Indigenous status of about 13%–15% of MED records is not able to be verified by linking the MED to the comparative data sets. Some of these records could be verified if the MED is linked to additional data sets, such as the National Non-admitted Patient Episode of Care Database (NNAPECD), which contains information on deaths that are on the MED but are not on the hospital morbidity, residential aged care or jurisdictional perinatal data sets.

### **A1.3 Assumptions of the method**

The method is based on a number of assumptions:

- Almost all deaths that occur in Australia are registered, though there could be delays in the registration of some deaths. The NDI contains all registered deaths in Australia. Extracts of the NDI and the National Mortality Database were used in creating the Mortality Extract Database (MED) that became the base data for the data linkage.
- The use of the comparative data sets is to help enhance the Indigenous status of death records that are already on the MED.
- A person is deemed Indigenous if that person is recorded on at least one data set as Indigenous.
- Indigenous status misclassification rates on unlinked records will be the same as was observed on linked records.

As well as the fact that the comparative data sets do not contain all the death records that are on the MED, there are three other reasons why some records on the MED could not link to any records on the additional data sets:

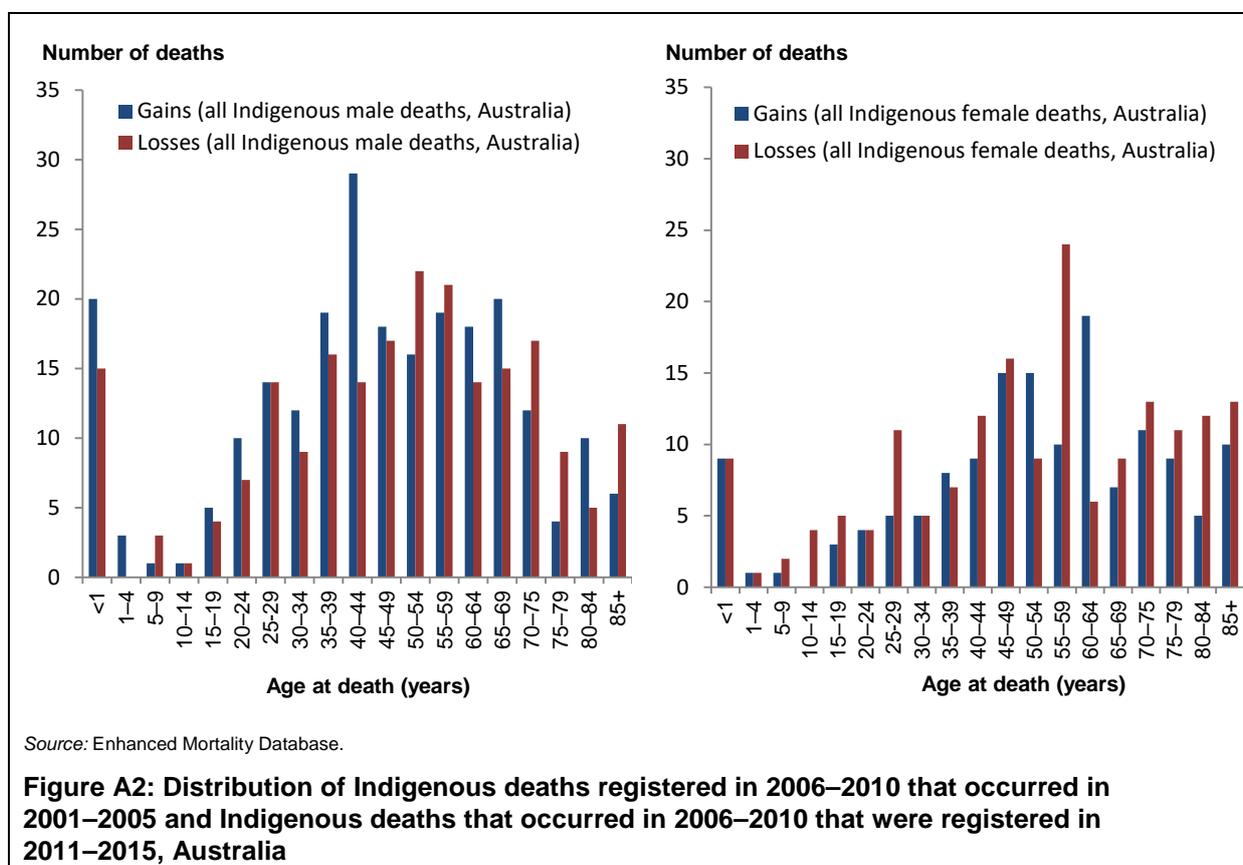
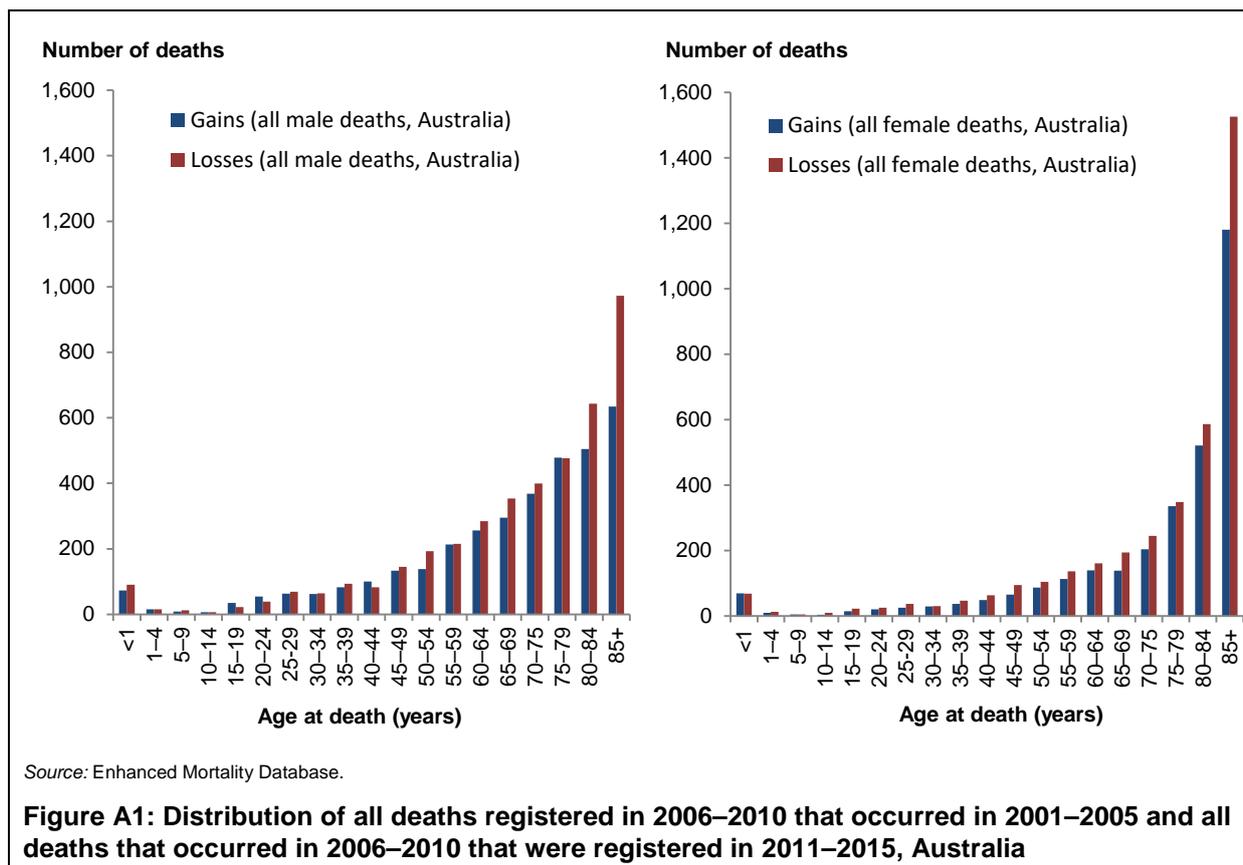
- MED records with missing, incomplete or poor-quality linkage variables will not be able to be linked to the comparative data sets
- records on the comparative data sets with missing, incomplete or poor-quality linkage variables will not be able to be linked to the MED
- lags in death registration which create an inherent anomaly in trying to match deaths (MED records) registered in a given period (2001–2010) to death records in data sets, such as the NHMD, RAC Database and jurisdictional PDCs which are compiled on the basis of year of occurrence of death.

### **Lags in death registration**

Deaths data used in the preparation of official mortality and life table estimates are based on deaths classified by year of registration rather than year of death occurrence. The principle of basing official death statistics and life tables on deaths classified by year of registration rests on the assumption that the number of deaths registered in a reference year that occurred before the reference year (gains) is approximately equal to the number of deaths that occurred in the reference year but were registered after the reference year (losses).

While this assumption may hold over the long term, the assumption may not hold over the short term, across age groups or for the Indigenous population, as figures A1 and A2 show.

Figure A2 shows that for the Indigenous population, in particular, there is much variability across age groups in the number of gains and losses, and that the number of gains is not approximately equal to the number of losses. There is also no discernible pattern to how the gains and losses occur.



This is because lags in death registration are the result not only of delays on the part of families and friends of the deceased to register the death, but also of administrative and technical processes as well as logistical requirements in the registration offices of jurisdictional registries of births, deaths and marriages.

With few exceptions, the number of losses appears to be greater than the number of gains. The net gain or loss over time is therefore not equal to zero. It is also variable by age and sex. This is consistent with an increase in the number of deaths over time due to increasing population. To ignore the net gain or loss in the preparation of mortality and life expectancy estimates risks under-estimating mortality and over-estimating life expectancy due to the tendency for losses to be greater than gains over time.

As a result, the method of enhancement of Indigenous status on death data also took into consideration gains and losses in compiled registered death data. The incorporation of this analysis into the enhancement methodology is described in section A1.13.

## **A1.4 Method**

The data set linked to the comparative data sets was the MED. To create the MED, an extract of the NDI was first validated against extracts of the AIHW NMD for completeness, accuracy and consistency of information, as well as to check for duplicate and missing records. The resulting data set is the MED (see Appendix B for further details).

After the MED was created, it was linked successively to the three comparative data sets. The linkage returned two results:

- records on the MED that linked to one or more corresponding records on the comparative data sets (these are described as linked records):
  - some of these records were labelled as Indigenous and were accepted as such
  - the remaining linked records were labelled as non-Indigenous or had missing Indigenous status information, and were further examined for misclassification
- records on the MED that did not link to a corresponding record on any of the additional data sets (these are described as unlinked records):
  - some of these records were labelled as Indigenous and were accepted as such
  - the remaining unlinked records either had missing Indigenous status information or were labelled as non-Indigenous on the MED.

Based on the criterion of 'Indigenous on the MED or in any one of the additional data sets', linked and unlinked records that are coded as Indigenous on the MED were accepted as Indigenous. Linked and unlinked records that are labelled as non-Indigenous or 'Indigenous status unknown' were further examined for misclassification, using information from the linked data sets. The linked and unlinked records are now examined in turn.

### **Linked records**

Because of misclassification, a certain proportion of the linked records coded as non-Indigenous or with missing Indigenous status information on the MED may be actually Indigenous. This is easily determined by comparing the Indigenous status of these records with the Indigenous status of corresponding records on the additional data sets. Based on this comparison, it could be determined what proportion of linked records coded as 'non-Indigenous' or as 'Indigenous status unknown' on the MED may be Indigenous in any one of the additional data sets. This comparison can yield an estimate of Indigenous misclassification among linked MED records in terms of the number and proportion of non-Indigenous records and records with missing Indigenous status information that may actually be Indigenous.

These measures are easily estimated by age, sex and state of usual residence. They can also be estimated separately for linked records that are non-Indigenous on the MED, as well as for linked records on the MED that have missing Indigenous status information.

### **Unlinked records**

Unlinked records coded as Indigenous on the MED are accepted as Indigenous. As was observed for the linked records, a certain proportion of unlinked records labelled as 'non-Indigenous' or as 'Indigenous status unknown' on the MED may actually be Indigenous. However, this cannot be determined because the unlinked records have no corresponding records on the additional data sets. This may be due to several factors, including the following:

- with the MED being the larger data set, some of its unlinked records may actually have no corresponding records on the comparative data sets. Some of these records could be:
  - deaths that occurred outside a health-care or residential aged care facility (for example, home deaths, road traffic deaths, deaths that occurred at workplaces, and so forth)
  - deaths that occurred in emergency hospital departments, where the deceased was not admitted before his or her death. These deaths will be on the MED and on the NNAPEDCD but not on any of the additional data sets
  - deaths that occurred on the way to hospital, which will be on the MED, if they are registered, and may appear on the NNAPEDCD, but will not be on any of the additional data sets
- a certain proportion of records on the MED could not link to a record on any of the additional data sets because the deaths occurred outside the period in scope but were registered during the period in scope
- a certain proportion of records on the MED could not link to a record on any of the additional data sets because of incomplete, missing or poor linkage variables on one or more of the data sets being linked (for example, there are no names on the hospital and perinatal records, so the linkage rates between the MED and these data sets are much lower than between the MED and the RAC database).

Having no identified corresponding records on any of the additional data sets, a possible approach to enhancing the Indigenous status of unlinked records coded as 'non-Indigenous' or as 'Indigenous status unknown' on the MED is to assume that the pattern of misclassification observed among the linked records will be similar to that for the unlinked records. If this assumption is accepted, the proportions of misclassified deaths observed in the linked records can be applied to the unlinked records labelled as 'non-Indigenous' or as 'Indigenous status unknown' on the MED. This will yield an estimate of misclassified Indigenous deaths among unlinked records labelled as 'non-Indigenous' or as 'Indigenous status unknown'. The estimated misclassified deaths can then be added to the number of linked and unlinked records already labelled on the MED as 'Indigenous' to yield an overall estimate of the number of enhanced Indigenous death records on the MED.

### **Unlinked records on the comparative data sets**

Except for very limited cases due to lags in death registration and data processing regimes in the various states and territories, all death records on the additional data sets, including all the unlinked records, can be assumed to also be on the MED, and to have already been accounted for in the estimation of the misclassified deaths.

The estimation procedure is now described notationally.

## Estimation procedure

Let

$L$  be the set of linked records on the MED

$\bar{U}$  be the set of unlinked records on the MED

$I$  be the set of records on the MED classified as Indigenous

$N$  be the set of records on the MED classified as non-Indigenous

$U$  be the set of records on the MED classified as 'Indigenous status unknown'

$M$  be the set of records on the MED that are misclassified (that is, linked MED records labelled as Indigenous status 'non-Indigenous' or 'unknown' on the MED but as Indigenous on at least one of the linked data sets)

$asj$  be the set of records with age  $a$ , sex  $s$  and jurisdiction  $j$ .

The following notation is used:

$n(A)$  is the number of records in set  $A$

$AB$  is the intersection of sets  $A$  and  $B$ ; that is,  $AB = A \cap B$

$ABC$  is the intersection of sets  $A$ ,  $B$  and  $C$ ; that is,  $ABC = A \cap B \cap C$

$A_{asj}$  is the intersection of sets  $A$  and  $asj$ , that is,  $A_{asj} = A \cap asj$ .

For example:

$LI$  is the set of linked records on the MED classified as Indigenous

$LN$  is the set of linked records on the MED classified as non-Indigenous

$LMN$  is the set of linked records on the MED misclassified as non-Indigenous

$LMN_{asj}$  is the set of linked records on the MED misclassified as non-Indigenous with age  $a$ , sex  $s$  and jurisdiction  $j$

$n(LMN_{asj})$  is the number of linked records on the MED misclassified as non-Indigenous with age  $a$ , sex  $s$  and jurisdiction  $j$

$n(LMU_{asj})$  is the number of linked records on the MED whose Indigenous status is classified as 'unknown', 'missing' or 'not stated', with age  $a$ , sex  $s$  and jurisdiction  $j$

$n(\bar{U}U_{asj})$  is the number of unlinked records on the MED misclassified as Indigenous status 'unknown' with age  $a$ , sex  $s$  and jurisdiction  $j$ .

## Misclassified linked death records on the MED

The proportion ( $p$ ) of linked ( $l$ ) death records misclassified ( $m$ ) as non-Indigenous ( $n$ ), by age, sex and state of usual residence, is given by:

$$plmn_{asj} = \frac{n(LMN_{asj})}{n(LN_{asj})} \dots\dots\dots (1)$$

and the proportion ( $p$ ) of linked ( $l$ ) death records misclassified ( $m$ ) as Indigenous status 'unknown' ( $u$ ) is given by:

$$plmu_{asj} = \frac{n(LMU_{asj})}{n(LU_{asj})} \dots\dots\dots (2)$$

## Application of proportions of misclassified linked death records to unlinked records

The number of unlinked death records misclassified as non-Indigenous can be approximated by:

$$n(\ddot{M}N_{asj}) \approx plmn_{asj} \times n(\ddot{U}N_{asj}) \dots\dots\dots (3)$$

The number of unlinked death records misclassified as 'Indigenous status unknown' can be approximated by:

$$n(\ddot{M}U_{asj}) \approx plmn_{asj} \times n(\ddot{U}U_{asj}) \dots\dots\dots (4)$$

### Adjustment for lags in death registration

Adjustment for a third category of deaths is also required. These are deaths on the NDI that, as a result of lags in death registration, occurred before the period in scope but were registered during the period in scope (Gains); and deaths that occurred during the period in scope, but were registered after the period in scope (Losses).

The total number of deaths (linked or unlinked) registered during the period in scope should be adjusted by the net difference between the number of deaths 'gained' or 'lost' as a result of lags in death registration. Net 'Gains' and 'Losses' can be compiled by age and sex, as well as by state of death registration and Indigenous status. These records are synthetic records, so they have no identifying variables or corresponding records on the alternative data sets. The Indigenous status of the net 'Gains' and 'Losses' can therefore be enhanced in the same manner as the Indigenous status of the unlinked records were enhanced, by applying to the net 'Gains' and 'Losses', the Indigenous misclassification rates observed for linked records.

### Gains in the number of deaths registered in a given period due to lags in death registration

Let

$n(GI_{asj})$  be the number of deaths classified as Indigenous on the NDI that occurred in period  $x-n$  but were registered in period  $x$  (Gains), classified by age  $a$ , sex  $s$ , and jurisdiction  $j$

$n(GN_{asj})$  be the number of deaths classified as non-Indigenous on the NDI that occurred in period  $x-n$  but were registered in period  $x$  (Gains), classified by age  $a$ , sex  $s$ , and jurisdiction  $j$

$n(GU_{asij})$  be the number of deaths whose Indigenous status is classified as 'unknown' on the NDI, that occurred in period  $x-n$  but were registered in period  $x$  (Gains), classified by age  $a$ , sex  $s$ , and jurisdiction  $j$ .

**Losses in the number of deaths registered in a given period due to lags in death registration**

Let

$n(DI_{asj})$  be the number of deaths classified as Indigenous on the NDI, that occurred in period  $x$  but were registered in period  $x+n$  (Losses), classified by age  $a$ , sex  $s$ , and jurisdiction  $j$

$n(DN_{asj})$  be the number of deaths classified as non-Indigenous on the NDI, that occurred in period  $x$  but were registered in period  $x+n$  (Losses), classified by age  $a$ , sex  $s$ , and jurisdiction  $j$

$n(DU_{asj})$  be the number of deaths on the NDI whose Indigenous status is classified as ‘unknown’, that occurred in period  $x$  but were registered in period  $x+n$  (losses), classified by age  $a$ , sex  $s$ , and jurisdiction  $j$ .

**Net gains in the number of deaths registered in a given period due to lags in death registration**

Let

$n(BI_{asj})$  be the net gains in Indigenous deaths (or the *balance* between ‘Gains’ and ‘Losses’) in a given period  $x$ , classified by age  $a$ , sex  $s$ , and jurisdiction  $j$

$n(BN_{asj})$  be the net gains in non-Indigenous deaths (the *balance* between ‘Gains’ and ‘Losses’) in a given period  $x$ , classified by age  $a$ , sex  $s$ , and jurisdiction  $j$

$n(BU_{asj})$  be the net gains (the *balance* between ‘Gains’ and ‘Losses’) in death records whose Indigenous status is recorded as ‘unknown’ in a given period  $x$ , classified by age  $a$ , sex  $s$ , and jurisdiction  $j$ .

**Application of proportions of misclassified linked death records to net gains in death records**

The net gains in Indigenous deaths in a given period,  $x$ , that was previously misclassified as non-Indigenous can be approximated by:

$$n(\Delta N_{asj}) \approx plmn_{asj} \times n(BN_{asj}) \dots\dots\dots (5)$$

The net gains in Indigenous deaths in a given period,  $x$ , whose Indigenous status was previously misclassified as ‘unknown’ can be approximated by:

$$n(\Delta U_{asj}) \approx plmu_{asj} \times n(BU_{asj}) \dots\dots\dots (6)$$

**Total number of enhanced Indigenous deaths**

The overall number of enhanced Indigenous death records ( $E$ ) by age, sex and jurisdiction can be obtained by adding together the values  $n(LI_{asj})$ ,  $n(LMN_{asj})$ ,  $n(LMU_{asj})$  and  $n(\ddot{U}I_{asj})$ , with the approximations of  $n(\ddot{U}MN_{asj})$ ,  $n(\ddot{U}MU_{asj})$ ,  $n(\Delta N_{asj})$  and  $n(\Delta U_{asj})$ .

$$E_{asj} = n(LI_{asj}) + n(LMN_{asj}) + n(LMU_{asj}) + n(\ddot{U}I_{asj}) + n(\ddot{U}MN_{asj}) + n(\ddot{U}MU_{asj}) + n(\Delta N_{asj}) + n(\Delta U_{asj}) \dots\dots\dots (7)$$

# Appendix B: Data sources

## B1 Data quality

Six main data sources were used in preparing this report. These were the:

- MED
- NDI
- NMD
- RAC Database
- NHMD
- jurisdictional PDCs.

This chapter describes the various data sources used.

A Data Quality Statement is also available for each data source, covering data description, institutional environment, timeliness, accessibility, interpretability, relevance and accuracy, among other details. Links to the relevant data quality statements are provided.

### **Mortality Extract Data Set**

The MED was created from extracts of the NDI and the NMD. The data quality of the MED therefore depends on the quality of its two constituent databases whose Data Quality Statements are now referenced.

### **National Death Index**

<<http://meteor.aihw.gov.au/content/index.phtml/itemId/480010>>.

### **National Hospital Morbidity Database**

<<http://meteor.aihw.gov.au/content/index.phtml/itemId/638202>>.

### **Residential Aged Care Database**

<<http://meteor.aihw.gov.au/content/index.phtml/itemId/586498>>.

### **National Mortality Database**

The data quality statements underpinning the AIHW NMD can be found in the following ABS publications:

- ABS quality declaration summary for deaths, Australia (ABS cat. no. 3302.0)
- ABS quality declaration summary for causes of death, Australia (ABS cat. no. 3303.0).

For more information on the AIHW NMD see 'Death data at AIHW' at the following site:

<<http://www.aihw.gov.au/deaths/aihw-deaths-data/>>.

### **National Perinatal Data Collection**

<<http://meteor.aihw.gov.au/content/index.phtml/itemId/587327>>.

## **B2 Mortality Extract Data Set**

The Mortality Extract Data Set (MED) was created specifically as the base data file that was linked with the comparative data sets (NHMD, RAC Database and jurisdictional PDCs) in order to create the EMD. The primary input into the MED was the NMD and the NDI.

The NMD is maintained by the AIHW and is based on Cause of Death Unit Record File (CODURF) data which are provided to the AIHW by the Registries of Births, Deaths and Marriages in each state and territory and the National Coronial Information System (managed by the Victorian Department of Justice). The cause of death data is compiled and coded by the Australian Bureau of Statistics (ABS).

The NDI is a 'fact of death' data file containing records of all deaths that occur in Australia. It is compiled from death registrations data obtained from jurisdictional registries of births, deaths and marriages throughout Australia. The cross-validation of the NDI and the NMD helps to remove duplication and to identify and correct for missing records as well as missing, incomplete or errors in information.

The NDI and NMD carry identical 'fact of death' information. However, unlike the NMD, the NDI contains names. The cross-validation of extracts of data from the NDI against extracts of data from the NMD resulted in the MED that contained edited and validated death records with names suitable for use as linking variables.

Data fields extracted from the NDI for inclusion in the MED were full names, sex, date of birth, date of death, state of death registration, year of death registration, geographic variables, Indigenous status, and a unique record identifier. Data fields extracted from the NMD comprised the same set of variables as were extracted from the NDI, with the exception of names and address, which are not included on the NMD. The resulting data set, the MED, contains only the variables required for linking to the comparative data sets. It does not contain any clinical or health care information. Of the three data sets linked to the MED, only the RAC contains personal names which could be used as linking variables. The other two comparative data sets do not contain information on names.

### **B2.1 Death registrations (National Death Index)**

Registration of deaths is the responsibility of state and territory registries of births, deaths and marriages. When a death occurs, all jurisdictions require that the funeral director, or any other person who arranges for the disposal of the remains, must complete a Death Registration Statement within a specific period of time (7 or 14 days) of the disposal of the remains, to inform the Registry of Births, Deaths and Marriages of the fact of death. The Death Registration Statement also includes other sociodemographic information on the deceased, including full name, sex, date of birth, date of death, full usual residence information, and Indigenous status, as well as information on place of death.

At the same time, a doctor who is responsible for the deceased's medical care immediately before death, or who examines the body of a deceased person after death must, within 48 hours after the death, give written notice of the death, including particulars required by legislation to the Registry of Births, Deaths and Marriages. This notification is in the form of a Medical Certificate of Cause of Death (MCCOD), and includes particulars such as Indigenous status and the cause of death.

Where a death is subject to coronial enquiry, then the coroner must, as soon as practicable, notify the Registry of Births, Deaths and Marriages of the fact of death. The information provided by the coroner may include the Indigenous status of the deceased. Information

provided to jurisdictional registrars by the funeral director, the attending physician and the coroner is used in compiling both the NDI and the NMD.

The question asked to ascertain Indigenous status on both the Death Registration Statement and the MCCOD is the standard question:

Was the deceased (or deceased person) of Aboriginal or Torres Strait Islander origin?

- No
- Yes, Aboriginal
- Yes, Torres Strait Islander
- Yes, both Aboriginal and Torres Strait Islander (not all states).

Death registration data are provided to the ABS to compile and publish annual death statistics. After de-identification and coding of causes of death, the ABS creates a file called the Cause of Death Unit Record File. These data are provided annually to the AIHW by the Registry of Births, Deaths and Marriages in each state and territory and by the National Coronial Information System (managed by the Victorian Department of Justice); the data are then maintained in the AIHW NMD.

The AIHW also receives from each registry monthly 'fact of death' files that include the names and demographic characteristics of the deceased, including their full name, sex, date of birth, date of death, place of usual residence, Indigenous status and a unique record identifier. This monthly data collection is used to compile the NDI, which contains a listing of all deaths that have occurred in Australia since 1980.

The analysis in this report is based on deaths classified by year of registration rather than by the year in which the deaths occurred. This is consistent with the type of death data used by the AIHW and the ABS to produce official mortality and life expectancy estimates. Registered deaths classified by year of registration are preferred for this type of analysis because of delays in death registration. While up to 95% of deaths are registered in the year in which the deaths occurred, the remaining deaths are often not registered for several years after the occurrence of the death. To base estimates of Indigenous life expectancy on deaths classified by year of occurrence means that the resulting life tables will have to be updated every year for several years until all deaths occurring in a given year are registered.

Table B1 shows the total number of all registered deaths on the NDI for 2001–2010, according to year of death registration and year of death occurrence, while Table B2 presents similar information only for deaths recorded as Indigenous on the NDI.

Tables B1 and B2 show that, in the long term, the number of deaths classified by year of registration is nearly the same as the number of deaths classified by year of death occurrence. However, due to variations in the extent of late registration, the difference between the number of deaths classified by year of occurrence and the number classified by year of registration varies from year to year.

**Table B1: All registered deaths on the NDI, Australia, 2001–2015**

Year	Males		Females	
	Year of registration	Year of occurrence	Year of registration	Year of occurrence
2001	66,835	66,927	61,709	61,905
2002	68,885	68,764	64,822	64,425
2003	68,330	68,043	63,962	63,889
2004	68,395	68,317	64,113	64,075
2005	67,241	67,554	63,473	63,927
2006	68,556	68,895	65,183	65,558
2007	70,569	71,538	67,285	68,165
2008	73,548	72,802	70,398	69,695
2009	72,320	72,661	68,440	68,635
2010	73,484	73,029	69,812	69,729
2011	75,330	75,355	71,602	71,396
2012	74,794	75,592	72,304	73,301
2013	75,782	76,116	71,896	72,059
2014	78,341	78,365	75,239	75,430
2015	81,330	75,843	77,722	72,814
<b>Total</b>	<b>1,083,536</b>	<b>1,079,801</b>	<b>1,027,960</b>	<b>1,025,003</b>

Source: Enhanced Mortality Database.

**Table B2: Registered Indigenous deaths on the NDI, Australia, 2001–2015**

Year	Males		Females	
	Year of registration	Year of occurrence	Year of registration	Year of occurrence
2001	1,218	1,207	846	867
2002	1,184	1,202	952	940
2003	1,237	1,218	842	828
2004	1,208	1,214	928	912
2005	1,227	1,260	914	944
2006	1,290	1,284	989	1,011
2007	1,292	1,288	1,076	1,092
2008	1,281	1,292	1,072	1,065
2009	1,275	1,270	1,102	1,105
2010	1,548	1,371	1,088	1,081
2011	1,408	1,425	1,150	1,157
2012	1,426	1,426	1,194	1,191
2013	1,534	1,517	1,277	1,274
2014	1,581	1,563	1,333	1,330
2015	1,699	1,485	1,389	1,213
<b>Total</b>	<b>20,258</b>	<b>20,022</b>	<b>16,152</b>	<b>16,010</b>

Source: Enhanced Mortality Database.

## B3 Comparative data sets

Comparative data sets that contain information on deaths and Indigenous status were linked to the MED to create the EMD. These data sets are the NHMD, the RAC Database, and the jurisdictional perinatal or midwives' data collections. These three data sets, together, account for between 83% and 87% of death records on the NDI, and cover mostly deaths that took place in health and residential aged care facilities. The 13% to 17% of deaths not covered by these data sources are mostly deaths that take place in private dwellings and in public places such as roads and highways, workplaces and recreational venues.

### B3.1 National Hospital Morbidity Database

The NHMD is a compilation of episode-level records from admitted patient morbidity data collection systems in Australian hospitals. It is a comprehensive data set that has records for all episodes of admitted patient care from essentially all public and private hospitals in Australia.

The data supplied are based on the National Minimum Data Set for Admitted patient care and include demographic, administrative and length of stay data, as well as data on the diagnoses of the patients, the procedures they underwent in hospital, and external causes of injury and poisoning.

Hospital patients who are not admitted (for example, emergency department patients, and outpatients) are not included. The exclusion of non-admitted deaths should not have a large impact on the project. In 2011–12, 1,955 patients died in emergency departments without being admitted, representing 0.03% of all hospital deaths.

Indigenous identification is ascertained through the standard question:

*Are you of Aboriginal or Torres Strait Islander origin? (For persons of both Aboriginal and Torres Strait Islander origin, mark both 'Yes' boxes.)*

- No
- Yes, Aboriginal
- Yes, Torres Strait Islander.

### B3.2 Residential Aged Care Database

The provision of residential aged care is the responsibility of the Australian Government. Residential aged care data are collected by the Aged Care Assessment Team (ACAT) at the time a person is assessed for government-subsidised aged care, and by the aged care home while they live there.

The data provided to the AIHW for this project are from the System for the Payment of Aged Residential Care, which is administered by the Department of Health. The system contains information gathered through a number of instruments (AIHW 2008). Of these, the one that relates to this project is the Aged Care Client Record (previously the Aged Care Application and Approval form).

The Aged Care Client Record is filled in at the time of assessment for government-subsidised aged care by persons applying for admission (or their carer), as well as by the ACAT. Data on Indigenous identification, date of birth, sex and usual place of residence at the time of assessment are recorded on this form.

The question to ascertain Indigenous identification on the Aged Care Client Record is the standard question (with a different order of answer categories):

*Is the client of Aboriginal or Torres Strait Islander origin?*

- Yes, Aboriginal
- Yes, Torres Strait Islander
- Yes, both
- No, neither.

Each year the Department of Health provides a copy of the residential aged care data to the AIHW for statistical analysis and publication. The data contain basic sociodemographic information about each resident, including full name, sex, Indigenous status, date of birth, date of death, usual residence, and address of the facility where the death occurred.

### **B3.3 Jurisdictional Perinatal Data Collections**

Health departments in each jurisdiction compile a perinatal or midwives' data collection containing information on pregnancy and childbirth of all women who attend midwives or antenatal clinics in their respective jurisdictions. Midwives and other health staff complete notification forms for each birth, using information obtained from mothers, hospital admission and inpatient records, and antenatal pregnancy records. Data from the various sources are collected and collated by the health departments of the respective jurisdictions into a jurisdiction-specific PDC. Specified data items from these data sets were obtained from each jurisdiction following ethics approval from each jurisdiction.

Only perinatal deaths, comprising fetal and neonatal deaths, are included in the PDCs. Until 2012, the various jurisdictions collected Indigenous status information of only the mother of the baby, and not that of the father or the baby. For this reason, the baby's Indigenous status has tended to be based on the Indigenous status of the mother.

The standard question to ascertain Indigenous status is not uniformly used in all the data sources for the PDC. While hospitals use the standard form of the question recommended by the ABS (ABS 1999), other collections, such as antenatal pregnancy records, may not.

As the PDC collects Indigenous identification only of the mother, neonatal deaths of babies with Indigenous fathers and non-Indigenous mothers may not be identified as Indigenous. Following an agreement between the Australian and state and territory governments about a national minimum data set for the national perinatal data collection, however, state and territory health departments started collecting information on the Indigenous status of the baby from January 2012. It is expected that this information will become available during the course of the Enhanced Indigenous Mortality Data Collection.

Unit records of each neonatal death were provided to this project without names, so linkage of this data set to the MED was based on sex, date of birth, date of death and the mother's usual address. Without names, the combination of date of birth and date of death provides an almost unique identifier for purposes of data linkage.

An approach using data linkage to enhance Indigenous status information on Victorian perinatal records was implemented by Freemantle and others (2013). In their approach, they first linked the Victorian perinatal data set with the corresponding birth registration data set, compared Indigenous status of corresponding records across the linked data sets, and developed algorithms with which to validate and/or enhance Indigenous status information on the two data sets. The linkage of the perinatal and birth registration data sets enabled an evaluation of the completeness of Indigenous identification in each data set, a definitive count of Indigenous births across the linked data sets, and a review of disparities in maternal characteristics and birth characteristics across the linked data sets (Freemantle et al. 2013).

### **B3.4 National Non-admitted Patient Episode of Care Database**

The data sets linked to create the EMD for this report do not currently include the National Non-admitted Patient Episode of Care Database (NNAPECD). It is, however, intended that it be included for the next phase of the project.

The NNAPECD contains records of deaths that occur in hospital among non-admitted patients. These may be records of persons who died at home, at workplaces, in vehicle accidents, on recreational grounds, or in ambulances on the way to hospital, or records relating to persons who presented at hospital emergency departments but died without being admitted. While these deaths will be recorded on the NDI, they will not be in the NHMD, the RAC Database or the jurisdictional PDCs because the deaths did not occur among residents of hospital or residential aged care facilities.

In the 5 years between 2006 and 2011, a total of 38,674 deaths were recorded in hospital emergency departments throughout Australia (AIHW 2008, 2009, 2010c, 2011c, 2012d). These comprised 28,961 persons who were dead on arrival at the emergency department, and a further 9,713 deaths that occurred in hospital emergency departments. These deaths will form part of the 13%–17% of deaths registered on the NDI that are not on the NHMD, RAC Database or jurisdictional PDCs. Including the NNAPECD among the data sets to be linked will enhance the proportion of records on the MED that will be able to be linked and, whose Indigenous status information is able to be directly verified with reference to comparable data sets.

Furthermore, while the residential aged care and the perinatal data sets capture deaths among the very old and the very young sub-populations, the sub-population in-between is missed and is only able to be captured by the hospital database. Including the NNAPECD might fill this gap, since a large proportion of deaths occurring as a result of incidents at workplaces, at recreational venues and through vehicular accidents are likely to be skewed towards younger people.

What is uncertain, however, is the quality of Indigenous status and demographic information on the NNAPECD since a not insubstantial proportion of persons presenting at NNAPECD may have been brought there by strangers, work colleagues and Emergency Services rather than by family or friends.

# Appendix C: Data linkage and results

## C1 Linkage of the MED to various data sets

The MED was linked probabilistically and sequentially to three comparative data sets: the RAC Database, the NHMD and the jurisdictional PDCs.

The linkage rate was 77.2%, substantially below the 99.1% and 94.8% rate for linkage of the MED to the RAC Database and the NHMD, respectively. The linkage rate was highest for South Australia because that jurisdiction allowed for some identifying variables to be provided (including names and full date of birth) if the linkage protocol met strict guidelines that were consistent with South Australian privacy and disclosure legislation.

The linkage rate was lowest for Queensland and Western Australia (64.9%) even though these states have equally good perinatal data. These very low rates are attributable to legislative or administrative constraints that prevented the two jurisdictions from including names and full date of birth on the perinatal data they provided to the AIHW. For example, current Western Australia legislation has no provision that allows the Health Data Steward to provide identifying variables to a third party outside of Western Australia. Other jurisdictions also do not routinely provide data containing names to third parties.

Solutions are being developed for this problem. For Western Australia, the solution lies in obtaining human research ethics and data custodian approval for the West Australian Data Linkage Branch to provide the AIHW with birth registration data containing linkage variables, as well as linkage keys between the perinatal and birth registration data sets. Linkage variables could then be extracted from the birth registration data set and attached to the perinatal data set. The perinatal data set containing the linkage variables could then be linked to the NDI much more successfully than would be possible without the linkage keys.

For Queensland, the solution lies in working closely with data custodians to develop a data linkage protocol that satisfies the provisions of data access under Section 280 of the *Public Health Act 2005* (Qld). The AIHW has recently worked with Queensland Health officials to develop this protocol for an unrelated project for which perinatal data, including linkage variables, have been provided. Fresh approaches will be made to Queensland Health to develop a similar protocol for the Enhanced Indigenous Mortality Database Collection. Similar solutions would have to be developed for other jurisdictions.

Another approach to improve linkage of the perinatal data set with the NDI would be to adopt the approach demonstrated by Freemantle and others (2013) for Victoria, by first linking the perinatal with the birth registration data set, comparing Indigenous status of corresponding records across the linked data sets, and using appropriate algorithms to validate and/or enhance Indigenous status information on the two data sets.

Linkage of the birth registration and perinatal data sets will enable linkage variables from the birth registration data sets to be attached to the perinatal data sets for better linkage to the NDI. This linkage will enable an evaluation of the completeness of Indigenous identification in each data set, a definitive count of Indigenous births across the linked data sets, and a review of disparities in maternal characteristics and birth characteristics across the linked data sets (Freemantle et al. 2013)

### C1.1 Linked and unlinked records

Table C1 shows the overall result of the linkage of the MED to the RAC Database, the NHMD and the jurisdictional PDCs for the period 2001–2010.

The number of data sets to which an MED record could link is limited by the fact that there were only three comparative data sets to be linked to the MED, two of which were age-based and were mutually exclusive. Records on the RAC Database were unlikely to have a corresponding record on the jurisdictional PDCs. Thus, a record on the MED was potentially only able to link to, at most, two other data sets—that is, either with the RAC Database and the NHMD, or with the NHMD and the jurisdictional PDCs.

In 2001–2005 and 2006–2010, 74.7% and 78.1%, respectively, of MED records linked to a corresponding record on at least one of the comparative data sets. A little over two-thirds of records on the MED (67.4% and 69.9%, respectively) linked to a record on only one other data set, while 7.3% and 8.2%, respectively, of MED records in 2001–2005 and 2006–2010 linked to a record on more than one data set.

In 2001–2005 and 2006–2010, 23.6% and 27.4%, respectively, of records on the MED linked to a corresponding record on only the RAC Database; 43.7% and 42.4%, respectively, linked to a record on only the NHMD, while 0.1% linked to a corresponding record on only the jurisdictional PDCs. A further 6.9% and 7.8%, respectively, of MED records in 2001–2005 and 2006–2010 linked to both the RAC Database and the NHMD, while a further 0.4% of MED records linked to corresponding records in both the NHMD and jurisdictional PDCs.

**Table C1: Linkage of MED records to corresponding records on other data sets, 2001–2010**

Data sets linked to the MED	2001–2005		2006–2010	
	No.	%	No.	%
<b>MED linked to</b>				
Aged Care and Hospital	45,570	6.9	54,728	7.8
Aged Care only	155,356	23.6	191,389	27.4
Hospital and Perinatal	2,408	0.4	2,562	0.4
Hospital only	287,703	43.7	296,954	42.4
Perinatal only	585	0.1	617	0.1
Linked to at least one other data set	491,621	74.7	546,250	78.1
Not linked to any	166,144	25.3	153,522	21.9
<b>Total</b>	<b>657,765</b>	<b>100.0</b>	<b>699,772</b>	<b>100.0</b>
<b>Of all MED records that linked with another data set</b>				
MED records that linked to only one other record	443,644	90.2	488,960	89.5
MED records that linked to 2 or more other records	47,978	9.8	57,290	10.5
<b>Total</b>	<b>491,622</b>	<b>100.0</b>	<b>546,250</b>	<b>100.0</b>

Source: Enhanced Mortality Database.

About one-quarter (25.3%) and one-fifth (21.9%), respectively, of MED records in 2001–2005 and 2006–2010 did not link to any record on any of the three comparative data sets. Of the 491,622 and 546,250 records on the MED in 2001–2005 and 2006–2010, respectively, that linked to another data set, 90.2% and 89.5%, respectively, linked to a record on only one other data set, while 9.8% and 10.5%, respectively, of MED records in 2001–2005 and 2006–2010, linked to more than one data set.

About 1 in 4 and 1 in 5 MED records, respectively, in 2001–2005 and 2006–2010 could not link to a record on any of the comparative data sets because the comparative data sets are not exhaustive sources of death records in Australia. Not all deaths take place in hospital or at residential aged care facilities. A certain proportion of deaths take place at home, workplaces or on the highway. While these deaths will be registered and will be on the MED, they may not be recorded on any of the three comparative data sets.

For example, the death of an elderly man in his own home or of a cyclist on the highway will not be recorded on any of the comparative data sets, even though they will be reported on the MED. A certain proportion of MED records also remained unlinked because of missing, incomplete or poor-quality linkage variables on the respective data sets. The Indigenous status of these records is therefore unable to be verified directly by comparing with Indigenous status information on corresponding records in another data set.

## C1.2 Misclassified deaths on the MED

While nearly all deaths are registered, not all Indigenous deaths are identified as Indigenous when they are registered. Linkage of the MED to the three comparative data sets enabled Indigenous deaths that were not originally identified as Indigenous on the MED to be identified. Table C2 presents details of misclassified Indigenous deaths that were identified as Indigenous as a result of linkage of the MED to the comparative data sets.

**Table C2: Records classified as Indigenous on the MED and comparative data sets, 2001–2010**

Linkage result	Number of deaths	
	2001–2005	2006–2010
<b>Indigenous in one source only</b>	<b>7,644</b>	<b>8,586</b>
<b>Indigenous in MED</b>		
<i>Indigenous in MED only</i>	<b>6,711</b>	<b>7,191</b>
<i>Indigenous in MED and one other source</i>		
Indigenous in MED and Hospital	3,144	3,927
Indigenous in MED and Residential Aged Care	411	593
Indigenous in MED and Perinatal	47	64
<b>Total MED and one other source</b>	<b>3,602</b>	<b>4,584</b>
<i>Indigenous in MED and two other sources</i>		
Indigenous in MED, Hospital and Residential Aged Care	137	212
Indigenous in MED, Hospital and Perinatal	106	157
<b>Total MED and two other sources</b>	<b>243</b>	<b>369</b>
<b>Total Indigenous in MED</b>	<b>10,556</b>	<b>12,144</b>

Source: National Mortality Database.

Of the 12,144 deaths in 2006–2010 originally identified on the MED as Indigenous, 8,586 (or 71%) were identified as Indigenous on only one data set (Table C2). Of the total of 12,144 deaths identified as Indigenous on the MED, 7,191 (or 59%) were identified as Indigenous on the MED and on no other data set. Just over 1 in 3 (4,584, or 38%) of the Indigenous death records on the MED were identified as Indigenous on the MED and one other data set, while 369 (3.0%) were identified as Indigenous on the MED and on two other data sets.

The results re-iterate an earlier observation that most MED death records linked to only one other data set, thereby precluding the use of more complex algorithms to derive Indigenous status from the linked data.

Table C3 provides details of death records on the MED that had been originally misclassified as non-Indigenous or as having ‘missing’, ‘unknown’ or ‘unstated’ Indigenous status. In 2006–2010 for instance, of the 12,144 death records originally identified as Indigenous on the MED, a total of 6,603 records (54.4%) were able to be linked to a corresponding record on one or more of the three comparative data sets, while 5,541 (45.6%) records were not able to be linked to any record on the comparative data sets.

In 2006–2010, linkage of the 6,603 MED records to the comparative data sets identified 1,441 records that were misclassified on the MED. These records were recorded as Indigenous on at least one of the comparative data sets. This means that the total number of linked Indigenous records on the MED should have been 8,044 (6,603 + 1,441) rather than 6,603, and that about 21.8% of linked Indigenous MED records had been misclassified.

As a result of comparing the Indigenous status of linked MED records with their corresponding records on the comparative data sets, the proportion of linked MED records that had been misclassified, by age and sex, can be estimated. By applying these proportions to the distribution of unlinked MED records by age and sex, an estimate of the number of misclassified MED records can be prepared. The sum of the misclassified unlinked MED records across all age and sex groups was estimated as 729, equivalent to about 13.2% of unlinked MED records originally identified as Indigenous.

**Table C3: Misclassified deaths on the MED and comparative data sets, 2001–2010, Australia**

Linkage result	Misclassified Indigenous deaths on the MED					
	2001–2005			2006–2010		
	Linked	Unlinked <sup>(a)</sup>	Total	Linked	Unlinked <sup>(a)</sup>	Total
<b>Total no. of Indigenous records on MED</b>	<b>5,236</b>	<b>5,320</b>	<b>10,556</b>	<b>6,603</b>	<b>5,541</b>	<b>12,144</b>
<i>Misclassified on MED and 1 other source</i>						
<i>Non-Indigenous on MED but ...</i>						
Indigenous on NHMD and PDC	19			25		
Indigenous on NHMD and RAC Database	9			21		
<i>Total misclassified on MED and 1 other source</i>	28			46		
<i>Misclassified on MED and 2 other sources</i>						
<i>Non-Indigenous on MED but ...</i>						
Indigenous on Hospital data set only	669			1,000		
Indigenous on Residential Aged Care only	246			369		
Indigenous on Perinatal only	18			26		
<i>Total misclassified on MED and 2 other sources</i>	933			1,395		
<i>Total no. misclassified</i>	961	507 <sup>(b)</sup>	1,468	1,441	729 <sup>(b)</sup>	2,170
<i>Total no. Indigenous in any source</i>	6,197	5,827 <sup>(c)</sup>	12,024	8,044	6,270 <sup>(c)</sup>	13,585
<b>Misclassified deaths as a percentage of original no. of Indigenous deaths on MED (%)</b>	<b>18.4</b>	<b>9.5</b>	<b>13.9</b>	<b>21.8</b>	<b>13.2</b>	<b>17.9</b>
<b>Misclassified deaths as a percentage of no. of enhanced Indigenous deaths (%)</b>	<b>15.5</b>	<b>8.7</b>	<b>12.2</b>	<b>17.9</b>	<b>11.6</b>	<b>16.0</b>

(a) There are no corresponding records on the comparative data sets for MED records that did not link to any records on the comparative data sets. The number of linked and unlinked records shown here are for Indigenous death records only, and are different from the linkage rates for all death records shown in table C1.

(b) The proportion of linked MED records with misclassified Indigenous status information was estimated by age and sex. These proportions were applied to the distribution of unlinked records by age and sex to yield an estimate of the number of misclassified death records, by age and sex, among unlinked records.

(c) The total number of Indigenous death records from any source is obtained by adding the number of misclassified death records, estimated as in footnote (b), to the number of death records originally identified on the MED as Indigenous.

Source: Enhanced Mortality Database.

An estimate of the total number of enhanced Indigenous death records can be made by adding together the number of linked and unlinked records originally identified as Indigenous to the number of misclassified MED records, among both linked and unlinked records. The total number of enhanced Indigenous death records in 2006–2010 was 2,170, or 17.9% of the total number of records originally identified as Indigenous on the MED. The number of enhanced Indigenous death records on the MED was then used as input data for Indigenous mortality and life expectancy analysis.

Table C3 also shows the source of the misclassified deaths on the MED. Of the 1,441 misclassified MED records identified as Indigenous, 1,395 (or nearly 97%) were identified from only one other source, with the bulk (1,000 or 69%) deriving from the NHMD and 369 (or 25.6%) deriving from the RAC Database.

## Misclassified death records on the MED

Table C4 shows the distribution of misclassified death records on the MED, by sex and broad age groups in 2006–2010, while figures 2.3 and 2.4 graphically represent the distribution of reported and enhanced deaths for the periods 2001–2005 and 2006–2010. The proportion of misclassified death records on the MED was marginally higher for males (18.1%) than for females (17.6%), and also higher for the youngest and oldest age groups than for other age groups.

Table C5 shows the number of misclassified death records identified post-linkage as Indigenous, classified by sex and state of registration. For males, misclassified death records as a proportion of deaths records originally reported as Indigenous on the MED ranged from 2.3% in the Northern Territory to 104.7% in Tasmania, with New South Wales, Victoria and the Australian Capital Territory also reporting very high rates of misclassification. For females, misclassification rates ranged from 1.9% in the Northern Territory to 60.9% in Tasmania, with New South Wales, Victoria and the Australian Capital Territory also reporting very high rates of misclassification.

The very high misclassification rates in Tasmania and the Australian Capital Territory, in addition to their very low Indigenous population and corresponding low number of Indigenous deaths, was among the reasons why mortality and life table analysis was not carried out for these two jurisdictions.

## C2 Enhancement of death records for 2011–2015

Indigenous mortality and life expectancy estimates for the period 2011–2015 were based on death data for 2011–2014 that had been enhanced by applying Indigenous status misclassification factors calculated from linked 2006–2010 MED data. Table C3 however, shows that Indigenous misclassification rates do change over time. This study therefore carried out a number of simulation exercises to assess the likely impact which the use of 2006–2010 misclassification rates could have on estimates of Indigenous life expectancy if Indigenous misclassification on death data changed after 2006–2010.

The study adopted three scenarios to assess the likely impact on Indigenous life expectancy estimates if Indigenous status misclassification rates changed as follows:

- did not change after 2006–2010
- increased by 5%, 10%, 15% or 20% from the levels observed in 2006–2010
- decreased by 5%, 10%, 15% or 20%, from the levels observed in 2006–2010.

For both males and females, if Indigenous identification improves—that is, if Indigenous status misclassification rates decline after 2006–2010, and the 2006–2010 misclassification rates are applied to the 2011–2015 death data—the number of enhanced Indigenous deaths will be overestimated and Indigenous life expectancy will be underestimated. On the other hand, if Indigenous status misclassification worsens after 2006–2010 and the 2006–2010 misclassification rates are applied to the 2011–2015 death data, the number of enhanced Indigenous deaths will be underestimated and Indigenous life expectancy will be inflated. The result of applying these assumed changes in Indigenous misclassification to the death data is shown in figures C1 and C2 for males and females, respectively.

**Table C4: Misclassified and enhanced deaths, by age and sex, Australia, 2006–2010**

Age group (years)	Males				Females			
	No. of records originally identified as Indigenous on MED	No. of records misclassified	% of misclassified records on NDI	Enhanced no. of Indigenous death records	No. of records originally identified as Indigenous on NDI	No. of records misclassified	% of misclassified MED on NDI	Enhanced no. of Indigenous death records
0–4	401	75	18.7	476	299	44	14.7	343
5–19	245	25	10.2	270	122	25	20.5	147
20–44	1,728	195	11.3	1,923	982	131	13.3	1,113
45–64	2,357	402	17.1	2,759	1,800	261	14.5	2,061
65+	1,956	511	26.1	2,467	2,255	501	22.2	2,756
<b>All ages</b>	<b>6,686</b>	<b>1,208</b>	<b>18.1</b>	<b>7,894</b>	<b>5,458</b>	<b>962</b>	<b>17.6</b>	<b>6,420</b>

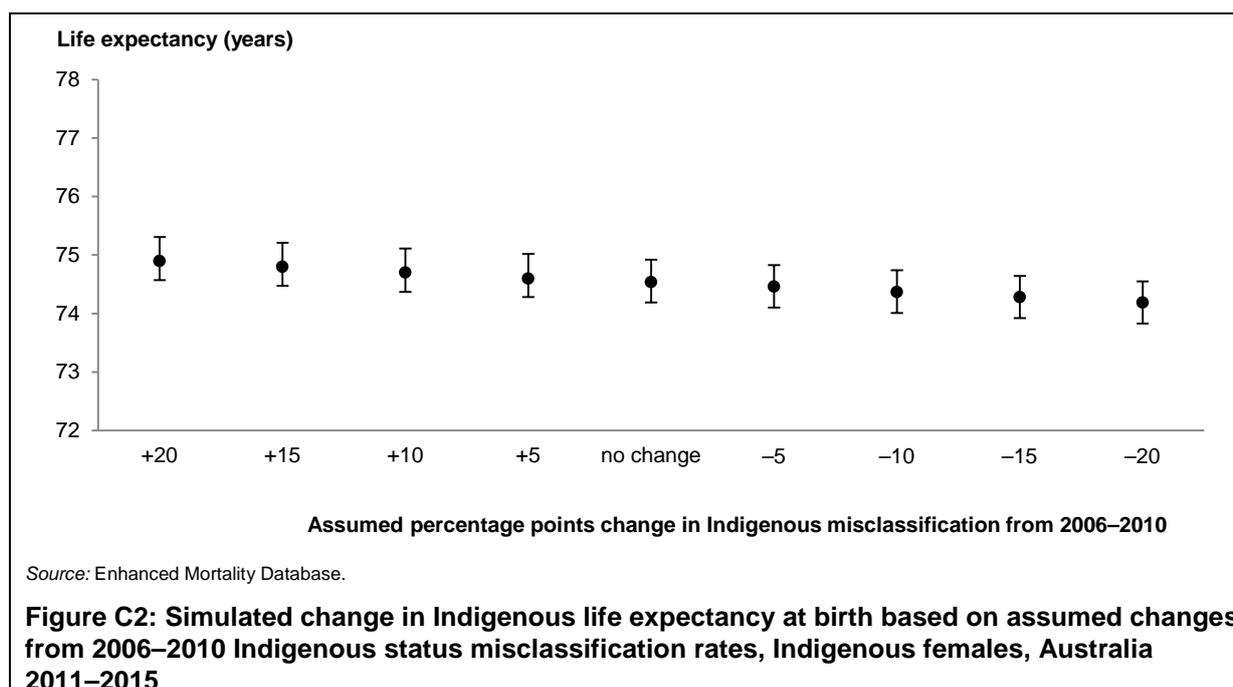
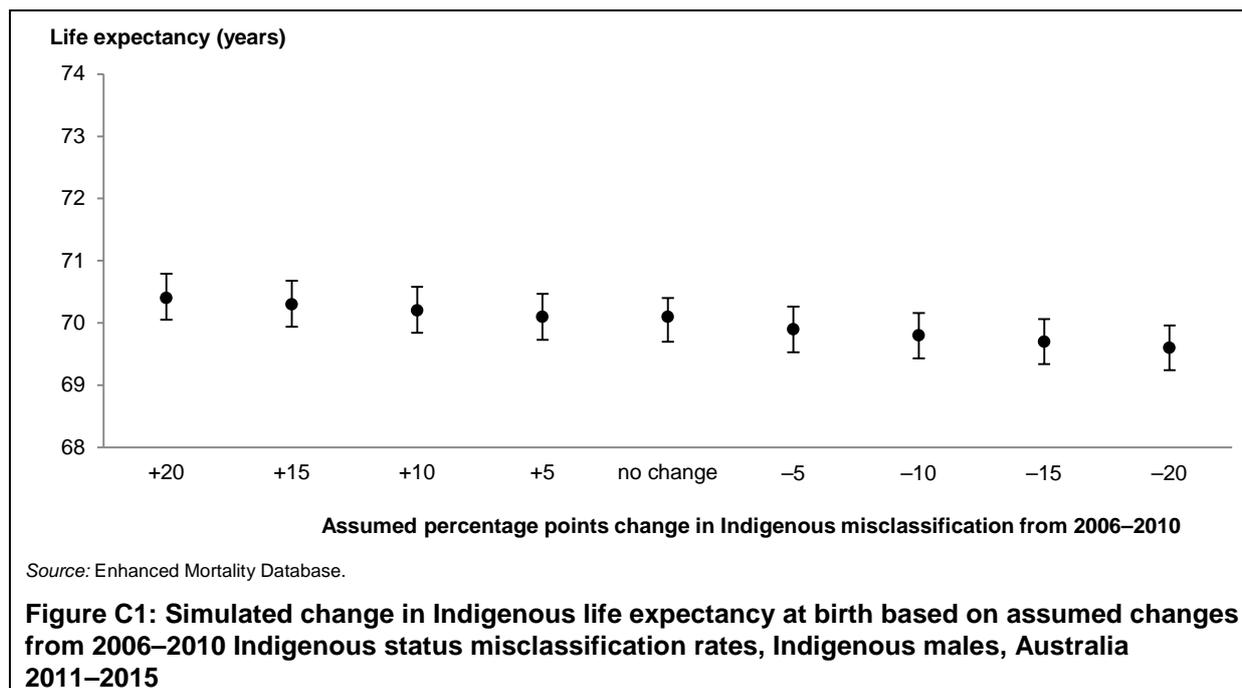
Source: Enhanced Mortality Database.

**Table C5: Misclassified and enhanced deaths, by state or territory, 2006–2010**

State/ territory	Males				Females			
	No. of records originally identified as Indigenous on MED	No. of records misclassified	Misclassified records as % of no. of records originally identified as Indigenous on MED	Enhanced no. of Indigenous death records	No. of records originally identified as Indigenous on MED	No. of records misclassified	Misclassified records as % of no. of records originally identified as Indigenous on MED	Enhanced no. of Indigenous death records
NSW	1,576	456	28.9	2,032	1,261	357	28.3	1,618
Vic	292	108	37.0	400	247	114	46.2	361
Qld	1,830	319	17.4	2,149	1,524	243	15.9	1,767
SA	396	61	15.4	457	371	59	15.9	430
WA	1,252	121	9.7	1,373	965	97	10.1	1,062
Tas	64	67	104.7	131	69	42	60.9	111
NT	1,227	28	2.3	1,255	991	19	1.9	1,010
ACT	49	18	36.7	67	30	13	43.3	43
<b>AUS<sup>(a)</sup></b>	<b>6,686</b>	<b>1,208</b>	<b>18.1</b>	<b>7,894</b>	<b>5,458</b>	<b>962</b>	<b>17.6</b>	<b>6,420</b>

(a) The sum of the misclassified estimates for the jurisdictions does not equal the Australia level estimates as the two sets of estimates were derived using different sets of adjustment factors classified by age and sex, which were specific for each jurisdiction.

Source: Enhanced Mortality Database.



The amount of underestimation or overestimation of Indigenous life expectancy, given various misclassification scenarios, shows that the impact will be small. For instance, if Indigenous misclassification declines by 5%, 10%, 15% and 20%, respectively, from the levels observed in 2006–2010, and the 2006–2010 misclassification rates are applied to the 2011–2015 death data, Indigenous deaths will be overestimated and Indigenous life expectancy will be underestimated by a little over 0.1 of a year for every 5% improvement in Indigenous misclassification. Thus, for the assumed 20% improvement in Indigenous misclassification, Indigenous male life expectancy will be underestimated by up to 0.4 of a year from 70.0 to 69.6 years.

Similarly, if Indigenous misclassification worsens and misclassification rates increase by 5%, 10%, 15% and 20%, respectively, from the levels observed in 2006–2010, and the 2006–2010 misclassification rates are applied to the 2011–2015 death data, Indigenous deaths will be underestimated and Indigenous life expectancy will be overestimated by 0.1 of a year for every 5 percentage point improvement in misclassification.

Thus, for a change in misclassification rates from the 2006–2010 misclassification rates by 40% (that is, from –20% to +20%), Indigenous life expectancy will change by 0.8 of a year for males and 0.7 of a year for females. Examination of the confidence intervals shows that, for both sexes, the estimated life expectancies are not substantially different from the estimates based on the unchanged 2006–2010 misclassification rates.

### C3 Comparison with ABS estimates

Table C6 compares various ABS and AIHW estimates of Indigenous life expectancy, while Figure C3 charts the same data on a time scale for visual clarification.

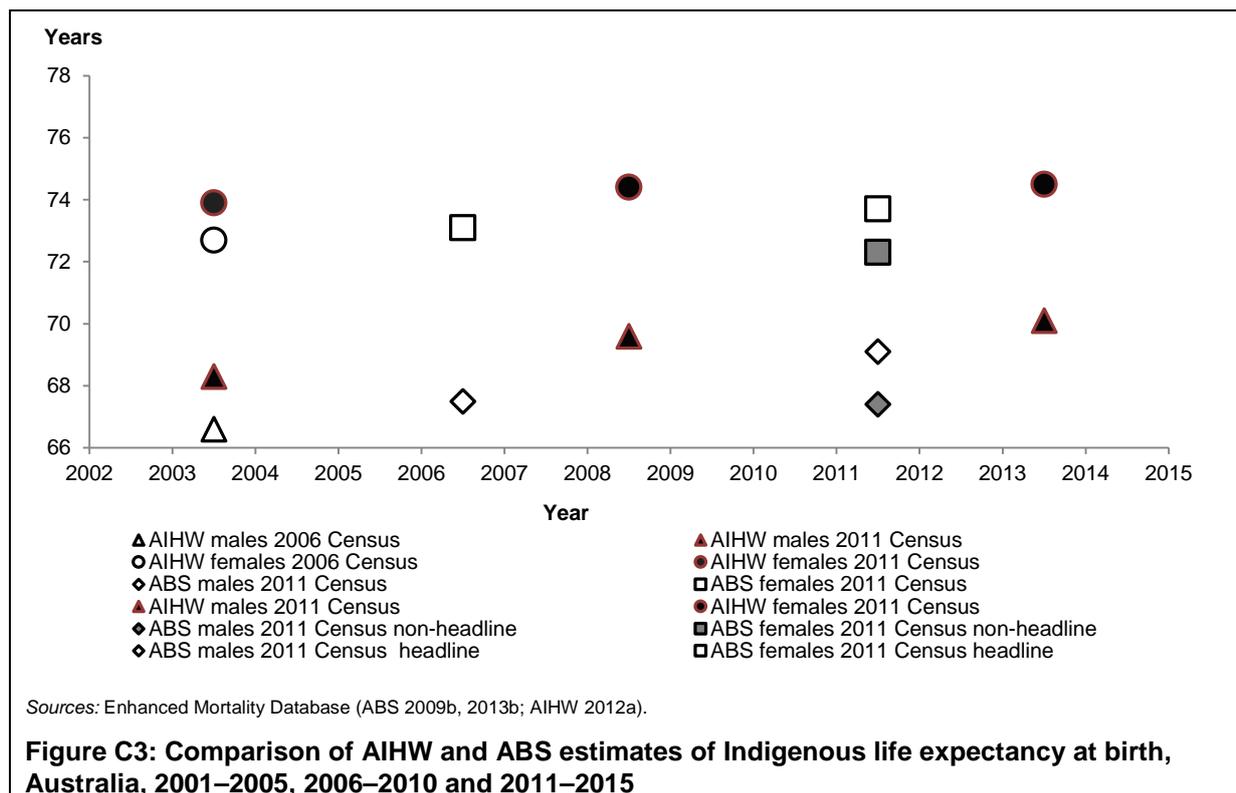
Both Table C6 and Figure C3 show that the estimates are sensitive to the method of estimation and, particularly, to the application (or non-application) of age adjustment to deal with Indigenous under-identification in the death data. For the period 2011–2015, Indigenous life expectancy at birth would have been 72.5 years for males and 76.8 years for females if the data had not been adjusted for misclassification of Indigenous status. Indigenous misclassification in the death data would have underestimated the number of Indigenous deaths and overestimated Indigenous life expectancy by about 2.5 years for males and 2.2 years for females.

**Table C6: AIHW and ABS estimates of Indigenous life expectancy, Australia, 2001–2005, 2006–2010 and 2011–2015**

Period	Males		Females	
	AIHW	ABS	AIHW	ABS
2001–2005 (based on 2006 Census)	66.6		72.7	
2001–2005 (based on 2011 Census)	68.3		73.9	
2005–2007 (based on 2006 Census and 2006 PES propensities)		67.2		72.9
2005–2007 (Revised, based on 2011 Census, 2011 PES propensities and age-specific adjustment)		67.5		73.1
2006–2010 (based on 2011 Census)	69.6		74.4	
2010–2012 (Headline: based on 2011 Census, 2011 PES propensities and age-specific adjustment)		69.1		73.7
2010–2012 (Non-headline: for comparison with state estimates; no age-specific adjustment)		67.4		72.3
2010–2012 (based on 2006 PES propensities: no age-specific adjustment)		68.8		73.5
2011–2015 (Enhanced; misclassified deaths added)	70.1		74.5	
2011–2015 (Not enhanced; misclassified deaths excluded)	72.5		76.8	

Note: PES = Post Enumeration Survey.

Source: Enhanced Mortality Database.



The AIHW estimates are about 0.8 of a year higher than ABS estimates for comparable periods. Part of the difference between the AIHW and ABS estimates may be related to different approaches adopted by each body in adjusting for Indigenous under-identification in the death data. The AIHW uses an ‘ever-Indigenous’ method of enhancing Indigenous status in the death data. The ABS uses Indigenous status adjustment factors calculated by ‘taking the ratio of the number of deaths reported as Aboriginal and Torres Strait Islander in death registrations to that reported in Census on a PES basis to calculate the Aboriginal and Torres Strait Islander deaths identification rate’ (ABS 2013b).

In the ABS method, if a person is classified as Indigenous on the death registration record but as ‘non-Indigenous’ in the Census, that person is reclassified as ‘non-Indigenous’. The AIHW method does not reclassify a person as ‘non-Indigenous’ if the person is classified as ‘Indigenous’ on the death registration record but as ‘non-Indigenous’ in any of the comparative data sets linked to the death registration data set.

The AIHW uses separate 5-year age-sex-specific adjustment factors to enhance its death records. The ABS, on the other hand, applies one set of adjustment factors, estimated for three broad age groups (0–14, 15–59 and 60 and over), to both male and female death records. The ABS headline estimates of Indigenous life expectancy for Australia in 2010–2012 (69.1 years for males and 73.7 for females)—which uses age-specific adjustment—are considerably different from its non-headline estimates for Australia that do not use age-specific adjustment factors (67.4 years for males and 72.3 for females).

Table C6 and Figure C3 show that, despite differences between the ABS and AIHW in the methods of enhancing Indigenous status information on death data, all the estimates point to an increasing trend in Indigenous life expectancy at birth. Estimates from the two agencies for any corresponding or close corresponding periods do not also vary by more than 1 year. An examination of the confidence intervals of the ABS and AIHW estimates however show that the two sets of estimates are not significantly different, with the AIHW estimates falling within the 95% confidence interval of the ABS estimates.

## C4 Life expectancy and denominator populations

Life expectancy estimates presented in this report are based on age-specific death rates that were calculated using population denominators based on back-cast Indigenous estimated resident population (Indigenous ERP) calculated from the 2011 Census (ABS 2014a). Table C6 has already shown that life expectancy estimates based on population denominators calculated from different censuses are different because of the different size and age structures of different Indigenous ERPs based on different censuses.

To continue with this theme, further sensitivity analysis was carried out using another population denominator, the cohort-interpolated Indigenous population based on the 2001, 2006 and 2011 Censuses. Population denominators based on the back-cast Indigenous ERP and the cohort-interpolated Indigenous population are now further discussed, together with estimates of Indigenous life expectancy based on the two population denominators.

### Indigenous life expectancy estimates based on two population denominators

Table C7 presents estimates of Indigenous life expectancy at birth, and at ages 20, 45 and 65, based on the back-cast and cohort-interpolated population denominators. There are no cohort-interpolated estimates for 2011–2015 because there is not a second Census after 2011 to interpolate between.

**Table C7: Indigenous life expectancy at selected ages based on two population denominators, Australia, 2001–2005, 2006–2010 and 2011–2015**

Age (years)/Period	Type of population denominator			
	Males		Females	
	Back-cast	Cohort- interpolated	Back-cast	Cohort- interpolated
<b>2001–2005</b>				
0	68.3 [67.9–68.7]	65.9 [65.5–66.3]	73.9 [73.6–74.2]	72.2 [71.8–72.6]
20	49.6 [49.3–50.0]	47.5 [47.1–47.8]	54.9 [54.6–55.2]	53.4 [53.1–53.8]
45	28.4 [28.1–28.8]	26.7 [26.4–27.1]	32.1 [31.7–32.5]	30.8 [30.5–31.1]
65	14.5 [14.1–14.9]	13.3 [12.9–13.6]	16.8 [16.4–17.2]	15.8 [15.5–16.2]
<b>2006–2010</b>				
0	69.6 [69.3–70.0]	68.2 [67.9–68.6]	74.4 [74.0–74.8]	73.3 [73.0–73.7]
20	50.8 [50.5–51.1]	49.5 [49.2–49.8]	55.2 [54.9–55.5]	54.3 [54.0–54.6]
45	29.1 [28.8–29.4]	28.0 [27.7–28.3]	32.2 [31.9–32.5]	31.4 [31.1–31.7]
65	14.8 [14.4–15.1]	13.9 [13.6–14.2]	16.7 [16.4–17.0]	16.1 [15.8–16.4]
<b>2011–2015</b>				
0	70.1 [69.7–70.3]	n.a.	74.5 [74.2–74.8]	n.a.
20	51.1 [50.8–51.5]	n.a.	55.4 [55.1–55.7]	n.a.
45	29.3 [29.0–29.6]	n.a.	32.4 [32.1–32.7]	n.a.
65	15.0 [14.7–15.3]	n.a.	16.8 [16.5–17.1]	n.a.

Note: n.a. = not available.

Source: Enhanced Mortality Database.

Table C7 shows that estimates of Indigenous life expectancy are also sensitive to the denominator population on which they are based. Life expectancy estimates based on the back-cast Indigenous population are different from those based on the cohort-interpolated population. For both males and females, and for all ages, estimates of life expectancy based on the back-cast population are higher than estimates based on the cohort-interpolated population. This is because the back-cast population estimates based exclusively on the 2011 Census are larger than population denominators derived by interpolating between the 2001, 2006 and 2011 Censuses. A larger population denominator will lead to lower age-specific death rates, and hence to higher life expectancy estimates.

## **C5 Numerator–denominator bias**

One potential issue that arises when using administrative data sets to prepare population-based rates is the problem of numerator–denominator bias—where the numerator (the events of interest) are not drawn entirely from the population included in the denominator. This may arise where the numerator and denominator are collected by different agencies, for different purposes, using different processes of data collection, and even relating to different reference periods.

For example, in the estimation of birth, death, morbidity and hospital separation rates, the numerator—such as the number of deaths, births, hospital admissions and separations—is based on the number of persons experiencing a certain event or accessing a particular service over a defined period. Conversely, the denominator is a synthetic estimate of the population in the middle of the reference period, based on information collected at the Census. The population of events estimated by the numerator is not necessarily a subset of the population estimated by the denominator because the numerator events occur at a known point in time, and the denominator is an estimate.

The problem of numerator–denominator bias also exists in other rates, such as marriage and divorce rates, school participation rates and hospital utilisation rates, where the numerator is based on administrative data on the number of persons participating in the activity, and the denominator is an estimate of the number of people in the middle of the year.

Putting aside any issues of bias that are not specific to the Indigenous context, in this study numerator–denominator bias will occur if the deaths identified as Indigenous at the end of the linkage process do not represent all deaths in the Indigenous population as estimated, based on the Census. This means that numerator–denominator bias will occur if some deaths within the Indigenous population are not identified as Indigenous (false negatives) or deaths of people who are not from the Indigenous population are recorded as Indigenous (false positives).

The degree of numerator–denominator bias has not been estimated in this project.

# Glossary

**Aboriginal and Torres Strait Islander people:** People who identify, or are identified, as being of Aboriginal and/or Torres Strait Islander origin. See also **Indigenous person**.

**administrative data:** Information that is required by law or that is collected for the purpose or in the process of service delivery, such as providing health care (National Hospital Morbidity Database), responding to the legal requirements of registering particular events (births and deaths registration data) or providing a particular service (Residential Aged Care data set).

**age-specific death rate:** The number of deaths (registered or occurred) during the calendar year in a specified age or age group per unit of population, usually 1,000 or 100,000, of the same age or age group at the mid-point of the year.

**age standardisation:** A method of removing the influence of age when comparing populations with different age structures. This is usually necessary because death rates vary strongly with age. The age structures of the different populations are converted to the same 'standard' structure, then the death rates that would have occurred with that structure are calculated and compared.

**age-standardised death rate:** A death rate that has been age standardised to a given standard population to remove the confounding effects of the age structures of the respective populations in order to make comparison of death rates possible and meaningful.

**algorithm:** A process or set of rules used for calculation or problem-solving. In this report, 'algorithm' refers to a set of rules used to determine the Indigenous status of an individual based on a linked data set.

**blocking:** In data linkage, blocking reduces the number of comparisons needed by only comparing record pairs where links are more likely to be found. Records on each file are placed into blocks so that only record pairs that agree on certain data items are compared.

**blocking variable:** A variables used in partitioning records into blocks. Only records having the same value in a blocking variable are compared. Blocking variables must be stable, accurate and available on all the files to be linked. Examples of blocking variables are first and last name, components of first and last name, sex, components of date of birth (for example, month of birth or year of birth) and components of usual place of residence.

**clerical review:** A manual review of record pairs whose link status cannot be automatically determined from their linkage weights or linkage probabilities. Clerical review helps determine the link status of these record pairs. Clerical review can also be used to obtain a quality assessment of a linkage.

**confidence interval (CI):** A statistical term describing a range (interval) of values within which one can be confident that the true value lies, usually because it has a 95% or higher chance of doing so.

**data linkage:** The process of bringing together two or more sets of information belonging to the same person, event or place, into a single record of information. See also **record linkage**.

**deterministic linkage:** A process that ranges from simple joining of two or more data sets by a reliable and stable key to sophisticated stepwise algorithmic linkage.

**enhanced Indigenous death records:** Indigenous death records that comprise those that were originally identified as Indigenous on death registration data and those that were not but which were subsequently reclassified as Indigenous after linkage with other data sets and comparison of their Indigenous status information across corresponding records on the linked data sets.

**Ethics Committee:** A committee set up by a body or institution whose principal responsibility is to form an opinion of the acceptability or otherwise, on ethical grounds, of activities engaged in by the institution or body with which it is associated. Membership of the AIHW Ethics Committee is in accordance with guidelines specified by the National Health and Medical Research Council, and includes the Director of the Institute (or his/her representative) and eight others appointed to provide a range of expertise and experience in health and welfare research areas, including a representative from a Registry of Births, Deaths and Marriages.

**expectation of life:** An indication of how long a person can expect to live, based on the age they have already reached. Technically, it is the number of years of life remaining to a person at a particular age if death rates do not change. The most commonly used example is life expectancy at birth. See also **life expectancy**.

**false-negative link:** A pair of records belonging to the same individual or entity that is incorrectly assigned as a non-match or as not belonging to the same individual or entity.

**false-positive rate:** The proportion of all record pairs belonging to two different individuals or entities that are incorrectly assigned as links.

**fetal death (stillbirth):** Death before the complete expulsion or extraction from its mother of a product of conception of 20 or more completed weeks of gestation or of 400 grams or more birthweight. The death is indicated by the fact that after such separation the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles.

**Indigenous identification:** The process of identifying or of being identified as being of Aboriginal and/or Torres Strait Islander origin.

**Indigenous person:** A person who identifies, or is identified, as being of Aboriginal and/or Torres Strait Islander origin. See also **Aboriginal and Torres Strait Islander people**.

**Indigenous status:** The name of the variable that describes whether or not a person identifies, or has been identified, as being of Aboriginal and/or Torres Strait Islander origin.

**Indigenous under-identification:** A situation that may occur if Indigenous status is not correctly collected and recorded for all clients. While this can also lead to over-identification, the tendency has often been for Aboriginal and Torres Strait Islanders to be recorded as non-Indigenous or for their Indigenous status not to be recorded at all.

**life expectancy:** An indication of how long a person can expect to live, based on the age they have already reached. Technically, it is the number of years of life remaining to a person at a particular age if death rates do not change. The most commonly used example is life expectancy at birth. See also **expectation of life**.

**life table:** A representation of the probable years of survivorship of a defined population of subjects. It comprises any of various tables describing mortality and survival data for groups of individuals at specific times or over defined intervals. Life tables may summarise combined mortality experience by age over a brief period, usually 1 to 3 years (period life table) or may follow a cohort over time (cohort life table).

**linked record:** A record that has passed through the data linkage process and was linked to a record from the other file.

**linking variable:** A variable that is common to the data files being linked, and is used to compare records. Examples of linking variables include first name, last name, sex, full date of birth, usual place of residence, and country of birth. Linking variables can also be used as blocking variables. See also **blocking variable** and **match**.

**live birth:** The complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered liveborn.

**match:** A record pair that contains information that relates to the same unit.

**median age at death:** The age at which exactly one-half of all deaths registered (or occurring) in a given time period were deaths of people above that age and one-half were deaths below that age. It is one of the simplest measures of the level and distribution of mortality.

**Medical Certificate of Cause of Death:** A document completed by a doctor who attended to a person before their death, or a document completed by a doctor who examined a person after their death, containing information on the underlying cause of death or the train of events leading directly to death. Information on the cause of death is coded according to rules and conventions of the tenth revision of the International Classification of Diseases.

**misclassified death:** An Indigenous death record whose Indigenous status was recorded as 'non-Indigenous', 'unknown' or 'not stated' on death registration data, or an Indigenous death record whose Indigenous status on death registration data was missing.

**neonatal death:** Death of a liveborn baby within 28 days of birth.

**numerator–denominator bias:** A bias arising where the numerator and denominator of a rate or statistical measure are derived from different populations. This may occur when different data sources are used in the numerator and denominator and where the data in the numerator and denominator are collected and/or compiled, often by different agencies, under different conditions and for different purposes. An example is mortality rates where the numerator is the number of deaths compiled by the registries of births, deaths and marriages, while the denominator is the estimated resident population compiled from Census and other data.

**pass:** One iteration of a record linkage, using a particular set of blocking and matching variables. See also **blocking**, **blocking variable**, **record linkage**.

**pass structure:** A set of passes or iterations of passes, in record linkage, using particular sets of blocking and matching variables. See also **blocking**, **blocking variable**, **pass**, **record linkage**.

**Post-neonatal death:** Death of a liveborn baby after 28 days and within 1 year of birth.

**probabilistic linkage:** A method of record linkage that uses the probabilities of agreement and disagreement between a range of linkage variables. See also **linking variable**, **record linkage**.

**reclassified Indigenous death record:** An Indigenous death record that was not recorded as Indigenous on death registration data but that was deemed to be Indigenous, and subsequently reclassified as Indigenous, after linkage with comparative data sets and comparison of their Indigenous status information with corresponding records across the linked data sets.

**record linkage:** The process of bringing together two or more sets of information belonging to the same person, event or place, into a single record of information, in a way that protects individual privacy. See also **data linkage**.

**separation:** The formal process by which an admitted patient in a hospital, resident in an aged care home or resident in any other facility that provides care or treatment completes an episode of care or treatment, such as by being discharged, dying, transferring to another institution or facility or changing type of care.

**unlinked record:** A record that has passed through the data linkage process and was unable to be linked to a record from the other file.

# References

- ABS (Australian Bureau of Statistics) 1999. Standards for statistics on cultural and language diversity. ABS cat. no. 1289.0. Canberra: ABS.
- ABS 2009a. Experimental estimates and projections, Aboriginal and Torres Strait Islander Australians. ABS cat. no. 3238.0. Canberra: ABS.
- ABS 2009b. Experimental life tables for Aboriginal and Torres Strait Islander Australians, 2005–2007. ABS cat. no. 3302.055.003. Canberra: ABS.
- ABS 2009c. Estimates and projections, Aboriginal and Torres Strait Islanders, 1991–2021. ABS cat. no. 3238.0. Canberra: ABS.
- ABS 2012a. Census of population and housing 2011—details of undercount. ABS cat. no. 2940.0. Canberra: ABS.
- ABS 2012b. Census of Population and Housing—counts of Aboriginal and Torres Strait Islander Australians, 2011. ABS cat. no. 2075.0. Canberra: ABS.
- ABS 2012c. Australian demographic statistics. ABS cat. no. 3101.0. Canberra: ABS.
- ABS 2013a. Australian demographic statistics, December 2012. ABS cat. no. 3101.0. Canberra: ABS.
- ABS 2013b. Life tables for Aboriginal and Torres Strait Islander Australians, 2010–2012. ABS cat. no. 3302.0.55.003. Canberra: ABS.
- ABS 2013c. Death registrations to Census linkage project—methodology and quality assessment, Australia, 2011–2012. ABS cat. no. 3302.0.55.004. Canberra: ABS.
- ABS 2013d. Census of Population and Housing: Understanding the Increase in Aboriginal and Torres Strait Islander Counts, 2006–2011. ABS cat. no. 2077.0. Canberra: ABS.
- ABS 2014a. Estimates and projections, Aboriginal and Torres Strait Islander Australians, 2001 to 2026. ABS cat. no. 3238.0. Canberra: ABS.
- ABS 2014b. Australian Demographic Statistics, June 2014. ABS cat. no. 3101.0. Canberra: ABS.
- ABS 2015. Deaths, 2014, Australia. ABS cat. no. 3302.0. Canberra: ABS.
- AHMAC (Australian Health Ministers' Advisory Council) 2017. Aboriginal and Torres Strait Islander Health Performance Framework 2017 Report. Canberra: AHMAC.
- AIHW (Australian Institute of Health and Welfare) 2008. Australian hospital statistics, 2006–07. Cat. no. HSE 55. Canberra: AIHW.
- AIHW 2009. Australian hospital statistics, 2007–08. Health services series no. 33. Cat. no. HSE 71. Canberra: AIHW.
- AIHW 2010a. Fatal burden of disease in Aboriginal and Torres Strait Islander people 2010. Australian Burden of Disease Study series no. 2. Cat. no. BOD 2. Canberra: AIHW.
- AIHW 2010b. Indigenous identification in hospital separations data: quality report. Cat. no. HSE 85. Canberra: AIHW.
- AIHW 2010c. Australian hospital statistics, 2008–09. Health services series no. 34. Cat. no. HSE 84. Canberra: AIHW.
- AIHW 2011a. Life expectancy and mortality of Aboriginal and Torres Strait Islander people. Cat. no. IHW 51. Canberra: AIHW.

- AIHW 2011b. Principles on the use of direct age-standardisation in administrative data collections: for measuring the gap between Indigenous and non-Indigenous Australians. Cat. no. CSI 12. Canberra: AIHW.
- AIHW 2011c. Australian hospital statistics 2009–10. Health services series no. 40. Cat. no. HSE 107. Canberra: AIHW.
- AIHW 2012a. An enhanced mortality database for estimating Indigenous life expectancy: a feasibility study. Cat. no. IHW 75. Canberra: AIHW.
- AIHW 2012c. Multiple causes of death. Bulletin no. 105. Cat. no. AUS 159. Canberra: AIHW.
- AIHW 2012d. Australian hospital statistics, 2010–11. Cat. no. HSE 117. Canberra: AIHW.
- AIHW 2013. Indigenous identification in hospital separations data: quality report. Cat. no. IHW 90. Canberra: AIHW.
- AIHW 2017. Aboriginal and Torres Strait Islander Health Performance Framework 2017. Online data tables. Canberra: AIHW. <https://www.aihw.gov.au/reports/indigenous-health-welfare/health-performance-framework/data>
- Andreev EM, Shkolnikov VM & Begun AZ 2002. Algorithm for decomposition of differences between aggregate demographic measures and its application to life expectancies, healthy life expectancies, parity-progression ratios and total fertility rates. *Demographic Research* 7:499–522.
- Arriaga EE 1984. Measuring and explaining the change in life expectancies. *Demography* 21:83–96.
- Chiang CL 1984. *The life table and its application*. Malabar, Florida, USA: Robert E Krieger Publishing Co.
- COAG (Council of Australian Governments) 2008. *Intergovernmental Agreement on Federal Financial Relations: National Indigenous Reform Agreement*. Council of Australian Governments. Canberra: COAG.
- Freemantle J, Ritte R, Heffernan B, Cutler T & Iskander D 2013. *Victorian Aboriginal Child Mortality Study, Phase 1: The Birth Report—Patterns and Trends in Births to Victorian Aboriginal and Torres Strait Islander and Non-Aboriginal and Torres Strait Islander Mothers and/or Fathers 1988-2008 Inclusive*. Melbourne: The Lowitja Institute.
- Kitagawa EM 1955. Components of a difference between two rates. *Journal of the American Statistical Association* 50:1168–94.
- Li N & Tuljapurkar S 2012. On the Accuracy of Life Expectancy, Population Association of America 2012 Annual Meeting Program. San Francisco: Population Association of America.
- Pollard JH 1988. On the decomposition of changes in expectation of life and differentials in life expectancy. *Demography* 25:265–76.
- PM&C (Department of the Prime Minister and Cabinet) 2015. *Closing the Gap: Prime Minister's report*. Canberra: Australian Government.
- PM&C 2016. *Closing the Gap: Prime Minister's report*. Canberra: Australian Government.
- Ring IT, Dixon T, Lovett RW & Al-Yaman F 2016. Are Indigenous mortality gaps closing: how to tell, and when? *Medical Journal of Australia* 205:11.
- Shryock HS & Siegel JS 1976. *The methods and materials of demography*. Orlando: Academic Press, Inc.

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# Related publication

The following AIHW publication might also be of interest:

AIHW (Australian Institute of Health and Welfare) 2012. An enhanced mortality database for estimating Indigenous life expectancy: a feasibility study. Cat. no. IHW 75. Canberra, AIHW.



This report examines Indigenous mortality and life expectancy during the period 2001 to 2015, based on evidence from the Enhanced Mortality Database. The study observed increases in life expectancy during the study period for both Indigenous males and females across most jurisdictions. Life expectancy however increased faster among non-Indigenous than among Indigenous males and females. As a result, there was little change in the life expectancy gap.

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