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Australian Institute of
Health and Welfare

The Enhanced Indigenous Mortality Data Collection

An evaluation of input data and
estimated trends in Indigenous life
expectancy 2011–2018

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The Enhanced Indigenous Mortality Data Collection: an evaluation of input data and estimated trends in Indigenous life expectancy 2011–2018

Australian Institute of Health and Welfare
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Summary

Progress against the target to close the gap in life expectancy within a generation, by 2031, is measured using estimates produced by the Australian Bureau of Statistics (ABS). The Enhanced Indigenous Mortality Data Collection (EIMDC), and its predecessor, the Enhanced Mortality Database (EMD) were created by the AIHW to assess the feasibility of providing more frequent estimates of Indigenous life expectancy at both the national and sub-national levels to support the “Closing the Gap” reporting.

The EIMDC contains information on enhanced Indigenous identification, fact of death, cause of death and demographic information for all registered deaths that occurred in Australia between 1 January 2011 and 31 December 2018.

This report presents results using the EIMDC to estimate the levels, age-sex patterns and trends in Indigenous and non-Indigenous mortality and life expectancy, as well as the gap between Indigenous and non-Indigenous mortality and life expectancy, over the period 2011–2018. The report also presents estimates of the relative contribution of different age groups and causes of death to the gap in life expectancy between Indigenous and non-Indigenous Australians.

The Indigenous and non-Indigenous mortality and life expectancy estimates were calculated using the EIMDC and a cohort-interpolated denominator population calculated from Australian Bureau of Statistics (ABS) back-cast and projected Indigenous population based on the 2011 and 2016 censuses of Population and Housing, and the Indigenous estimated resident population from the 2021 Census of Population and Housing.

A number of mortality measures and indicators – namely, age-specific death rates, the cumulative proportions of deaths occurring by specified ages, and age-standardised death rates – have shown that mortality has declined, albeit slightly, in most age groups for both Indigenous males and females across the 6 jurisdictions considered. There were also similar declines in mortality for non-Indigenous males and females.

The analysis shows that in 2016–2018, Indigenous life expectancy was estimated to be about 72 years for males and about 77 years for females. About 50% of Indigenous males now survive to age 74–77, while 50% of Indigenous females now survive to age 77–82. There are wide variations in the estimates of Indigenous life expectancy between states and territories.

During the reference period 2011–2013 to 2016–2018, estimated life expectancy at birth increased by about 0.6 years for both Indigenous males and females. At the same time, estimated life expectancy at birth increased by about 0.7 years for non-Indigenous males and by about 0.5 years for non-Indigenous females.

Within age groups, mortality among Indigenous males aged 45–64 and among Indigenous females aged 65 and over contributed the most to the gap in estimated life expectancy between Indigenous and non-Indigenous Australians. Within causes of death, deaths from circulatory diseases, injuries and neoplasms were the main contributors to the gap in life expectancy between Indigenous and non-Indigenous males and between Indigenous and non-Indigenous females.

While the EIMDC has produced promising results, estimation of Indigenous life expectancy involves many challenges, including random variation in death counts, inconsistency in Indigenous identification between the death data and the denominator population, the absence of a dedicated, ongoing and reliable population-at-risk to underpin the mortality and life expectancy estimates as well as differences between jurisdictions in the protocols and processes for identifying and recording Indigenous identification on death data. These challenges make estimation of life expectancy challenging in some jurisdictions and contribute to uncertainty about time trends and comparisons between jurisdictions.

The AIHW is investigating and consulting on measures to address these problems, including the possibility of using linked datasets to define the population at risk in a way that is consistent with the deaths data. Future AIHW publications will describe these methods in more detail and evaluate their performance.

1 What this report is about

Official life expectancy estimates for Indigenous Australians are produced every 5 years by the Australian Bureau of Statistics. The purpose of this report is to present key indicators of mortality and life expectancy 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 13 months following a census (ABS 2013a). The AIHW method is based on linking all death registrations for a specified period with other administrative data sets that contain information on Indigenous status.

As well as providing Indigenous life expectancy estimates that complement the official ABS estimates, the AIHW method enables estimates to be made for jurisdictions with small Indigenous populations, such as Victoria and South Australia, for which official life expectancy estimates are currently not available.

This report is the fourth in a series of analytical reports by the Australian Institute of Health and Welfare's (AIHW) on using enhanced death data from the Enhanced Indigenous Mortality Data Collection (EIMDC) and its predecessor, the Enhanced Mortality Database (EMD), to assess the feasibility of providing more frequent estimates of Indigenous life expectancy at both national and sub-national levels to support "Closing the Gap" reporting (AIHW 2012a, 2017a, 2019).

The current iteration of the EIMDC contains information on enhanced Indigenous identification, fact of death, cause of death and demographic information for all registered deaths that occurred in Australia between 1 January 2011 and 31 December 2018. The EIMDC will be updated every year as new data become available and are linked.

The Indigenous and non-Indigenous mortality and life expectancy estimates presented in this report were calculated using the EIMDC enhanced deaths data and denominator populations based on Australian Bureau of Statistics (ABS) estimates. These include ABS back-cast and projected Indigenous population based on the 2011 and 2016 censuses of Housing and Population, and the Indigenous estimated resident population from the 2021 Census of Population and Housing.

Estimates of age-sex patterns and trends in Indigenous and non-Indigenous mortality and life expectancy were carried out over the period 2011–2018 using linked data, and for the period 2019–2021 using projected data based on mortality enhancement factors derived from the 2016–2018 linked data. The report also examines the gap between Indigenous and non-Indigenous mortality and life expectancy and presents the contribution of causes of death and age patterns of mortality to the gap in life expectancy between Indigenous and non-Indigenous Australians.

The EIMDC has produced promising results. For instance, whereas earlier linked data sets linked less than 80% of in-scope death records to at least one other data set, the EIMDC has achieved link rates of 96%. However, some challenges remain. The report describes ongoing and planned work to improve Indigenous identification in deaths data, to develop more reliable denominator populations, and to produce more reliable, timely and detailed estimates of Indigenous mortality and life expectancy on a regular basis.

Some of the challenges include:

- inconsistency in Indigenous identification between the death records and the population data on which any estimates of mortality and life expectancy are based which makes it difficult to estimate trends in Indigenous life expectancy due to the discrete nature of the census-based population denominators on which the life expectancy estimates are based.
- inconsistency in Indigenous identification across linked data sets
- variations in linkage rates according to age at death, year of death and the jurisdiction where the death occurred and was reported.
- small cell counts and random variations in the distribution of deaths by age and jurisdiction of usual residence.
- the cumbersome, complex and time-consuming nature of the current process of obtaining jurisdictional hospital, aged care, perinatal and birth registration data from multiple jurisdictional data custodians for linkage to create enhanced death data.

The current approach to estimating indigenous mortality and life expectancy using the EIMDC began well before the advent of large-scale linked administrative databases such as the Multi-Agency Data Integration Project ([MADIP](#)), National Integrated Health Services Information Analysis Asset ([NIHSI AA](#)), and the [National life events initiative](#). To address the challenges above, the AIHW is exploring an extension of the EIMDC, using epidemiological methods with the linked national databases to estimate Indigenous mortality and life expectancy. Consulting on this approach and exploring the feasibility of the extended epidemiological approach will form the next phase of the Indigenous life expectancy project.

1.1 Structure of the report

The report is organised into 6 chapters.

Chapter 1 describes the background and aims of the EIMDC project.

Chapter 2 discusses the history and structure of the EIMDC and the considerations that guided the choice of data sources, data linkage methodology, and algorithms to enhance Indigenous identification in death records.

Chapter 3 discusses the evaluation of the data sources linkage, and potential biases in data sources, including choice of population denominator, and choice of algorithm.

Chapter 4 examines various mortality estimates based on the EIMDC and the insights these provide for closing the life expectancy gap.

Chapter 5 discusses Indigenous life tables and measures derived from the life tables based on the EIMDC, including life expectancy, the life expectancy gap and survival ratios.

Chapter 6 discusses preliminary estimates of Indigenous and non-Indigenous life expectancy for Australia for the period 2019–2021 based on the application of Indigenous identification reclassification rates estimated from linked data for 2016–2018 to unlinked deaths data for 2019–2021.

Chapter 7 discusses the strengths and weaknesses of the EIMDC estimates, and considers possible extension of the EIMDC, using an epidemiological approach to estimate Indigenous mortality and life expectancy in order to avoid some of the difficulties identified.

2 History and structure of the EIMDC

The EIMDC project, and its predecessor, the Enhanced Mortality Database (EMD) project, were developed to provide robust estimates of Indigenous mortality and life expectancy to support the Australian Government's 2008 and 2020 initiatives to close the gap in life expectancy between Indigenous and non-Indigenous Australians.

In 2008, the Council of Australian Governments (COAG) committed to various strategies to closing the gap between Indigenous and non-Indigenous Australians (COAG 2008). Among these strategies were 2 key initiatives aimed at:

- closing the gap in life expectancy between Indigenous and non-Indigenous Australians within a generation
- halving the gap in mortality rates between Indigenous and non-Indigenous children under 5 within a decade.

The measurement of these 2 Closing the Gap initiatives requires robust measures of Indigenous and non-Indigenous mortality and life expectancy. Robust measures of the levels, patterns and trends of mortality and life expectancy are also needed to monitor and evaluate the effectiveness of government and community programs in closing the gap.

In July 2020, the Joint Council on Closing the Gap updated the 2008 Closing the Gap but kept the 2008 target to

- Close the Gap in life expectancy within a generation, by 2031 (Joint Council on Closing the Gap 2020).

Although virtually all deaths that occur in Australia are registered and included in the [National Death Index \(NDI\)](#), not all Indigenous deaths are identified as such during the death registration process. Thus, while the NDI contains all the deaths and demographic information required to prepare life expectancy measures, it lacks reliable information on Indigenous identification.

Because of this incompleteness of information on Indigenous identification in death records, ABS life expectancy estimates are published for only the 4 jurisdictions (New South Wales, Queensland, Western Australia and the Northern Territory) deemed to have the least incomplete Indigenous deaths data (ABS 2013a).

ABS Indigenous mortality estimates are published for only 5 jurisdictions – South Australia and the 4 listed above. These official mortality estimates are not adjusted for Indigenous under-identification and are therefore subject to error, as the missing Indigenous deaths could be different in characteristics from those that are identified (ABS 2015).

Previous work undertaken by the AIHW and the ABS has shown that the quality of reporting of Indigenous identification in death data varies by age and sex, and also between jurisdictions. Not adjusting the official deaths data for Indigenous under-identification obscures not only the true levels, patterns and trends of mortality and life expectancy in these jurisdictions, but also the gap between Indigenous and non-Indigenous life expectancy, and the differences between jurisdictions in their mortality and life expectancy parameters.

This means that the impact of Closing the Gap policies and programs cannot be accurately determined while there are inconsistencies in Indigenous identification in deaths data across age-sex groups and jurisdictions, and while official life expectancy estimates cannot be produced for jurisdictions such as Victoria, South Australia, Tasmania and the Australian Capital Territory.

To address some of the issues regarding Indigenous under-identification in death data, the AIHW developed the EMD project, which was subsequently endorsed and supported by the Council of Australian Governments, to add to the efforts by Australian, state and territory departments and statistical agencies, and the research community, to find solutions to the problems of Indigenous identification in death data.

The EMD project was initially conceived and implemented as a series of ad hoc feasibility studies. Its aim was to explore the feasibility of using data linkage to enhance Indigenous identification in registered death data, by linking the registered death data to independent and specially selected national and jurisdictional data sets that contain information on Indigenous identification, and comparing the Indigenous status of linked records across these data sets.

The EMD feasibility study which covered the period 2001–2010 provided proof of concept for the use of data linkage to enhance Indigenous identification in official mortality data.

The EMD has now been replaced by the EIMDC, which unlike its predecessor is designed as a permanent and ongoing data collection. It contains information on enhanced Indigenous identification and fact of death, including cause of death, from 2011 on an ongoing basis.

Further information on the EMD projected, including the linkage method and the data sets linked, can be found in the first and second project reports (AIHW 2012a, 2017a).

2.1 Aims and objectives of the EIMDC

The EIMDC was established to enable the AIHW to fulfil its obligations, as Australia's national health statistics agency, to produce accurate and timely Indigenous life expectancy estimates for ongoing reporting to support the Australian and state and territory governments' policy initiatives towards closing the gap in life expectancy between Indigenous and non-Indigenous Australians.

The EIMDC was also established to support analysis that will be used to monitor progress towards Australian, state and territory governments' Closing the Gap initiatives.

Specifically, the aim of the EIMDC was to enable the AIHW to produce yearly life expectancy estimates for all jurisdictions, including Victoria, South Australia, Tasmania and the Australian Capital Territory for which official life expectancy estimates could not hitherto be produced, and also to enable Indigenous life expectancy estimates to be produced at the sub-state level, including for Indigenous regions and remoteness areas.

2.2 Data sets and methods used to create the EIMDC

The first iteration of the EIMDC was created by linking records of all deaths that occurred throughout Australia during the period 1 January 2011 to 31 December 2018 to their corresponding records in selected independent hospital, aged care, perinatal and birth registration data sets.

As the EIMDC is a permanent and ongoing data collection, it will be updated yearly as new data become available and are linked.

2.2.1 Data sets

The data sets that were linked to create the first iteration of the EIMDC consist of:

- Death registrations
 - [National Death Index \(NDI\)](#)
 - [AIHW National Mortality Database \(NMD\)](#)
- Hospital data sets from various jurisdictions, comprising:
 - Admitted Patient Care (APC)
 - Non-Admitted Patient Episode of Care (NAPEC) database or Outpatient Care database
 - Emergency Department (ED) database
- [AIHW National Aged Care Data Clearinghouse](#)
- Perinatal Data Collection
- Birth registration data sets.

While registered death, hospital and aged care data are available from national data sets, birth registration and perinatal data sets are available only from state and territory data sets. Birth registrations data were available for all jurisdictions, while perinatal data were available for all jurisdictions except Queensland.

In addition to national hospital and aged care data, Western Australia separately provided its own hospital data sets (APC and ED), while in addition to national hospital data, the Northern Territory separately provided its own hospitals data sets in the form of the Hospital Inpatient Activity (IA) Data Collection, Hospital Outpatient Activity (OA) Data Collection and Emergency Department Presentations Data Collection.

2.2.2 Linkage strategy

The EIMDC was created by linking the NDI and NMD to various state, territory and national hospital, residential aged care, birth registrations and perinatal data collections listed in section 2.2.1. Linkage was probabilistic.

To enhance the quality of the linkage, the NDI was first linked to the NMD to check for completeness and consistency of information in the NDI, such as for sex, date of birth, date of death, age at death, and place of usual residence at time of death. Linkage of the NDI to the NMD also enabled the AIHW to obtain additional information, such as cause of death and Indigenous status, and to check for duplicate and missing records.

The cohort and scope for this linkage was all records in the NDI with dates of death between 1 January 2010 and 31 December 2018. The overall linkage strategy was to link all hospitals, aged care, birth registrations and perinatal data to the NDI via the AIHW's National Linkage Map, which was created by the AIHW as a tool for data linkage within the AIHW.

The National Linkage Map contains records of all individuals who have registered with Medicare since 1984. There are 33 million people listed in the National Linkage Map. Identifiers available for linkage include all names (3 given names and surname), dates of birth, sex and address (both residential and mailing). Variations on all these items are available to use in linkage. This feature improves linkage rates and quality. Second and third given names are available for 77% and 4% of records, respectively.

Linking to the National Linkage Map, rather than directly to the NMD, ensured that individuals were linked to their best candidate, either dead or alive. This strategy reduced the likelihood of incorrect links to deceased relatives who had lived at the same residential address.

This strategy was adopted so that Medicare person identification numbers (PINs) from the Medicare Consumer Directory (MCD) could be used to identify individuals. The MCD is a reliable identifier of individuals in Australia. Using the Medicare PINs reduced the likelihood of duplicates existing in the final data collection, and ensured that all perinatal, aged care and hospital Indigenous identifiers could be brought together. Linkage information from the MCD was used only to improve data linkage. No output data were sourced from the MCD.

As part of this intermediate linkage, 1,377,330 NDI records covering the period 1 January 2010 to 31 December 2018 were linked to the MCD, and 1,377,330 records with enhanced personal identifiers for linkage were returned. No duplicate records were produced.

2.2.3 Results of data linkage

The improved linkage strategy used for the EIMDC compared to the earlier EMD is reflected in the improved linkage rates between the NDI and the hospitals data, and between the NDI and aged care data. Of the 1,377,330 records in the NDI scope (2010–2018), 1,073,222 were found in the national hospital data, giving a linkage rate of 77.9%. The proportion of death records that linked to national hospital data was higher than the proportion of deaths that occur in hospital, which is 55%–60% (ABS 2021; AIHW 2017b) This discrepancy is probably because hospital data include all people with hospital or emergency department records, not just those who died in hospital.

Similarly, of the 1,377,330 records in the NDI scope, 566,674 were found in the Residential Aged Care (RAC) database, giving a linkage rate of 41.1%. The proportion of deaths linked to the RAC database is higher than the proportion of deaths that occur in aged care, which is 30%–35% (ABS 2021; AIHW 2021). This discrepancy could be because RAC includes all people with an RAC record, and not just those who died in care.

Compared to earlier EMD linkage, many more records linked to a corresponding record on another data set in the EIMDC

In the previous EMD linkage, only 74.7% and 78.1%, respectively, of 2001–2005, and 2006–2010 in-scope NDI records could be linked to at least one other data set. This means that about 1 in 4 NDI records could not be linked to a corresponding record on another data set (Table 2.1). By contrast, in the current EIMDC linkage, 95.9% of all in-scope NDI records were able to be linked to a corresponding record on at least one other data set.

Table 2.1: Number of records linked to a corresponding record on another data set

Number of records linked	EMD				EIMDC	
	2001–2005		2006–2010		2011–2018	
	No.	%	No.	%	No.	%
Linked to at least 1 other data set	491,621	74.7	546,250	78.1	1,183,914	95.9
Not linked to any other data set	166,144	25.3	153,522	21.9	51,029	4.1
Total	657,765	100.0	699,772	100.0	1,234,943	100.0

Source: Enhanced Indigenous Mortality Data Collection

The higher linkage rate in the current EIMDC linkage could be due in part, not only to the linkage strategy outlined above, but also to the inclusion in the current linkage of the hospital ED and NAPEC databases. These databases were not included in previous linkages, and

could explain, in part, the high proportion of NDI records (21%–25%) that could not be linked to any other data set in the previous EMD linkage.

Previous analysis of EMD data showed that the number of deaths that occurred in hospital or in a residential age care facility accounted for up to 85% of all deaths that occurred in Australia (AIHW 2012a, 2017a). This means that up to 15% of death records would not be in the hospital or residential aged care databases. The inclusion of the hospital ED and NAPEC data sets in the current EIMDC linkage meant that NDI records that previously could not be linked to any other data set now had a greater chance of being linked.

Table 2.2 shows that of all records that linked to another data set in the previous EMD linkage (2001–2005 and 2006–2010), about 90% linked to only 1 data set, while 10% linked to 2 or more data sets.

In the EIMDC linkage of 2011–2018, only about 12% of all records linked to only one data set, 43% to 2 data sets, 36% to 3 data sets, and just under 10% linked to 4 or more data sets (Table 2.3). Higher proportions of Indigenous records linked to only 1 or 2 other data sets, while lower proportions linked to 3 or 4 or more data sets.

Compared with the previous EMD linkage of 2001–2010, 88% of records in the current EIMDC linkage linked to 2 or more data sets (Table 2.3), while only about 10% of records in the previous EMD linkage linked to 2 or more data sets (Table 2.2).

Table 2.2: Number of data sets that linked to the NDI among all linked NDI records, EMD

Number of data sets that NDI records were linked to	2001–2005		2006–2010		Total	
	No.	%	No.	%	No.	%
1 only	443,644	90.2	488,960	89.5	932,604	89.9
2 or more data sets	47,978	9.8	57,290	10.5	105,268	10.1
Total	491,622	100.0	546,250	100.0	1,037,872	100.0

Source: Enhanced Indigenous Mortality Data Collection

The number of data sets that a record in the NDI is linked to has implications for algorithms that could be used to determine Indigenous status. The greater the number of data sets that linked to the NDI, the greater the number and types of algorithms that could be developed to enhance Indigenous identification in the death records.

In the previous EMD linkage, apart from the perinatal data set, only 2 major data sets were linked to the NDI. These were the RAC data set, and the National Hospital Morbidity Database, which comprised mostly APC data.

The National Hospital Morbidity Database used in the previous EMD linkage had only one Indigenous status value, while in the current EIMDC linkage there is an Indigenous status value for each of the 3 hospital data sets (APC, ED and NAPEC), and also an Indigenous status value for each episode of care.

Similarly, in the EMD linkage, whereas each record on the RAC data set had only one Indigenous status value, in the current linkage, there were 2 RAC data sets, RAC_Resi (comprising mostly long-term residential aged care data) and RAC_TCP (comprising transitional care program data). Not only was there an Indigenous status value for each record on each of these 2 data sets, but each record also had as many Indigenous status entries as there were episodes of care. Up to 8 years of birth registration data were also included in the current EIMDC linkage, whereas these were not used in the EMD linkage.

In the EMD linkages of 2001–2005 and 2006–2010, only 75%–78% of all in-scope NDI records linked to another data set, while about 90% of all linked records linked to only one

other data set. This minimised the types and choice of algorithms that could have been developed and applied to the linked data to enhance Indigenous identification on the death records. As a result, the choice of algorithms was limited to the 'Ever Indigenous' algorithm.

Table 2.3: Number of data sets that linked to the NDI among all linked NDI records, EIMDC, 2011–2018

Number of data sets that linked to the NDI	Number of NDI records: EIMDC 2011–2018					
	Indigenous		Non-Indigenous		Total	
	No.	%	No.	%	No.	%
1	4,106	18.7	134,735	11.6	138,841	11.7
2	11,142	50.8	492,901	42.4	504,043	42.6
3	5,520	25.1	422,195	36.3	427,715	36.1
4 or more	1,187	5.4	112,128	9.7	113,315	9.6
Total	21,955	100.0	1,161,959	100.0	1,183,914	100.0

Source: Enhanced Indigenous Mortality Data Collection

In the current linkage, on the other hand, up to 95% of all records could be linked to a corresponding record on a hospital, aged care, birth registration or perinatal data set, and over 88% of linked records could be linked to 2 or more data sets. In this scenario, not only were more algorithms possible, but the Ever Indigenous algorithm was likely to be unreliable and it stood the risk of exaggerating Indigenous identification.

The choice of algorithms possible from the current linkage was wider and extended to other frequency-based algorithms such as the 'within and across' data sets approach. This approach was identified as more reasonable, as it took into account how an individual identified across multiple episodes of care and across multiple data sets (AIHW 2012b).

The 'within and across' data sets algorithms were found to be particularly applicable to data sets such as the APC, ED, NAPEC and RAC data sets where a person could have had multiple episodes of care over many years, and an Indigenous status value was expected to be recorded during each episode of care.

2.2.4 Creation of the EIMDC

After data linkage, all the linked data sets were merged to create the first iteration of the EIMDC. It covers the period 1 January 2011 to 31 December 2018, and contains 1,234,943 records. The EIMDC will be updated yearly as new data become available and are linked.

The EIMDC contains fact of death information from the NDI and NMD, including cause of death and demographic information, as well as information on Indigenous identification from the linked hospital, aged care, perinatal and birth registration data sets.

2.2.5 Algorithms to enhance Indigenous identification in death data

Because of Indigenous under-identification in death data, algorithms were developed and used to enhance Indigenous identification on the death records within the EIMDC. To develop the algorithms, Indigenous identification was compared across the linked data sets. The results of the comparison were then used to develop 4 algorithms to enhance Indigenous identification on the death records.

Some data sets had only one Indigenous identification value for each record while other data sets had multiple values of Indigenous identification. For example, the NDI had only one value of Indigenous identification for each record since a person could only die once. Similarly, a baby was only born once, and their birth was registered only once during their lifetime, so each baby only had only one value of Indigenous identification.

On the other hand, a person could have multiple values of Indigenous identification in their hospital and aged care records depending on the number of episodes of care that they received when they were alive. Aged care comprises both transitional care and permanent care, and individuals could have multiple episodes of care across the 2 programs during their lifetime. Information on Indigenous identification was independently collected and recorded during each episode of care.

In developing the algorithms, consideration was therefore given to the number of times a record was identified as Indigenous within a data set and across data sets.

The following factors were also taken into consideration in the creation of the algorithms:

- number of data sets that were able to be linked to the NDI
- number of records in the NDI that linked to a corresponding record on another data set
- number of corresponding records that each record in the NDI could be linked to
- the consistency in Indigenous identification between records in the NDI and records on the data sets that were linked to the NDI
- the consistency in Indigenous identification between linked record pairs
- number of times a record was identified as Indigenous within a data set and as Indigenous across data sets.

The initial set of algorithms developed considered the number of times a record was identified as Indigenous during multiple episodes of care within a given data set.

The initial set of algorithms were:

Indigenous on the NDI: A record was deemed Indigenous if it was identified as Indigenous on the NDI. This was the original Indigenous identification attached to a record.

Ever Indigenous : A record was deemed Indigenous if it was identified as Indigenous in at least one data set.

Under the *Majority Indigenous* algorithm, a person was deemed Indigenous if the person was recorded as Indigenous in a majority of episodes of care within the same data set *and* in a majority of data sets across all linked data sets.

Under the *2-Plus Indigenous* algorithm, a person was deemed Indigenous if the person was recorded as Indigenous in 2 or more episodes of care within the same data set *and* as Indigenous across 2 or more data sets.

Under the *Always Indigenous* algorithm, a person was deemed Indigenous if the person was recorded as Indigenous in all episodes of care within the same data set *and* as Indigenous across all data sets.

Application of the initial algorithms showed that there was a high level of inconsistency in Indigenous identification between data sets (see Section 3.2), as a result of which a large number of records that were non-Indigenous on the NDI were deemed Indigenous according to the *Ever Indigenous* algorithm. The high level of inconsistency in Indigenous identification between data sets also meant that many records were Indigenous on only one other data set and not on multiple data sets. This situation was most relevant for the *Majority*, *2-Plus* and *Always Indigenous* algorithms.

Therefore, the initial criteria under which a record could be deemed Indigenous under the *Majority*, *2-Plus* and *Always Indigenous* algorithms seemed to be too stringent and should be relaxed by resorting to an *Ever Indigenous* algorithm within data sets while retaining the *Majority*, *2-Plus* and *Always Indigenous* algorithms between data sets.

The algorithms were therefore revised as follows:

Ever Indigenous : A record is deemed Indigenous if it is identified as Indigenous in at least one data set.

Majority Indigenous: A record is deemed Indigenous if it is identified as Indigenous at least once within a data set or at least once across multiple episodes of care within the same data set *and* in a majority of data sets across all linked data sets.

2-Plus Indigenous: A record is deemed Indigenous if it is identified as Indigenous at least once within a data set or at least once across multiple episodes of care within the same data set *and* as Indigenous across 2 or more linked data sets.

Always Indigenous: A record is deemed Indigenous if it is identified as Indigenous at least once within a data set or at least once across multiple episodes of care within the same data set *and* as Indigenous across all linked data sets.

Based on these algorithms, 5 series of Indigenous deaths were extracted. Deaths that were not deemed Indigenous according to each of these algorithms were deemed to be non-Indigenous. The extracted deaths were then used as the input data for the estimation of mortality rates and for the development of Indigenous and non-Indigenous life tables.

2.2.6 Indigenous misclassification and reclassification

Analysis of the EIMDC revealed the following issues relating to Indigenous identification:

- records with missing information on Indigenous identification on the NDI that were deemed to be Indigenous after data linkage and the application of the algorithms
- records that were originally identified on the NDI as non-Indigenous, but deemed to be Indigenous after data linkage and the application of the algorithms
- records that were originally identified on the NDI as Indigenous, but deemed to be non-Indigenous after data linkage and the application of the algorithms.

The totality of these issues is referred to in this report as ‘misclassification of Indigenous identification’ or Indigenous misclassification. Records with misclassified Indigenous identification were reclassified as either Indigenous or non-Indigenous after data linkage and the application of relevant algorithms. Reclassified records include records that changed status from non-Indigenous to Indigenous and from Indigenous to non-Indigenous. Reclassification rates could therefore be estimated by comparing the number of records originally classified on the NDI as Indigenous and the number of records now deemed Indigenous after data linkage and the application of a relevant algorithm. Misclassification and reclassification rates are more fully discussed in Section 3.3 (see also Table 3.2).

2.2.7 Unlinked records

A small percentage of NDI death records (4%) could not be linked to a corresponding record on any of the hospital, aged care, birth registration or perinatal data sets (Table 2.1). The Indigenous status on these records could therefore not be verified against the Indigenous status of the independent data sets linked to the NDI, and consequently, the algorithms for enhancing Indigenous identification could not be applied to these records.

To address possible misclassification of Indigenous status on the unlinked death data, it was assumed that the unlinked death records would be subject to the same pattern of Indigenous misclassification as was observed among linked records. Given this assumption, age-sex reclassification rates, based on each algorithm, were estimated by comparing the number of linked death records classified as Indigenous under the 4 algorithms with the number of linked death records originally classified as Indigenous on the NDI.

The estimated reclassification rates observed among linked death records were then applied separately by age, sex and jurisdiction of usual residence to the unlinked records. This application yielded an estimate of reclassified Indigenous deaths, by age and sex, among unlinked death records in each jurisdiction. These reclassified deaths were then added to the 96% of linked death records whose Indigenous status had been verified and enhanced.

This approach is fully described in Section 1.4.3 in earlier AIHW reports (AIHW 2012a, 2017a).

Unlinked data for the period 2011–2018

While the percentage of unlinked records was about 4% nationally, it varied by age and sex as well as by jurisdiction of usual residence. Figure 2.1 shows unlinked records by sex, year of death and jurisdiction of usual residence for all death records on the NDI, as well as separately for records classified as Indigenous on the NDI.

The percentage of all NDI records that were unlinked was between 2% and 10% in all jurisdictions except South Australia and the Northern Territory, while the percentage of unlinked records classified as Indigenous on the NDI was up to 15% except in South Australia the Northern Territory, where the percentages were also higher.

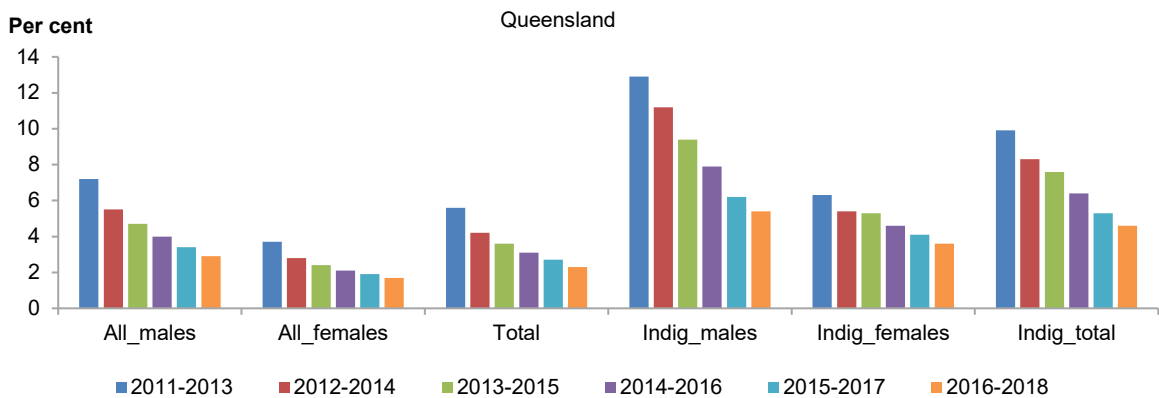
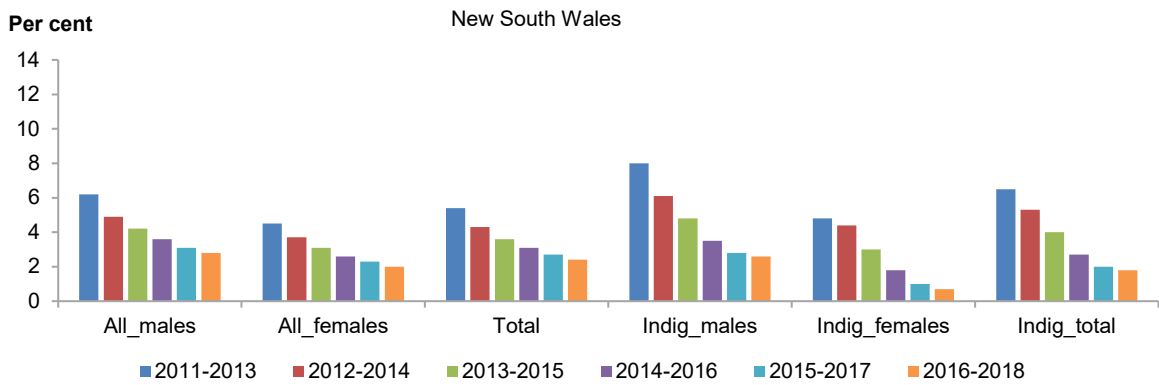
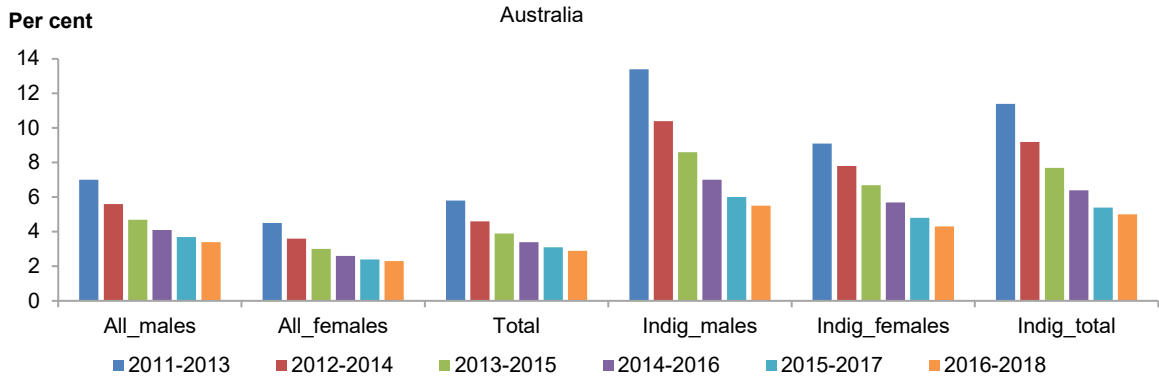
The percentage of unlinked records declined consistently in most jurisdictions, except in Victoria, where the percentages varied from one year to the next, and no clear pattern was discernible.

Although very high percentages of unlinked death records were reported for the Northern Territory, this did not affect the quality of Indigenous identification on their deaths records as the Northern Territory provided one consistent Indigenous identification per person across all its hospital data sets, comprising the Hospital Inpatient Activity and Hospital Outpatient Activity data collections, as well as the Emergency Department Presentations.

For other jurisdictions, especially Victoria and South Australia, there are implications for the high but declining percentage of unlinked NDI records. Firstly, the Indigenous status of the percentage of unlinked records cannot be directly verified and would have to be enhanced using enhancement factors based on linked records. Since fewer records were linked in these jurisdictions, the enhancement factors would be less stable and less representative than enhancement factors in other jurisdictions with higher linkage rates.

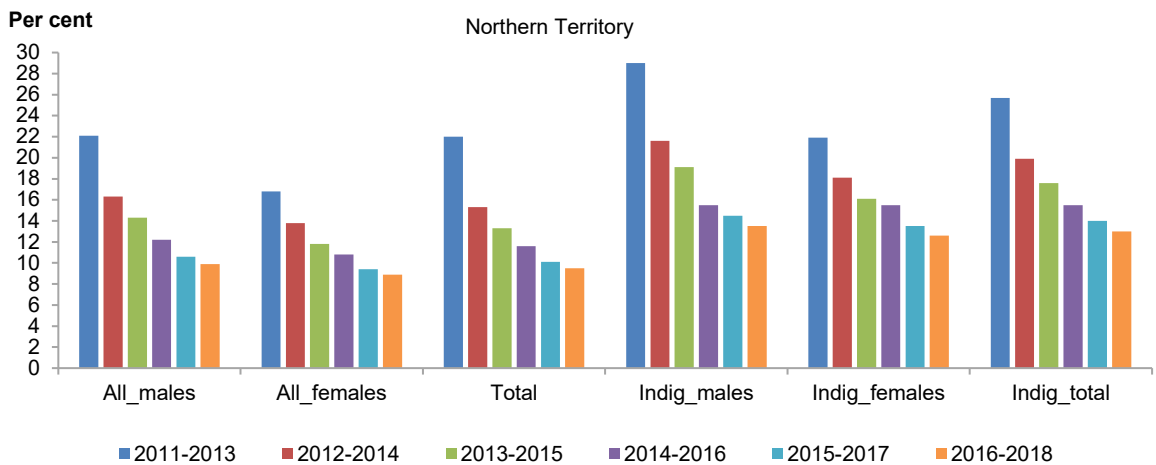
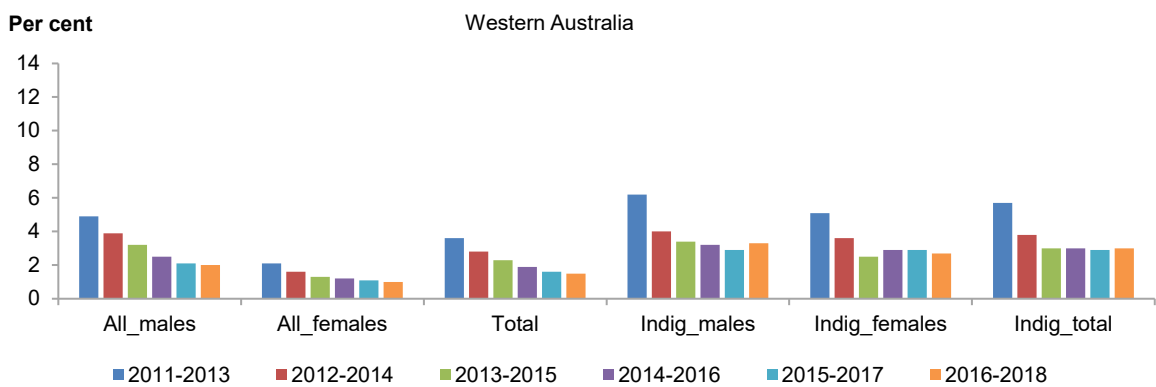
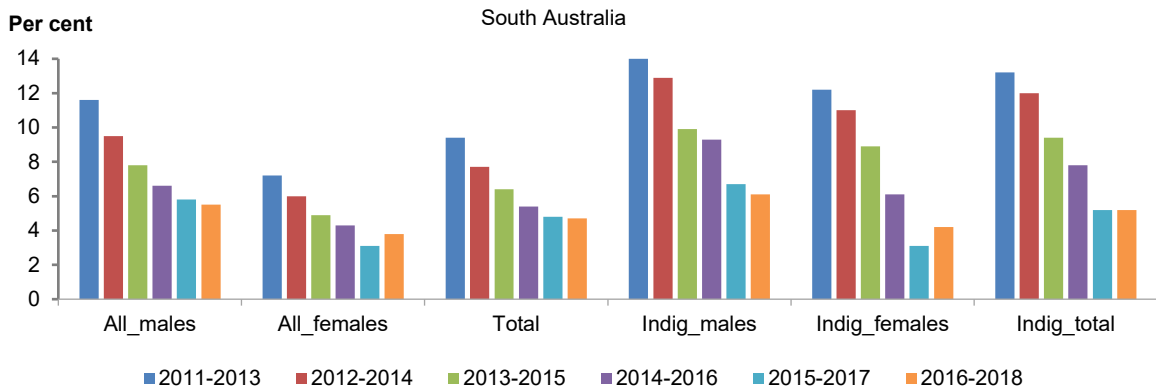
Secondly, if increasing linkage rates lead to more Indigenous deaths being identified, then they could create the spurious trend of increasing Indigenous death rates, and declining life expectancy.

Figure 2.1: Percentage of unlinked NDI records, selected jurisdictions



continued

Figure 2.1: Percentage of unlinked NDI records, selected jurisdictions (continued)



Note: Despite the high percentage of unlinked records in the NT, misclassification rates of Indigenous identification were very low in the NT because the NT Department of Health provided one consistent Indigenous identification per person across its Hospital Inpatient Activity and Hospital Outpatient Activity data collections, as well as the Emergency Department Presentations

Source: Enhanced Indigenous Mortality Data Collection.

2.3 Population denominators

Of critical importance to the mortality and life expectancy estimates presented in this report is the choice of a denominator population. An appropriate denominator population is required to prepare the mortality measures shown in Chapter 4 and the age-specific death rates that served as the input data for the life expectancy estimates shown in Chapter 5.

There is a choice of 3 denominator populations:

- the ABS back-cast and projected Indigenous population estimates based on the most recent Census (2021) [only the 2016 Census projections and back-cast population are able to be used because a final estimated resident population (ERP) from the 2021 Census is not yet available].
- cohort-interpolated Indigenous population estimates based on the relevant censuses that straddle the reference period; thus, for the current mortality and life expectancy estimates covering the period 2011–2018, the cohort-interpolated population will be based on the 2011, 2016 and 2021 censuses.
- linear-interpolated Indigenous population estimates based on the relevant censuses that straddle the reference period; for the current mortality and life expectancy estimates covering 2011–2018, the linear-interpolated population will be based on the 2011, 2016 and 2021 censuses.

The strengths and weaknesses associated with using either the back-cast or cohort-interpolated populations as a denominator population were explored in 2 previous publications (AIHW 2017a, 2019), where estimates based on the 2 denominator populations were compared. The linear-interpolated population is discussed in Section 2.3.2 along with the cohort-interpolated population.

2.3.1 Indigenous ERP, back-cast and projected population

After each census, the ABS prepares an Indigenous ERP at 30 June of the census year, based on the latest census. From the Indigenous ERP at 30 June of the census year, the ABS prepares 10 years back-cast and 15 years forward estimates or projections of the Indigenous population using assumptions about future fertility, paternity, mortality and migration (ABS 2019). For the 2016 Census, the back-cast and projected Indigenous population covered a period of 25 years from 2006 to 2031.

The advantage of the Indigenous ERP and back-cast and projected Indigenous populations is that they represent a demographically-consistent population, and are based on the most recent census. The ABS believes them to be the most accurate and up-to-date series and advises that, wherever possible, they should be used (ABS 2014).

Several issues must be taken into consideration when deciding whether to use the back-cast and projected Indigenous population for preparing trend estimates. These include:

- the Indigenous identification information that is used in the preparation of the 25 years back-cast and projected Indigenous population is anchored on a single census, that is, the most recent census, and does not change over the course of the estimates
- due to changing Indigenous identification and changes in census methodology:
 - the estimated Indigenous population based on any given census constitutes a unique series, and is not comparable to estimates based on another census
 - the estimated Indigenous population for a given point in time (for example, 30 June 2021), changes from one census-based estimate to the other, and estimates based on a later census are often higher than estimates based on an earlier census (Table 2.4).

The Indigenous ERP at 30 June 2016, based on the 2011 Census, was projected to be 744,956. After the 2016 Census, the Indigenous ERP at 30 June 2016 based on the 2016 Census was revised upwards by 7.2% to 798,365.

Similarly, the Indigenous ERP at 30 June 2021, based on the 2011 Census, was estimated at 830,668. After the 2016 Census, the Indigenous ERP at 30 June 2021, based on the 2016 Census, was revised upwards to 878,998.

Preliminary estimates of the Indigenous ERP of 984,002, at 30 June 2021, based on the 2021 Census, show an increase of 11.9% and 18.9%, respectively, from estimates for the same period based on the 2016 and 2011 censuses. This is because changes in identification across censuses are not taken into account when estimating back-cast and projected populations (ABS 2022a).

Table 2.4: Indigenous population, Australia, at 30 June 2021 and 30 June 2016 based on various censuses

Estimate	Males	Females	Total
<i>Indigenous population as at 30 June 2021 based on ...</i>			
2011 Census (a)	417,657	413,011	830,668
2016 Census (b)	439,472	439,526	878,998
2021 Census (c)	493,484	490,518	984,002
Percentage difference of (a) from (b) (%)	5.2	6.4	5.8
Percentage difference of (b) from (c) (%)	12.3	11.6	11.9
Percentage difference of (a) from (c) (%)	18.2	18.8	18.5
<i>Indigenous population as at 30 June 2016 based on ...</i>			
2011 Census (d)	372,978	371,978	744,956
2016 Census (e)	398,413	399,952	798,365
2021 Census (f)	n/a	n/a	n/a
Percentage difference of (d) from (e) (%)	6.8	7.5	7.2
<i>Growth in Indigenous population between ...</i>			
30 June 2016 (2016 Census) & 30 June 2021 (2021 Census)	23.9	22.6	23.3
Average annual growth 30 June 2016 – 30 June 2021 (%)	4.8	4.5	4.7

Source (ABS 2014, 2019, 2022a)

It is also possible to compare the growth of the Indigenous population from any given point in time at one census (for example, 30 June 2011 based on the 2011 Census) to a later point in time at another census (for example, 30 June 2016 based on the 2016 Census).

Table 2.4 shows that if the Indigenous population at 30 June 2016 and 30 June 2021 were based on the 2016 and 2021 censuses, respectively, then the Indigenous population would have increased by 23.9% for males and 22.6% for females during the 5-year period from 30 June 2016 to 30 June 2021. This is equivalent to an average annual increase of 4.8% for males and 4.5% for females.

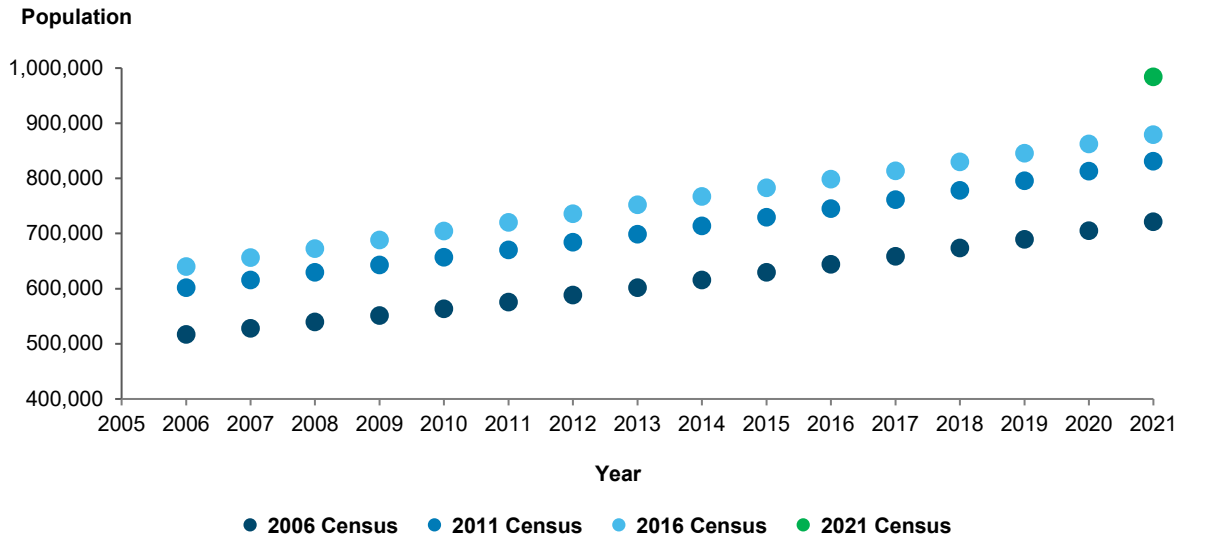
This increase is about twice the rate of natural increase, with the additional increase most likely due to improvements in census methodology, as well as to an increased likelihood that individuals identified themselves and their children as Indigenous (ABS 2014, 2019, 2022a).

Following the release of a new series of back-cast and projected Indigenous population estimates after each census, Indigenous measures and indicators (for example, life expectancy), based on population denominators calculated from the previous census, are required to be revised, using the new set of population denominators calculated from the new census.

Both Table 2.4 and Figure 2.2, however, show that for any given period (for example, 30 June 2018), Indigenous population estimates based on a later census are larger than estimates based on a preceding census. There are implications for using back-cast and projected Indigenous population from the latest census as the preferred denominator population due to the likelihood that denominator populations based on a later census will be bigger than those based on a preceding census.

Indigenous measures and indicators based on denominator populations calculated from a later census will therefore be lower (due to the larger denominator population) than estimates based on an earlier census (due to the smaller denominator population). In the case of Indigenous life expectancy, larger denominator populations from a later census will result in lower mortality rates and higher life expectancy. This makes it difficult to obtain a reliable indication of trends in Indigenous life expectancy.

Figure 2.2: Back-cast and projected Indigenous population of Australia at 30 June of specified years, based on various censuses



Source: (ABS 2014, 2019, 2022a)

2.3.2 Cohort-interpolated and linear-interpolated population

While each series of Indigenous back-cast and projected populations is based on a single census, cohort-interpolated and linear-interpolated Indigenous population estimates are based on Indigenous back-cast and projected populations estimated from multiple censuses that straddle the years for which the estimates are being made.

Thus, life expectancy estimates covering the period 2011–2018 were calculated using population estimates based on the 2011, 2016 and 2021 censuses, since the period 2011–2018 straddles the 3 censuses.

A key advantage of the cohort-interpolated population is that it takes into consideration changes in the size of birth cohorts between censuses. The changing patterns of Indigenous identification in the denominator population is also likely to be more closely aligned with the changing patterns of Indigenous identification in the numerator (in this case, deaths). This is because while Indigenous identification in the numerator is dynamic and is assigned at the time of death, Indigenous identification in the denominator population is also based on multiple points in time according to the censuses that straddle the events in the numerator.

A key difference between the cohort-interpolated and the linear-interpolated population estimates is that the cohort-interpolated population is based on interpolating between birth cohorts in one census and their survivors, who are 5 years older, in the next census. The linear-interpolated population, on the other hand, is based on interpolating between an age group in one census and the corresponding age group in the next census.

The ABS recommends that a range of different census-based population estimate series could be considered if transitioning from one series to the next will maximise consistency of identification levels and coverage between the numerator and denominator (ABS 2014).

2.4 Future work

The enhanced Indigenous mortality and life expectancy projects have undergone many changes over the years in a bid to improve the reliability and robustness of the Indigenous mortality and life expectancy estimates. Some of the improvements include the linkage of additional and more relevant data sets, the application of alternative algorithms to enhance Indigenous identification on death data beside the *Ever Indigenous* algorithm that was used in the EMD, and the use of alternative population denominators beside the ABS back-cast Indigenous population denominator that was used in the EMD.

Despite these improvements, significant challenges remain. These challenges must be addressed to enable the AIHW to meet its commitments to produce yearly Indigenous life expectancy estimates at lower levels of geography, including by remoteness area and Indigenous regions, to support government Closing the Gap initiatives.

The current EIMDC, and previous EMD estimates of Indigenous life expectancy, are based on a standard demographic approach to mortality estimation. The numerator is registered Indigenous deaths, and the denominator is the Indigenous ERP. The numerator and denominator are compiled independently of each other.

An alternative strategy is to derive the numerator and denominator from the same data set, which allows a consistent definition of Indigenous status to be applied to both numerator and denominator. This is referred to as the epidemiological approach, as it resembles the approach that epidemiologists take in cohort studies. Unlike in classic cohort studies, however, individuals are allowed to enter the population of interest via birth, migration, or change in Indigenous status. This shared data set is formed from linked administrative data.

The AIHW proposes 3 approaches towards this aim. These include 2 approaches relating to source of data and a third relating to the method of producing the Indigenous life expectancy estimates:

- expanding the EIMDC to include a population-at-risk created from the National Linkage Map, MCD and the Voluntary Indigenous Identifier (VII)
- using a population-at-risk based on the Multi-Agency Data Integration Project (MADIP)
- using hierarchical Bayesian models to estimate Indigenous life expectancy.

These approaches are discussed more fully in Chapter 7.

3 Data evaluation, sensitivity tests and choice of methods

Indigenous identification is often misclassified on death data. As a result, the EIMDC project and its 2 earlier iterations used data linkage to enhance Indigenous identification on death records (see Section 2.2). However, the use of linked data to enhance Indigenous identification is susceptible to various biases primarily because population subgroups vary in their exposure to administrative data collections. Among these are potential biases due to:

- age at death: older decedents have had more opportunities than younger decedents to access multiple services over time and to be recorded on multiple data sets
- linkage of infant death records:
 - early neonatal deaths, particularly those occurring during or soon after birth, are less likely than other infant deaths to have corresponding records on other data sets
 - perinatal and birth registration data were not available for some jurisdictions
- year of death: the death data for the EIMDC commenced from 1 January 2011; a look-back period of 2 years (2009–2011) was implemented to enable persons who did not seek a service in the year of death or the year prior to their death, and were therefore not on specified data sets, to be captured and included in the EIMDC. This was, however, unlikely to be sufficient to cover all persons who died in the period from 1 January 2011 if they did not access a relevant service during 2009–2011.

The reliability of the estimates of Indigenous mortality and life expectancy derived from linked data may also be affected by the choice of algorithm and population denominator on which the estimates are based. These potential biases are discussed in the following sections.

3.1 Biases due to unlinked data

The greater the number of data sets a record is linked to, the greater the number of separate Indigenous identifications that could be obtained from the linked data sets to enhance the recorded Indigenous identification on the National Death Index (NDI).

In this section, the minimum number of linked data sets for a record is set at 1 (one).

This means that the record has not been linked to any other data set, and information on Indigenous identification for that record is available from a single data set only, which in this case is the NDI. Where the number of linked data sets is 2 or more than 2, it means that the record linked to one or more data sets beside the NDI, and Indigenous identification for that record could be obtained from 2 or more data sets.

Indigenous identification varies by age and sex as well as by jurisdiction of usual residence. Table 3.1 shows the relationship between the number of data sets linked and the number of Indigenous identifications, separately for records with age at death of under 15 years and records with age at death of 15 years and over. This separation was undertaken to account for age differences in Indigenous identification (see Section 3.1.1 and Figure 3.1).

Table 3.1 shows that records of deaths with age at death of under 15 years had a lower percentage of Indigenous identifications due to the lower number of linked data sets compared with the records with age at death of 15 years and over.

Table 3.1 Number of linked data sets and number of Indigenous identifications, Australia, 2011–2018

No. of data sets linked	Number of Indigenous identifications – Age at death => 15 years								No. of data sets linked	Number of Indigenous identifications – Age at death < 15 years							
	0	1	2	3	4	5	6	Total		0	1	2	3	4	5	6	Total
Number of Indigenous identifications and number of linked data sets									Number of Indigenous identifications and number of linked data sets								
1	46,966	1,618						48,584	1	2,248	217					2,465	
2	135,558	1,235	3,940					140,733	2	1,872	91	251				2,214	
3	489,095	3,150	3,074	8,977				504,296	3	3,578	69	129	354			4,130	
4	479,722	2,731	927	1,414	3,868			488,662	4	1,339	40	26	49	176		1,630	
5+	40,089	380	76	75	124	261		41,005	5+	1,020	31	16	25	33	94	5	1,038
<i>Total</i>	<i>1,191,430</i>	<i>9,114</i>	<i>8,017</i>	<i>10,466</i>	<i>3,992</i>	<i>261</i>	<i>0</i>	<i>1,223,280</i>	<i>Total</i>	<i>10,057</i>	<i>448</i>	<i>422</i>	<i>428</i>	<i>209</i>	<i>94</i>	<i>5</i>	<i>11,663</i>
Indigenous identifications (%) and number of linked data sets									Indigenous identifications (%) and number of linked data sets								
1	3.9	17.8						4.0	1	22.4	48.5					21.1	
2	11.4	13.6	49.1					11.5	2	18.6	20.3	59.5				19.0	
3	41.1	34.6	38.3	85.8				41.2	3	35.6	15.4	30.6	82.7			35.4	
4	40.3	30.0	11.6	13.5	96.9			39.9	4	13.3	8.9	6.1	11.5	84.2		14.0	
5+	3.4	4.2	0.9	0.7	3.1	100.0		3.4	5+	10.1	6.9	3.8	5.8	15.8	100.0	10.5	
<i>Total</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>0.0</i>	<i>100.0</i>	<i>Total</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>

Note: Estimates for selected states and territories are shown in Appendix A3.1.

Source: Enhanced Indigenous Mortality Data Collection

About 1 in 5 death records (21.1%) of persons who died aged under 15 was unlinked, and Indigenous identification was therefore available from one data set only, namely, the NDI. On the other hand, of persons who died aged 15 and over, only 4% of their records could not be linked to another data set.

Similarly, 40% of persons who died aged under 15 had information on Indigenous identification from only 1–2 data sets compared with 15.5% of decedents aged 15 and over. Altogether, Indigenous identification for 81% of decedents aged 15 and over was available from 3–4 data sets compared with 49% for decedents aged under 15.

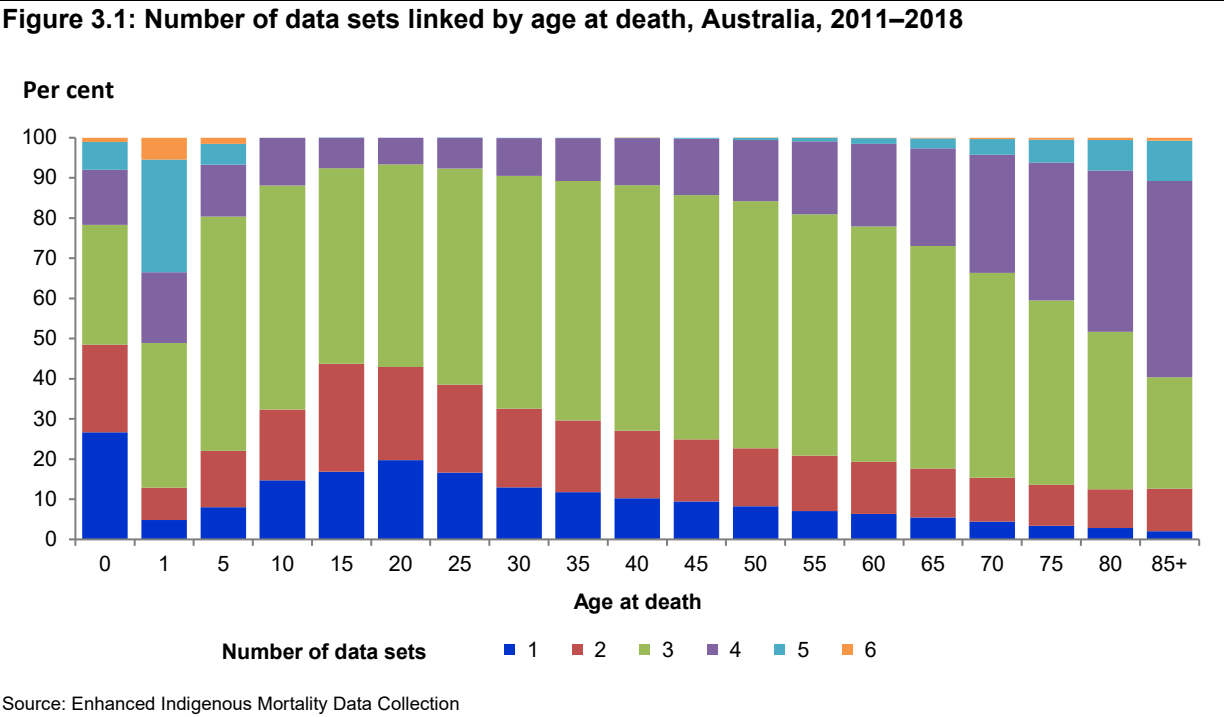
The greater number of linked data sets and Indigenous identifications for older decedents aged 15 and over could be due to the 2 residential aged care data sets which did not include information on younger decedents. In addition, the older a decedent was, the greater the opportunities they would have had to receive care in hospital and to have an admitted patient care, outpatient care record.

On the other hand, perinatal and birth registration data were available for younger but not for older decedents. Due to difficulties accessing data in some jurisdictions, however, perinatal data were not available for Queensland, while neither perinatal nor birth registration data were available for Victoria.

The absence of these 2 data sets for Victoria and Queensland would have contributed to the smaller number of linked data sets and Indigenous identifications for younger decedents. The higher percentage of unlinked records and fewer Indigenous identifications for younger decedents aged under 15 could have an age-related impact on the reliability of frequency-based algorithms for younger decedents in particular jurisdictions.

3.1.1 Number of linked data sets according to age at death

The previous section examined the number of linked data sets for 2 broad ages at death groups, namely, age at death of under 15 years, and age at death of 15 years and over. Figure 3.1 shows the number of linked data sets for 5-year age groups, starting with ages 0 and 1–4, and thereafter, for 5-year age groups from 5–9 years to 85 years and over.



In all jurisdictions, the number of data sets a record was linked to increased with age at death. The percentage of records that linked to only 1, 2 or 3 data sets increased from age 1–4 till age 20–24, and then declined afterwards, while the percentage of records that linked to 4, 5 or 6 data sets increased from age 20–24. The oldest age at death groups starting from 65 years had the highest percentages of records that were linked to 4, 5 or 6 data sets.

The higher percentages of records of older decedents linked to a larger number of data sets could be mostly due to the greater opportunities for older decedents to access multiple services and to be on multiple data sets compared with younger decedents.

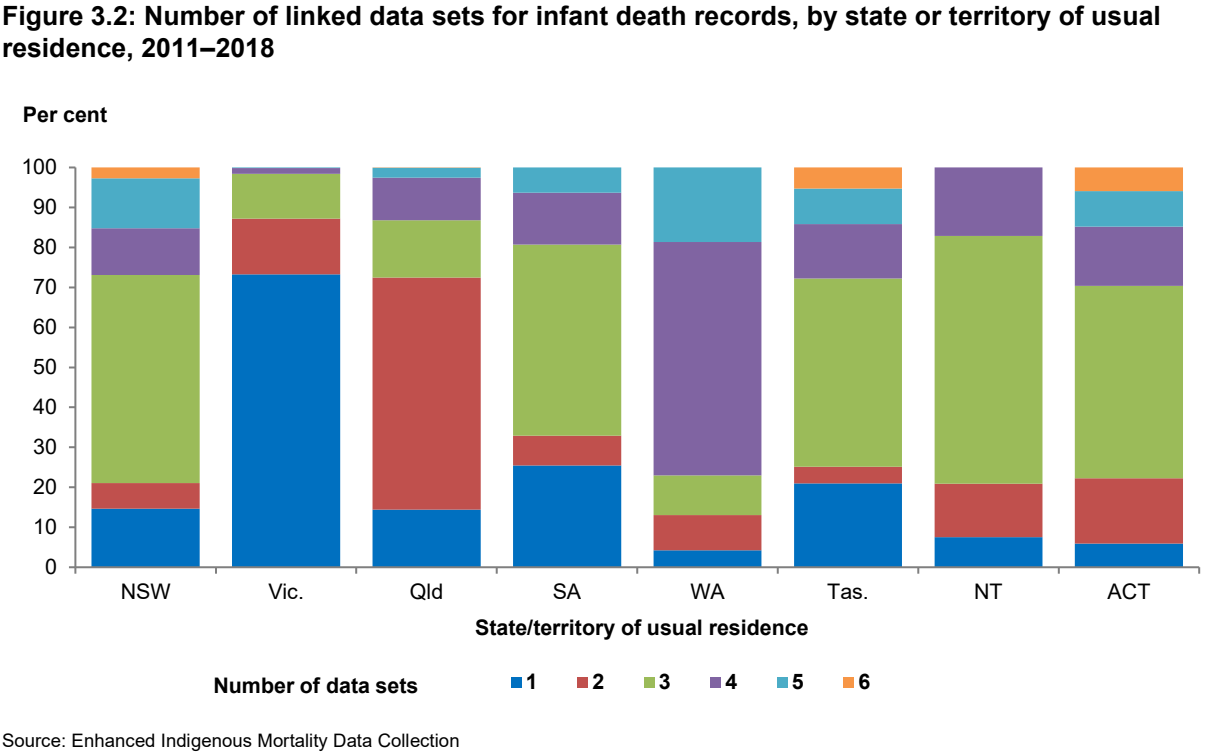
3.1.2 Linkage of infant death records to other data sets

Reliable linkage and enhancement of infant death records are important for the accurate estimation of infant mortality and life expectancy. As was shown in Section 3.1.1, however, there were difficulties accessing perinatal and birth registration data for some jurisdictions, particularly Victoria and Queensland.

Figure 3.2 shows the percentage distribution of infant death records in each state and territory according to the number of linked data sets. The number of linked data sets determines the possible number of Indigenous identifications available for enhancing Indigenous status on the death records.

Figure 3.2 shows considerable variation between jurisdictions in the distribution of infant death records according to the number of linked data sets. The problems with access to perinatal and birth registration data in Victoria and Queensland appear to have affected the number of linked data sets in the 2 jurisdictions.

Nearly 3 in 4 (73%) infant death records in Victoria had only one linked data set. This represents the highest percentage of infant death records in any jurisdiction that had only one linked data set. About 87% and 72%, respectively, of infant death records in Victoria and Queensland also linked to only 1–2 data sets.



In other jurisdictions, 75% or higher of all infant death records were able to be linked to 3 or more records, except in South Australia where the proportion was 67%.

The number of infant death records with 4 or more linked data sets varied widely between jurisdictions. Only 1.6%, 2.7% and 13.2% respectively of infant death records in Victoria, New South Wales and Queensland linked to 4 or more data sets, compared with up to 77% of infant death records in Western Australia. This means that the quality of data for enhancing Indigenous identification on infant death records would also vary considerably between jurisdictions and could affect the choice of algorithms for enhancing infant death data.

3.1.3 Number of linked data sets according to year of death

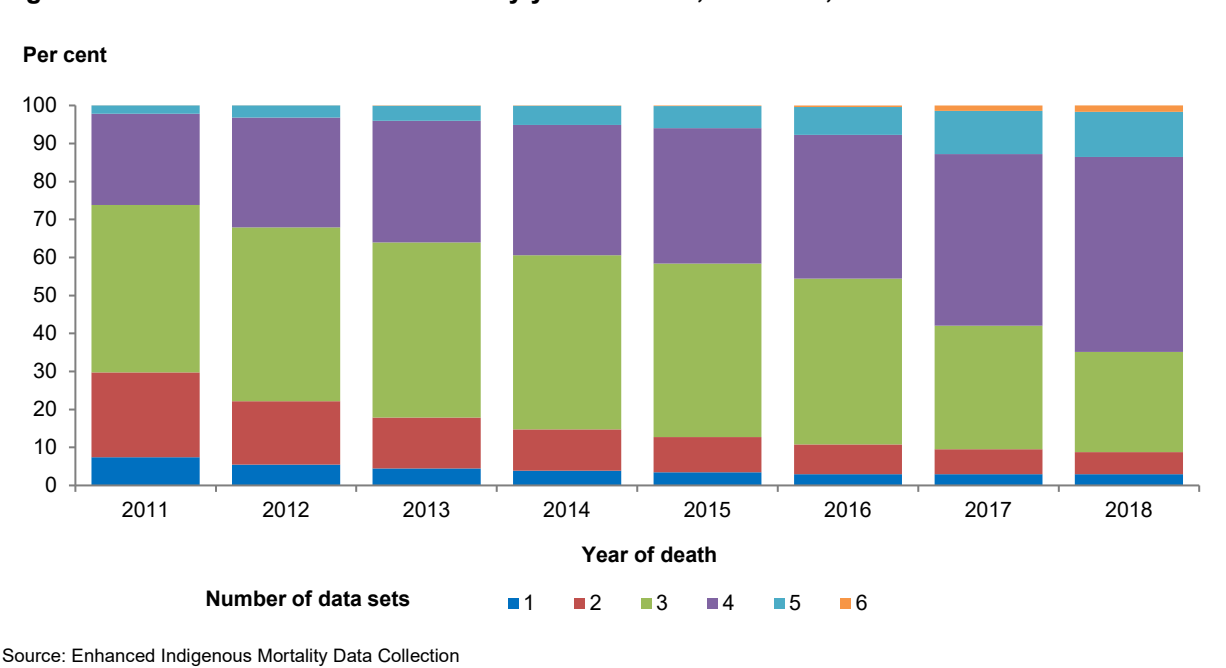
The number of linked data sets appeared to increase systematically by year of death. This is an indication of improvements in the quality of reporting of deaths data and in the quality of the data linkage variables over time.

Figure 3.3 shows the number of data sets that were linked to a corresponding record on another data set in Australia, and classified by year of death. For Australia as a whole, the percentage of records that linked to only 1, 2 or 3 data sets declined over time from 2011 to 2018, while the percentage of records that linked to 4, 5 or 6 data sets increased during the same period.

In 2011, nearly 3 in 4 records (74%) linked to 1–3 data sets, while only about 1 in 4 (26%) linked to 4 or more data sets. By 2018, the percentage of records that linked to only 1–3 data sets had more than halved from 74% in 2011 to 35%, while the percentage of records that linked to 4, 5, or 6 data sets had increased from 26% in 2011 to 65% in 2018.

The increase in the number of linked data sets over time could result in an increase in the number of Indigenous identifications and more flexibility in the choice of algorithms for enhancing Indigenous identification on the deaths data over time. This is likely to enhance the reliability of trend estimates of Indigenous mortality and life expectancy.

Figure 3.3: Number of data sets linked by year of death, Australia, 2011–2018



3.2 Consistency of Indigenous identification between data sets

The choice of algorithms for enhancing Indigenous identification across linked data sets depends on the consistency of Indigenous identification between data sets. A consistent response is where the same Indigenous identification is indicated on a pair of matched records from different data sets belonging to the same individual. An inconsistent response occurs when Indigenous identification is recorded on one of the matched records and not the other (Choi & Smith 2018).

The consistency of Indigenous identification between 2 data sets is measured using the Consistency Index, which shows how consistent Indigenous identification is in a pair of data sets as a percentage of Indigenous responses in either of the 2 data sets. An index of 1.0 shows complete consistency; an index of zero (0) shows no consistency, and an index of 0.5 shows that half of the records on the 2 matched data sets are inconsistent with each other (Choi and Barnes 2015; Choi and Smith 2018).

To check for consistency of Indigenous identification between data sets, a consistency index was estimated between the NDI and each of the following data sets.

- Admitted Patient Care
- Emergency Department
- Residential Aged Care (Residential Care Programme)
- Residential Aged Care (Transitional Care Programme)
- WA Morbidity
- WA Aged Care Assessment Program (ACAP)
- NT Hospital
- Perinatal Data Collection
- Birth registrations

The results are presented in Figure 3.4. They show 3 estimates of consistency between the NDI and specified data sets. The estimates of consistency are:

- overall consistency index: Indigenous in both data sets (NDI and data set x) as a percentage of Indigenous records in either or both data sets
- consistency index for NDI: Indigenous in both data sets (NDI and data set x) as a percentage of Indigenous records on the NDI
- consistency index for data set x: Indigenous in both data sets (NDI and data set x) as a percentage of Indigenous records on data set x.

With the exception of Western Australia and the Northern Territory, the consistency of Indigenous identification between the NDI and each of the data sets, as measured by the overall consistency index, was 46%–58%. In Western Australia, the overall consistency index between the WA death data and the WA hospital data and that between the WA death data and the WA Aged Care Assessment Program data was 82% and 85%, respectively. In the Northern Territory the overall consistency index between the NT death data and the NT hospital data was 94%.

The overall low consistency index of 46%–58%, between the NDI and each of the individual data sets, means that up to half of records on the NDI and each of the linked data sets have comparatively inconsistent Indigenous status values. The observed low consistency of

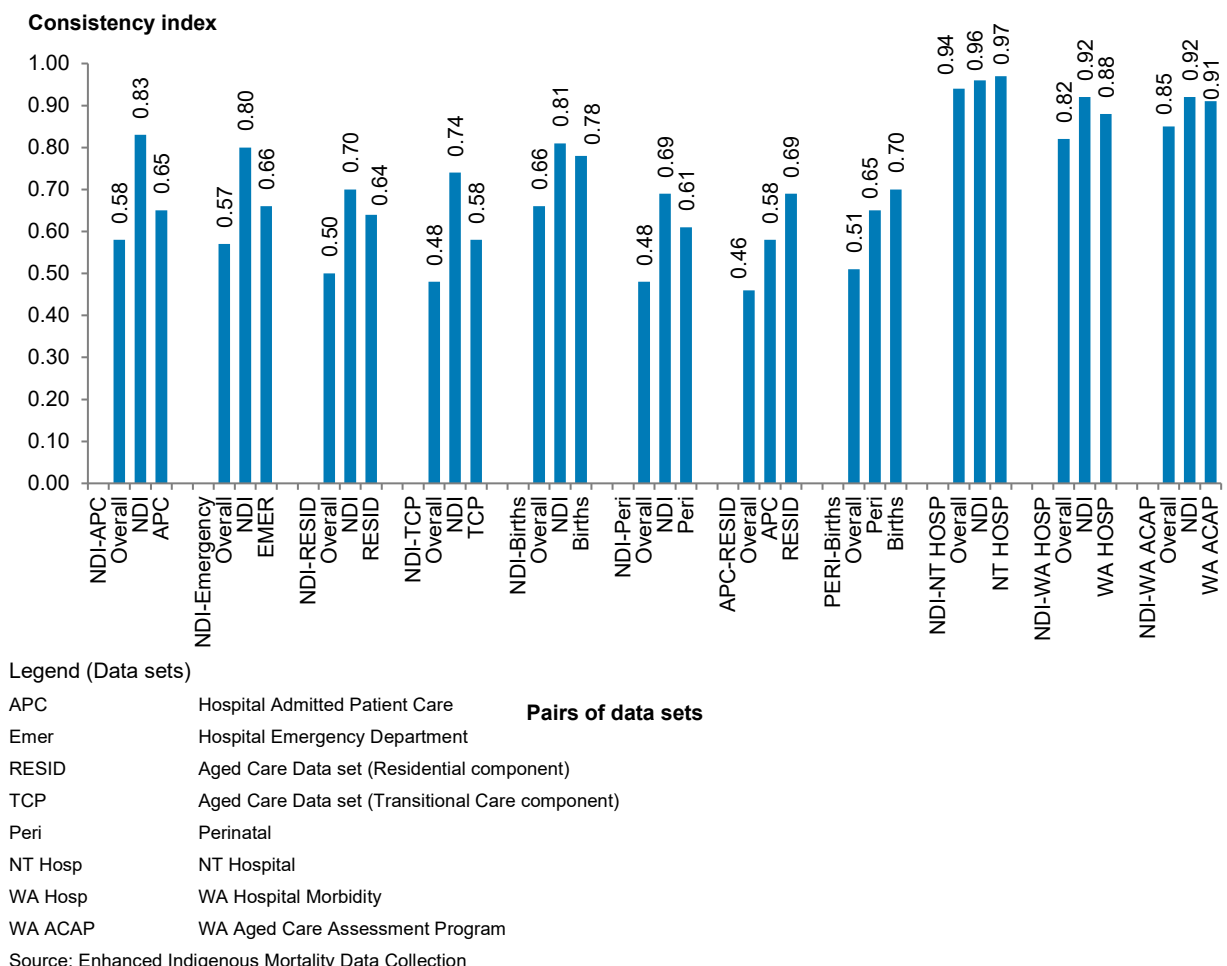
Indigenous identification between the NDI and the listed data sets has implications for the choice of algorithm for enhancing Indigenous identification on the NDI.

The greater the number of linked data sets, and the greater the inconsistency in Indigenous identification between the linked data sets, the greater the number of Indigenous deaths that the *Ever Indigenous* algorithm is likely to identify as Indigenous, and the greater the likelihood that the *Ever Indigenous* algorithm will overestimate Indigenous deaths. On the other hand, an *Always Indigenous* algorithm is likely to underestimate Indigenous deaths.

Estimates of Indigenous deaths based on the *Ever Indigenous* and *Always Indigenous* algorithms are therefore likely to represent the highest and lowest extremes of the number of Indigenous deaths, while estimates of Indigenous deaths based on the *Majority Indigenous* and *2-Plus Indigenous* algorithms are likely to fall between the 2 extremes described.

Under these conditions, estimates of Indigenous deaths based on the *Majority* and *2-Plus* Indigenous algorithms may be more appropriate. The consistency of Indigenous identification between data sets was therefore an important consideration in the choice of algorithm for enhancing Indigenous identification on the NDI.

Figure 3.4: Consistency Index – Consistency of Indigenous identification between the NDI and other data sets, 2011–2018



3.3 Choice of algorithm

This section discusses estimates of Indigenous deaths based on the 4 algorithms for enhancing Indigenous identification on death records described in Section 2.2.5. Table 3.2 shows estimates of Indigenous deaths according to the reported Indigenous identification on the NDI, and the number of Indigenous deaths based on the 4 algorithms for enhancing identification on the NDI.

Panel A shows the number of deaths reported as Indigenous on the NDI and estimates of enhanced Indigenous deaths based on the algorithms for enhancing Indigenous deaths described in Section 2.2.5. The difference between the number of Indigenous deaths reported on the NDI and the number of enhanced Indigenous deaths shows the net change in the number of deaths identified as Indigenous after the application of the specified algorithms to the reported deaths on the NDI.

Panel B shows the percentage difference between the number of enhanced Indigenous deaths and the original estimates of Indigenous deaths derived from the NDI.

Table 3.2: Estimates of Indigenous deaths based on various algorithms for enhancing deaths, Australia 2011–2018

State/Territory	Indigenous on NDI	Number of Indigenous deaths after application of specified algorithms for enhancing Indigenous deaths on the NDI ^(a)			
		Ever Indigenous	Majority Indigenous	2 or more Indigenous	Always Indigenous
Panel A: Estimated number of Indigenous deaths					
NSW	6,451	9,810	7,774	7,494	4,903
VIC	1,189	3,331	1,659	1,555	756
QLD	6,293	8,678	7,007	6,638	5,152
SA	1,382	1,876	1,512	1,465	1,180
WA	3,931	4,431	3,998	3,928	3,533
TAS	352	809	596	548	185
NT	4,052	4,125	4,102	3,975	3,943
ACT	129	254	149	150	98
<i>AUS^(b)</i>	<i>23,787</i>	<i>33,456</i>	<i>26,916</i>	<i>25,862</i>	<i>19,758</i>
Panel B: Percentage difference from NDI					
NSW	n.a.	52.1	20.5	16.2	-24.0
VIC	n.a.	180.2	39.5	30.8	-36.4
QLD	n.a.	37.9	11.3	5.5	-18.1
SA	n.a.	35.7	9.4	6.0	-14.6
WA	n.a.	12.7	1.7	-0.1	-10.1
TAS	n.a.	129.8	69.3	55.7	-47.4
NT	n.a.	1.8	1.2	-1.9	-2.7
ACT	n.a.	96.9	15.5	16.3	-24.0
<i>Australia^(b)</i>	<i>n.a.</i>	<i>40.6</i>	<i>13.2</i>	<i>8.7</i>	<i>-16.9</i>

(a) The enhanced Indigenous deaths in this table relate to only those death records on the NDI that were able to be linked to a corresponding record on another data set. Table 1.1 had shown that 95.9% of all death records were able to be linked to a corresponding record on another data set while 4.1% of death records were not able to be linked. Please see Table 2.2 for estimates of enhanced deaths incorporating both linked and unlinked records.

(b) Estimates for Australia include Tasmania and the Australian Capital Territory

Source: Enhanced Indigenous Mortality Data Collection

The *Ever Indigenous* and *Always Indigenous* algorithms yielded the highest and lowest estimates of enhanced Indigenous deaths among the specified algorithms for enhancing Indigenous deaths, while estimates based on the *Majority* and *2-Plus Indigenous* algorithms lay between the estimates based on the *Ever Indigenous* and *Always Indigenous* algorithms. The criteria for a death record to be identified as Indigenous is most relaxed under the *Ever Indigenous* algorithm and most stringent under the *Always Indigenous* algorithm.

Nationally, the *Ever Indigenous* algorithm identified 41% more deaths while the *Always Indigenous* algorithm, which had the very stringent requirement that a record be identified as Indigenous on all linked data sets, identified 17% fewer deaths than were identified as Indigenous on the NDI. The *Majority* and *2-Plus Indigenous* algorithms identified 13.2% and 8.7% additional Indigenous deaths, respectively.

In all states and territories, the number of deaths identified as Indigenous was highest under the *Ever Indigenous* algorithm, while the *Always Indigenous* algorithm identified the lowest number of Indigenous deaths.

The percentage of additional deaths identified as Indigenous varied substantially between states and territories, and was highest in Victoria, Tasmania and the Australian Capital Territory, and lowest in Western Australia and the Northern Territory.

About 39.5% and 30.8% additional deaths were identified in Victoria as Indigenous, under the *Majority Indigenous* and *2-Plus Indigenous* algorithms, respectively. Corresponding estimates for Tasmania were 69.3% and 55.7%, while in the Australian Capital Territory it was 15.5% and 16.3%, respectively. In New South Wales, 20.5% and 16.2% additional deaths were identified as Indigenous under the *Majority Indigenous* and *2-Plus Indigenous* algorithms, respectively.

In Western Australia, the percentage of additional deaths identified as Indigenous under the *Majority* and *2-Plus Indigenous* algorithms was 1.7% and -0.1%, respectively. Corresponding estimates for the Northern Territory were 1.2% and -1.9%, respectively. The very minimal change in the number of deaths after the application of the algorithms points to the relatively more accurate identification of Indigenous deaths on the NDI in these 2 jurisdictions.

Our analysis identified the *Majority Indigenous* algorithm as likely to give the most plausible estimates of the number of Indigenous deaths.

These estimates of Indigenous deaths differ from Indigenous mortality measures published annually by the ABS and the AIHW that are not adjusted for Indigenous under-identification (ABS 2015; AIHW 2011b, 2012c).

The EIMDC 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.

3.4 Reported and enhanced number of deaths

Table 3.3 shows the number of reported, reclassified and enhanced Indigenous deaths covering the period 2011–2018. Deaths that were reclassified as Indigenous had originally been misclassified on the NDI as non-Indigenous, unknown or missing. Some deaths that were originally misclassified on the NDI as Indigenous would also have been reclassified as non-Indigenous after application of the *Majority Indigenous* algorithm. The number of reclassified deaths therefore represents the net change in the number of Indigenous deaths after application of the algorithms for enhancing Indigenous deaths.

Table 3.3: Reported^(a), reclassified^(b) and enhanced^(c) number of Indigenous deaths, Australia, 2011–2018

Indigenous death records	Males	Females	Total
Total number of reported deaths	633,334	599,870	1,233,204
Reported Indigenous deaths on the NDI	12,958	10,829	23,787
Additional deaths reclassified as Indigenous ^{(b), (c)}	1,899	1,354	3,253
Total number of enhanced Indigenous deaths	14,857	12,175	27,032
Reclassified deaths as % of enhanced Indigenous deaths	12.8	11.1	12.0

- (a) Reported Indigenous deaths are the number of deaths originally recorded on the NDI as Indigenous.
- (b) Reclassified deaths are Indigenous deaths that were not classified as Indigenous on the NDI but were deemed to be Indigenous after data linkage and the application of the *Majority Indigenous* algorithm.
- (c) The number of reclassified deaths represents a net change in the number of deaths classified as Indigenous as some deaths that were originally reported on the NDI as Indigenous could have been reclassified as non-Indigenous after application of the *Majority Indigenous* algorithm.

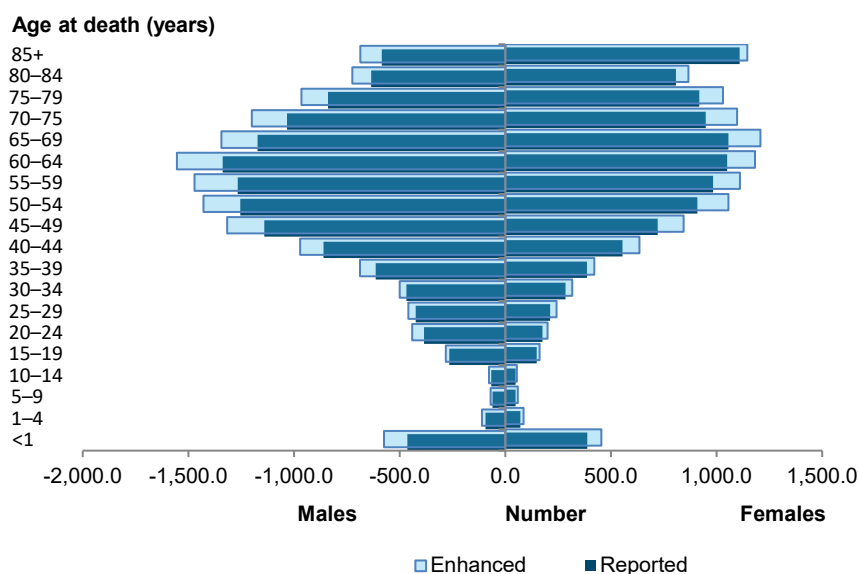
Source: Enhanced Indigenous Mortality Data Collection.

After application of the *Majority Indigenous* algorithm to the death records on the NDI, 1,899 additional male deaths and 1,354 additional female deaths were reclassified as Indigenous during the reference period. The number of deaths reclassified as Indigenous amounted to nearly 13% of the number of enhanced Indigenous male deaths, and just over 11% of the number of enhanced Indigenous female deaths. The application of the *Majority Indigenous* algorithm to the reported deaths on the NDI therefore added 12% more deaths to the total number of deaths reported as Indigenous on the NDI.

Figure 3.5 is an age pyramid showing the age-sex distribution of reported and enhanced Indigenous deaths for the period 2011–2018. The darker-coloured bars show the distribution of reported deaths while the lighter-shaded bars show the distribution of enhanced deaths.

The difference between the reported and enhanced deaths is the net change in the number of deaths identified as Indigenous after data linkage and the application of the *Majority Indigenous* algorithm to the deaths originally reported on the NDI as Indigenous.

Figure 3.5: Distribution of reported and enhanced Indigenous deaths by age and sex, Australia, 2011–2018



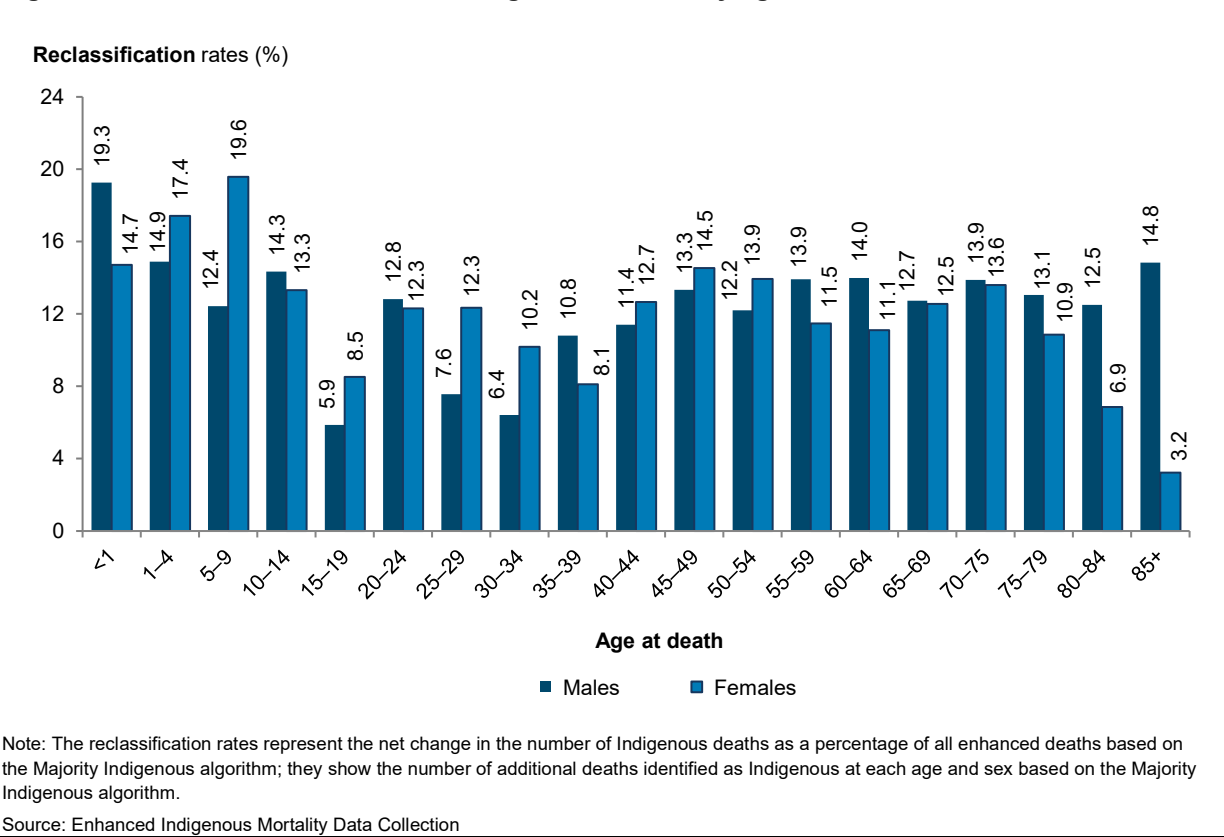
Note: The enhanced deaths consist of deaths reported on the NDI which were enhanced using the *Majority Indigenous* algorithm

Source: Enhanced Indigenous Mortality Data Collection

Figure 3.6 shows reclassification rates of Indigenous deaths by age and sex. The reclassification rates represent the net percentage change in the number of Indigenous deaths at each age and sex as a result of the application of the *Majority Indigenous* algorithm to the deaths registered on the NDI.

Reclassification rates were marginally higher for males than for females, and varied within the range 11%–13% for most ages. Higher reclassification rates were observed for the 3 youngest age groups (under 1, 1–4 and 5–9 years) for both males and females.

Figure 3.6: Reclassification rates of Indigenous deaths by age and sex, Australia, 2011–2018



3.5 Sensitivity of life expectancy estimates to potential errors in algorithms

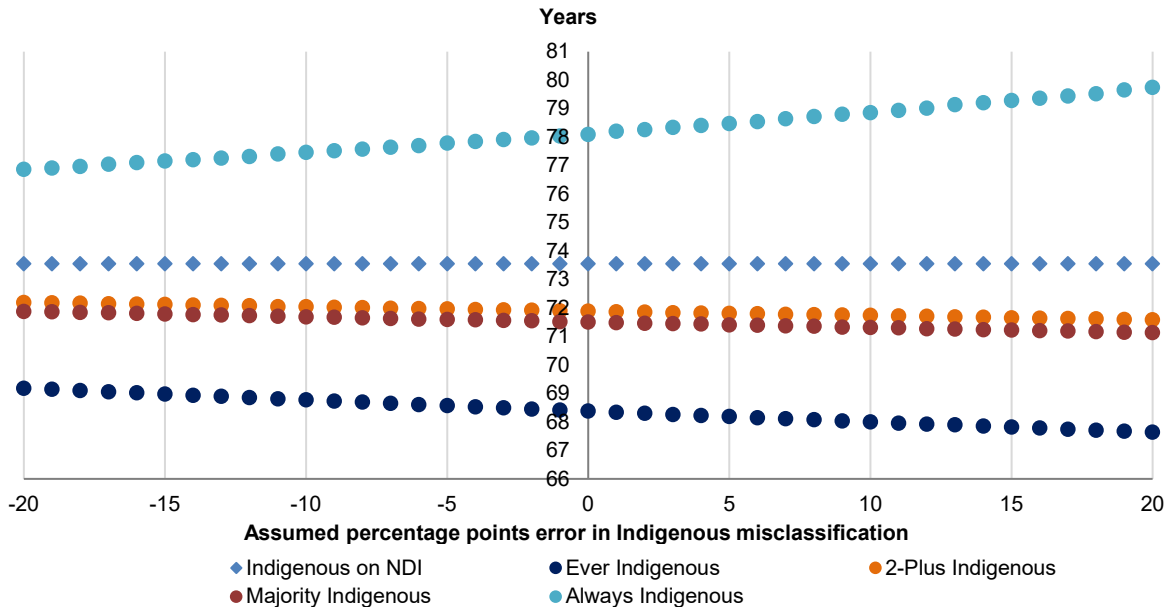
An important consideration in the choice of algorithm for enhancing Indigenous identification on the NDI is the sensitivity of the life expectancy estimates to the choice of algorithm.

The *Ever Indigenous* algorithm identified 41% more Indigenous deaths than were reported on the NDI, while the *2-Plus* and *Majority Indigenous* algorithms, respectively, identified 9% and 13% more Indigenous deaths than were reported on the NDI. Implementation of the *Always Indigenous* algorithm led to a loss in the number of Indigenous deaths by 17%.

Using deaths that occurred in 2016–2018 as a test case, a sensitivity analysis was carried out to determine the impact on estimates of Indigenous life expectancy during 2016–2018 if the specified algorithms had underestimated or overestimated Indigenous deaths by up to 20% (± 20%) compared with the level originally indicated by the algorithm.

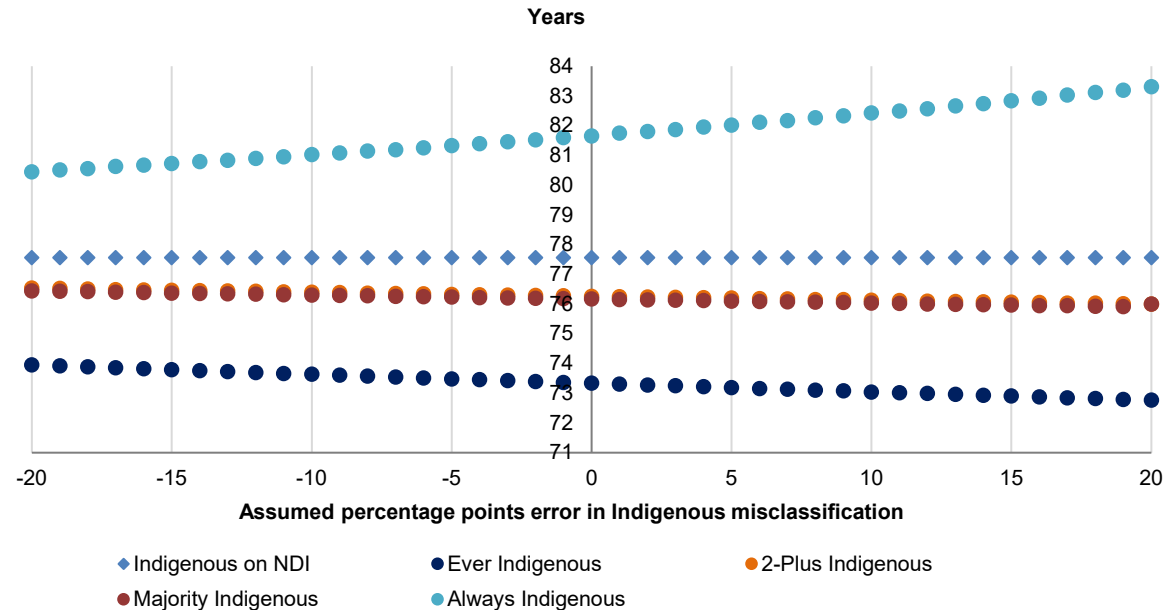
The results of the sensitivity analysis (figures 3.7a and 3.7b) show that assuming that there was an error in the underlying assumptions or implementation of the *Always Indigenous* algorithm, and the expected loss of Indigenous deaths had been underestimated by up to about 20% (-20%) then Indigenous life expectancy would be about 1.2–1.3 years lower for both Indigenous males and females than was indicated by the algorithm.

Figure 3.7a Sensitivity of Indigenous male life expectancy estimates to assumed errors in Indigenous misclassification, Australia, 2016–2018: based on cohort-interpolated population



Source: Enhanced Indigenous Mortality Data Collection

Figure 3.7b: Sensitivity of Indigenous female life expectancy estimates to assumed errors in Indigenous misclassification, Australia, 2016–2018: based on cohort-interpolated population



Source: Enhanced Indigenous Mortality Data Collection

On the other hand, if the number of deaths identified as Indigenous under the *Always Indigenous* algorithm had been overestimated by about 20% (+20%) compared with the level indicated by the algorithm, then Indigenous life expectancy would be about 1.7–1.8 years higher for both Indigenous males and females than originally indicated by the algorithm.

Unlike the *Always Indigenous* algorithm, assuming there was an error in the underlying assumptions or implementation of the *Ever Indigenous*, *Majority Indigenous* and *2-Plus Indigenous* algorithms, and the additional deaths identified as Indigenous had been underestimated, then there would be a reduction in the number of additional deaths that would be identified as Indigenous. This would lead to higher Indigenous life expectancy. The reverse would be the case if there was an error in the underlying assumptions or implementation of the 3 algorithms and the expected additional deaths had been overestimated beyond the level originally indicated by the algorithms (point 0).

If the number of additional Indigenous deaths had been underestimated under the *Ever Indigenous* algorithm by 5%, 10%, 15% or 20%, then Indigenous life expectancy would be overestimated by about 0.2, 0.4, 0.6 and 0.8 of a year, respectively, for males, and about 0.15, 0.3, 0.45 and 0.6 of a year, respectively, for females, beyond the level originally indicated by the algorithm.

In the case of the *Majority Indigenous* algorithm, if the number of additional Indigenous deaths had been underestimated by 5%, 10%, 15% or 20%, then Indigenous life expectancy would be overestimated by only about 0.1, 0.2, 0.3 and 0.4 of a year for males, and by about 0.1, 0.15, 0.2 and 0.3 for females.

An underestimation of additional Indigenous deaths by about 20% under the *Majority Indigenous* algorithm would therefore lead to higher life expectancy than indicated by the algorithm by up to about 0.3 to 0.4 of one year for both males and females.

If the number of additional Indigenous deaths under the *2-Plus Indigenous* algorithm had been underestimated by 5%, 10%, 15% and 20%, then Indigenous life expectancy would be overestimated by only about 0.06–0.08, 0.15–0.17, 0.23–0.27 and 0.30–0.35 of a year, respectively, for both males and females. This means that assuming the underlying assumptions and implementation of the *2-Plus Indigenous* algorithm had led to an underestimation of additional Indigenous deaths by up to 20%, the impact on Indigenous life expectancy would be about one-third of one year.

An over-estimation of additional Indigenous deaths by about 20% under the *2-Plus Indigenous* algorithm would lead to lower life expectancy than indicated by the algorithm by less than one-third of one year for males and females, respectively.

The results show that the *Majority Indigenous* and *2-Plus Indigenous* algorithms are relatively stable and are not very sensitive to small-to-moderate errors in overestimation or underestimation of additional Indigenous deaths.

The *Majority Indigenous* algorithm was the least sensitive to small-to-moderate errors in overestimation or underestimation of additional Indigenous deaths. This is one of the reasons why the *Majority Indigenous* algorithm was selected as the preferred algorithm for enhancing Indigenous identification in the EIMDC.

3.6 Choice of denominator population

Figure 3.8 shows trend estimates of Indigenous life expectancy for Australia based on 3 denominator populations, namely (i) ABS back-cast Indigenous ERP (ii) cohort-interpolated Indigenous population, and (iii) linear-interpolated Indigenous population.

A key observation from Figure 3.8 is that the level and trends in Indigenous life expectancy seem to depend on the choice of denominator population. Estimates based on the back-cast and linear-interpolated populations are, on the whole, marginally higher than estimates based on the cohort-interpolated population across nearly all periods of analysis.

Whereas the *Always Indigenous* estimates show a decreasing trend in life expectancy for all denominator populations, the *Ever Indigenous* algorithm shows a decreasing trend in Indigenous life expectancy for the back-cast population, and an increasing trend for the cohort-interpolated and linear-interpolated populations, for both males and females.

Estimates based on the 2 interpolated populations show an increasing trend in life expectancy for the *Ever Indigenous*, *Majority* and *2-Plus Indigenous* algorithms, while estimates based on the back-cast population show a declining trend for these algorithms.

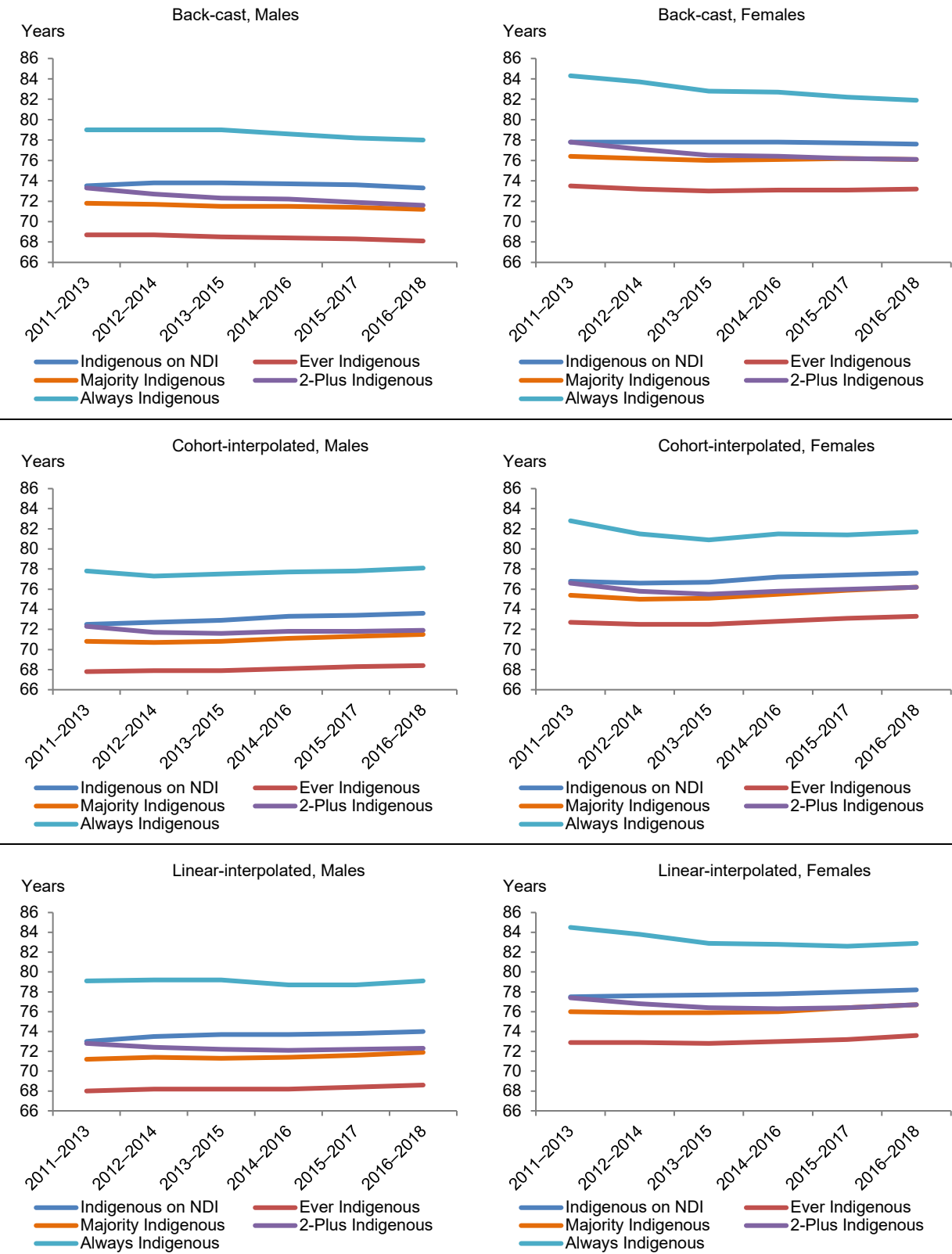
During 2011–2013, 2012–2014 and 2013–2015, the back-cast population denominators based on the 2016 Census were larger than the corresponding cohort-interpolated and linear-interpolated population denominators based on the 2011 and 2016 censuses. Given the same number of deaths, a bigger population denominator such as that used for the 2011–2013, 2012–2014 and 2013–2015 back-cast life expectancy estimates would lead to lower mortality rates and higher life expectancy whereas smaller denominator populations will lead to higher mortality rates and lower estimates of life expectancy.

The reverse is true for later periods, where life expectancy estimates for 2016–2018 based on cohort-interpolated denominator populations were higher than estimates based on the back-cast and projected populations.

After considering the advantages of the 3 denominator populations, the cohort-interpolated population based on the 2011, 2016 and 2021 censuses was selected as the preferred population denominator for the preparation of the mortality and life expectancy estimates presented in this report.

The estimates show, however, that Indigenous life expectancy estimates are sensitive to the choice of denominator population. This brings into sharp focus the current proposal by the AIHW to explore the feasibility of developing a population-at-risk or epidemiological approach from linked administrative data collections.

Figure 3.8: Estimates of Indigenous life expectancy for Australia based on 3 population denominators



Source: Enhanced Indigenous Mortality Data Collection

Among the key reasons for preferring the cohort-interpolated population over other denominator populations are:

- The cohort-interpolated population is based on Indigenous population estimated from the 3 censuses (2011, 2016 and 2021) that straddle the reference period for the estimates (2011–2021). Because the cohort-interpolated population is based on multiple censuses, it is likely to moderate the effects of large variability and sudden changes in Indigenous identification and the size of the Indigenous population.
- The cohort-interpolated population takes into consideration changes in the size of birth cohorts between censuses.
- The changing patterns of Indigenous identification in the denominator population are also likely to be more closely aligned with the changing patterns of Indigenous identification in the numerator (in this case, deaths).
- For any census-based Indigenous population, the information on Indigenous identification that is used in the preparation of the 25 years back-cast and projected Indigenous population is anchored on a single point in time at a single census, and does not change over the course of the estimates. On the other hand, the information on Indigenous identification that is used to derive the cohort-interpolated population is based on multiple points in time according to the different censuses that straddle the events in the numerator.
- The Indigenous population based on any given census constitutes a unique series of estimates, and is not comparable to estimates based on another census. One cannot therefore study trends in Indigenous life expectancy since estimates calculated using one census-based denominator population must be discarded when a new census-based denominator population is produced.
- The Indigenous population relating to the same point in time (for example, 30 June 2021), changes from one census-based estimate to the other, and estimates based on a later census are often higher than estimates based on an earlier census (see Table 2.4 and Figure 2.1). This could lead to a spurious increase in Indigenous life expectancy as a result of the larger denominator populations that are based on later censuses.
- Whereas the cohort-interpolated population is based on interpolating between birth cohorts in one census and their survivors, who are 5 years older, in the next census, the linear-interpolated population estimates are based on interpolating between age cohorts in one census and age cohorts of the same age in the next census.

3.7 Evaluation of algorithms

The reliability of algorithms for enhancing Indigenous identification on death data is affected by several factors including the consistency of Indigenous identification across data sets, the number of data sets linked and the number of Indigenous identifications available across data sets for developing algorithms. The reliability of Indigenous life expectancy estimates is, in turn, affected by how Indigenous identification is defined in the death and population data that serve as the main inputs into the estimation of life expectancy.

This section discusses modelled estimates of Indigenous life expectancy based on various algorithms, and notes that some of the inconsistent results could be explained by some of the biases discussed in sections 3.1–3.4, particularly some very high estimates of Indigenous life expectancy in some jurisdictions, inconsistent estimates of Indigenous life expectancy across algorithms, and the downward trend in Indigenous life expectancy in some jurisdictions such as Victoria.

Accurate estimation of Indigenous mortality rates requires that the numerator and denominator – deaths and the population at risk – define Indigenous status in the same way. The standard approach to calculating death rates is to use the Estimated Resident Population for Aboriginal and Torres Strait Islander Australians (Indigenous ERP) produced by the ABS as the denominator. When taking this approach, the numerator in death rates should in principle consist of deaths of people who would have, under ABS procedures, been included within the Indigenous ERP. Section 3.4 shows that from the way Indigenous status is defined in death data, there would be inconsistency between jurisdictions in the way Indigenous status is defined in the death data and in the denominator population.

Determining whether an individual would have been included in the Indigenous ERP is, however, difficult. The Indigenous ERP is a set of counts, disaggregated by dimensions such as age, sex, and state or territory, rather than a list of individuals. The ABS Indigenous ERP uses responses to the Post-Enumeration Survey (PES) as the gold standard. To extrapolate from PES responses to the entire Australian population, the ABS uses a complex procedure that includes assessing the relationship between responses on the census and responses in the PES, adjustments for under-coverage in the census, and adjustments for linkage errors between the census and PES.

In the absence of a feasible method for establishing the performance of the Indigenous status algorithms at the individual level, the algorithms were evaluated in relation to:

- whether the algorithms lead to life expectancy estimates that are neither implausibly high nor implausibly low
- whether differences in life expectancy across states, and trends over time, are plausible.

3.7.1 Data and methods

The evaluation used deaths data from the EIMDC for the period 2011–2018, and linear-interpolated Indigenous population based on the Indigenous ERP for Census years 2011, 2016 and 2021. Population values for intermediate years were obtained by linearly interpolating between the Indigenous ERP based on Census years 2011, 2016 and 2021 within each combination of age, sex, and jurisdiction. Census-year estimates of Indigenous ERP were used for estimating the linear-interpolated population because they reflect changing propensities to report Indigenous status, rather than the ABS population backcasts, which attempt to remove the effect of changing propensities.

Census-year Indigenous population estimates were used for this analysis because the deaths data used for these estimates have not been adjusted for changing propensities to identify as Indigenous, and are therefore more likely to be comparable to the original census-year estimates than to the back-casted values.

3.7.2 Modelled estimates of Indigenous life expectancy

To deal with random variation in the number and distribution of deaths by age and sex, Bayesian hierarchical models were used in the preparation of the life expectancy estimates. The models allow for different age-sex profiles in each jurisdiction, but assume that the shapes of these profiles remain constant over the period 2011–2018. Overall levels are permitted to differ across jurisdictions, and to follow different time trends (Bijak & Bryant 2016; Bryant & Zhang 2018).

3.7.3 Results

Figure 3.9 shows estimates of Indigenous life expectancy calculated from the Bayesian hierarchical model. The lines represent point estimates. Each row shows results for a different state or territory, excluding Tasmania and the Australian Capital Territory, while each column shows results for a different algorithm. Results for the *Always Indigenous* algorithm are not included in Figure 3.9 because including them would require stretching the vertical scale to the point where patterns in the other algorithms are obscured.

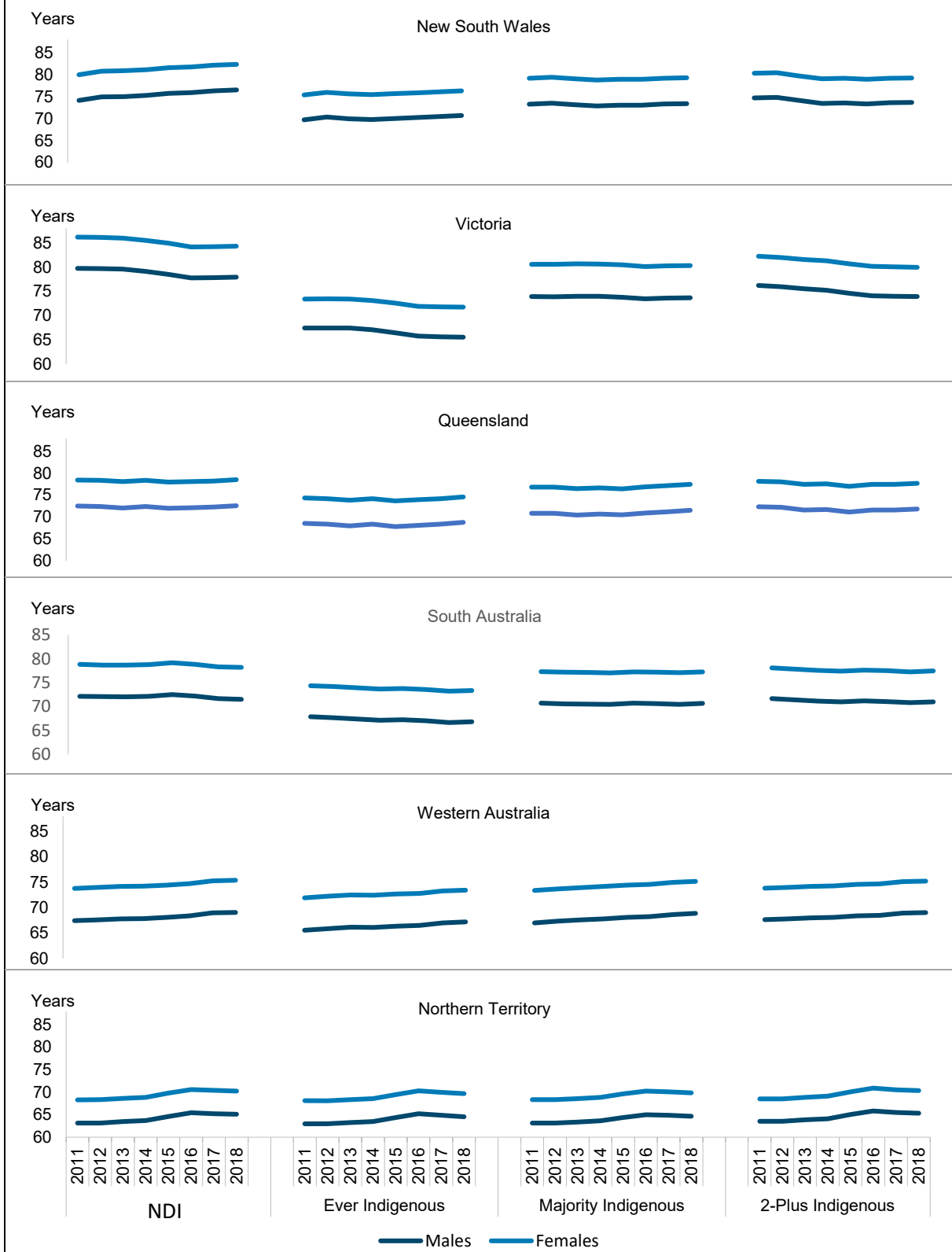
The life expectancies obtained for Victoria using the original NDI Indigenous status variables are implausibly high. Some of the remaining estimates are also high, in that they imply little or no difference from the non-Indigenous population. The jurisdictions with the greatest variability across algorithms also appear to have the highest life expectancies.

The time trends in life expectancies are in many cases inconsistent across algorithms. In New South Wales, for instance, life expectancy appears to be rising when the original NDI Indigenous statuses are used, and to be declining when the *2-Plus* algorithm is applied. The most likely explanation for downward trends in life expectancy is that improvements in reporting are outweighing declines in underlying mortality risks. The *2-Plus* algorithm appears to be particularly susceptible to changes in reporting.

The apparent switch from increasing to decreasing life expectancy in the Northern Territory is presumably not due to changes in death reporting, given that the quality of deaths data in the Northern Territory has been high for some time. A more likely explanation is that there are problems with the population denominator, probably as a result of census non-response, and the difficulty of accurately adjusting for this non-response.

A longstanding challenge when interpreting estimates of Indigenous life expectancy has been knowing how much of the variability to attribute to small numbers and random variation. Applying a statistical model that accounts for random variation, as has occurred here, allows for this challenge to be addressed. It turns out that, when modern statistical methods are applied to the data, estimates for most jurisdictions can be reasonably precise. The results indicate that most of the apparent variation across jurisdictions, algorithms, and time is due to factors other than small sample sizes.

Figure 3.9: Model-based estimates of Indigenous life expectancy at birth, by sex, year, for selected jurisdictions, using 2 different methods for inferring Indigenous identification



Source: Enhanced Indigenous Mortality Data Collection

4 Mortality levels, patterns and trends

4.1 Introduction

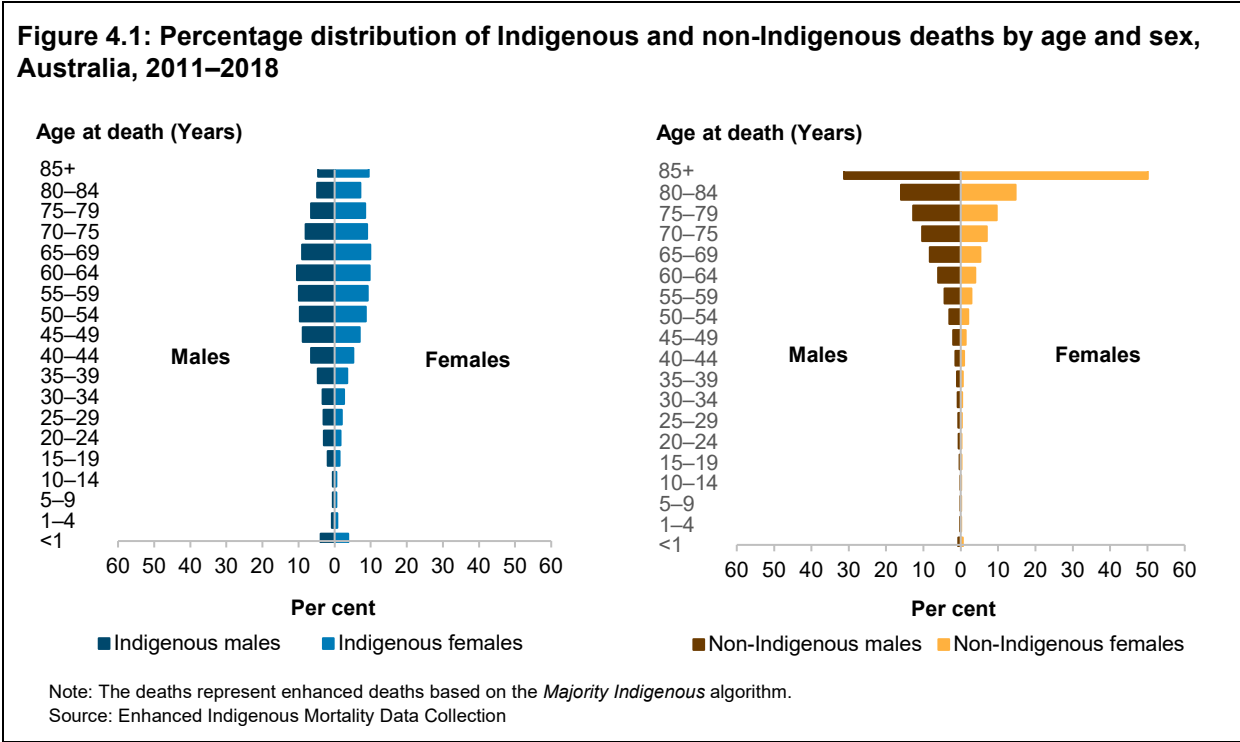
This chapter, and the next two, present measures of Indigenous mortality and life expectancy based on the *Majority Indigenous* algorithm and a cohort-interpolated population based on the 2011, 2016 and 2021 Censuses, as described in Chapter 2. As discussed in Chapter 3, despite the significant progress that has been made in the reporting of Indigenous identification across data sets, some issues with the input data are still being resolved. For instance, the AIHW is still investigating the contribution that variations in linkage rates have made to reported changes in mortality rates over time, and to reported differences across jurisdictions. These remaining data limitations need to be borne in mind when interpreting the results shown in these chapters.

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

4.1.1 Indigenous deaths have a young age profile

The age distribution of deaths is related to the age structure of the population from which the deaths are derived. The distribution of deaths by age in a relatively young population will be different from that in a relatively older population. It may reflect past fertility and age structure of the population, and may also be related to the level and cause of death in the population.

Figure 4.1 shows the vastly different distribution of deaths by age among Indigenous and non-Indigenous males and females.



The age pyramid shows the early age at death among Indigenous males and females compared with non-Indigenous males and females. Among the Indigenous population, a bulge in deaths occurs from about age 35, highlighting the ages where most deaths are concentrated. This reflects 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.

Higher percentages of both Indigenous male and Indigenous female deaths, relative to non-Indigenous deaths, occurred at almost every age until 60–64 years, after which higher percentages of non-Indigenous male and non-Indigenous female deaths were observed.

Figure 4.1 points to younger ages at death among males compared with females irrespective of Indigenous status. Higher percentages of both Indigenous male and non-Indigenous male deaths occurred at almost every age up to 65–69, whereas after this age, higher percentages of Indigenous female and non-Indigenous female deaths were observed.

About 9.4% of Indigenous female deaths occurred at age 85 and above compared with 4.6% of Indigenous male deaths. With regard to non-Indigenous deaths, more than 50% of all non-Indigenous female deaths occurred at age 85 and over compared with about 31% of non-Indigenous male deaths.

4.2 Summary measures of mortality

Summary measures are useful when one is looking for a single and simple measure to describe the mortality level in a specified population at a point in time. Among the measures often used for this purpose are the crude death rate and the median age at death. There are, however, limitations to these measures, and these are discussed in the sections that follow.

4.2.1 The crude death rate

The crude death rate is the simplest measure of mortality. It has minimal data requirements, is simple to calculate, and has a very simple interpretation (AIHW 2011a). It is defined as the number of deaths in a given period per 1,000 of the mid-year population or the population exposed to the risk of death in that period (Shryock & Siegel 1980).

There is, however, a problem with the crude rate when it is used to measure the force of events, such as disease and death, that are heavily influenced by age. When the crude death rate is used to compare the level of mortality between 2 populations with different age structures, the different age structures of the 2 populations will make it difficult to determine whether mortality is actually higher in one population than the other.

Table 4.1 shows crude death rates among Indigenous and non-Indigenous males and females between 2011–2013 and 2019–2021 based on EIMDC data. Although mortality is known to be higher among Indigenous than non-Indigenous Australians, the crude death rates among Indigenous males and females are lower in each state and territory than the corresponding non-Indigenous rates. This is mostly because the Indigenous population is skewed towards younger ages where mortality is lower, while the non-Indigenous population is skewed towards older ages where mortality is higher (see Figure 4.3).

Reliance on the crude death rate as a measure of mortality could therefore create the spurious impression that mortality was lower among Indigenous than non-Indigenous Australians. Consequently, other measures of mortality are needed to help us to understand the level and age distribution of deaths in the Indigenous and non-Indigenous populations.

Table 4.1: Crude death rates per 100,000 Indigenous and non-Indigenous males and females, selected states and territories^(a, b)

State/Territory	Males			Females		
	2011–2013	2014–2016	2016–2018	2011–2013	2014–2016	2016–2018
Indigenous						
NSW	399	453	465	326	360	358
Vic	410	423	438	314	355	392
Qld	438	466	479	356	382	373
WA	493	508	525	390	414	434
SA	588	589	577	442	450	453
NT	771	673	698	670	707	674
<i>Australia</i>	<i>472</i>	<i>492</i>	<i>500</i>	<i>383</i>	<i>408</i>	<i>405</i>
Non-Indigenous						
NSW	718	720	722	680	688	670
Vic	654	657	651	642	634	623
Qld	642	663	681	573	589	589
WA	788	795	801	784	782	763
SA	565	593	598	523	537	536
NT	399	441	416	240	251	262
<i>Australia</i>	<i>672</i>	<i>683</i>	<i>686</i>	<i>637</i>	<i>643</i>	<i>632</i>

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

(b) Estimates are based on enhanced deaths according to the *Majority Indigenous* algorithm and cohort-interpolated population based on the 2011, 2016 and 2021 Censuses.

Source: Enhanced Indigenous Mortality Data Collection

4.3 Age pattern of mortality

The gap in life expectancy between Indigenous and non-Indigenous Australians is the result of differences in mortality between the 2 populations. Understanding the differences in the levels, age-sex patterns and trends in mortality between Indigenous and non-Indigenous Australians will contribute to our knowledge of the source of the life expectancy gap and what can be done to address it. Several mortality measures can contribute to this knowledge.

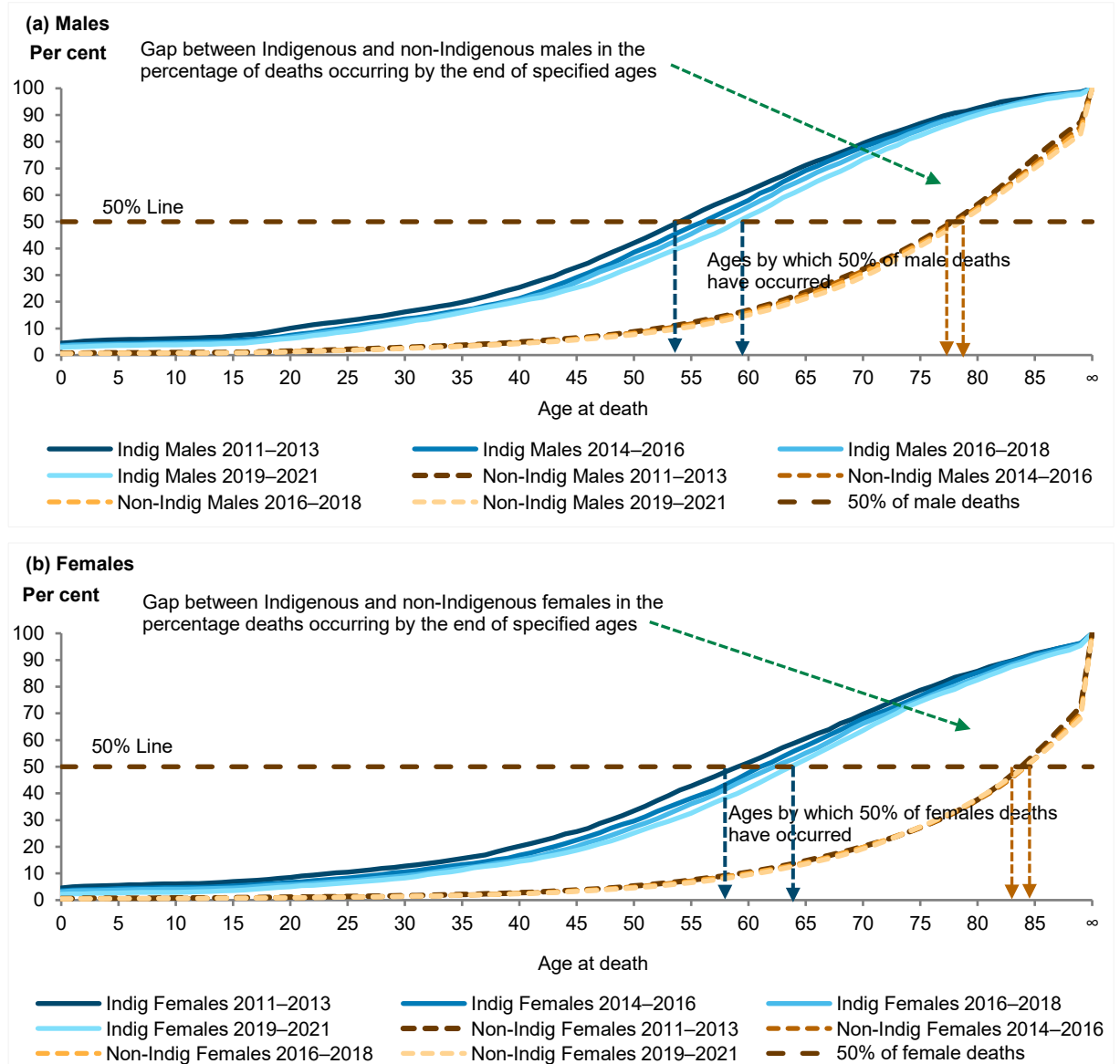
Death rates vary by age and sex. Knowing the age pattern of mortality is important in developing policies to address age-related mortality. The cumulative percentage of deaths occurring by specified ages and age-specific death rates are 2 key mortality measures that can provide this information. They reflect both the level of mortality and the age structure of mortality. Populations, like the Indigenous population, with younger age profiles are likely to have a higher proportion of deaths occurring at younger ages than is likely to be the case in the non-Indigenous population that has an older age profile.

The proportion of Indigenous deaths occurring before age 50 is declining

Figure 4.2 shows the cumulative percentages of deaths occurring by the end of specified ages separately for males and females. It confirms earlier observations that Indigenous males and females die at much younger ages than non-Indigenous males and females.

For both males (Panel a) and females (Panel b), only small differences between Indigenous and non-Indigenous mortality were observed at the youngest ages. The gap between the Indigenous and non-Indigenous curves represents the mortality gap that must be bridged in order to close the life expectancy gap between Indigenous and non-Indigenous Australians.

Figure 4.2: Cumulative percentage of deaths occurring by the end of specified ages, 2011–2018 (linked data) and 2019–2021 (projected data), Australia



Note: Estimates are based on the *Majority Indigenous* algorithm.

Source: Enhanced Indigenous Mortality Data Collection

For all 4 periods (2011–2013, 2014–2016, 2016–2018 and 2019–2021), 4%–6% of all Indigenous male deaths had occurred by age 15 compared with less than 1% of non-Indigenous male deaths. The cumulative percentage of deaths that had occurred among Indigenous males and non-Indigenous males began to diverge substantially from age 15. By age 40, between 21% and 25% of all Indigenous male deaths had occurred, compared with less than 5% of non-Indigenous male deaths. About 50% of all Indigenous male deaths occurred between ages 53 and 58, whereas 50% of non-Indigenous male deaths did not occur till age 78.

About 2 out of every 3 Indigenous male deaths (64%–69%) had occurred by the beginning of age 64, whereas only 21%–22% of non-Indigenous male deaths had occurred by that age.

This means that by age 65, about 45% more Indigenous male deaths had occurred than non-Indigenous male deaths.

A similar pattern of age at death was observed for Indigenous females (Figure 4.2b). On the whole, the percentage of both Indigenous male and female deaths occurring at younger ages is slowly declining. During the reference period, the percentage of deaths occurring before age 50 declined from 40% to 32% for males, and from 32% to 24% for females.

In addition to comparing the cumulative percentages of Indigenous and non-Indigenous deaths occurring by specified ages as in Figure 4.2, one can compare age-specific death rates or death rates at specific ages or age groups. Panel (a) of Figure 4.2 compares age-specific death rates between Indigenous and non-Indigenous males while Panel (b) presents corresponding estimates for Indigenous and non-Indigenous females.

For both Indigenous males and females and non-Indigenous males and females, death rates were very low from infancy to about age 25–44, and rose sharply thereafter.

Age-specific death rates have declined in nearly all age groups

Table 4.2 shows the trends in age-specific death rates among Indigenous and non-Indigenous males and females during selected periods from 2011–2013 to 2019–2021. Among Indigenous males and females, death rates declined in all age groups except some variability in infant death rates (age under 1), while among non-Indigenous males and females, death rates declined in all age groups.

Table 4.2: Age-specific death rates per 100,000 population, Australia, selected periods

Age	Males			Females		
	2011–2013	2014–2016	2016–2018	2011–2013	2014–2016	2016–2018
Indigenous						
Under 1	865	733	707	735	623	569
1–4	55	25	29	37	28	26
5–14	23	23	16	19	17	13
15–24	129	108	112	70	61	54
25–44	356	346	328	214	210	190
45–64	1,215	1,249	1,207	825	825	779
65–84	4,214	3,963	3,949	3,374	3,418	3,247
85 and over	16,230	18,452	17,181	15,207	14,981	15,579
Non-Indigenous						
Under 1	350	304	315	309	270	260
1–4	17	16	15	14	13	12
5–14	10	8	9	8	7	6
15–24	47	45	46	22	19	19
25–44	96	97	93	50	50	48
45–64	429	429	419	258	254	250
65–84	2,685	2,493	2,403	1,812	1,702	1,622
85 and over	14,878	14,519	14,414	12,738	12,766	12,550

Notes

1. Estimates for Australia include Tasmania, the Australian Capital Territory and Other Territories.
2. Estimates are based on enhanced deaths according to the *Majority Indigenous* algorithm and cohort-interpolated population based on the 2011, 2016 and 2021 Censuses.

Source: Enhanced Indigenous Mortality Data Collection

Age-specific death rates at childhood and early adulthood (1–4, 5–14 and 15–24 years) were relatively low, and the declines in death rates at these ages were also nominally small. However, the declines were relatively bigger than the declines observed at age groups with much higher age-specific death rates.

Indigenous male childhood and early adulthood death rates declined by between 13% (age 25–44 years) and 35% (age 1–4), while rates for Indigenous females declined by between 11% (age 15–24) and 46% (age 1–4). Mortality under age 1 declined by about 6% for Indigenous males and by about 23% for Indigenous females.

Death rates at ages 45–64, 64–84 and 85 years and over declined by about 8%, 12% and 12%, respectively, for Indigenous males; for Indigenous females, death rates in those 3 age groups declined by about 9%, 11% and 16%, respectively.

Table 4.2 shows that death rates were higher at every age for Indigenous males and females than for non-Indigenous males and females. This appears to contradict estimates in Table 4.1 which showed that crude death rates were lower for Indigenous males and females than for non-Indigenous males and females. This anomaly is due to the different age profiles of the 2 populations. The Indigenous population is skewed towards younger ages where death rates are lower, while the non-Indigenous population is skewed towards older ages where death rates are higher. Figure 4.3 can help to illustrate and explain this anomaly.

Figure 4.3 shows age-specific death rates and the corresponding percentage share of the population at each age group. The blue columns represent the percentage share of the population, and are plotted against the secondary vertical axis (% of population) while the rust-coloured dots represent the age-specific death rates, and are plotted against the primary vertical axis. Panel (a) compares the age-specific death rates and percentage share of population at each age for Indigenous and non-Indigenous males, while Panel (b) compares corresponding estimates for Indigenous and non-Indigenous females.

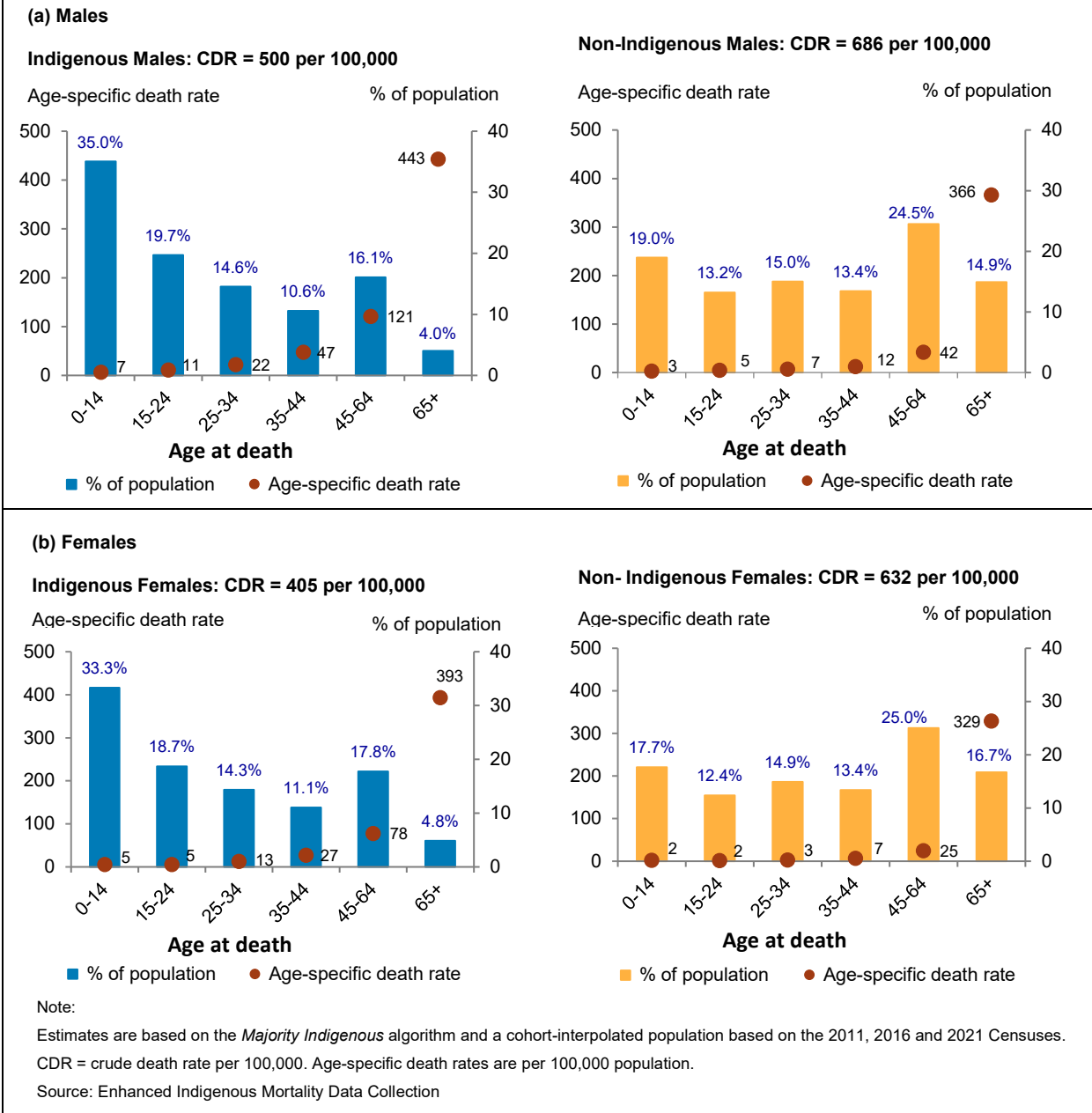
The chart shows that at each age, age-specific death rates were higher among Indigenous males and females than among non-Indigenous males and females.

Among Indigenous males and females, however, age-specific death rates were low at ages 0–14 and 15–24 where the share of the population was relatively higher. On the other hand, the percentage share of the population was relatively lower at ages 45–64 and 65 years and over where the age-specific death rates were high.

The reverse was the case for non-Indigenous males and females. Age-specific death rates were low at ages 0–14 and 15–24 where the percentage share of the population was also relatively low. On the other hand, age-specific death rates were relatively high at ages 45–64 and 65 years and over where the percentage share of the population was higher.

Age-specific death rates therefore provide additional insights into the mortality situation in a population beyond the information that can be provided by summary measures such as the crude death rate and the median age at death.

Figure 4.3: Age groups by death rate and percentage of population: Australia, 2016–2018



Rate differences and rate ratios are declining for younger ages

Another way of understanding the mortality differences between 2 or more populations is to compare the absolute and relative differences between their death rates. In this section, rate differences and rate ratios between Indigenous and non-Indigenous age-specific death rates are compared (Table 4.3 and Figure 4.4).

Age-specific death rate differences show the absolute difference between Indigenous and non-Indigenous age-specific death rates, while age-specific death rate ratios show the relative difference between the 2 rates. Both are essential tools for monitoring the gap between Indigenous and non-Indigenous health indicators, such as mortality rates.

Consistent with the observed decline in age-specific death rates during the reference period, rate ratios also declined for nearly all age groups among both males and females. The ratio between Indigenous and non-Indigenous male age-specific death rates declined among the youngest age groups up to 25–44 years, and increased thereafter. For females, rate ratios declined up to age 45–64 and either remained stable or increased thereafter.

Table 4.2 shows that with the exception of Indigenous infant males, Indigenous males and females enjoyed bigger declines in death rates at the youngest ages (up to 24 years) than did non-Indigenous males and females. On the other hand, non-Indigenous males and females experienced bigger declines in death rates at the oldest ages (65 years and over) than did Indigenous males and females. As a result, rate differences and rate ratios declined more substantially at the youngest ages, particularly ages 1–4, 5–14 and 15–24, than at the oldest ages, as Table 4.3 shows.

Table 4.3: Age-specific death rate differences and rate ratios, Australia, selected periods

Age	Males			Females		
	2011–2013	2014–2016	2016–2018	2011–2013	2014–2016	2016–2018
Rate differences						
Under 1	515	429	392	426	353	309
1–4	38	9	14	23	15	14
5–14	13	15	7	11	10	7
15–24	82	63	66	48	42	35
25–44	260	249	235	164	160	142
45–64	786	820	788	567	571	529
65–84	1,529	1,470	1,546	1,562	1,716	1,625
85 and over	1,352	3,933	2,767	2,469	2,215	3,029
Rate ratios						
Under 1	2.5	2.4	2.2	2.4	2.3	2.2
1–4	3.2	1.6	1.9	2.6	2.2	2.2
5–14	2.3	2.9	1.8	2.4	2.4	2.2
15–24	2.7	2.4	2.4	3.2	3.2	2.8
25–44	3.7	3.6	3.5	4.3	4.2	4.0
45–64	2.8	2.9	2.9	3.2	3.2	3.1
65–84	1.6	1.6	1.6	1.9	2.0	2.0
85 and over	1.1	1.3	1.2	1.2	1.2	1.2

1. Estimates for Australia include Tasmania, the Australian Capital Territory and Other Territories.

2. Estimates are based on enhanced deaths according to the *Majority Indigenous* algorithm and cohort-interpolated population based on the 2011, 2016 and 2021 Censuses.

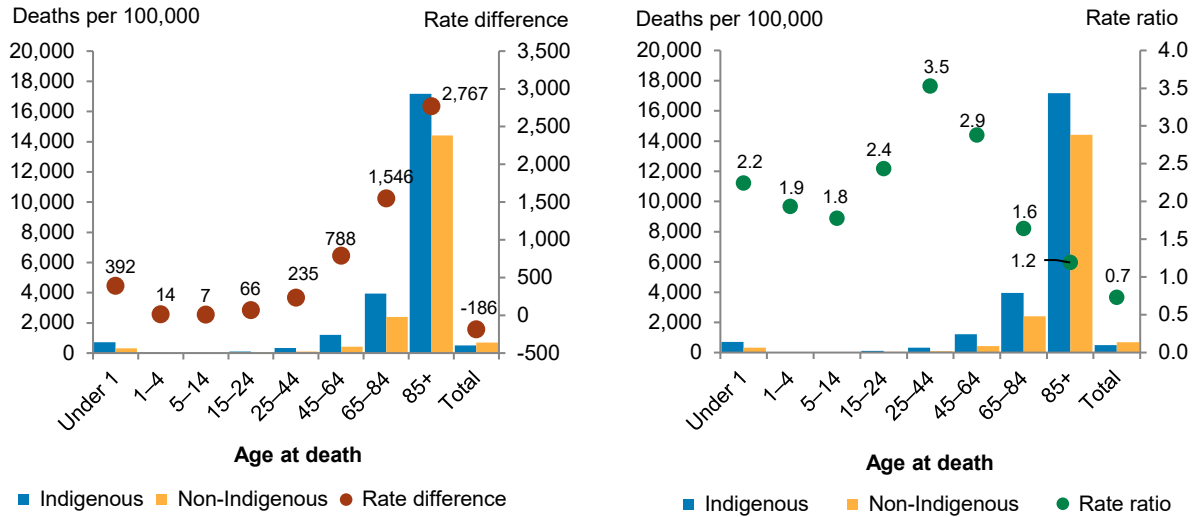
Source: Enhanced Indigenous Mortality Data Collection

Trends in age-specific death rate differences can be used to indicate movement in the absolute size of the difference and the magnitude of improvement required for the mortality gap to close, while trends in the rate ratios will indicate whether the relative rate of improvement in Indigenous mortality is faster than for non-Indigenous mortality – the fundamental requirement for the ‘gap’ to finally close (Ring et al. 2016).

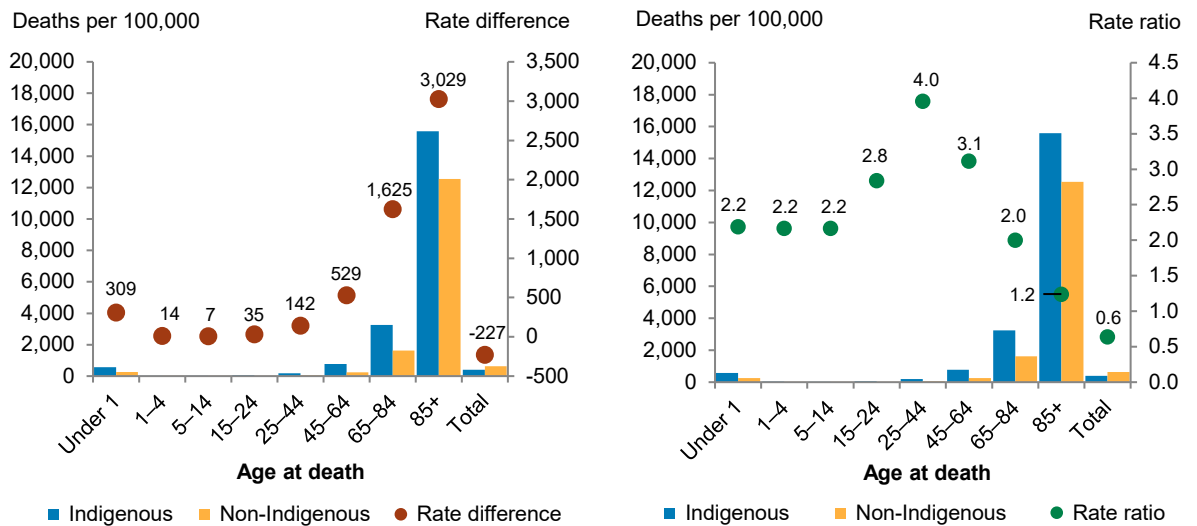
Figure 4.4 shows rate differences and rate ratios between Indigenous and non-Indigenous age-specific death rates. The blue and yellow columns represent the age-specific death rates while the rust-coloured dots represent rate differences; the green dots represent rate ratios.

Figure 4.4: Age-specific death rate differences and rate ratios between Indigenous and non-Indigenous Australians, 2016–2018

(a) Indigenous and non-Indigenous males



(b) Indigenous and non-Indigenous females



Note:
 Estimates are based on the *Majority Indigenous* algorithm and a cohort-interpolated population based on the 2011, 2016 and 2021 Censuses.
 Source: Enhanced Indigenous Mortality Data Collection

For both males and females, rate differences were at their lowest at ages up to 24, and highest at ages 45 and over. On the other hand, rate ratios were higher at ages less than 1 and 1–4 than at ages 65–84 and 85 years and over. For both males and females, the 85 years and over age group had both the largest rate difference and the lowest rate ratio. Figure 4.4 therefore shows the different uses to which rate ratios and rate differences can be put.

For example, the rate ratios show that age-specific death rates for ages less than 1, 1–4 and 5–14 were between 1.8 and 2.4 times higher for Indigenous males than for non-Indigenous males, and about 2.2 to 2.8 times higher for Indigenous females than for non-Indigenous

females. Their respective rate differences were, however, relatively small. This would be largely due to age-specific death rates being relatively low at these ages.

On the other hand, both the rate differences and rate ratios for the 25–44, 45–64 and 65–84 years age groups were relatively high. Reducing mortality in these age groups would therefore have a substantial impact on reducing the gap in mortality and life expectancy between Indigenous and non-Indigenous Australians.

The observations made for the 25–44, 45–64 and 65–84 years age groups present an interesting contrast with the previously cited age group 85 years and over, which had the lowest rate ratio but the highest rate difference. Although the rate ratio for the 85 years and over age group is low (1.2), the large rate differences mean that reducing Indigenous mortality in this age group will also contribute substantially to reducing the Indigenous and non-Indigenous mortality gap.

4.4 Age-standardised death rates

Indigenous age-standardised death rates are declining

Although age-specific death rates are useful measures of the level and distribution of deaths by age, they can be overwhelming when comparing several age-specific death rates in 2 or more populations. For purposes of comparing mortality levels in 2 or more populations, a single summary measure that takes into account the age profile of the populations being compared is indispensable. The age-standardised death rate is one such summary measure.

The age-standardised death rate is another single mortality measure that summarises the mortality experience in a population at a given period of time. Unlike the crude death rate, however, the age-standardised death rates take into consideration the age structure of the study population.

Age-standardised rates are hypothetical rates that would have been observed if the populations being studied had the same age profile as that of a comparative population, selected as the standard population, while all other factors remained unchanged (AIHW 2011a; Earyes 2008). Being hypothetical rates, age-standardised death rates have no intrinsic value outside of the comparison situation.

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 2 populations unless the mortality rates that are being compared are standardised to a common age structure (AIHW 2011a).

In Australia, the common age structure that is used for facilitating comparisons of age-dependent event rates between 2 or more populations with different age structures is the 2001 Standard Population of Australia (ABS 2013b). A new standard population will be developed after the 2026 Census. The age-standardised death rates discussed in this section are therefore based on the *2001 Standard Population of Australia*.

Table 4.4 shows age-standardised death rates among Indigenous and non-Indigenous males and females in Australia and selected jurisdictions during 2011–2018. In all the jurisdictions considered, age-standardised death rates were higher among both Indigenous males and females than among non-Indigenous males and females. The rates were also higher among Indigenous and non-Indigenous males than among Indigenous and non-Indigenous females.

In 2011–2018, there were about 1,200 Indigenous male deaths and 900 Indigenous female deaths, respectively, for every 100,000 Indigenous males and females in Australia. These figures were about twice as high as the estimates of 435–455 for non-Indigenous males and 617–656 for non-Indigenous females.

Across all 4 periods 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 and the Northern Territory had the highest age-standardised death rates for Indigenous males, while the Northern Territory had the highest age-standardised death rates for Indigenous females.

Table 4.4: Age-standardised death rates per 100,000 population, selected states and territories

State/Territory	Males			Females		
	2011–2013	2014–2016	2016–2018	2011–2013	2014–2016	2016–2018
Indigenous						
NSW	1,023	1,076	1,102	788	815	787
Vic	998	929	997	779	794	845
Qld	1,249	1,333	1,237	953	941	913
WA	1,672	1,496	1,420	919	898	840
SA	1,001	1,198	1,134	782	940	947
NT	1,772	1,623	1,565	1,375	1,474	1,364
<i>Australia</i>	<i>1,211</i>	<i>1,214</i>	<i>1,182</i>	<i>914</i>	<i>924</i>	<i>892</i>
Non-Indigenous						
NSW	667	638	623	458	452	437
Vic	635	612	595	451	440	432
Qld	665	645	636	453	448	437
WA	630	623	596	429	428	414
SA	667	634	617	465	452	434
NT	746	735	659	479	442	442
<i>Australia</i>	<i>656</i>	<i>633</i>	<i>617</i>	<i>455</i>	<i>448</i>	<i>435</i>

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

(b) Estimates of deaths are based on the *Majority Indigenous* algorithm

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

Source: Enhanced Indigenous Mortality Data Collection.

For Australia as a whole, age-standardised death rates declined for both Indigenous and non-Indigenous males and females. Age-standardised death rates for non-Indigenous Australians also declined in the Northern Territory and in all the 5 states considered.

Trends in age-standardised death rates for Indigenous males and females across jurisdictions were, however, variable. There were declines in age-standardised death rates for Indigenous males and females in Queensland, Western Australia and the Northern Territory, while there was either a slight increase or stable rates in the remaining states.

Age-standardised death rate differences are variable but declining

Table 4.5 shows age-standardised death rate differences between Indigenous and non-Indigenous Australians, while Table 4.6 shows the age-standardised death rates ratios. Both tables 4.5 and 4.6 are based on the age-standardised death rates shown in Table 4.4.

Nationally, and for most jurisdictions, the rate difference declined for both males and females in line with the declining age-standardised death rates shown in Table 4.4.

The rate difference varied between states and territories, ranging from about 350–480 deaths per 100,000 Indigenous males in New South Wales to about 1,000–1,300 deaths per 100,000 Indigenous males in Western Australia and the Northern Territory. For females, the rate difference was about 300–500 in nearly all jurisdictions except the Northern Territory where it was 1,032 in 2014–2016 and between 500 and 600 thereafter.

To close the mortality gap, the age-standardised death rates need to decline by 500–600 deaths per 100,000 Indigenous males, and by 400–500 deaths per 100,000 Indigenous females. The expected decline is equivalent to reducing the age-standardised death rate for males by about 50%–60%, and for females, by about 40%–50%, in most jurisdictions.

Table 4.5: Age-standardised death rate differences per 100,000 population, selected states and territories, 2011–2018

State/Territory	Males			Females		
	2011–2013	2014–2016	2016–2018	2011–2013	2014–2016	2016–2018
NSW	356	438	479	330	363	350
Vic	363	317	402	328	354	413
Qld	584	688	601	500	493	476
WA	1,042	873	824	490	470	426
SA	334	564	517	317	488	513
NT	1,026	888	906	896	1,032	922
<i>Australia</i>	<i>555</i>	<i>581</i>	<i>565</i>	<i>459</i>	<i>476</i>	<i>457</i>

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

(b) Rate differences are based on death rates that have been age standardised to the age distribution of the 2001 Australian standard population (ABS 2013b) (see Table 2.5).

Source: Enhanced Indigenous Mortality Data Collection.

Trends in age-standardised death rate ratios are variable

Table 4.6 shows that in Australia as a whole, the ratio between Indigenous and non-Indigenous age-standardised death rates remained relatively unchanged during the period 2011–2018, at about 1.8–1.9 for males and about 2.0–2.1 for females. Age-standardised death rates for Indigenous males and females were therefore nearly twice as high as the rates for non-Indigenous males and females.

Table 4.6: Age-standardised death rate ratios, selected states and territories

State/Territory	Males			Females		
	2011–2013	2014–2016	2016–2018	2011–2013	2014–2016	2016–2018
NSW	1.5	1.7	1.8	1.7	1.8	1.8
Vic	1.6	1.5	1.7	1.7	1.8	2.0
Qld	1.9	2.1	1.9	2.1	2.1	2.1
WA	2.7	2.4	2.4	2.1	2.1	2.0
SA	1.5	1.9	1.8	1.7	2.1	2.2
NT	2.4	2.2	2.4	2.9	3.3	3.1
<i>Australia</i>	<i>1.8</i>	<i>1.9</i>	<i>1.9</i>	<i>2.0</i>	<i>2.1</i>	<i>2.1</i>

Notes:

1. Estimates for Australia include Tasmania, the Australian Capital Territory and Other Territories.

2. Rate ratios are based on death rates that have been age standardised to the age distribution of the 2001 Australian standard population (ABS 2013b) (see Table 4.4).

Source: Enhanced Indigenous Mortality Data Collection.

Rate ratios remained relatively stable during the reference period because even though age-standardised death rates for Indigenous males and females declined, the rate ratios did not change much due to age-standardised death rates for non-Indigenous males and females declining at the same or faster rate than those for Indigenous males and females.

While the rate ratio for males was between 1.5 and 2.5 in most jurisdictions, it was as high as 3.4–3.9 in Western Australia and the Northern Territory, an indication that the mortality gap between Indigenous and non-Indigenous males was much wider in Western Australia and the Northern Territory than in the remaining jurisdictions.

The rate ratios show that in nearly all jurisdictions except the Northern Territory, rate ratios were about 1.2–1.5 times as high for Indigenous females as for non-Indigenous females. Rate ratios were highest in the Northern Territory (1.8–2.1).

4.5 Conclusion

This chapter has presented mortality estimates based on the EIMDC. A number of mortality measures and indicators – namely, 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, albeit slightly, in most age groups for both Indigenous males and females across the 6 jurisdictions considered.

Some of the specific findings from the study include:

- Age-specific death rates were highest at ages 45–64, 65–84 and 80 years and over, but the biggest declines were in childhood and early adulthood where age-specific death rates for Indigenous males declined by about 13% in the age group 25–44 and 35% in the age group 1–4, while rates for Indigenous females declined by about 11% in the age group 15–24, and by 46% in the 1–4 age group.
- Age-standardised death rates declined for both Indigenous males and females as well as for non-Indigenous males and females in Australia. The age-standardised death rate declined for Indigenous females in several jurisdictions including New South Wales, Queensland, South Australia and the Northern Territory, and for Indigenous males in Western Australia and Queensland.
- Despite the reported declines in Indigenous mortality, the mortality gap did not close because mortality also declined among non-Indigenous males and females by nearly identical amounts.
- To close the mortality gap, the age-standardised death rates need to decline by 500–600 deaths per 100,000 Indigenous males, and by 400–500 deaths per 100,000 Indigenous females. The expected decline is equivalent to reducing the age-standardised death rate for males by 50%–60%, and for females, by about 40%–50%, in most jurisdictions.

5 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 age 65 refers to the probable years of life remaining for a group of people at ages 20 or 65 if they experienced the prevailing mortality rates for the rest of their lives (see Table 5.3).

The most commonly used estimate of life expectancy is life expectancy at birth. It reflects the mortality pattern that prevails across all age groups. It is the total number of years a baby born at a particular period of time will expect to live if it is exposed to the prevailing age-specific death rates throughout its lifetime (Shryock & Siegel 1980).

Estimates of life expectancy are obtained from a life table. The life expectancy estimates in this chapter, including all estimates derived from the life tables, are based on the assumption that a given cohort of babies will experience the prevailing age-specific death rates throughout their lifetime.

5.1 Key data inputs

The key inputs into the construction of a life table are age-specific death rates, which are calculated by dividing the number of deaths that occurred at each age in a population during a defined reference period by the mid-year population at each age during the same period. Other functions in the life table are based on the age-specific death rates.

This approach is referred to as the direct approach. While it can produce reliable estimates of Indigenous life expectancy, it is susceptible to problems of small cell counts and random variation in death rates which could affect the reliability of the estimates. In recent years, statistical models such as Bayesian hierarchical models have been used to deal with the problems of small cell counts and random variation. While these methods have not been used in this report except as an evaluation tool (see Section 3.7), the AIHW plans to use them in future iterations of the report.

The death data used in preparing the life tables and life expectancy estimates in this report were extracted from the EIMDC, and were enhanced using the *Majority Indigenous* algorithm. The cohort-interpolated population was used as the population-at-risk in preparing the age-specific death rates on which the life tables were based.

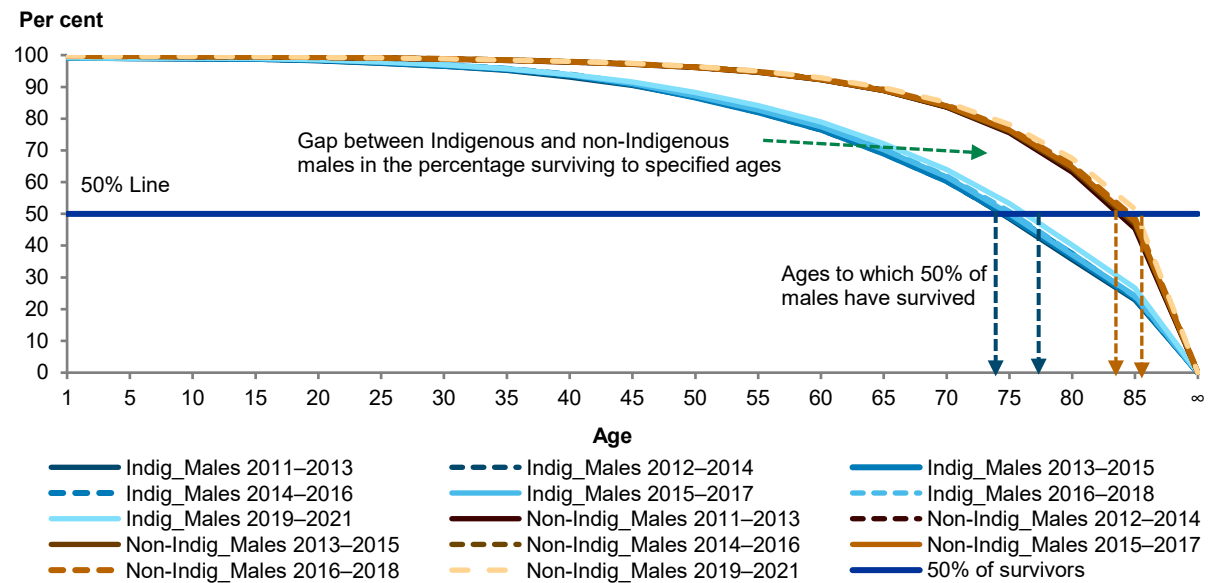
5.2 Survival from birth to specified ages

Half of Indigenous babies will survive to age 75

Life expectancy at birth is the most widely known life table measure, although other measures are also important and offer further insights into survival and the timing of death. One such measure is the percentage of a cohort of newly-born babies that will survive from birth to specified ages if the prevailing age-specific death rates observed in the population do not change.

Figures 5.1 and 5.2 show the estimated percentage of Indigenous and non-Indigenous male and female babies that survived from birth to specified ages during the periods 2011–2018 and 2019–2021.

Figure 5.1: Percentage of Indigenous and non-Indigenous males surviving to the beginning of specified ages, 2011–2018 (linked data) and 2019–2021 (projected data), Australia

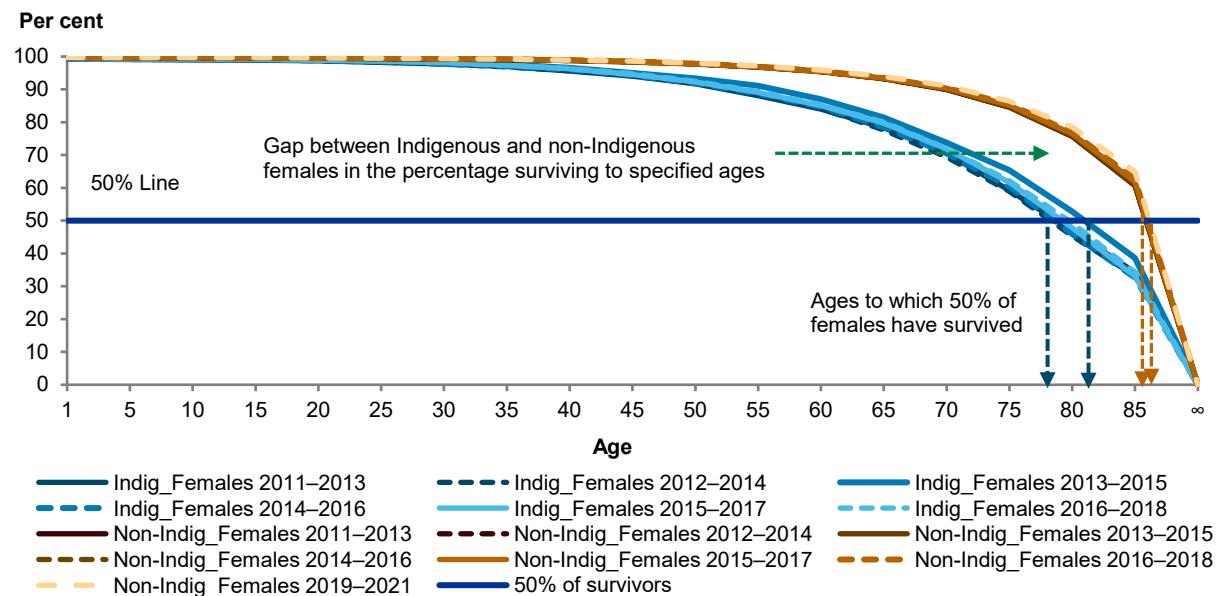


Notes

1. Estimates are based on the *Majority Indigenous* algorithm and cohort-interpolated denominator population estimated from the official back-cast and projected Indigenous population based on the 2011, 2016 and 2021 Censuses.
2. Estimates for 2011–2018 are based on linked data while estimates for 2019–2021 are preliminary and are based on unlinked death data for 2019–2021 and projected linkage rates from 2016–2018.

Source: Enhanced Indigenous Mortality Data Collection

Figure 5.2: Percentage of Indigenous and non-Indigenous females surviving to the beginning of specified ages, 2011–2018 (linked data) and 2019–2021 (projected data), Australia



Notes

1. Estimates are based on the *Majority Indigenous* algorithm and cohort-interpolated denominator population estimated from the official back-cast and projected Indigenous population based on the 2011, 2016 and 2021 Censuses.
2. Estimates for 2011–2018 are based on linked data while estimates for 2019–2021 are preliminary and are based on unlinked death data for 2019–2021 and projected linkage rates from 2016–2018.

Source: Enhanced Indigenous Mortality Data Collection

Knowledge of the survival profile of Indigenous males and females compared with that of non-Indigenous males and females can inform the formulation of policies and the development of programs and services to close the life expectancy gap.

Figures 5.1 and 5.2 show that based on EIMDC data, 50% of Indigenous male babies will survive up to and beyond age 74 years, while 50% of Indigenous female babies will survive up to and beyond age 77. There are still substantial differences in survival between Indigenous and non-Indigenous Australians, however.

Based on EIMDC data, the vast majority of Indigenous babies survive to adulthood. The percentage of Indigenous male babies that did not survive to age 30 (3.0%–3.5%) was about 3 times that for non-Indigenous male babies (1.1%–1.3%), while the percentage of Indigenous female babies that did not survive to age 30 (1.8%–2.3%) was also nearly 3 times that for non-Indigenous female babies (0.7%–0.8%) that did not survive to age 30.

At age 60, 76%–77% of Indigenous males were still alive compared with 92% of non-Indigenous males – a gap of 15%–16%. The gap was slightly smaller for females. By age 60, 84%–86% of Indigenous females were still alive compared with 95% of non-Indigenous females – a gap of about 10%–11%.

While only 48%–50% of Indigenous male babies survived to age 75, about 75%–77% of non-Indigenous male babies survived to age 75. About 59%–62% of Indigenous female babies also survived to age 75 compared with 85% of non-Indigenous female babies.

5.3 Indigenous life expectancy (2011–2018)

Estimated Indigenous life expectancy has increased to about 72 years for males and about 77 years for females

Table 5.1 presents estimates of Indigenous and non-Indigenous life expectancy at birth together with their 95 per cent confidence intervals, for the periods 2011–2013, 2012–2014, 2013–2015, 2014–2016, 2015–2017 and 2016–2018. (See Chapter 6 for preliminary estimates for 2019–2021 which are based on registered deaths for the period 2019–2021 and projected Indigenous classification rates from 2016–2018).

Table 5.1: Estimates of Indigenous and non-Indigenous life expectancy at birth: Australia, 2011–2018

Period	Indigenous		Non-indigenous	
	Males	Females	Males	Females
2011–2013	71.1 [70.6 – 71.5]	75.9 [75.4 – 76.3]	80.8 [80.8 – 80.9]	85.1 [85.0 – 85.1]
2012–2014	71.1 [70.7 – 71.5]	75.6 [75.3 – 76.0]	81.0 [81.0 – 81.1]	85.1 [85.1 – 85.2]
2013–2015	71.0 [70.6 – 71.4]	76.3 [75.2 – 76.0]	81.1 [81.1 – 81.2]	85.2 [85.2 – 85.3]
2014–2016	71.2 [70.9 – 71.6]	75.9 [75.5 – 76.2]	81.2 [81.2 – 81.3]	85.3 [85.2 – 85.3]
2015–2017	71.4 [71.1 – 71.8]	76.2 [75.9 – 76.6]	81.3 [81.2 – 81.3]	85.3 [85.3 – 85.4]
2016–2018	71.7 [71.3 – 72.0]	76.5 [76.2 – 76.9]	81.5 [81.4 – 81.5]	85.6 [85.5 – 85.6]

Notes:

1. Estimates are based on the *Majority Indigenous* algorithm and cohort-interpolated denominator population estimated from the official back-cast and projected Indigenous population based on the 2011, 2016 and 2021 Censuses.
2. The confidence intervals take into account sampling error but not measurement error.

Source: Enhanced Indigenous Mortality Data Collection

Box 5.1: 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 5.1 and 5.2 in this chapter show estimates of life expectancy followed by upper and lower 95% confidence levels of the estimates 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.

In Table 5.1, life expectancy at birth for Indigenous males in Australia during 2016–2018 was 71.7 [71.3–72.0]. This means that 71.7 years is the best estimate of Indigenous male life expectancy in Australia during 2016–2018. Since this is only an estimate, the true value could be different from 71.7 years. There is 95% confidence, however, that the true value is between 71.3 and 72.0 years, indicating a confidence interval of 0.7 of a year.

On the other hand, life expectancy at birth for Indigenous males in Victoria in 2016–2018 (Table 5.2) was 74.6 [73.1–76.1]. This means that 74.6 years is the best estimate of Indigenous male life expectancy in Victoria during 2016–2018. This is only an estimate, and the true value could be different from 74.6 years. There is 95% confidence, however, that the true value is between 73.1 and 76.1 years, indicating a confidence interval of 3.0 years.

In general, confidence intervals are smallest for Australia-level estimates and biggest for Victoria and South Australia. Both states 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 Indigenous male and female life expectancy estimates compared with corresponding estimates for non-Indigenous males and females. This is due to the much smaller Indigenous population and fewer Indigenous deaths compared with corresponding estimates for the non-Indigenous population.

The confidence intervals only allow for uncertainty due to individual-level randomness in deaths. They do not take account of measurement errors, such as mismatches between definitions of Indigenous status used for deaths and for the Indigenous ERP. These are potential sources of error that could affect the accuracy of the life expectancy estimates.

An Indigenous male baby born in Australia during the period 2011–2018 can expect to live for about 71–73 years if they experienced, throughout their lifetime, the prevailing age-specific death rates for Indigenous males, while an Indigenous female baby born during the same period can expect to live for about 76–77 years. During the same period, a non-Indigenous male baby born in Australia can expect to live for 81–82 years, while a non-Indigenous female can expect to live for about 85–86 years.

Indigenous life expectancy varied between states and territories

Table 5.2 shows estimates of Indigenous and non-Indigenous life expectancy at birth for selected states and territories during 2011–2018. While steps have been taken to ensure the estimates are as robust as possible, they are nonetheless affected by differences between states and territories in linkage rates, and in the reporting of Indigenous status over time.

Between states and territories, estimates of Indigenous male and female life expectancy at birth varied considerably from the national average of 71–72 years for males and 76–77 years for females during the period 2011–2018. Between states and territories, Indigenous life expectancy at birth varied by about 8–11 years for both males and females.

Estimates of Indigenous male life expectancy at birth during 2011–2018 was highest in Victoria (74–75 years), followed by New South Wales (73–74 years), South Australia (71–74 years) and Queensland (71 years). Life expectancy at birth for Indigenous males was lowest in Western Australia (67–69 years) and the Northern Territory (63–66 years).

Table 5.2: Estimates of Indigenous and non-Indigenous life expectancy at birth, selected states and territories, 2011–2018

State/Territory	Indigenous		Non-indigenous	
	Males	Females	Males	Females
New South Wales				
2011–2013	74.1 [73.4 – 74.8]	78.2 [77.5 – 79.0]	80.7 [80.6 – 80.7]	85.0 [84.9 – 85.1]
2012–2014	73.8 [73.1 – 74.5]	77.8 [77.1 – 78.5]	80.8 [80.8 – 80.9]	85.1 [85.0 – 85.2]
2013–2015	73.4 [72.7 – 74.0]	77.8 [77.1 – 78.4]	81.0 [81.0 – 81.1]	85.2 [85.1 – 85.2]
2014–2016	73.2 [72.6 – 73.9]	77.8 [77.2 – 78.4]	81.1 [81.1 – 81.2]	85.2 [85.1 – 85.2]
2015–2017	73.4 [72.8 – 74.0]	78.4 [77.8 – 79.0]	81.2 [81.1 – 81.2]	85.3 [85.2 – 85.3]
2016–2018	73.3 [72.8 – 73.9]	78.6 [78.0 – 79.2]	81.4 [81.3 – 81.5]	85.5 [85.5 – 85.6]
Victoria				
2011–2013	74.4 [72.7 – 76.1]	78.8 [77.4 – 80.2]	81.3 [81.2 – 81.4]	85.2 [85.1 – 85.3]
2012–2014	74.4 [72.8 – 76.0]	79.6 [78.2 – 81.1]	81.5 [81.4 – 81.6]	85.3 [85.2 – 85.3]
2013–2015	75.6 [74.0 – 77.3]	79.8 [78.3 – 81.2]	81.6 [81.5 – 81.7]	85.4 [85.3 – 85.5]
2014–2016	75.1 [73.5 – 76.7]	78.3 [76.9 – 79.7]	81.7 [81.6 – 81.8]	85.5 [85.4 – 85.6]
2015–2017	75.5 [73.8 – 77.2]	77.6 [76.3 – 78.9]	81.8 [81.7 – 81.8]	85.5 [85.4 – 85.6]
2016–2018	74.6 [73.1 – 76.1]	77.4 [76.2 – 78.7]	82.0 [81.9 – 82.1]	85.7 [85.6 – 85.8]
Queensland				
2011–2013	71.0 [70.2 – 71.7]	75.7 [75.0 – 76.4]	80.6 [80.5 – 80.7]	85.0 [84.9 – 85.1]
2012–2014	71.1 [70.4 – 71.8]	75.8 [75.1 – 76.5]	80.8 [80.7 – 80.9]	85.1 [85.0 – 85.2]
2013–2015	70.4 [69.8 – 71.1]	75.5 [74.8 – 76.2]	80.8 [80.7 – 80.9]	85.1 [85.0 – 85.2]
2014–2016	71.0 [70.3 – 71.6]	75.9 [75.2 – 76.6]	80.9 [80.8 – 81.0]	85.2 [85.1 – 85.3]
2015–2017	70.7 [70.1 – 71.4]	76.0 [75.4 – 76.7]	80.9 [80.8 – 81.0]	85.2 [85.1 – 85.3]
2016–2018	71.3 [70.6 – 71.9]	76.7 [76.0 – 77.3]	81.0 [80.9 – 81.1]	85.5 [85.4 – 85.6]
South Australia				
2011–2013	73.6 [71.2 – 75.9]	77.8 [75.9 – 79.8]	80.6 [80.4 – 80.7]	84.9 [84.7 – 85.0]
2012–2014	72.6 [70.4 – 75.0]	75.8 [73.9 – 77.8]	80.7 [80.6 – 80.9]	84.9 [84.7 – 85.0]
2013–2015	72.7 [70.7 – 74.8]	77.0 [75.0 – 79.0]	81.0 [80.8 – 81.2]	85.0 [84.9 – 85.2]
2014–2016	71.5 [69.8 – 73.2]	76.1 [74.4 – 77.8]	81.3 [81.1 – 81.4]	85.2 [85.0 – 85.3]
2015–2017	71.0 [69.3 – 72.6]	76.6 [75.0 – 78.3]	81.5 [81.3 – 81.7]	85.4 [85.2 – 85.5]
2016–2018	71.6 [70.0 – 73.3]	75.5 [73.9 – 77.1]	81.6 [81.4 – 81.7]	85.6 [85.5 – 85.7]
Western Australia				
2011–2013	66.8 [65.9 – 67.8]	73.8 [72.7 – 75.0]	81.3 [81.1 – 81.4]	85.8 [85.6 – 86.0]
2012–2014	67.3 [66.3 – 68.4]	74.3 [73.1 – 75.4]	81.4 [81.3 – 81.6]	85.8 [85.6 – 85.9]
2013–2015	67.7 [66.6 – 68.7]	74.4 [73.3 – 75.5]	81.5 [81.3 – 81.6]	85.9 [85.0 – 85.2]
2014–2016	67.7 [66.7 – 68.7]	74.1 [73.1 – 75.2]	81.4 [81.3 – 81.5]	85.8 [85.6 – 85.9]
2015–2017	68.3 [67.4 – 69.3]	74.3 [73.2 – 75.3]	81.5 [81.4 – 81.7]	86.0 [85.8 – 86.1]
2016–2018	68.6 [67.6 – 69.5]	74.8 [73.8 – 75.8]	81.8 [81.7 – 82.0]	86.2 [86.0 – 86.3]

continued

Table 5.2: Estimates of Indigenous and non-Indigenous life expectancy at birth, selected states and territories, 2011–2018 (continued)

State/Territory	Indigenous		Non-Indigenous	
	Males	Females	Males	Females
Northern Territory				
2011–2013	63.1 [61.9 – 64.3]	67.8 [66.6 – 69.0]	79.4 [78.8 – 80.0]	84.2 [83.6 – 84.8]
2012–2014	63.5 [62.4 – 64.6]	67.1 [66.0 – 68.2]	79.5 [78.9 – 80.1]	84.8 [84.1 – 85.4]
2013–2015	64.8 [63.6 – 65.9]	67.0 [65.9 – 68.0]	79.0 [78.5 – 79.6]	84.7 [84.1 – 85.4]
2014–2016	66.0 [64.9 – 67.1]	68.0 [66.9 – 69.1]	79.5 [78.9 – 80.0]	85.4 [84.7 – 86.1]
2015–2017	66.5 [65.4 – 67.6]	69.1 [68.1 – 70.2]	79.9 [79.3 – 80.5]	85.5 [84.8 – 86.1]
2016–2018	66.3 [65.2 – 67.4]	69.3 [68.3 – 70.4]	80.7 [80.1 – 81.3]	85.5 [84.8 – 86.1]

Notes:

Estimates are based on the *Majority Indigenous* algorithm and cohort-interpolated denominator population estimated from the official back-cast and projected Indigenous population based on the 2011, 2016 and 2021 Censuses.

Source: Enhanced Indigenous Mortality Data Collection

Estimates of Indigenous female life expectancy at birth during 2011–2018 was also highest in New South Wales and Victoria (77–79 years), and lowest in Western Australia (74–75 years) and the Northern Territory (68–69 years).

On the other hand, estimates of non-Indigenous life expectancy at birth was similar across states and territories, and varied by only about 1 to 2 years, between 79 and 81 years for males and between 84 and 86 years for females.

5.3.1 Partial life expectancy

Surviving the first few years of life improves survival outcomes

Although life expectancy at birth (or at age zero) is the most widely known indicator of life expectancy, other indicators of life expectancy are also important. One such indicator is partial life expectancy, or the remaining years of life at specified ages other than age zero. One can obtain from a life table an estimate of the remaining years that a person at any age (for example, age 20, 45, 65 or 75 years) can expect to live if that person experienced the prevailing age-specific death rates throughout their lifetime. This information is presented in Table 5.3.

The remaining years of life are, however, more than the difference between life expectancy at birth (or at age zero) and a person's current age. For example, an Indigenous male baby born during 2016–2018 could expect to live for another 30.6 years, or till he was 75.6 years old, if he experienced the prevailing age-specific death rates throughout his lifetime, even though the life expectancy at birth for a person born that year was only 71.4 years. Thus, once the reference person had lived up to age 45 years, the person stood the chance of living for an additional 4.2 years beyond the estimated life expectancy at birth.

Similarly, even though life expectancy at birth was about 71.1 years for Indigenous males born during 2011–2013, an Indigenous male aged 75 could expect to live for a further 10.9 years, up to about age 85.9 years, or about 14.8 years more, on the average, than the estimated life expectancy at birth.

In the same way, even though life expectancy at birth was about 75.9 years for Indigenous females born during 2011–2013, an Indigenous female aged 75 could expect to live for a further 12.5 years, on the average, up to about 88.4 years.

The difference between the age that a person, at birth, would be expected to live to, that is, life expectancy at birth, and the age that person, at an older age, would be expected to live to, is due to the higher mortality often experienced at ages under 5 years than at subsequent ages, other than at the oldest or terminal ages of life. High early-age mortality exerts a considerable lowering effect on overall life expectancy. Thus, once a person has survived the first 5 years of life, the person stands the chance of living beyond the age indicated by the estimate of life expectancy at birth.

Table 5.3: Estimates of Indigenous life expectancy at specified ages: Australia, 2011–2018

Period/Selected ages	Males	Females
2011–2013		
0	71.1 [70.6 – 71.5]	75.9 [75.4 – 76.3]
20	52.3 [51.9 – 52.7]	56.9 [56.5 – 57.3]
45	30.4 [30.1 – 30.8]	33.9 [33.5 – 34.3]
65	16.3 [15.9 – 16.7]	18.3 [18.0 – 18.7]
75	10.9 [10.5 – 11.3]	12.5 [12.1 – 12.8]
2012–2014		
0	71.1 [70.7 – 71.5]	75.6 [75.3 – 76.0]
20	52.3 [51.9 – 52.7]	56.7 [56.3 – 57.0]
45	30.4 [30.0 – 30.7]	33.7 [33.3 – 34.0]
65	16.4 [16.0 – 16.8]	18.2 [17.9 – 18.6]
75	10.9 [10.5 – 11.3]	12.4 [12.0 – 12.7]
2013–2015		
0	71.0 [70.6 – 71.4]	75.6 [75.3 – 76.0]
20	52.3 [51.9 – 52.6]	56.7 [56.3 – 57.0]
45	30.3 [30.0 – 30.7]	33.7 [33.3 – 34.0]
65	16.3 [16.0 – 16.7]	18.2 [17.9 – 18.6]
75	10.8 [10.4 – 11.2]	12.1 [11.8 – 12.5]
2014–2016		
0	71.2 [70.9 – 71.6]	75.9 [75.5 – 76.2]
20	52.3 [51.9 – 52.6]	56.8 [56.4 – 57.1]
45	30.3 [30.0 – 30.7]	33.7 [33.4 – 34.1]
65	16.2 [15.9 – 16.6]	18.1 [17.8 – 18.4]
75	10.5 [10.1 – 10.8]	12.0 [11.6 – 12.3]
2015–2017		
0	71.4 [71.1 – 71.8]	76.2 [75.9 – 76.6]
20	52.4 [52.1 – 52.8]	57.1 [56.7 – 57.4]
45	30.5 [30.2 – 30.8]	33.9 [33.6 – 34.3]
65	16.2 [15.9 – 16.5]	18.1 [17.8 – 18.4]
75	10.6 [10.3 – 10.9]	11.8 [11.5 – 12.1]
2016–2018		
0	71.7 [71.3 – 72.0]	76.5 [76.3 – 76.9]
20	52.6 [52.3 – 53.0]	57.4 [57.0 – 57.7]
45	30.6 [30.3 – 31.0]	34.2 [33.9 – 34.5]
65	16.4 [16.0 – 16.7]	18.3 [18.0 – 18.6]
75	10.6 [10.3 – 10.9]	12.1 [11.8 – 12.4]

1. Estimates are based on the *Majority Indigenous* algorithm and cohort-interpolated denominator population estimated from the official back-cast and projected Indigenous population based on the 2011, 2016 and 2021 Censuses.

2. Estimates for Australia include Tasmania and the Australian Capital Territory.

Source: Enhanced Indigenous Mortality Data Collection

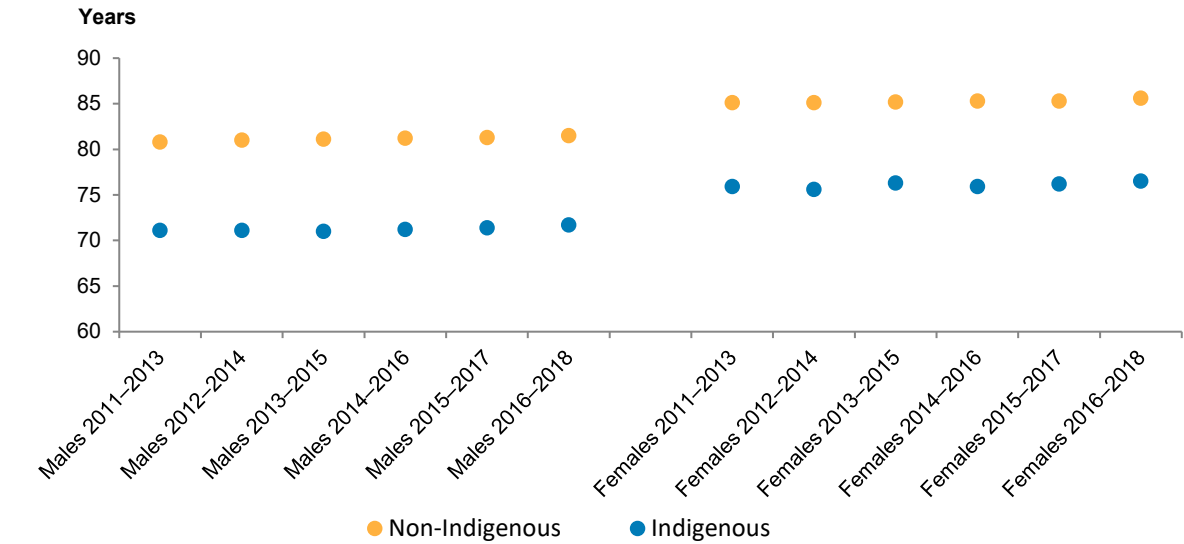
5.3.2 Trends in life expectancy at birth

Life expectancy increased for both Indigenous males and females

Between 2011 and 2018, estimated life expectancy at birth increased by about 0.6 of a year for Indigenous males, from 71.1 years in 2011–2013 to 71.7 years in 2016–2018, while that for Indigenous females also increased by 0.6 of a year, from 75.9 to 76.2 years in 2016–2018. During the same period, life expectancy at birth increased by 0.7 and 0.5 of a year for non-Indigenous males and females, respectively (Table 5.1 and Figure 5.3).

Despite the gains in life expectancy for both Indigenous males and females, the gap in life expectancy did not close because life expectancy increased by about the same amount for Indigenous males as it did for non-Indigenous males, while life expectancy for Indigenous females also increased by only a marginally higher amount than for non-Indigenous females.

Figure 5.3: Trends in Indigenous and non-Indigenous life expectancy at birth, 2011–2018, Australia



Notes:
 Estimates are based on the Majority Indigenous algorithm and a cohort-interpolated population based on the 2011, 2016 and 2021 Censuses
 Source: Enhanced Indigenous Mortality Data Collection

Estimates of life expectancy at birth and their 95% confidence intervals presented in Table 5.2 show that trends in life expectancy at birth were variable across states and territories for both Indigenous males and females, with some jurisdictions showing marked increases in life expectancy, while in other jurisdictions, life expectancy changed only marginally.

Indigenous life expectancy at birth appeared to have increased the most in the Northern Territory, Western Australia and Queensland during the period 2011–2013 to 2016–2018, a fact also observed in other studies (Ring & Griffiths 2022) in relation to the Northern Territory. In the Northern Territory, life expectancy at birth increased for Indigenous males by 3.2 years or just under half a year per year, from 63.1 years in 2011–2013 to 66.3 years in 2016–2018, while for Indigenous females, life expectancy at birth increased by about 1.5 years from 67.8 in 2011–2013 to 69.3 years in 2016–2018.

In Western Australia, life expectancy at birth increased from 66.8 years in 2011–2013 to 68.6 years in 2016–2018 for Indigenous males, and from 73.8 years in 2011–2013 to 74.8 years

in 2016–2018 for Indigenous females. At the same time, life expectancy at birth increased by about 0.3 and 1.0 years, respectively, for Indigenous males and females in Queensland.

The ABS do not publish life expectancy estimates for Victoria and South Australia because of very low levels of Indigenous identification on death records in the 2 states. Figure 2.1 shows high, but variable, proportions of unlinked death records in Victoria and South Australia. This means that the Indigenous status of a high proportion of death records in the 2 jurisdictions could not be verified through comparing them with corresponding records on other data sets.

There have been improvements in both jurisdictions over the past decade in data quality, especially in Indigenous identification. These improvements have been variable. This has meant that more, but a variable number of, Indigenous deaths were being identified than in previous years, leading to a variable impact on estimates of Indigenous life expectancy.

As a result, a robust trend in Indigenous identification and life expectancy could not be established, particularly for Victoria. The estimates show, however, that Indigenous male life expectancy in Victoria was about 74–75 years, while that for Indigenous females was about 77–79 years during the period 2011–2013 to 2016–2018.

Except for 2011–2013, life expectancy for Indigenous males in New South Wales appeared to have remained stable at about 73–74 years, while that for Indigenous females increased by about 0.4 of a year, from 78.2 years in 2011–2013 to 78.6 years in 2016–2018.

With continuing improvements in data quality, especially in Indigenous identification in Victoria and South Australia, more robust estimates and a more consistent trend in Indigenous life expectancy could be determined.

5.3.3 The gap in life expectancy

The gap between Indigenous and non-Indigenous life expectancy at birth in Australia is 9–10 years and stable, but variable between jurisdictions

Estimates show that there was a gap in life expectancy at birth of about 10 years between Indigenous and non-Indigenous males, and about 9 years between Indigenous and non-Indigenous females in Australia during the period 2011–2018 (Table 5.4).

Table 5.4: Gap between Indigenous and non-Indigenous life expectancy at birth, Australia, 2011–2018

Period	Gap between Indigenous & non-Indigenous males	Gap between Indigenous & non-Indigenous females
2011–2013	9.7	9.2
2012–2014	9.9	9.5
2013–2015	10.1	8.9
2014–2016	10.0	9.4
2015–2017	9.9	9.1
2016–2018	9.8	9.1

Notes:

Estimates are based on the *Majority Indigenous* algorithm and cohort-interpolated denominator population estimated from the official back-cast and projected Indigenous population based on the 2011, 2016 and 2021 Censuses.

Source: Enhanced Indigenous Mortality Data Collection

The life expectancy gap between Indigenous males and non-Indigenous males, and between Indigenous females and non-Indigenous females gives an indication of the differences in the proximate factors, including differential access to health care, differences in cause of death, and differences in health risk factors, underlying the estimated mortality differences between males and females.

Table 5.1 has shown that life expectancy at birth in Australia increased by about 0.6 of a year for both Indigenous males and females, and by about 0.7 and 0.5 of a year, for non-Indigenous males and females, respectively, between 2011–2013 and 2016–2018. However, due to nearly identical increases in life expectancy for both Indigenous and non-Indigenous males and females, the life expectancy gap remained nearly unchanged at 9–10 years during the period 2016–2018.

Trends in the life expectancy gap between Indigenous males and females is variable

The life expectancy gap between males and females is a function of differences in age-specific death rates between males and females. The life expectancy gap between males and females gives an indication of the differences in the proximate factors, including differential access to health care, differences in cause of death, and differences in health risk factors, underlying the estimated mortality differences between males and females.

Table 5.5 presents estimates of the gap in life expectancy between Indigenous males and Indigenous females and between non-Indigenous males and non-Indigenous females during the period 2011–2018. The life expectancy gap between Indigenous males and females and between non-Indigenous males and females in Australia during 2011–2018 was 4–5 years.

The gap in life expectancy was marginally bigger between Indigenous males and females than between non-Indigenous males and females in Australia as a whole. The gap between Indigenous males and females was also more variable than that between non-Indigenous males and females.

The life expectancy gap between Indigenous males and females and between non-Indigenous males and females in 2011–2018 was 4–5 years nationally and in most jurisdictions.

Table 5.5: Gap between male and female life expectancy at birth, Australia, 2011–2018

Period	Gap between Indigenous males and females (years)	Gap between non-Indigenous males and females (years)
2011–2013	4.8	4.3
2012–2014	4.5	4.1
2013–2015	5.3	4.1
2014–2016	4.7	4.1
2015–2017	4.8	4.0
2016–2018	4.8	4.1

Notes:
 Estimates are based on the *Majority Indigenous* algorithm and cohort-interpolated denominator population estimated from the official back-cast and projected Indigenous population based on the 2011, 2016 and 2021 Censuses.
 Source: Enhanced Indigenous Mortality Data Collection

5.4 Age decomposition of the gap in life expectancy

The aim of age decomposition of the life expectancy of 2 populations is to estimate the additive contributions of various age groups to the overall difference in life expectancy between 2 populations of interest, based on their age-specific death rates (Andreev et al. 2002; Arriaga 1984; Kitagawa 1955; Pollard 1988).

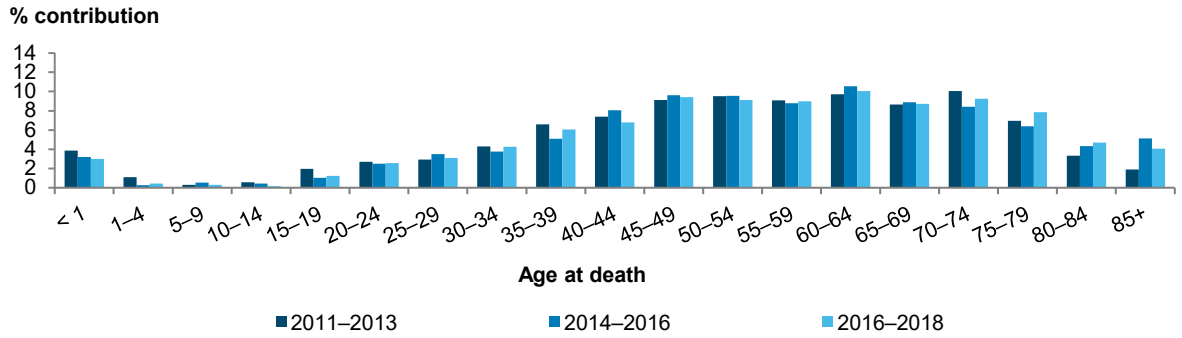
The method is based on the premise that the difference in life expectancy between 2 populations is a function of differences in mortality between the 2 populations at various ages. The estimates presented in this section are based on the algorithms developed by Andreev and others (2002) and Andreev and Shkolnikov (2012).

This section discusses the contribution of age groups to the gap in life expectancy between Indigenous males and non-Indigenous males and between Indigenous females and non-Indigenous females. Understanding the contributions of age groups to the life expectancy gap is important in developing targeted policies and programs to close the gap.

Higher mortality of Indigenous males aged 45–64 and Indigenous females aged 65 and over contributed the most to the life expectancy gap

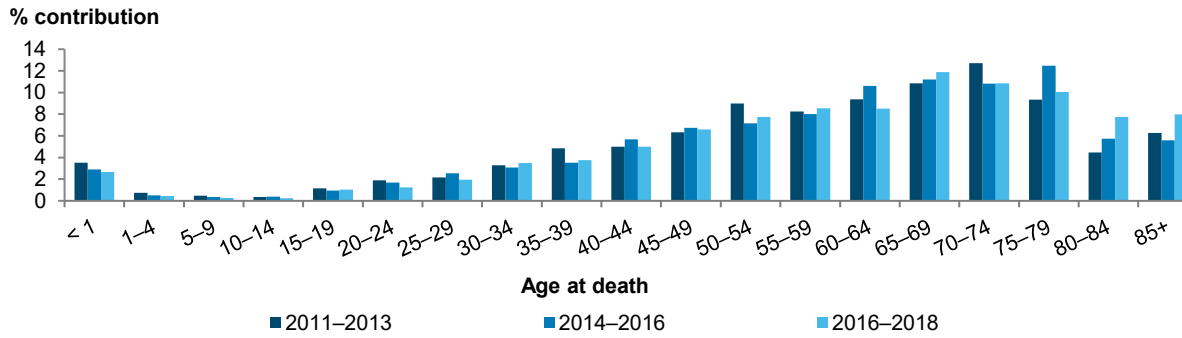
Figures 5.4, 5.5 and 5.6 show the percentage contribution that higher Indigenous death rates in various 5-year age groups make to the overall gap in life expectancy between Indigenous males and non-Indigenous males, and between Indigenous females and non-Indigenous females. Table 5.6 presents a summary of the data that was used in creating Figure 5.6.

Figure 5.4: Percentage contribution of 5-year age groups to the gap in life expectancy at birth between Indigenous males and non-Indigenous males, Australia, selected periods



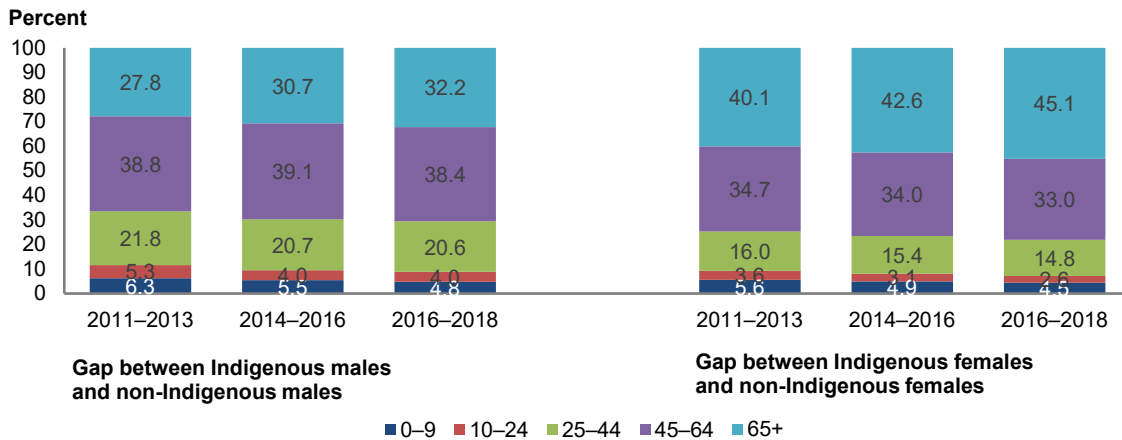
Source: Enhanced Indigenous Mortality Data Collection

Figure 5.5: Percentage contribution of 5-year age groups to the gap in life expectancy at birth between Indigenous females and non-Indigenous females, Australia, selected periods



Source: Enhanced Indigenous Mortality Data Collection

Figure 5.6: Percentage contribution of broad age groups to the gap between Indigenous and non-Indigenous life expectancy at birth, Australia, selected periods



Source: Enhanced Indigenous Mortality Data Collection

The gap in estimated life expectancy between Indigenous males and non-Indigenous males, and between Indigenous females and non-Indigenous females was about 9–10 years during the period between 2011 and 2021. Higher Indigenous mortality relative to non-Indigenous mortality in the age groups 45–64 and 65 and over contributed a combined 6–7 years, or 60%–70%, of the gap between Indigenous males and females and a combined 7–8 years, or 70%–80%, of the gap between Indigenous females and non-Indigenous females.

Table 5.6: Contribution of age groups to the gap between Indigenous and non-Indigenous life expectancy at birth, Australia, selected periods (a)

Age group	Contribution to the gap between Indigenous and non-Indigenous males			Contribution to the gap between Indigenous and non-Indigenous females		
	2011–2013	2014–2016	2016–2018	2011–2013	2014–2016	2016–2018
Contribution in years to the gap between Indigenous and non-Indigenous in life expectancy						
0–14	0.7	0.6	0.5	0.6	0.5	0.4
15–24	0.5	0.4	0.4	0.3	0.3	0.2
25–44	2.1	2.1	2.0	1.5	1.4	1.3
45–64	3.8	3.9	3.8	3.2	3.2	3.0
65 & over	2.7	3.1	3.2	3.7	4.0	4.1
Total	9.8	10.0	9.8	9.2	9.4	9.0
Per cent contribution to the gap between Indigenous and non-Indigenous in life expectancy						
0–14	6.8	5.9	4.9	6.0	5.3	4.7
15–24	4.8	3.6	3.8	3.2	2.7	2.4
25–44	21.8	20.7	20.6	16.0	15.4	14.8
45–64	38.8	39.1	38.4	34.7	34.0	33.0
65 & over	27.8	30.7	32.2	40.1	42.6	45.1
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Enhanced Indigenous Mortality Data Collection

Higher death rates among Indigenous male children aged under 15 and 15–24 years contributed a combined 10%–15% of the 9–10-year life expectancy gap between Indigenous males and non-Indigenous males, while higher death rates among Indigenous female children in the same age groups contributed a combined 5%–8% of the life expectancy gap between Indigenous females and non-Indigenous females.

There are positive signs from Figure 5.6 and Table 5.6 that Indigenous mortality is declining and the locus of death is shifting from younger to older ages. Both Figure 5.6 and Table 5.6 show that the contribution of younger age groups (0–14, 15–24 and 25–44 years) to the life expectancy gap, due to their previously higher death rates, declined among both males and females, while the contribution of older age groups (65 years and over) to the gap increased, due to the progressive shifting of deaths to older ages.

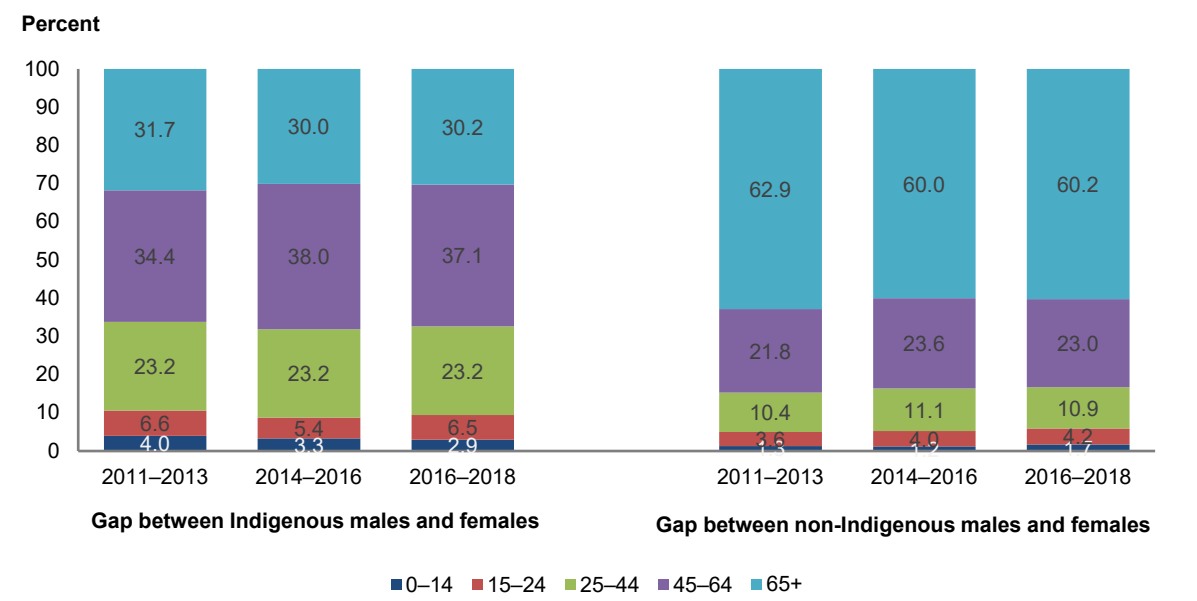
The 45–64 years age group contributed the most to the life expectancy gap between Indigenous males and females

There was a gap in life expectancy of about 4.5–5.3 years between Indigenous males and Indigenous females and about 4.0–4.3 years between non-Indigenous males and non-Indigenous females during the period 2011–2013 to 2019–2021 (see Table 5.5).

While much of the attention on the life expectancy gap is focused on the gap between Indigenous and non-Indigenous Australians, the life expectancy gap between males and females also deserves attention as some of the age groups contributing to the life expectancy gap between Indigenous males and females could also be contributing to the gap between Indigenous and non-Indigenous Australians.

This section discusses the contribution of age groups to the gap in life expectancy between Indigenous males and Indigenous females compared to that between non-Indigenous males and non-Indigenous females, in Australia. The results are shown in Figure 5.7.

Figure 5.7: Percentage contribution of broad age groups to the gap in life expectancy between Indigenous males and females and between non-Indigenous males and females, Australia, selected periods



Source: Enhanced Indigenous Mortality Data Collection

There are differences between the Indigenous and non-Indigenous population in the contribution of higher male than female mortality to the gap in life expectancy between Indigenous and non-Indigenous males and between Indigenous and non-Indigenous females. Among non-Indigenous males and females, higher male than female mortality at the oldest ages contributed more to the male-female gap in life expectancy than was the case among Indigenous males and females.

While higher mortality among non-Indigenous males aged 65 and over accounted for 60% or higher of the life expectancy gap between non-Indigenous males and females, higher mortality among Indigenous males aged 65 and over contributed only about half as much to the gap in life expectancy between Indigenous males and females (30%–32%).

About two-thirds of the 4–5 years life expectancy gap between Indigenous males and females was due to higher male than female mortality in 2 age groups: 45–64 and 65 years and over, while higher male than female mortality among 25–44 years old Indigenous males accounted for a further 22%–23% of the life expectancy gap. Higher mortality among Indigenous males aged 0–14 and 15–24 contributed only about 9%–10% of the gap.

On the whole, Figure 5.7 shows much higher Indigenous male than female mortality from as early as age 25 compared with the non-Indigenous population, where substantial divergence in age-sex-specific mortality rates did not begin till after age 45–64.

5.4.1 Decomposition of life expectancy gap by cause of death

Circulatory diseases, neoplasms and injury contributed about 5–6 years of the Indigenous and non-Indigenous life expectancy gap

While differences in life expectancy between 2 populations could be due to differences in their age-specific death rates, the differences in the age-specific death rates themselves may be the result of differences between the 2 populations in the age distribution of cause of death. Understanding the main causes of death contributing to the gap in life expectancy between Indigenous and non-Indigenous Australians will contribute to the development of appropriate policies, programs and services to address the life expectancy gap.

Figure 5.8 shows the contribution of 5 major causes of death to the life expectancy gap between Indigenous males and non-Indigenous males and between Indigenous females and non-Indigenous females in Australia during the period 2011–2021. The first panel shows the contribution of cause of death to the gap in years while the second panel shows the percentage contribution of cause of death to the gap.

The 5 major causes of death accounted for about 75% of the gap in life expectancy at birth of 9.6 years between Indigenous males and non-Indigenous males, and about 70% of the gap of 8.9 years between Indigenous and non-Indigenous female life expectancy.

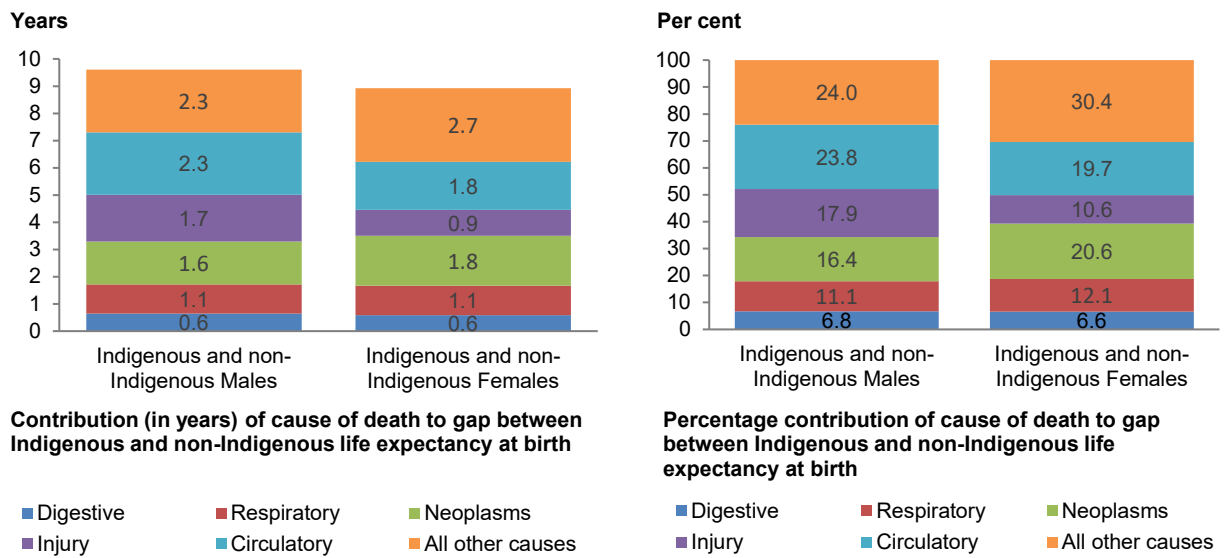
The single largest contributors to the life expectancy gap between Indigenous and non-Indigenous males were higher death rates among Indigenous males from diseases of the circulatory system, injury and neoplasms which, individually, contributed about 2.3, 1.7 and 1.6 years, respectively, or about 24%, 18% and 16%, respectively, of the gap.

Higher Indigenous male deaths from diseases of the respiratory system contributed about 1.1 years or 11% of the gap while all other causes of death contributed about 2.3 years or about 24% of the gap.

The single largest contributors to the life expectancy gap between Indigenous and non-females were higher death rates among Indigenous females from neoplasms, diseases of the circulatory system and diseases of the respiratory system, which contributed about 1.8, 1.8 and 1.1 years, respectively, or about 21%, 20% and 12%, respectively, of the gap. Injury, including violence and accidents, accounted for about 1 year or 11% of the gap, while all other causes of death accounted for about 2.7 years or about 30% of the gap.

The 5 major causes of death accounted for about 75% of the gap in life expectancy at birth of 9.6 years between Indigenous males and non-Indigenous males, and about 70% of the gap of 8.9 years between Indigenous and non-Indigenous female life expectancy.

Figure 5.8: Contribution of cause of death to the gap between Indigenous and non-Indigenous life expectancy at birth, 2011–2018 (linked data) and 2019–2021 (projected data), Australia



Notes:

1. Estimates are based on the Majority Indigenous algorithm and a cohort-interpolated population based on the 2011, 2016 and 2021 Censuses
2. The chart combines estimates for 2011–2018 which are based on linked data and estimates for 2019–2021 which are preliminary and are based on unlinked cause of death data for 2019–2021 and projecting linkage rates from 2016–2018.

Source: Enhanced Indigenous Mortality Data Collection

The single largest contributors to the life expectancy gap between Indigenous and non-Indigenous males were higher death rates among Indigenous males from diseases of the circulatory system, injury and neoplasms which, individually, contributed about 2.3, 1.7 and 1.6 years, respectively, or about 24%, 18% and 16%, respectively, of the gap.

Higher Indigenous male deaths from diseases of the respiratory system contributed about 1.1 years or 11% of the gap between Indigenous and non-Indigenous male life expectancy while all other causes of death contributed about 2.3 years or about 24% of the gap.

The single largest contributors to the life expectancy gap between Indigenous and non-Indigenous females were higher death rates among Indigenous females from neoplasms, diseases of the circulatory system and diseases of the respiratory system, which contributed about 1.8, 1.8 and 1.1 years, respectively, or about 21%, 20% and 12%, respectively, of the gap. Injury, including violence and accidents, accounted for about 1 year or 11% of the gap, while all other causes of death accounted for about 2.7 years or about 30% of the gap.

Circulatory diseases are the major contributors to the gap between Indigenous male and female life expectancy

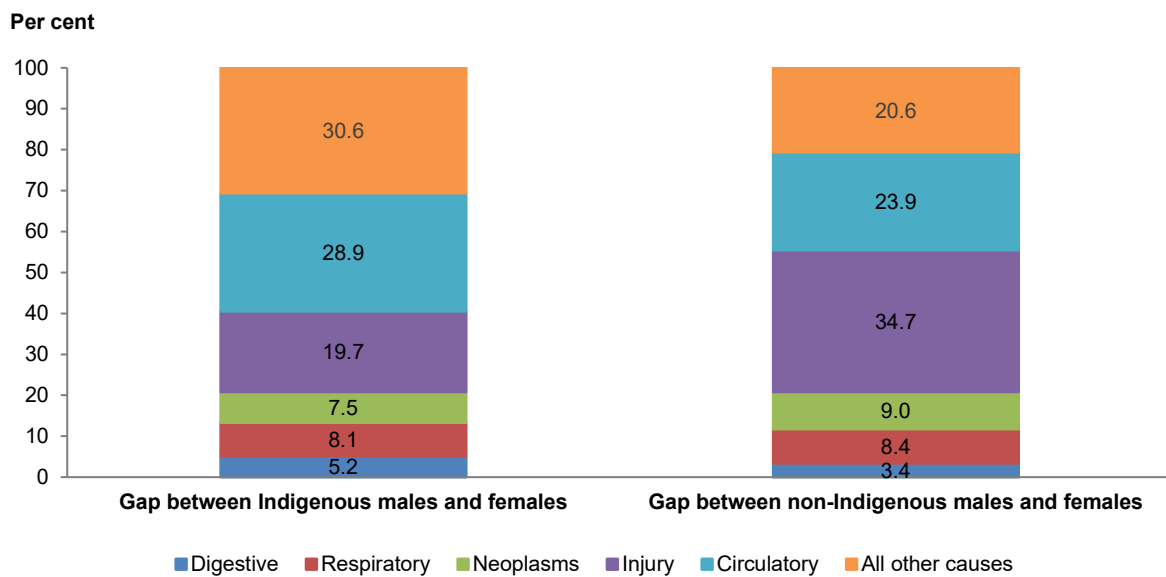
While the gap in life expectancy between Indigenous males and females (4.7 years) was not much different from that between non-Indigenous males and females (4.1 years), the causes of death contributing to the respective gaps were different (Figure 5.9).

The 5 major causes of death contributed a lesser share of the life expectancy gap between Indigenous males and females than they did to the gap between non-Indigenous males and females. All other causes of death other than neoplasms, circulatory, digestive, respiratory diseases and injury contributed 31% of the life expectancy gap between Indigenous males and females compared with 21% of the gap between non-Indigenous males and females.

Higher Indigenous male deaths from respiratory diseases contributed 29% of the gap in life expectancy between Indigenous males and females compared with 24% of the gap between non-Indigenous males and females. On the other hand, injury, including violence and accidents, contributed nearly twice the share of the life expectancy gap between non-Indigenous males and females (35%) as that between Indigenous males and females (20%).

Digestive and respiratory diseases and neoplasms contributed nearly the same share of the gap between Indigenous males and females (20%–21%) as they did to the gap between non-Indigenous males and females

Figure 5.9: Contribution of cause of death to the life expectancy gap between Indigenous males and females and between non-Indigenous males and females, 2011–2018 (linked data) and 2019–2021 (projected data), Australia



Notes:

1. Estimates are based on the Majority Indigenous algorithm and a cohort-interpolated population based on the 2011, 2016 and 2021 Censuses
2. The chart combines estimates for 2011–2018 which are based on linked data and estimates for 2019–2021 which are preliminary and are based on unlinked cause of death data for 2019–2021 and projecting linkage rates from 2016–2018.

Source: Enhanced Indigenous Mortality Data Collection

5.5 Probability of survival

The contribution of differences in age-specific death rates to the life expectancy gap can also 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 a hypothetical estimate of life table deaths, or the expected number of deaths by age from an initial cohort of 100,000 babies from the life table. It is calculated by multiplying the life table probability of dying from one age to the next (qx) by the number of survivors at that age (lx) out of 100,000 births. The results are shown in figures 5.10 and 5.11 for males and females, respectively.

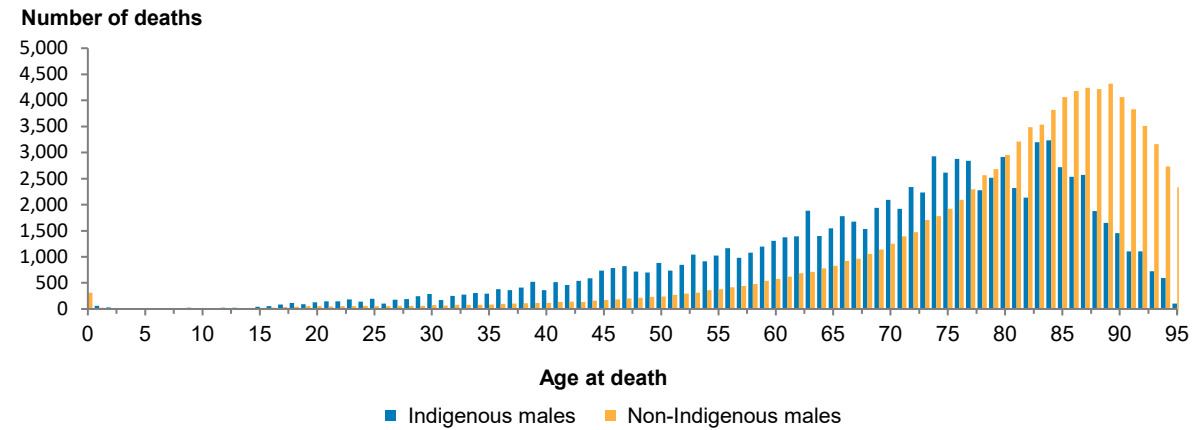
Figures 5.10 and 5.11 show the hypothetical number of expected Indigenous and non-Indigenous life table deaths that occur at each age, from 100,000 births, if mortality rates observed in 2016–2018 do not change. While the number of Indigenous deaths has been enhanced, they have not been smoothed for age-specific fluctuations in the reported number of deaths.

The blue columns showing above the yellow columns represent excess Indigenous deaths while the yellow columns showing above the blue columns represent excess non-Indigenous deaths over Indigenous deaths.

Figures 5.10 and 5.11 show that among Indigenous males and females, the expected number of deaths is skewed towards younger ages, while among non-Indigenous males and females, the expected number of deaths is skewed more towards older ages. Figures 5.10 and 5.11 show an excess of Indigenous over non-Indigenous male deaths between ages 20 and 75 years, and for females, between ages 25 and 82.

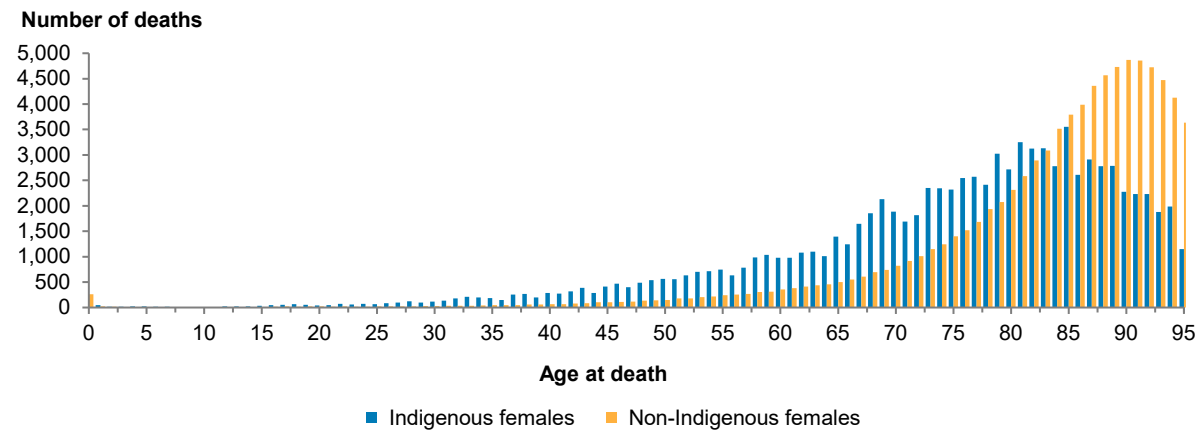
On the other hand, there was an excess of non-Indigenous over Indigenous deaths at ages 80 and over for males, and at ages 85 and over for females. Indigenous male deaths are also more skewed towards younger ages relative to non-Indigenous male deaths than was the case for Indigenous and non-Indigenous female deaths.

Figure 5.10: Expected number of Indigenous and non-Indigenous male deaths out of 100,000 births, Australia, 2016–2018



Source: Enhanced Indigenous Mortality Data Collection

Figure 5.11: Expected number of Indigenous and non-Indigenous female deaths out of 100,000 births, Australia, 2016–2018



Source: Enhanced Indigenous Mortality Data Collection

5.6 Conclusion

- The life expectancy estimates presented in this chapter were based on enhanced death data from the EIMDC. The estimates were based on the *Majority Indigenous* algorithm and a cohort-interpolated population calculated from the Indigenous back-cast population derived from the 2011 and 2016 censuses and preliminary Indigenous estimated resident population from the 2021 Census, as described in Chapter 2.
- All efforts were made to ensure that the life expectancy estimates were as accurate as possible; they are still subject to potential biases resulting from Indigenous misclassification and differences in the way Indigenous status is classified by jurisdictional registries of births, deaths and marriages, in the death data, and in the Indigenous population produced by the ABS.
- Indigenous life expectancy in Australia had increased to nearly 72 years for males and nearly 77 years for females during 2016–2018. About 50% of Indigenous males now survive to age 74–77, while 50% of Indigenous females now survive to age 77–82.
- There are wide variations in Indigenous life expectancy between states and territories. During the period 2011–2018, Indigenous life expectancy varied from 63–66 years for males and 68–69 years for females in the Northern Territory to 73–75 years for males and 77–79 years for females in New South Wales and Victoria.
- The improvements in life expectancy experienced within jurisdictions sometimes varied between males and females, with females in some jurisdictions experiencing larger increases in life expectancy while in others, males enjoyed larger increases in life expectancy than females.
- During the reference period, life expectancy at birth increased by about 0.6 of a year, respectively, for Indigenous males and females. At the same time, life expectancy at birth increased by about 0.7 of a year for non-Indigenous males and by about 0.5 of a year for non-Indigenous females.
- Due to nearly identical increases in life expectancy for both Indigenous and non-Indigenous males and females, however, the life expectancy gap remained nearly unchanged at about 9–10 years during the period from 2011 to 2018.
- Indigenous life expectancy at birth appeared to have increased the most in the Northern Territory, Western Australia and Queensland (females) during the reference period.
- In the Northern Territory, life expectancy at birth increased by 3.2 years for Indigenous males and by about 1.3 years for Indigenous females during the reference period.
- In Western Australia, life expectancy at birth for Indigenous males increased by 1.8 years during the reference period, from 66.8 years to 68.6 years, and by 1 year for Indigenous females, from 73.8 years to 74.8 years.
- Higher mortality among Indigenous males aged 45–64 and Indigenous females aged 65 and over contributed the most to the life expectancy gap between Indigenous and non-Indigenous Australians. These were followed by relatively higher mortality among Indigenous males aged 65 and over and 25–44 years, and indigenous females aged 45–64 and 25–44 as contributing the most to the life expectancy gap.
- Higher mortality and its associated cause of death among males aged 25–44, 45–64 and 65 and over must be addressed in order to reduce the life expectancy gap not only between males and females, but also between Indigenous males and females.
- The biggest contributors to the gap between Indigenous and non-Indigenous male life expectancy were higher Indigenous male death rates from circulatory diseases, injury

(including violence and accidents) and neoplasms which, individually, accounted for 2.3, 1.7 and 1.6 years, or about 24%, 18% and 16%, respectively, of the gap.

- The largest contributors to the gap between Indigenous and non-Indigenous female life expectancy were higher Indigenous female death rates from circulatory diseases, neoplasms and injuries which accounted for about 1.8, 1.8 and 0.9 years, respectively, or about 20%, 21% and 11%, respectively, of the gap.

6 Preliminary estimates for 2019–2021

6.1 Unlinked deaths data for 2019–2021

This report contains estimates of Indigenous mortality and life expectancy for the period 2011–2013 to 2019–2021. Estimates for the period 2011–2018 were based on linked and enhanced death data for the same period. The various national and state and territory data sets used in the 2011–2019 data linkage were not available in time to enable them to be linked. As a result, there were no linked death data for 2019–2021. Life expectancy estimates for 2019–2021 were therefore based on projected enhanced death data, which were derived by applying Indigenous reclassification rates for 2016–2018 to the unlinked death data for 2019–2021.

Indigenous reclassification rates for 2016–2018 were used for this enhancement under the assumption that Indigenous identification during 2019–2021 would not have changed substantially from what it was in 2016–2018, and that using adjustment factors for 2016–2018 to enhance unlinked deaths data for 2019–2021 would not result in a substantial distortion of life expectancy rates for the period 2019–2021.

The enhanced data were then used as the input death data, together with the cohort-interpolated population denominator for the same period, to produce estimates of Indigenous mortality and life expectancy for 2019–2021.

6.2 Impact of COVID-19 lockdowns

During the first 3 waves of COVID-19 in 2019–2021, there were widespread lockdowns throughout Australia, and particularly in Indigenous-specific areas.

While the impact of COVID-19 on the level and age-sex distribution of Indigenous and non-Indigenous deaths and cause of death are reflected in the deaths data for 2019–2021, it is not clear whether linkage rates and Indigenous identification reclassification rates for 2019–2021 would have been affected by these emergency measures, and how different linkage rates and Indigenous reclassification rates for 2019–2021 would have been from corresponding rates for 2016–2018 had the same set of emergency circumstances existed in 2016–2018.

As a result, it is advised that the 2019–2021 preliminary Indigenous and non-Indigenous life expectancy estimates based on 2016–2018 Indigenous identification reclassification rates be treated with caution. Preliminary life expectancy estimates for 2019–2021 are therefore produced for Australia only, and not for the states and territories.

6.3 Preliminary estimates of Indigenous mortality, 2019–2021

This section discusses preliminary estimates of various Indigenous and non-Indigenous mortality measures covering the period 2019–2021. Estimates for 2019–2021 are based on unlinked death data for 2019–2021 and projected linkage rates from 2016–2018.

For purposes of comparison, estimates for 2011–2013 based on linked data are also provided.

6.3.1 Age-specific death rates

Table 6.1 shows preliminary age-specific death rates for Indigenous males and females during 2019–2021 with corresponding estimates for non-Indigenous males and females. For purposes of comparison, estimates for 2011–2013 based on linked data are also provided.

Table 6.1: Age-specific death rates per 100,000 population, Australia, selected periods

Age group	Males		Females	
	2011–2013	2019–2021	2011–2013	2019–2021
Indigenous				
Under 1	865	810	735	529
1–4	55	36	37	20
5–14	23	16	19	14
15–24	129	107	70	62
25–44	356	309	214	183
45–64	1,215	1,118	825	749
65–84	4,214	3,703	3,374	2,988
85 and over	16,230	14,249	15,207	12,729
Non-Indigenous				
Under 1	350	308	309	264
1–4	17	12	14	10
5–14	10	8	8	6
15–24	47	47	22	19
25–44	96	86	50	43
45–64	429	400	258	236
65–84	2,685	2,240	1,812	1,499
85 and over	14,878	13,697	12,738	12,040

Notes:

1. Estimates are based on the *Majority Indigenous* algorithm and cohort-interpolated denominator population estimated from the official back-cast and projected Indigenous population based on the 2011, 2016 and 2021 Censuses.
2. Estimates for 2011–2018 are based on linked data while estimates for 2019–2021 are preliminary and are based on unlinked death data for 2019–2021 and projected linkage rates from 2016–2018.

Source: Enhanced Indigenous Mortality Data Collection

The preliminary estimates for 2019–2021 follow the same pattern as those for 2011–2013 (see Table 4.2). In both periods, the estimates show relatively low age-specific death rates at ages 1–4, 5–14 and 15–24, compared with other age groups, for both Indigenous males and females. The estimates also show declining death rates in each age group for both Indigenous males and females as well as for non-Indigenous males and females.

6.3.2 Age-standardised death rates

Table 6.2 shows preliminary age-standardised death rates for Indigenous males and females during 2019–2021, with corresponding estimates for non-Indigenous males and females. For purposes of comparison, estimates for 2011–2013 based on linked data are also provided.

Table 6.2 shows improvements in Indigenous mortality between 2011 and 2021. Age-standardised death rates declined for both Indigenous males and females as well as for non-Indigenous males and females between 2011 and 2021. For the mortality gap to close, however, age-standardised death rates need to decline by a further 46%, or by 498–555

deaths per 100,000 Indigenous males, and by about 50%, or 400–459 deaths per 100,000 Indigenous females.

However, while the rate differences appear to have declined, the rate ratios have remained unchanged, an indication that the mortality gap is not closing.

Table 6.2: Age-standardised death rates per 100,000 population, Australia, 2019–2021

Type of estimate	Males		Females	
	2011–2013	2019–2021	2011–2013	2019–2021
Indigenous	1,211	1,073	914	808
Non-Indigenous	656	575	455	408
Rate difference	555	498	459	400
Rate ratio	1.8	1.9	2.0	2.0

Notes:

1. Estimates for Australia include Tasmania, the Australian Capital Territory and Other Territories
2. Estimates are based on the *Majority Indigenous* algorithm and cohort-interpolated denominator population estimated from the official back-cast and projected Indigenous population based on the 2011, 2016 and 2021 Censuses.
3. Estimates for 2011–2018 are based on linked data while estimates for 2019–2021 are preliminary and are based on unlinked death data for 2019–2021 and projected linkage rates from 2016–2018.

Source: Enhanced Indigenous Mortality Data Collection

6.4 Preliminary estimates of life expectancy at birth, 2019–2021

Table 6.3 presents preliminary estimates of Indigenous and non-Indigenous life expectancy at birth for the period 2019–2021 as well as estimates for 2011–2013 based on linked data.

Table 6.3: Preliminary estimates of life expectancy at birth, Australia, 2011–2013 and 2019–2021

Period	Indigenous		Non-indigenous	
	Males	Females	Males	Females
2011–2013	71.1 [70.6 – 71.5]	75.9 [75.4 – 76.3]	80.8 [80.8 – 80.9]	85.1 [85.0 – 85.1]
2019–2021	72.6 [72.3 – 72.9]	77.3 [77.0 – 77.7]	82.3 [82.2 – 82.3]	86.3 [86.2 – 86.3]
Gap (2011–2013)	9.7	9.2		
Gap (2019–2021)	9.7	9.0		

Notes:

1. Estimates are based on the *Majority Indigenous* algorithm and cohort-interpolated denominator population estimated from the official back-cast and projected Indigenous population based on the 2011, 2016 and 2021 Censuses.
2. Estimates for 2011–2018 which are based on linked data while estimates for 2019–2021 are preliminary, and are based on unlinked death data for 2019–2021 and projected linkage rates from 2016–2018.

Source: Enhanced Indigenous Mortality Data Collection

Preliminary estimates of life expectancy at birth increased to 72.6 years for Indigenous males and to 77.3 years for Indigenous females in 2019–2021. This represents an increase in life expectancy at birth by about 1.5 years for Indigenous males and by about 1.4 years for Indigenous females from the level of 71.1 years and 75.9 years, respectively, in 2011–2013.

During the same period, estimated life expectancy at birth for non-Indigenous males increased by 1.5 years to 82.3 years from 80.8 years in 2011–2013, while for non-Indigenous females, life expectancy at birth increased by 1.2 years to 86.3 years, from 85.1 years in 2011–2013.

Despite these increases in estimated life expectancy at birth for both Indigenous males and females, the life expectancy gap did not close, because life expectancy estimates at birth increased by nearly identical amounts for both Indigenous and non-Indigenous males as well as for Indigenous and non-Indigenous females. As a result, the gap in life expectancy at birth between Indigenous and non-Indigenous males remained at 9.7 years during 2011–2013 and 2019–2021, while for Indigenous and non-Indigenous females, the gap decreased marginally from 9.2 years in 2011–2013 to 9.0 years in 2019–2021.

6.5 Conclusion

In the absence of linked data for the period 2019–2021, preliminary estimates of Indigenous mortality and life expectancy for the period were obtained by adjusting the unlinked 2019–2021 death data with Indigenous reclassification rates based on linked data for 2016–2018.

The resulting enhanced death data showed that life expectancy at birth during 2019–2021 was 72.6 years for Indigenous males and 77.3 years for Indigenous females. The life expectancy gap did not close because life expectancy at birth for Indigenous males and females increased by nearly identical amounts as increases experienced by non-Indigenous males and females.

For the mortality gap to close, however, age-standardised death rates need to decline by about 46%, or by 498–555 deaths per 100,000 Indigenous males, and by about 50%, or 400–459 deaths per 100,000 Indigenous females.

Final estimates of Indigenous mortality and life expectancy will be produced when linked data become available.

7 Discussion

The EIMDC is an invaluable resource for studying both reporting patterns and mortality patterns. Since 2012, the AIHW has developed 2 databases and methods for using linked data to enhance Indigenous identification on death data in order to assess the feasibility of providing more frequent estimates of Indigenous life expectancy at both the national and sub-national levels to support the “Closing the Gap” reporting. The AIHW has also published 3 reports on Indigenous mortality and life expectancy based on the enhanced death data (AIHW 2012a, 2017a, 2019).

Chapter 3 has shown, however, that the estimation of Indigenous life expectancy faces some challenges. The number of data sets each record is linked to appeared to increase with age at death and year of death, and also varied by jurisdiction, which could result in inconsistent time trends in life expectancy across algorithms as well as across jurisdictions.

- There is inconsistency between the numerator (deaths) and the denominator (population) in the reporting of Indigenous identification.
- The ABS back-cast and projected population cannot be used as a population-at-risk for the preparation of trend estimates of Indigenous life expectancy based on the Enhanced Indigenous Mortality Data Collection (EIMDC).
- The algorithms for enhancing Indigenous identification are sensitive to the choice of denominator population.
- Trends in Indigenous life expectancy are inconsistent across algorithms and jurisdictions
- Life expectancy estimates for some jurisdictions are inexplicably high.
- Linkage rates for infant and child death records are lower than for adult death records, particularly in Victoria and Queensland. Lower linkage rates will affect the enhancement of Indigenous identification on infant and child death records.

Some of these challenges have been addressed in chapters 1 and 3. To make further progress in improving the accuracy of Indigenous life expectancy estimates, including estimates at the subnational level, the AIHW is investigating alternative or complementary approaches to measuring deaths and population.

7.1 The way forward

The AIHW is committed to producing annual Indigenous life expectancy estimates both at the national and sub-national levels. This commitment requires the AIHW to prepare life expectancy estimates that do not need to be revised after each census when new census-based Indigenous back-cast and projected population becomes available.

Due to this commitment and the problems associated with using an external data source such as the back-cast Indigenous population as a population-at-risk, the AIHW has recently started exploring the feasibility of using a population-at-risk from linked administrative data.

To address some of the challenges outlined above, the AIHW is investigating the possibility of adopting an ‘epidemiological’ approach to estimating Indigenous life expectancy by developing a population-at-risk that will enable both the numerator (deaths) and denominator (population-at-risk) to be derived from the same data set. The dataset would need to cover the total Australian population, be representative of the Indigenous population, contain reliable and complete death data, and contain reliable information on Indigenous identification that could also be applied consistently to the death data.

The AIHW is investigating the use of two different datasets:

- Expanding the EIMDC to include a population-at-risk created from the National Linkage Map, Medicare Consumer Directory (MCD) and the Voluntary Indigenous Identifier (VII)
- Using a population-at-risk based on the Multi-Agency Data Integration Project (MADIP).

Alongside this work, the AIHW is investigating the use of hierarchical Bayesian models to smooth death rates when the input data are highly disaggregated.

These 3 approaches are discussed below.

Expanding the EIMDC to include the Medicare Consumer Directory (MCD) and Voluntary Indigenous Identifier to create a population-at-risk

To create the EIMDC, the hospitals, aged care, birth registrations and perinatal data were linked to the National Death Index (NDI) *via* the spine or the AIHW National Linkage Map on which 33 million individuals are listed. The main data set in the AIHW National Linkage Map is the MCD.

The MCD contains records of nearly every Australian resident who has registered with Medicare since 1984, and is a reliable identifier of individuals in Australia. It contains identifiers such as full name (3 given names and surname), date of birth, sex and both residential and mailing address. Since it was the main data set in the spine that was used in the EIMDC linkage, it has links to all the death records that were used in the EIMDC linkage although it is not part of the analysis data in the EIMDC.

The EIMDC could be expanded to include the MCD. It would then contain not only records of all deaths, but also the population-at-risk that contributed to the deaths. This would make it possible for the AIHW to adopt an epidemiologic approach to estimating age-specific death rates, whereby both the events of interest in the numerator (deaths) and the denominator population are from the same population-at-risk.

The expanded EIMDC could be further enhanced by integrating the MCD with the VII. The VII is a database of individuals with a Medicare record who have elected to have their Aboriginal and Torres Strait Islander status recorded. Information on the VII includes Indigenous status and 'entry' and 'exit' dates, such as dates of enrolment in Medicare and date of disenrolment. The VII also contains unique Personal Identification Numbers (PINs) that will allow the VII to be integrated with the MCD. Date of entry and date of exit, together with fact of death information from the EIMDC will enable population estimates to be prepared for calendar years.

The Multi-Agency Data Integration Project (MADIP)

Instead of using an external denominator population such as the back-cast and projected Indigenous population or a cohort-interpolated population based on the back-cast and projected Indigenous population, the AIHW has recently also started investigating the feasibility of using a population-at-risk developed from linking several multi-sector and multi-purpose administrative data sets that cover the total population. One such data set that the AIHW is exploring is the MADIP.

MADIP is a secure data asset combining information on health, education, government payments, income and taxation, employment, and population demographics (including the Census) over time (ABS 2022b). Several of the data sets on MADIP contain independently collected information on Indigenous identification. MADIP also includes records of all births and deaths that occurred in Australia from 2006.

The multi-sector and multi-purpose administrative data sets that are part of the infrastructure of MADIP cover the key services that individual's access during their lifetime as well as events that are legislated to be registered (for example, births and deaths). Consequently, not only does MADIP cover the total population of Australia, but it is also likely to be representative of the population composition of Australia.

Due to the unique characteristics of the data sets within MADIP, it is a good candidate for consideration as a population-at-risk. The use of MADIP as a population-at-risk would enable the AIHW to adopt an epidemiological approach in the estimation of mortality rates, whereby incidence rates (death rates) occurring within the population-at-risk could be used as the input data in the preparation of Indigenous life tables.

Using MADIP as the population-at-risk and deaths within MADIP as the events of interest will enable the AIHW to overcome both the problems of numerator-denominator bias and the difficulty of preparing long-term trends of Indigenous measures and indicators.

Use of hierarchical Bayesian modelling

The current direct approach to estimating indigenous mortality and life expectancy using the EIMDC cannot sufficiently address the challenges outlined in the Background section of this report.

To deal with random variation in the distribution of deaths by age and sex, Bayesian hierarchical models will be used in the preparation of the life expectancy estimates. Hierarchical modelling will be used because data exists at different levels: geography (for example, national, state and territory and regional), time (year of death) demographic (age-sex) and so on.

By using information across groups of observations, sensitivity of the resulting estimates from random variations, extreme values and low counts will be reduced. The models will allow for different age-sex profiles in each jurisdiction but assume that the shapes of these profiles remain constant over the period of the estimates. Overall levels are permitted to differ across jurisdictions, and to follow different time trends.

All this work on the revised approach and the use of hierarchical Bayesian modelling will require consultations with the AIHW Advisory Group as they are being developed.

7.2 Conclusion

The AIHW is committed to producing annual Indigenous life expectancy estimates at both national and sub-national level as part of its obligations towards "Closing the Gap" reporting. Estimation of Indigenous life expectancy involves many challenges, including random variation in death counts, inconsistency in Indigenous identification between the death data and the denominator population, the absence of a dedicated, ongoing and reliable population-at-risk to underpin the mortality and life expectancy estimates as well as differences between jurisdictions in the protocols and processes for identifying and recording Indigenous identification on death data. These challenges make estimation of life expectancy challenging in some jurisdictions and contribute to uncertainty about time trends and comparisons between jurisdictions.

The AIHW is investigating and consulting on measures to address these problems, including the possibility of using linked datasets to define the population at risk in a way that is consistent with the deaths data. Future AIHW publications will describe these methods in more detail and evaluate their performance."

Appendix A: Source of data

A1 Enhancement of Indigenous identification on death records on the National Death Index

A1.1 Background

Although all deaths in Australia are registered, not all Indigenous deaths are identified as Indigenous when they are registered. As a result, official Indigenous life expectancy estimates are produced only for the 4 jurisdictions (New South Wales, Queensland, Western Australia and the Northern Territory) that are deemed to have the least incomplete Indigenous identification. The true mortality characteristics of Indigenous Australians can therefore not be reliably measured.

To enable more robust estimates of Indigenous life expectancy to be produced for all states and territories, the AIHW has developed the Enhanced Indigenous Mortality Data Collection (EIMDC) as a permanent and ongoing national data collection. The EIMDC will enable the AIHW to produce accurate and timely Indigenous mortality and life expectancy estimates to support the Commonwealth and state and territory governments' policy initiatives towards closing the gap in life expectancy between Indigenous and non-Indigenous Australians.

To create the EIMDC, death records on the National Death Index (NDI) and National Mortality Database (NMD) were linked to several independent Commonwealth, state and territory administrative data sets that contain information on Indigenous identification. By comparing Indigenous identification across the linked data sets, algorithms were developed and then used to enhance Indigenous identification on the NDI.

The EIMDC contains fact of death information from the NDI and NMD together with the original as well as the enhanced information on Indigenous identification obtained from the independent data sets that were linked to the NDI and NMD.

This report is based on the first iteration of the EIMDC, and covers all deaths that occurred in Australia between 1 January 2011 and 31 December 2018. As the EIMDC is a permanent and ongoing data collection, it will be updated as more data become available and are linked.

The next iteration will extend the EIMDC to deaths that occurred between 1 January 2019 and 31 December 2021, depending on data availability.

A1.2 Data sets

The key data sets that were linked to create the EIMDC are the following national, state and territory data sets:

- National Death Index and National Mortality Database (national)
- Residential Aged Care database (national)
- Admitted Patient Care data set (state/territory)
- Emergency Department data set (state/territory)
- Birth registration data set (state/territory)
- Perinatal or Midwives data collections (state/territory)

These data sets are further described in Section A1.2.1 to A1.2.5.

A1.2.1 National Death Index and National Mortality Database

It is compulsory to register all deaths that occur in Australia with the Registry of Births, Deaths and Marriages in the jurisdiction where the death occurred. In most jurisdictions, deaths are expected to be registered within 7–14 days of the burial or cremation.

The AIHW receives from each jurisdictional Registry of Births, Deaths and Marriages monthly 'fact of death' files that include the names and demographic characteristics of all deaths registered with each state and territory registry. The AIHW uses this monthly data file to compile the NDI. The NDI is used for data linkage only.

The demographic information on the NDI includes sex, date of birth, date of death, age at death, place of death, place of usual residence of the deceased at the time of death, as well as the name and date of birth of the deceased and the mother and father of the deceased.

The AIHW also receives from the Australian Coordinating Registry a yearly mortality data file which the AIHW refers to as the National Mortality Database or NMD. The NMD includes similar demographic and fact of death information to that available on the NDI. It also contains coded information on cause of death, which is not available on the NDI.

Before the NDI is made available to be used for data linkage, it is linked to the NMD to check for completeness and consistency of information such as sex, date of birth, date of death, age at death, and place of usual residence at time of death. Linkage of the NDI to the NMD also enables the AIHW to obtain additional information, such as cause of death and Indigenous status, and to check for duplicate and missing records (AIHW 2012a, 2017a).

The question asked to ascertain Indigenous status on the NMD is the standard question, 'Was the deceased (or deceased person) of Aboriginal or Torres Strait Islander origin?' with answer categories:

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

A1.2.2 Hospital data sets

Three state and territory hospital data sets were used for this linkage. They comprised:

- Admitted Patient or Inpatient Care data sets
- Non-Admitted/Outpatient Care data sets
- Emergency Department data sets

These data sets are compiled by state and territory health departments and made available to the AIHW for approved statistical purposes. The hospital data sets that were used to create the first iteration of the EIMDC covered all persons who presented for service in a public or private hospital during the period 1 January 2010 to 31 December 2018 across all episodes of care, and not only persons who died in hospital during this period.

The reference period for the hospital data sets includes a look-back period of 1 year, from 1 January 2010 to 31 December 2010, to increase the chances of including persons who died later than the year in which they attended hospital.

The main data item of interest in these data sets was Indigenous identification. Indigenous identification was ascertained through the standard question which was required to be asked of all persons each time they presented in hospital for service: '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.

A1.2.3 Residential Aged Care database

The Residential Aged Care data used for this project comprised all persons who obtained service in residential aged care facilities during the period 1 January 2010 to 31 December 2018, including a look-back period of 1 year, from 1 January 2010 to 31 December 2010.

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 at the time a person is assessed for government-subsidised aged care, and by the aged care home while they live there.

Aged care comprises both transitional care and permanent care, and individuals could have multiple episodes of care across the 2 programs during their lifetime. Information on Indigenous identification was independently collected and recorded during each episode of care. The 2 data sets generated from the transitional care and permanent care programs were used for this project.

The question used to ascertain Indigenous identification under both the transitional care and permanent care programs is the standard question, 'Is the client of Aboriginal or Torres Strait Islander origin?' with answer categories:

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

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

In addition to the national residential aged care data which was provided to the AIHW by the Department of Health, aged care data for Western Australia was provided separately to the AIHW as a linked data set through the Data Linkage Branch of the Western Australia Department of Health.

A1.2.4 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 Perinatal Data Collection or 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.

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.

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 had tended to be based on the Indigenous status of the mother.

As the PDC collected Indigenous identification only of the mother until 2012, neonatal deaths of babies with Indigenous fathers and non-Indigenous mothers may not have been 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.

A1.2.5 Birth registrations

Birth registrations data used for this study were provided by jurisdictional registries of births, deaths and marriages; they covered all babies born in Australia between 1 January 2010 and 31 December 2018.

All births in Australia must be registered within 60 days of the birth with the Registry of Births, Deaths and Marriages in the jurisdiction where the birth occurred. In practice, however, birth registration coverage is incomplete due to registration lags and non-registration (ABS 2015; Lanyon and John 2015). Apart from processing delays, registration lags and non-registration are often influenced by remoteness location and cost considerations, especially where a birth certificate 'gives you nothing ... and costs money' (Lanyon and John 2015).

For example, birth certificates are not required to access certain government services as parents can access Centrelink child payments or related family allowances on presentation of a birth notification or a sticker from the hospital where the birth took place.

Analysis of the timeliness of birth registration in 5 jurisdictions (Victoria, Queensland, South Australia, Western Australia and Tasmania) revealed an under-registration rate of 3.2% for 2009 births and 3.6% for 2013 births that were yet to be registered by 2014. The estimated under-registration rate over the 5 years between 2009 and 2014 amounted to about 6,400 unregistered births of children within the 5 jurisdictions considered in the study (Lanyon and John 2015).

Birth registration data provided for this study included personal identifiers for linkage, as well as information on the Indigenous status of the mother and father of the baby. Since both the birth registrations and perinatal data covered the same babies, the use of the 2 data sets improved the chances that most babies would be identified and included in the EIMDC.

An additional benefit of linking both the perinatal and birth registrations data to the NDI was that birth registrations data contained information on the Indigenous status of both the mother and father of the baby. This information was used to verify the Indigenous status of the mother and to supplement information on the Indigenous status of the baby after 2012.

Table A3.1: Number of data sets linked and number of Indigenous identifications for persons aged 15 and over at death, 2011–2018

Number of linked data sets	Number of Indigenous identifications								Per cent of Indigenous identifications							
	0	1	2	3	4	5	6	Total	0	1	2	3	4	5	6	Total
<i>New South Wales</i>																
1	14,902	197						15,099	3.7	7.9	-	-	-	-	-	3.7
2	36,536	354	362					37,252	9.0	14.3	17.7	-	-	-	-	9.0
3	165,016	975	1290	2788				170,069	40.8	39.3	63.0	80.2	-	-	-	41.1
4	174,300	883	370	666	1236			177,455	43.1	35.6	18.1	19.1	95.5	-	-	42.8
5	13,971	73	25	24	58	95		14,246	3.5	2.9	1.2	0.7	4.5	100.0	-	3.4
Total	404,725	2,482	2,047	3,478	1,294	95	0	414,121	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0
<i>Victoria</i>																
1	11,804	66						11,870	3.9	3.5	-	-	-	-	-	3.9
2	36,045	180	66					36,291	12.0	9.6	9.9	-	-	-	-	11.9
3	126,666	732	416	400				128,214	42.1	39.0	62.6	75.3	-	-	-	42.2
4	116,413	761	170	120	166			117,630	38.7	40.5	25.6	22.6	96.5	-	-	38.7
5	9,607	140	13	11	6	21		9,798	3.2	7.5	2.0	2.1	3.5	100.0	-	3.2
Total	300,535	1,879	665	531	172	21	0	303,803	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0
<i>Queensland</i>																
1	7,959	351						8,310	3.6	15.1	-	-	-	-	-	3.6
2	31,106	361	484					31,951	14.0	15.5	32.3	-	-	-	-	13.9
3	91,171	862	743	2,474				95,250	41.1	37.1	49.6	87.2	-	-	-	41.4
4	82,538	670	240	349	1,366			85,163	37.2	28.8	16.0	12.3	97.6	-	-	37.0
5	9,064	82	31	13	34	118	2	9,344	4.1	3.5	2.1	0.5	2.4	100.0	-	4.1
Total	221,838	2,236	1,498	2,836	1,400	118	2	9,344	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0

continued

Table A3.1: Number of data sets linked and number of Indigenous identifications for persons aged 15 and over at death, 2011–2018 (continued)

Number of linked data sets	Number of Indigenous identifications								Per cent of Indigenous identifications							
	0	1	2	3	4	5	6	Total	0	1	2	3	4	5	6	Total
South Australia																
1	6,818	111						6,929	6.6	21.3	-	-	-	-	-	6.6
2	13,379	61	149					13,589	13.0	11.7	41.9	-	-	-	-	13.0
3	45,909	204	172	753				47,038	44.6	39.1	48.3	93.9	-	-	-	44.9
4	36,860	146	35	49	107			37,197	35.8	28.0	9.8	6.1	100.0	-	-	35.5
5	35							35	-	-	-	-	-	-	-	0.0
Total	103,001	522	356	802	107	0	0	104,788	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0
Western Australia																
1	2,446	146						2,592	2.3	23.5	-	-	-	-	-	2.4
2	9,148	74	279					9,501	8.6	11.9	48.1	-	-	-	-	8.6
3	46,776	265	233	2,092				49,366	44.1	42.7	40.2	97.5	-	-	-	44.8
4	47,605	135	68	54	843			48,705	44.9	21.8	11.7	2.5	100.0	-	-	44.2
5	3							3	0.0	-	-	-	-	-	-	0.0
Total	105,978	620	580	2,146	843	0	0	110,167	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0
Northern Territory																
1	458	726						1,184	10.2	83.6	-	-	-	-	-	14.15
2	3,070	124	2,586					5,780	68.4	14.3	99.0	-	-	-	-	69.07
3	948	17	26	399				1,390	21.1	2.0	1.0	100.0	-	-	-	16.61
4	9	1			3			13	0.2	0.1	-	-	100.0	-	-	0.16
5	1							1	0.0	-	-	-	-	-	-	0.01
Total	4,486	868	2,612	399	3	0	0	8,368	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0

Source: Enhanced Indigenous Mortality Data Collection

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Abbreviations

ABS	Australian Bureau of Statistics
ACAP	Aged Care Assessment Program
ACAT	Aged Care Assessment Team
ACT	Australian Capital Territory
AIHW	Australian Institute of Health and Welfare
AIR	Australian Immunisation Register
APC	Admitted Patient Care
COAG	Council of Australian Governments
CTG	Closing the Gap
EIMDC	Enhanced Indigenous Mortality Data Collection
ED	Emergency Department
EMD	Enhanced Mortality Database
ERP	estimated resident population
MADIP	Multi-Agency Data Integration Project
MBS	Medicare Benefits Scheme
MCCOD	Medical Certificate of Cause of Death
MCD	Medicare Consumer Directory
NDI	National Death Index
NHMD	National Hospital Morbidity Database
NIHSI AA	National Integrated Health Services Information Analysis Asset
NAPEC	Non-admitted Patient Episode of Care
NMD	National Mortality Database
NSW	New South Wales
NT	Northern Territory
PBS	Pharmaceutical Benefits Scheme
PDC	Perinatal Data Collection
PES	Post-Enumeration Survey
PIN	Personal Identification Number
Qld.	Queensland
RAC	Residential Aged Care

SA	South Australia
Tas.	Tasmania
Vic.	Victoria
VII	Voluntary Indigenous Identifier
WA	Western Australia

Symbols

Symbol	Definition
n.a.	not available, not applicable
n.p.	not published
...	Not available

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 (Admitted Patient Care 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 2 or more sets of information belonging to the same person, event or place, into a single record of information. See **record linkage**.

deterministic linkage: A process that ranges from simple joining of 2 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 8 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 2 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 10th 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.

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 **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 2 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 **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.

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This report presents results using the Enhanced Indigenous Mortality Data Collection to estimate the levels, age sex patterns and trends in Indigenous and non-Indigenous mortality and life expectancy, as well as the gap between Indigenous and non-Indigenous mortality and life expectancy, over the period 2011–2013 to 2016–2018. The report also presents estimates of the relative contribution of different age groups and causes of death to the gap in life expectancy between Indigenous and non-Indigenous Australians. There were marginal gains in life expectancy for Indigenous males and females during the reference period.

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