

# Patterns and trends in mortality of Western Australian infants, children and young people 1980-2008



Government of **Western Australia**  
Department for Child Protection  
and Family Support



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**Child Health  
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The views and opinions expressed in this report are those of the authors, and do not necessarily represent the views of The University of Western Australia or the Western Australian Government Department for Child Protection and Family Support.

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## EXECUTIVE SUMMARY

This report is the third in a series examining patterns and trends in mortality among Western Australian infants, children and young people, and covers the period 1980–2008. The report was commissioned by the Western Australian Government Department for Child Protection and Family Support and compiled by the Telethon Institute for Child Health Research (TICHR).

The report—and series—aims to provide a comprehensive resource to inform policy and strategies aimed at preventing deaths in early life. The findings draw on unique, population-level datasets that include details on the perinatal, demographic and geographic characteristics of all children born in Western Australia from 1980–2007 and the circumstances of death for the children and youth in this cohort that died in Western Australia from 1980–2008.

Data on cause of death has been generated by the *Child Mortality Database project*. This project involves establishing an accurate and complete source of information on the cause of all infant, child and youth deaths, including investigations on the circumstances of deaths that are subject to coronial investigation.

## KEY FINDINGS

### *Infant deaths*

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- The rate of infant mortality in Western Australia has dropped substantially in recent decades, and continued to fall in the most recent triennium—from 8.9 per 1,000 live births in 1980-84 to 3.6 per 1,000 live births in 2005-07. The current rate equates to around 103 infant deaths per year.
- There is a pervasive gap in the infant mortality rates of Aboriginal and non-Aboriginal populations in Western Australia. While both populations now have a considerably lower absolute risk of dying in infancy than previous years, Aboriginal infants continue to have a 3-4 fold increased risk of death in the first year of life relative to non-Aboriginal infants.
- The data consistently indicate that the majority of infant deaths (about 60%) occur in the first 28 days of life.
- Mortality rates in Australia are typically highest among infants born to teenage mothers although, in contrast, the rate of Aboriginal infant mortality in 2005-07 was highest for births to women aged 30 years and over.
- Infant death rates did not differ appreciably by geographic location—with the exception of Aboriginal populations in remote locations of Western Australia, who were at an elevated risk of dying in the first year of life when compared with Aboriginal children in the Perth metropolitan and regional areas of the state.
- Overall, the top three causes of infant deaths in 2005-07 were birth defects, prematurity and SIDS + unascertainable deaths. These collectively account for 64% of all infants deaths in this period. Infection was the leading cause of death among Aboriginal infants (25%).

- The data since 1980 have consistently highlighted that the risk of death is higher for Aboriginal than non-Aboriginal infants for *all* main causes of death.
- Encouragingly, there has been a substantial decline in SIDS + unascertainable deaths in recent decades. The rate of SIDS + unascertainable deaths in the Aboriginal population was halved between 2000-04 and 2005-07, and suggests that educational campaigns and programs to reduce the risks of SIDS in Aboriginal communities have been influential.
- Smoking in pregnancy continues to be a pressing concern. This is particularly the case in the Aboriginal population, where around half of the mothers of Aboriginal children born in 2005–2007 stated that they smoked during their pregnancy (14% for non-Aboriginal children). These data underscore the need for continued, and extensive, efforts to assist pregnant women to quit (and abstain from) smoking.

### *Child and youth deaths*

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- There were 692 deaths of persons aged 1-24 years in Western Australia in 2005-08, which corresponds to a rate of 2.9 per 10,000 person-years.
- There are marked disparities in the rate of child and youth deaths between Aboriginal and non-Aboriginal populations. While Aboriginal males had the highest absolute risk of death in this age group (12 per 10,000 person-years), Aboriginal females had the highest relative risk of death than their non-Aboriginal counterparts (a 5-fold risk).
- Overall, the Aboriginal death rates have remained at 3-4 times higher than those recorded for non-Aboriginal children and youth throughout the 2000s.
- Child and youth death rates are typically higher among males, those born preterm and to teenage mothers, and those living in remote areas at birth.
- Death rates decline sharply after infancy, with the lowest rates recorded in the 5-12 years age group (0.8 per 10,000 person-years). The rates then increase into young adulthood, to a peak of 6.0 among those aged 17-24 years.
- Accidents and injuries was the leading cause of death among children and youth—in both the Aboriginal and non-Aboriginal populations—and account for 67% of all deaths in this age group. Cancers was the second leading cause (10%), followed by Infection (5.6%).
- In 2005-08, the rate of child and youth death was higher in the Aboriginal than non-Aboriginal population for all main causes, with the exception of Cancers.
- Accident and injury deaths were most commonly attributed to suicide in the Aboriginal population (41%) and to road traffic accidents in the non-Aboriginal population (47%). These two causes collectively account for about three-quarters of all accident and injury deaths in both populations.
- The majority of child and youth suicides involved hanging (88% of Aboriginal and 67% of non-Aboriginal suicide deaths). Suicide deaths from carbon monoxide poisoning, gunshot, suffocation and jumping from height were also reported, although these methods were rarely reported in Aboriginal suicide deaths.

## RECOMMENDATIONS

### *Reduce smoking in pregnancy*

- There is a need for continued, and extensive, efforts to motivate, assist and support women to quit (and abstain from) smoking—particularly when pregnant. The rates of smoking in pregnancy among Aboriginal women are of particular concern and call for culturally appropriate and adequately resourced intervention initiatives.

### *Reduce SIDS*

- The number of deaths attributed to SIDS appears to have decreased in recent years, although the level continues to be unacceptably high. An increased awareness of the risks of death in infancy from co-sleeping—through the continuation of education programs and renewed public awareness campaigns—is likely to reduce the number of deaths from this cause.

### *Minimise birth defects*

- Birth defects remain the leading cause of death in infancy. Strategies to reduce rates of birth defects need to focus on: promoting good nutrition (including adequate intake of folic acid and iodine) and avoiding obesity, diabetes, excessive alcohol consumption, smoking and other substances that may be harmful during and before pregnancy; and improving access to prenatal screening. Provision of effective post-surgery clinical services and follow-up should also be considered, particularly among children returning to remote locations.

### *Evidence-based initiatives*

- Many other deaths in the early lifecourse are preventable—this includes SIDS and many of the deaths caused by infection. There is a range of evidence-based programs and initiatives that have been successful in reducing preventable deaths in early life. These should be sought out and assessed in terms of their likelihood of success in Aboriginal and other high-risk population groups in Western Australia.

### *An enhanced research agenda*

- The existing empirical evidence-base would be enhanced by an increased focus on the pathways to mortality, including the range of factors that impact on individuals over the trajectory of life (genetic history, biology, environmental exposures and social factors) and across generations. This could include a closer examination of the factors that may increase the risk of death but are amenable to changes in clinical practice or wider public health policy. This focus requires an ongoing program of analysis of mortality data linked to other population datasets, including education, justice, child protection, and family connections.

### *Enabling high impact research*

- Outcomes for children will be enhanced by a more collaborative approach to research in this field. This requires researchers, clinicians, pathologists, coroners, health departments, community and advocacy groups and others to work together to target priority research questions, design and implement the research, assess the findings and apply them to policy and practice. While this approach will enable the

development of better data to enhance the scope and relevance of research, it is also likely to promote the use of alternative methods. For example, qualitative surveys and ethnographic studies are likely to provide insights and lead to conclusions that are outside the reach of statistical analytic techniques, particularly in ethnic contexts.

*Improved data*

- An enhanced research agenda will be supported by better data. This includes: the routine collection of information on antenatal attendances, maternal weight, and alcohol and substance use in the Midwives' Notification Form; complete and detailed data on clinical history; and the availability of the suite of information from pathology investigation and autopsy for all deaths.
- The quality of information on mortality in Aboriginal populations will be improved by a more accurate ascertainment of Indigenous status. Collaborative efforts to improve the process of collecting, recording and identifying Aboriginal people in administrative data sources (e.g. routinely collecting the Indigenous status of the father on the Midwives' Notification Form) require continued investment.

## BACKGROUND

Mortality data are an important source of information on the health and wellbeing of populations, and generally form a key part of the health monitoring, evaluation and planning systems of communities, countries and global health organisations. Aggregated measures of mortality—such as estimates of life expectancy and rates of infant mortality—are sentinel indicators in this regard and can highlight inequalities in health and development between different population groups. Further, the pattern of mortality rates and causes by age, sex, geographic area and other population characteristics can provide important insights into the reasons for health inequalities. Changes over time in measures of mortality also reveal whether the health of a population is improving and whether the health care system is being effective, and therefore underpin the efforts of those working in health policy and planning.

Data on deaths in Australia are generally a by-product of administrative processes, and primarily sourced from state and territory registrars of births, deaths and marriages (compulsory death registration data) and coroners (for cases requiring coronial investigation).

The Australian data highlight that mortality rates have declined substantially over the course of the last century. This has been attributed to improvements in public infrastructure (e.g. water supply and sewerage systems), improved understanding of health risk and benefits, advances in medicine and surgery, and better access to medical and other health services.<sup>1</sup>

## MORTALITY RESEARCH AT THE TELETHON INSTITUTE

The Telethon Institute for Child Health Research (TICHR) has had an active involvement in mortality-related research since its inception in the early 1990s. Much of this research has focused on infants and young children, given that many of the causes of infant and childhood mortality are potentially preventable, e.g. accidents and injuries, and infections. The work to date has provided vital information on the many serious diseases, accidents and injuries that impact on children.

The core of the existing work program is known as the *Child Mortality Database (CMD) project* and involves establishing an accurate and complete source of information on the cause of death of infants, children and youth in Western Australia. The existing project is an extension of the innovative research conducted by Louisa Alessandri, Fiona Stanley and others, and has been guided by the subsequent methodological enhancements of Jane Freemantle. The project follows all persons born in Western Australia since 1980 and collects and reviews information on causes of death for persons who died in Western Australia before their 26<sup>th</sup> birthday. The resultant database is a unique and comprehensive database that enables researchers to analyse patterns and trends in infant and child deaths in Western Australia.

The focus of reporting in the last decade has been on trends in all-cause and cause-specific mortality rates since 1980, with a particular focus on the disparities between Aboriginal and Torres Strait Islander (hereafter referred to as 'Aboriginal') and non-Aboriginal

persons and patterns in the main causes of deaths (such as Sudden Infant Death Syndrome (SIDS), infection, birth defects, prematurity and accidents). In that time, the database has informed a range of research reports and journal articles and been used by the Western Australian Government to inform policy and strategic direction in the prevention of deaths in the Western Australian population.

In 2004 the database was used to produce the *First Research Report: Patterns and Trends in Mortality of WA Infants, Children and Young People*.<sup>2</sup> This report was commissioned by the *Advisory Council on the Prevention of Deaths of Children and Young People (ACPDCYP)* and tabled in Western Australia's State Parliament in 2005. It highlighted that there were many infants and children in Western Australia dying from potentially preventable deaths such as SIDS, accidents and injuries, and that the disparities in preventable deaths between Aboriginal and non-Aboriginal infants were increasing. These findings emphasised the need for immediate action to improve healthcare and address the pervasive social and economic disadvantage faced by Aboriginal families and communities.

The analysis of mortality trends was extended to include deaths from 1980-2005 and released in 2010 as *The Second Research Report: Patterns and Trends in Mortality of Western Australian Infants, Children and Young People 2004-2005*.<sup>3</sup> This report included information gleaned from forensic toxicology reports in autopsy cases (e.g. whether alcohol or drugs were detected in the bloodstream at the time of death), on whether seat belts were worn in motor vehicle-related deaths, and methods of suicide.

This report represents the third report in the series examining patterns and trends in mortality among Western Australian infants, children and young people. It includes the deaths of persons aged less than 25 years, to the year 2008.

## OVERVIEW OF REPORT

This report addresses the following aims:

- Describe the patterns and trends of deaths of infants, children and young people in Western Australia. This includes identifying the disparities in mortality rates by:
  - Age
  - Gender
  - Geographic remoteness, and
  - Aboriginal status.
- In achieving the above aim, provide a comprehensive resource to inform policy and strategies aimed at preventing deaths in the early lifecourse.

The report is divided into three main sections. The first section provides an introduction to the research project and outlines the background (Chapter 1) and methods (Chapter 2). The second section of the report provides results in the area of infant mortality, including trends in mortality rates over time and causes of infant mortality (Chapter 3). The third section of the report focuses on mortality among children (1-16 years) and young people (or youth; 17-24 years) (Chapter 4).

## METHODS

This chapter outlines the design of the study and the research methods employed. It includes a brief description of the datasets used and an overview of the main analytic techniques.

### METHODS SUMMARY

The study examines the aforementioned aims with a quantitative analytic framework applied to a series of linked administrative datasets provided by the Data Linkage Branch at the WA Department of Health (DoH DLB). The study datasets have undergone a rigorous process of validation and data cleaning to ensure they are fit for purpose. Our validation strategy has included data confrontation against published births and deaths information and related research reports.

The study data were primarily sourced from core population health datasets held by DoH DLB—including the Midwives' Notification System, the Hospital Morbidity Data System, and the Birth Registration and Death Registration datasets. Data on cause of death were generated by the *Child Mortality Database project* and provided to the DoH DLB for linking to other study datasets. The process of establishing an informed cause of death code for this study is described below (see section on *Cause of death data*, below).

Stillbirths, terminations and live births that were less than 400g and less than 20 weeks gestation have been excluded from the study datasets. Further, any births or deaths that occurred out of the state of Western Australia are also out of scope of the study.

A range of statistical techniques were used to address the research aims. Simple univariate and cross-tabulation data are used to describe population characteristics, while a suite of mortality rates have been generated to highlight differences in mortality by perinatal, demographic and geographic factors, by cause and to assess trends over time. All cause and cause-specific infant mortality rates are expressed as deaths per 1,000 live births. Childhood mortality rates are expressed as the deaths per 10,000 person-years, which allows for comparisons of child mortality rates by age. Outputs are displayed in both tabular and graphical formats.

Confidence intervals (95%) and p-values have been included, where appropriate, to provide a guide on the statistical significance of study findings.

### DATA SOURCES

The data used in this study are sourced from four statutory collections and have been supplemented with cause of death data generated by the *Child Mortality Database project*. A brief description of these data sources is provided below.

## *Midwives' Notification System*

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The Midwives' Notification of Birth system has complete data on births (including home births) in WA from 1980, collecting antenatal and perinatal information and demographic details for the mother and infant with some paternal information. It is a statutory requirement under the Health Act and Midwifery Nurses' Regulations that the Midwives' Notification Form (MNF) be completed for births greater than or equal to 400 grams birthweight or greater than or equal to 20 weeks gestation. The MNF is forwarded to the Western Australian Department of Health (DoH WA) within 48 hours of the birth, where it is coded, validated and entered on a database.<sup>4</sup> Together with the hospital summary admission form this provides the information for the Midwives' Notification System (MNS).<sup>5</sup> Validation of the MNS estimated that 99.9% of WA births have a completed record,<sup>6</sup> and studies conducted in 1987 and 1994 confirmed the accuracy of data on the MNF compared with the mother's medical record. According to these studies, mother's race was recorded on the MNF with between 90% and 96% accuracy.<sup>7, 8</sup>

## *Birth and death registration datasets*

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Information on birth and death registrations is sourced from the Western Australian Registry of Births, Deaths and Marriages (RBDM), which is managed by the Western Australian Department of the Attorney General. Birth data is obtained from birth registration forms, which are completed for all births in Western Australia greater than 20 weeks gestation. This form contains information relating to parents' age, occupation, country of birth, marital status, date of marriage and the number of previous children of the mother.

The RBDM collects descriptive data pertaining to cause of death in addition to age and place of death from the death certificates completed by registered doctors. A perinatal death certificate is completed for infants dying in the perinatal period. In cases of sudden or unexpected death, a death certificate is not completed and a post-mortem and coronial investigation are conducted. Multiple cause history from the death certificate is forwarded to the Australian Bureau of Statistics (ABS) where coding according to the International Classification of Diseases (9<sup>th</sup> and 10<sup>th</sup> Revision) takes place. The coded data are forwarded to the DoH DLB where they are linked to the individual's birth information.

## *Hospital Morbidity Data System*

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The Hospital Morbidity Data System includes detailed information on all inpatient episodes in Western Australian public and private hospitals. Basic demographic information, length of stay, principal condition treated and other conditions present, operations and procedures, outcome and place of admission and discharge are included. Diseases and other health problems are coded according to the International Classification of Diseases (ICD).

Data on cause of death were generated by the *Child Mortality Database project* in a multi-stage process. Initially, all in-scope death records for a specified year are provided to the *Child Mortality Database (CMD)* team at the Telethon Institute for Child Health Research (TICHR) by the DoH DLB. The transfer, storage and management of these data are conducted in accordance with a Memorandum of Understanding (MOU; between TICHR, DoH DLB and the Western Australian Department of the Attorney General) and the TICHR Division of Population Sciences Confidentiality Policy, in order to ensure the confidentiality and security of the data.

The circumstances of deaths that are subject to coronial investigation are ascertained by the CMD team, who check the status of the investigation at the Coroner's Office (under the approval of the Coronial Ethics Committee). Cases which have a Coroner's finding are reviewed at the Department of Forensic Pathology at QE11 Medical Centre (PathWest), with the CMD team recording information from the autopsy case reports on place of death (if out of hospital, the geographical location of death), circumstances surrounding death, the Child Death Questionnaire (infant deaths only for the years covered by this report) and the Coroner's Record of Investigation of Death. Cases that are still under coronial investigation are regularly checked for an outcome and reassessed as soon as the Coroner's verdict is obtained; in the meantime, and where possible, these cases are coded according to the medical cause of death. All information recorded from case files at the Department of Forensic Pathology are entered into electronic forms on a dedicated, password protected laptop computer.

The information collected at the Department of Forensic Pathology is considered in conjunction with the original information supplied by the DoH DLB in order to make an informed decision on the classification of death records. All death records were independently coded by two experienced coders according to a classification based on the Perinatal Society of Australia and New Zealand's (PSANZ) Perinatal Death and Neonatal Death Classifications and extended by Freemantle.<sup>9, 10</sup> The classification used in this study is a three-digit coding system, comprising ten major categories, and is based on the antecedent factor of death (see Table 1 for major categories and Table A1 in Appendix A for the full classification). Cases that cannot be resolved by coders (insufficient data or disagreement between coders) are referred to a senior researcher for resolution.

It should be noted that there has been an observed diagnostic shift in the classification of SIDS deaths over time.<sup>11</sup> Deaths for which the cause is not known are usually classified as either attributable to SIDS or determined to be of an unascertainable cause. The proportion of deaths classified as unascertainable (code 990; see Table A1 in Appendix A) increased significantly during the 1990s, and this increase was disproportionately observed among the Aboriginal population. Accordingly, to enable meaningful analysis of changes over time, deaths coded as SIDS have been incorporated with those deemed unascertainable and are described as 'SIDS + unascertainable' in this report. Essentially, these are all sudden or unexpected deaths for which the Coroner, after extensive investigation, has been unable to ascertain a definite cause.

TABLE 1: MAJOR CATEGORIES FOR THE CLASSIFICATION OF DEATH

<i>Code</i>	<i>Description of cause of death</i>
0	Normally formed fetuses (without recognised sufficient cause of death)
1	Intrapartum causes
2	Significant birth defects
3	Prematurity
4	Infection
5	Accidents and injuries
6	Cancers
7	Sudden Infant Death Syndrome
8	Other specific conditions
9	Unknown/not classifiable

Final codes are checked and validated and entered into a central database with personal identifiers removed. Note that death information is subject to update and change. Coronial cases can take a number of years to be completed—in these instances, cases are coded as ‘pending’. As a result, aggregate mortality statistics can change over time.

The final cause of death codes for all in-scope death records were provided to DoH DLB and linked to other study datasets using unique identifiers available only to the DoH DLB.

## LINKING DATA

Data from the aforementioned sources were linked together by the DoH DLB to create a dataset with one record for each in-scope birth (see *Scope and coverage*, below). The linkage processes undertaken by DoH DLB involve probabilistic matching on demographic items, with clerical reviews performed as required.<sup>12</sup> Encrypted ‘linkage keys’ are provided to researchers by the DoH DLB to enable researchers to link datasets without the need to use identifiable information. The procedures used in the extraction of data from the WA Data Linkage System (WADLS) have been internationally accepted as best practice.<sup>12</sup>

## SCOPE AND COVERAGE

Data were provided by the DoH DLB for all live births in Western Australia between 1980 and 2007, inclusive. For the purposes of this study, stillbirths and terminations, and live births that were less than 400g and less than 20 weeks gestation, were excluded from the dataset provided by DoH DLB. Births and deaths that occurred out of the state of Western Australia are also out of scope of the study (including deaths in Western Australia to persons born outside of Western Australia in the study period) and, therefore, not included in the results of this study.

## ABORIGINAL IDENTIFICATION

Identifying Aboriginal people in administrative data sources is a vexed issue, and one that has been given increased scrutiny in recent years. While most surveys and data collections rely on respondents to self-identify as an Aboriginal person, this is not necessarily the case in data collected via administrative processes. Accordingly, status in these collections can

be subject to bias and often provide incomplete information on status.<sup>13</sup> This can lead to an undercount or underestimation of the size of Aboriginal population groups and make it difficult to accurately assess or estimate the scale of an outcome of interest.<sup>14</sup>

One method for obtaining a more consistent and accurate measure of Aboriginal status in administrative data is to combine information on the status of an individual from different sources. This method has been adopted in this study, using the draft guidelines of the *Getting Our Story Right* project (a cross-agency data linkage and analysis project, part-funded by the Council of Australian Governments through the National Indigenous Reform Agreement). For the purposes of this study, the *Getting Our Story Right* guidelines have been interpreted and applied as follows:

### *Deriving Aboriginal status*

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The identifiers within the following four study datasets were used to derive Aboriginal status:

- the Midwives' Notification System (MNS); using information on the Aboriginal status of the mother
- the Hospital Morbidity Data System (HMDS)
- Birth Registrations
- Death Registrations

First, each person is given a derived Aboriginal status for each dataset—although only for those datasets that they are recorded in, e.g. most children and young people do not have a death record and therefore the Death Registrations dataset is not used to determine Aboriginal status for these persons. Persons with three or more records per dataset are recorded as Aboriginal if two or more of their (non-missing) records indicate that they are Aboriginal (this is primarily of relevance to the HMDS, where a person may have recorded many hospital inpatient episodes). Persons with one or two records are considered Aboriginal if at least one record indicates they are Aboriginal.

Second, an overall derived Aboriginal status is calculated for each person, by summing the derived information on Aboriginal status across all datasets. If Aboriginal status was able to be derived in three or more datasets, and at least two identified them as Aboriginal, then that person is considered to be Aboriginal in this study. If Aboriginal status was able to be derived in only one or two datasets (for example, if they had a birth record and Midwives' notification, but not a death or hospital record), and one identified them as Aboriginal, then that person is considered to be Aboriginal in this study.

## ETHICS

The principal ethical issues for this study concern privacy, confidentiality and data security. The security and confidentiality of the study data have been of the utmost importance, and been critical considerations in planning and undertaking the study. We have developed strong safeguards to ensure that the identification of individuals (and communities) remains confidential at all stages, including data analysis and dissemination.

The study was conducted under ethical approvals from the University of Western Australia's Human Research Ethics Committee, the Western Australian Aboriginal Health

Ethics Committee (WAAHEC), and the Western Australian Department of Health Human Research Ethics Committee. The collection of cause of death information from case files at the Department of Forensic Pathology at QE11 Medical Centre (PathWest; for cases requiring coronial investigation) was conducted with the approval of the Coroner's Ethics Committee.

In addition, the transfer, storage and management of identifiable death records is undertaken in accordance with a Memorandum of Understanding (MOU) between TICHR, DoH DLB and the Western Australian Department of the Attorney General, in order to ensure the confidentiality and security of these data. The safeguards of this MOU are consistent with the strict guidelines of TICHR's Division of Population Sciences Confidentiality Policy. This policy ensures that all data are kept in either locked metal filing cabinets within a locked office in a restricted area of TICHR or as password protected computer files on TICHR's securely controlled and centrally maintained network. Access to study data is restricted to named research staff.

## ANALYSIS AND VALIDATION

The final analysis file used in this study includes information from a total of 694,096 persons that were born in Western Australia between 1980 and 2007 inclusive. A total of 6,898 of these persons had died in the period 1980-2008. The birth and death numbers were validated against published estimates produced by the Western Australian Department of Health (for example, Gee (2010) and the Perinatal and Infant Mortality Committee series) and earlier reports produced by the *Child Mortality Database project* (which were produced using separately issued datasets with the same scope exclusions for births in 1980-2004).<sup>2, 3, 15, 16</sup>

A range of statistical techniques were used to address the research aims. Simple univariate and cross-tabulation data are used to describe population characteristics, while a suite of mortality rates have been generated to highlight differences in mortality by perinatal, demographic and geographic factors, by cause and to assess trends over time. Outputs are displayed in both tabular and graphical formats. Proportions and rates in the text have been rounded to the nearest whole number (for numbers greater than or equal to ten) or to one decimal place (numbers less than 10).

All cause and cause-specific infant mortality rates were generated for those infants who died before reaching their first birthday. Infant mortality rates are divided into neonatal (first 28 days of life) and post-neonatal rates (after 28 days and before 365 days), where applicable. Infant mortality rates have been calculated for each birth cohort by dividing the number who had died (by a certain age) by the number of live births in the population at risk of mortality, and are expressed as deaths per 1,000 live births. These rates are a reflection of the cumulative risk of dying within the first 28 days and first year of life. The baseline birth counts used in these calculations are provided in Appendix B (see Tables B1 and B2).

In addition, all cause, cause-specific and age-specific mortality rates were calculated for infant survivors who died before reaching their 25<sup>th</sup> birthday. Child (1-16 years) and youth (17-24 years) mortality rates are expressed as deaths per 10,000 person-years.

Person-years (or person-time) refers to the amount of time ‘at-risk’ of a particular study outcome—in this case, death—and enables us to calculate the incidence of that outcome over a period for a given population group. For example, a mortality rate for 1-4 year-olds in 2005-07 of 20 per 10,000 person-years indicates that 20 of every 10,000 (or 2 out of every 1,000) persons aged 1-4 years died in each year, from 2005 to 2007. Importantly, using person-years as a denominator for calculating child and youth mortality rates allows us to compare mortality rates (the incidence of death) by age and other characteristics of interest.

In order to calculate person-years, it was necessary to calculate an “exit date” for each child. The termination date (or exit date) for each child was either the date of death of the child or the last date of follow-up of the cohort (31/12/2008) if the child was still alive. Person-years was calculated as the sum over all children of the time spent ‘at-risk’ during a period of interest and, depending on the population group, was restricted by Aboriginality, sex and geographic remoteness.

It should be noted that age-specific rates have been calculated for children and young people (or youth) aged 1-4 years, 5-12 years, 13-16 years and 17-24 years. These ages broadly represent important transition points from birth to entry into the formal schooling system, to high school and post-school experiences.

Mortality rates can randomly fluctuate year-on-year—especially for population subgroups with few recorded deaths. Accordingly, the data in this report have generally been aggregated across multiple years. For example, the latest infant mortality rates are presented for 2005–07.

All analyses were performed using IBM SPSS Statistics Release Version 19.9.9.1 (IBM SPSS Inc., 2010, Chicago, IL).

### *Measures of error*

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As the study data are based on administrative records for the entire cohort of Western Australian births, descriptive statistics on this population are presented on the assumption that there is no sampling error. However, interstate and international migration flows are likely to alter the size and composition of the cohorts over time and, accordingly, limit the accuracy of estimates of change. As a result, 95% confidence intervals and *p*-values have been included as appropriate for these comparisons.

### *Migration between location at time of birth and death*

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Mortality rates for different areas of geographic remoteness have been calculated using the place of usual residence of the mother at the time of the child’s birth. While information on the place of residence at birth may not necessarily be a reflection of the current place of residence of infants and children at any particular point in time (or where the birth occurred), it has been used here on the basis of completeness and consistency, i.e. the study team only have access to place of residence at death for a small subset of the study population. Our previous research has highlighted that there is high agreement between residence at time of birth and residence at time of infant death (suggesting little migration in the first year of life) but that children over the age of one were significantly

more likely to die in a geographical location that was different to the one in which they were born.<sup>3</sup>

### *Geographic remoteness*

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The distribution of deaths across different areas of geographic remoteness has been determined using information on the place of usual residence of the mother at the time of the child's birth. Geographic remoteness is defined using the 2006 Accessibility/Remoteness Index of Australia (a widely used classification of remoteness in Australia). The five categories of remoteness reflect differences in access to services, and range from Major cities (Perth metropolitan area), to inner regional, outer regional, remote and very remote areas.<sup>17</sup> For the purposes of this study, these five categories are generally collapsed into three groups: Major cities, Regional areas and Remote areas.

## INFANT DEATHS

This section presents data on the likelihood of death in the first year of life among cohorts of children who were born and died in Western Australia from 1980. It includes mortality rates in the neonatal (first 28 days of life) and post-neonatal (after 28 days and before 365 days) periods and provides trends over time and disaggregation by Aboriginal status, where possible. The leading causes of infant death are identified and discussed.

### TRENDS SINCE 1980

The rate of infant mortality in Western Australia has dropped substantially in recent decades, and continued to fall in the most recent triennium—from 8.9 per 1,000 live births in 1980-84 to 3.6 per 1,000 live births in 2005-07. The current rate equates to around 103 infant deaths per year. This level represents a reduction of about 94 infant deaths per year, on average, when compared with the number of deaths in the early 1980s.

These trends were observed in both the neonatal (first 28 days of life) and post-neonatal (after 28 days and up to one year) rates. While there has been some convergence in neonatal and post-neonatal mortality rates since 1980, the data consistently indicate that infant deaths are more likely to occur in the first 28 days of life. The latest results indicate that the neonatal mortality rate was 2.3 per 1,000 live births compared with 1.3 per 1,000 live births in the post-neonatal period.

TABLE 2: SUMMARY OF BIRTHS AND INFANT DEATHS, FOR BIRTHS FROM 1980-2007

<i>Birth year group</i>	<i>Live Births</i>	<i>Neonatal deaths<sup>a</sup></i>		<i>Post-neonatal deaths<sup>b</sup></i>		<i>Infant deaths<sup>c</sup></i>	
	<i>No.</i>	<i>No.</i>	<i>Rate<sup>d</sup></i>	<i>No.</i>	<i>Rate<sup>d</sup></i>	<i>No.</i>	<i>Rate<sup>d</sup></i>
1980-84	110,538	609	5.5	377	3.4	986	8.9
1985-89	121,207	640	5.3	390	3.2	1030	8.5
1990-94	126,204	469	3.7	334	2.6	803	6.4
1995-99	126,828	371	2.9	236	1.9	607	4.8
2000-04	124,227	300	2.4	196	1.6	496	4.0
2005-07	85,118	195	2.3	114	1.3	309	3.6

a. Excludes stillbirths but includes deaths in the first 28 days of life.

b. Includes deaths after 28 days and up to 1 year.

c. Includes neonatal and post-neonatal deaths (deaths in the first year of life).

d. Per 1,000 live births.

These trends generally reflect high and improving standards of medical care, including reported advancements in the identification and management of problems in the perinatal and neonatal periods and during labour—including fetal growth restriction, peripartum sepsis, maternal diabetes and hypertension.<sup>16, 18</sup>

## ALL-CAUSE MORTALITY

### *By Aboriginal status*

Aboriginal births constituted 6.7% of all births in Western Australia in 2005-07 (5,694 Aboriginal births of 85,118 total births) but accounted for 21% of all infant deaths in this cohort. In total, there were 65 Aboriginal infant deaths—of these, 32 occurred in the neonatal period and 33 were in the post-neonatal period. There were 241 non-Aboriginal infant deaths in this cohort, of which 160 occurred in the neonatal period and 81 in the post-neonatal period.

The 65 Aboriginal infant deaths in the 2005-2007 birth cohort represented an infant mortality rate of 11 per 1,000 live births. In comparison, the non-Aboriginal infant mortality rate was 3.0 per 1,000 live births. The rates indicate that Aboriginal children were almost four times more likely to die in infancy than non-Aboriginal children (relative risk (RR) = 3.8; 95% confidence interval (CI): 2.9–5.0) (see *Glossary* for a definition of relative risk). This elevated risk among Aboriginal children was evident in both the neonatal (RR = 2.8; 95% CI: 1.9–4.1) and post-neonatal period (RR = 5.7; 95% CI: 3.8–8.6), although the disparity was greater in the post-neonatal period where the mortality rate was 5.8 per 1,000 live births among Aboriginal children.

TABLE 3: INFANT MORTALITY RATES, BY ABORIGINAL STATUS, FOR BIRTHS FROM 1980-2007, WA

	<i>Aboriginal</i>			<i>Non-Aboriginal</i>			<i>TOTAL<sup>a</sup></i>			<i>RR (95% CI)<sup>c</sup></i>
	<i>No.</i>	<i>%</i>	<i>Rate<sup>b</sup></i>	<i>No.</i>	<i>%</i>	<i>Rate<sup>b</sup></i>	<i>No.</i>	<i>%</i>	<i>Rate<sup>b</sup></i>	
Neonatal	369	47.6	8.4	2,189	63.8	3.4	2,584	61.1	3.7	2.5 (2.2–2.8)
Post-neonatal	406	52.4	9.2	1,241	36.2	1.9	1,647	38.9	2.4	4.9 (4.3–5.4)
<i>Infant deaths</i>	775	100	17.6	3,430	100	5.3	4,231	100	6.1	3.4 (3.1–3.7)

a. Includes cases where Aboriginal status was unable to be derived.

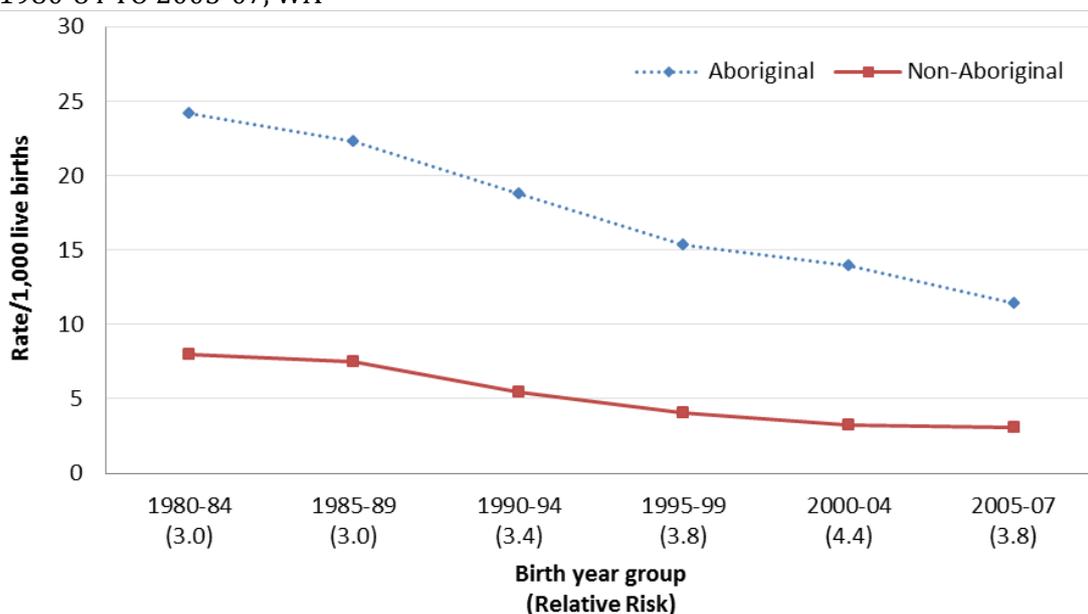
b. Per 1,000 live births.

c. Relative risk of death (between Aboriginal and non-Aboriginal infants).

The Aboriginal infant mortality rate was 18 per 1,000 live births across the entire study period (1980-2007), significantly higher than that among non-Aboriginal infants (5.3 per 1,000 live births) (Table 3). The rate has dropped significantly between 1980-84 and 2005-07, in both populations—from 24 to 11 per 1,000 Aboriginal live births ( $\chi^2 = 73.5$ ;  $p < 0.0001$ ) and from 8.0 to 3.0 non-Aboriginal live births ( $\chi^2 = 501.0$ ;  $p < 0.00001$ ) (Figure 1).

Tables 3 and 4 and Figure 1 highlight that there is a pervasive gap in mortality outcomes between Aboriginal and non-Aboriginal infants, despite the considerable reductions in infant death rates in Western Australia in recent decades. The gap in mortality outcomes can be measured in absolute and relative terms. While the absolute difference in rates suggests that the gap is reducing (from 16 per 1,000 live births in 1980-84 to 8.4 per 1,000 live births in 2005-07), the relative risk of death in infancy between the Aboriginal and non-Aboriginal population has remained fairly static over the study period. The data indicate that there was a 3-4 fold increased risk of death among Aboriginal infants in the last three decades (with a peak of 4.4 in 2000-04) (Figures 1 and 3).

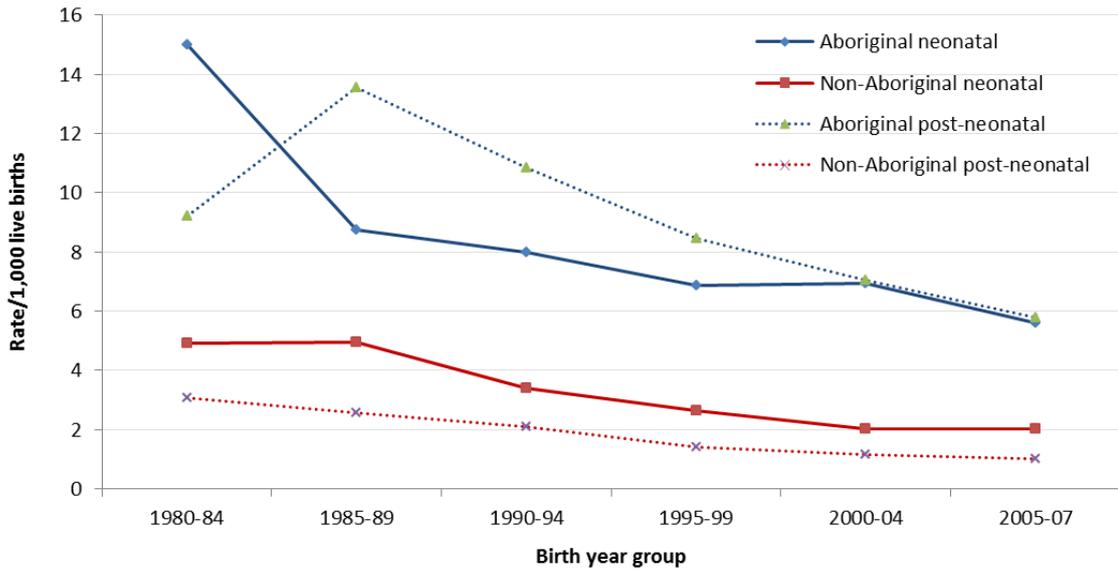
FIGURE 1: INFANT MORTALITY RATES, BY ABORIGINAL STATUS, FOR BIRTHS FROM 1980-84 TO 2005-07, WA



Note: see Table B3 in Appendix B for the source data used in this figure.

Figure 2 presents neonatal and post-neonatal infant mortality rates by Aboriginal status. The figure highlights two primary points: first, that the neonatal and post-neonatal mortality rates for Aboriginal infants continue to be significantly higher than those observed in the non-Aboriginal infant population; second, and in contrast to the non-Aboriginal population, Aboriginal infant deaths have generally been more likely to occur in the post-neonatal than neonatal period. This is a pattern that is usually observed in less developed countries and in Native American populations, and is associated with excess preventable deaths that stem from poverty, disadvantage, marginalisation, and poor health care.<sup>19, 20</sup>

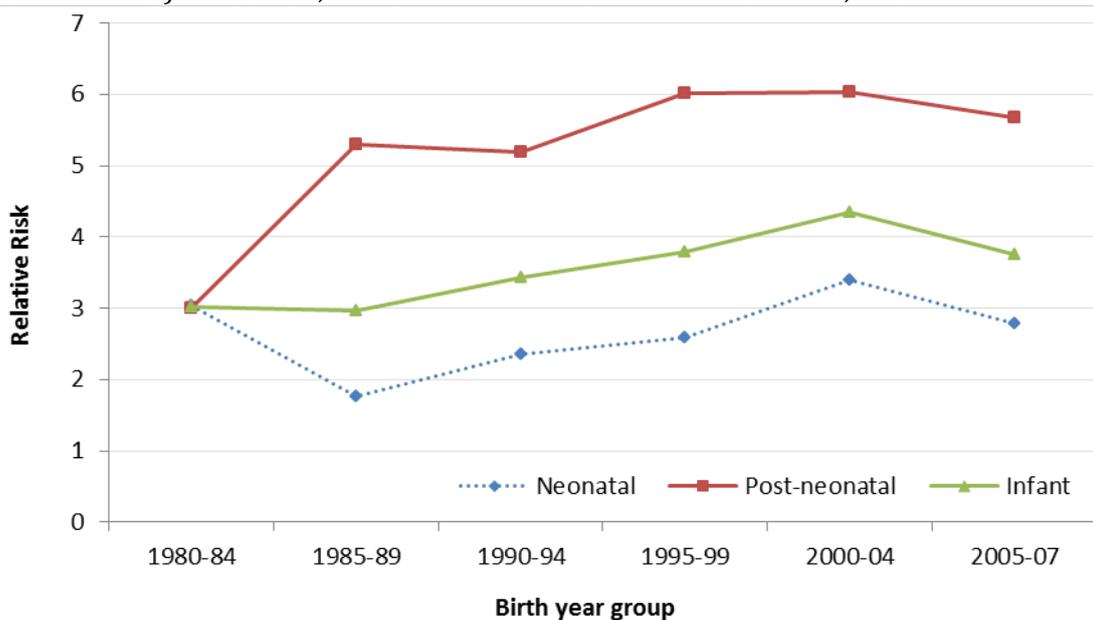
FIGURE 2: NEONATAL AND POST-NEONATAL MORTALITY RATES, BY ABORIGINAL STATUS, FOR BIRTHS FROM 1980-84 TO 2005-07, WA



Note: see Table B4 in Appendix B for the source data used in this figure.

Figure 3 shows the relative risk of death in the first year of life for Aboriginal compared with non-Aboriginal infants. Across all years (1980-2007), the relative risk of death for Aboriginal infants is highest in the post-neonatal period (RR = 4.9; 95% CI: 4.3–5.4) and considerably higher than that recorded among neonates (RR = 2.5; 95% CI: 2.2–2.8). While there have been some fluctuations in the scale of relative risk over time, there was little overall change between the 1980s and mid-2000s among neonates (and infants overall). The relative risk of dying in the post-neonatal period increased from 3.0 (95% CI: 2.3–4.0) in 1980-84 to 5.7 (95% CI: 3.8–8.6) in 2005-07, although most of this increase occurred in the 1980s.

FIGURE 3: RELATIVE RISK OF INFANT DEATH FOR ABORIGINAL (RELATIVE TO NON-ABORIGINAL) CHILDREN, FOR BIRTHS FROM 1980-84 TO 2005-07, WA



### *By gender*

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The rate of infant death (for those born in 2005–2007) was similar among males and females, in both the Aboriginal and non-Aboriginal population. While there was a slightly higher rate among Aboriginal males (12 per 1,000 live births) than females (11 per 1,000 live births), the difference was not statistically significant (RR = 1.1; 95% CI 0.9–1.4). Accordingly, the relative risk of death between Aboriginal and non-Aboriginal infants was marginally higher among males (RR = 4.4; 95% CI: 3.0–6.4) than females (RR = 3.3; 95% CI: 2.2–4.9).

### *By maternal age at birth*

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Mortality rates in Australia are typically highest among infants born to teenage mothers.<sup>21</sup> This was evident among non-Aboriginal births in 2005–07, where the infant mortality rate was 9.1 per 1,000 live births to women aged less than 20 years, declining to 3.3 per 1,000 live births in the 20–29 years group and 2.4 per 1,000 live births in the 30 years and over group. In contrast, the rate of Aboriginal infant mortality in this period did not differ appreciably by maternal age (11–12 per 1,000 live births).

Aboriginal children had an elevated risk of death in infancy (compared with non-Aboriginal children) within every maternal age at birth group. The scale of relative risk increased at older age groups—from 1.3 (95% CI: 0.7–2.4) among births to teenage mothers, to 3.3 (95% CI: 2.3–4.9) among births to mothers aged 20–29 years and 5.1 (95% CI: 3.0–8.9) in the 30 years and over age group. Encouragingly, the infant mortality rate for Aboriginal and non-Aboriginal children born to teenage mothers has decreased in the last few decades (although there was a slight increase between 2000–2004 and 2005–2007) and the relative risks between Aboriginal and non-Aboriginal infants has remained fairly steady (1.4 in 1980–1984, to 2.2 across 1990–1999 and 1.3 in 2005–2007).

### *By gestational age*

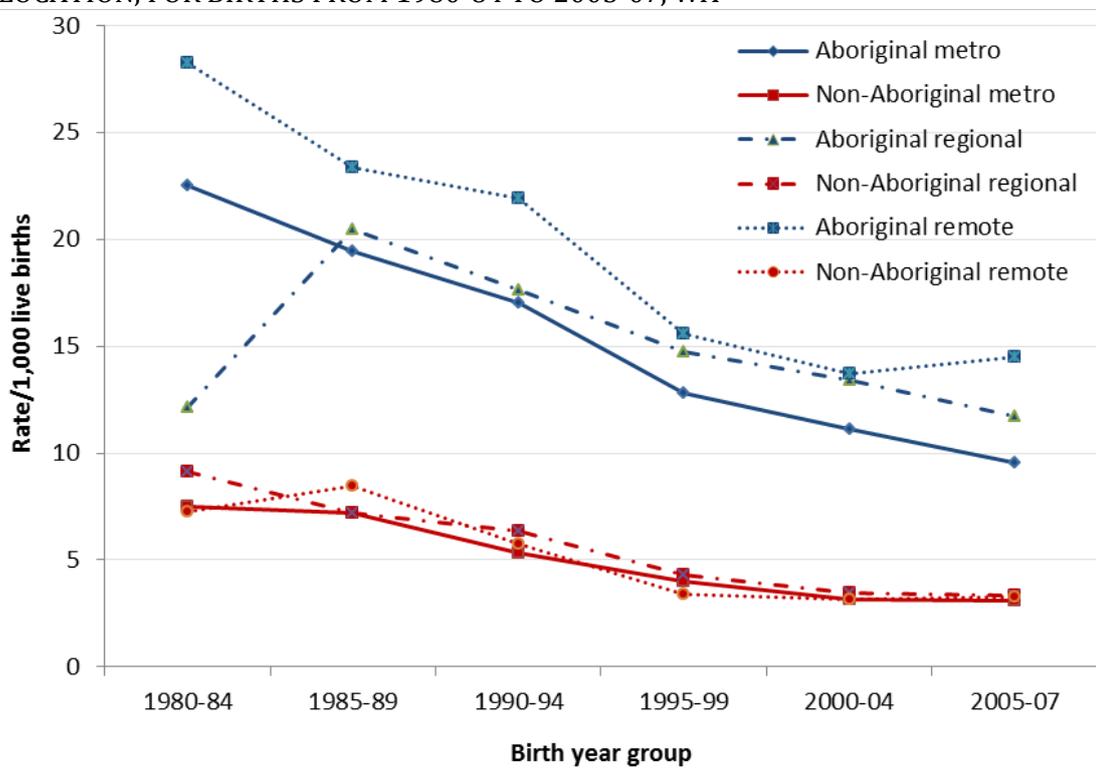
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Babies born preterm are at a substantially increased risk of death in infancy. While 8.7% of births in 2005–07 were preterm (less than 37 weeks gestation), they accounted for the majority (57%) of infant deaths in this cohort. This translates to 23 in every 1,000 preterm babies dying in the first year of life—this compares with a rate of 1.7 per 1,000 for babies born at term.

The infant death rates in the Aboriginal population were higher than rates in the non-Aboriginal population at every gestational age, although it should be noted that the relative risks for Aboriginal infants were higher for those born at term (37–42 weeks; RR = 4.5; 95% CI: 3.0–6.8) than preterm (RR = 1.8; 95% CI: 1.2–2.6). This suggests that risks associated with being born preterm explain only some of the differences in infant mortality between Aboriginal and non-Aboriginal populations.

The rate of infant death did not differ appreciably by geographic location, in either the Aboriginal or non-Aboriginal population in 2005-07. The one exception pertains to Aboriginal children in remote locations, who were at a greater risk of dying in the first year of life (15 per 1,000 live births) than children in regional areas (12 per 1,000 live births) and the Perth metropolitan area (9.6 per 1,000 live births). Accordingly, the relative risk of death for Aboriginal infants was highest in remote locations—where rates were more than four times higher than that of non-Aboriginal infants (RR = 4.4; 95% CI: 2.3-8.8). The relative risks in the Perth metropolitan and regional areas were in the range of 3.1–3.5.

FIGURE 4: INFANT MORTALITY RATES, BY ABORIGINAL STATUS AND GEOGRAPHIC LOCATION, FOR BIRTHS FROM 1980-84 TO 2005-07, WA



Infant mortality rates have decreased progressively over the study period in the Perth metropolitan area and remote locations. While there has been a reduction in the rate over time for non-Aboriginal infants in regional areas ( $\chi^2 = 110.8$ ;  $p < 0.00001$ ), the rate for Aboriginal infants in these areas was not significantly reduced and was prone to fluctuation ( $\chi^2 = 39.5$ ;  $p = 0.058$ ).

## CAUSE-SPECIFIC MORTALITY

The top three causes of infant deaths in the 2005-07 birth cohort were birth defects, prematurity, and SIDS + unascertainable deaths. These collectively accounted for 64% of all infants deaths in this period.

The largest proportion of all non-Aboriginal infant deaths (of those born in 2005-07) was classified as birth defects (26%), followed by prematurity (25%), SIDS + unascertainable (16%) and infections (8%). In contrast, infection (25%) was the leading cause of death among Aboriginal infants, with substantial proportions classified as being caused by prematurity (22%), SIDS + unascertainable (19%), and birth defects (15%).

The data since 1980 have consistently highlighted that the risk of death is higher for Aboriginal than non-Aboriginal infants for *all* main causes of death. The relative risks have tended to be at least twice as high among Aboriginal infants, although they were considerably higher over the study period (1980-2007) for deaths caused by infections (RR = 8.5; 95% CI: 7.2–10.1) and SIDS + unascertainable causes (RR = 5.0; 95% CI: 4.3–5.8) (Figure 5 and Table 4).

FIGURE 5: RELATIVE RISK OF INFANT DEATH FOR ABORIGINAL (RELATIVE TO NON-ABORIGINAL) CHILDREN, FOR BIRTHS FROM 1980-2007, WA

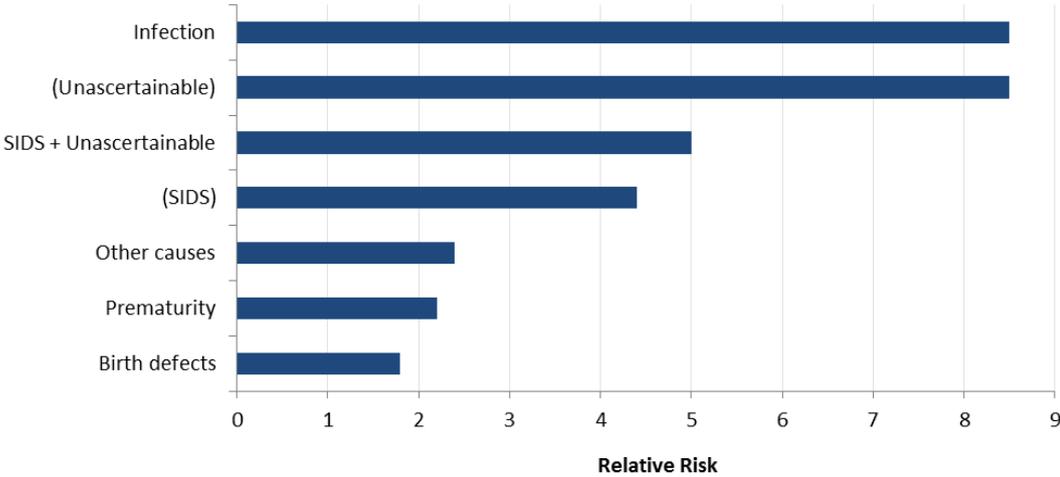


TABLE 4: INFANT MORTALITY STATISTICS, BY SELECTED CAUSE OF DEATH AND ABORIGINAL STATUS, FOR BIRTHS FROM 1980-2007, WA

<i>Cause of death (major categories)</i>	<i>Aboriginal</i>			<i>Non-Aboriginal</i>			<i>TOTAL</i>			<i>Relative Risk (95% CI)</i>
	<i>No.</i>	<i>%</i>	<i>Rate</i>	<i>No</i>	<i>%</i>	<i>Rate</i>	<i>No</i>	<i>%</i>	<i>Rate</i>	
Birth defects	110	14.2	2.5	924	26.9	1.4	1,039	24.6	1.5	1.8 (1.4–2.1)
Prematurity	130	16.8	3.0	885	25.8	1.4	1,029	24.3	1.5	2.2 (1.8–2.6)
SIDS + Unascertainable	231	29.8	5.2	688	20.1	1.1	919	21.7	1.3	5.0 (4.3–5.8)
SIDS	176	22.7	4.0	592	17.3	0.9	768	18.2	1.1	4.4 (3.7–5.2)
Unascertainable	55	7.1	1.2	96	2.8	0.1	151	3.6	0.2	8.5 (6.1–11.8)
Infection	212	27.4	4.8	367	10.7	0.6	579	13.7	0.8	8.5 (7.2–10.1)
Other causes	92	11.9	2.1	566	16.5	0.9	665	15.7	1.0	2.4 (1.9–3.0)

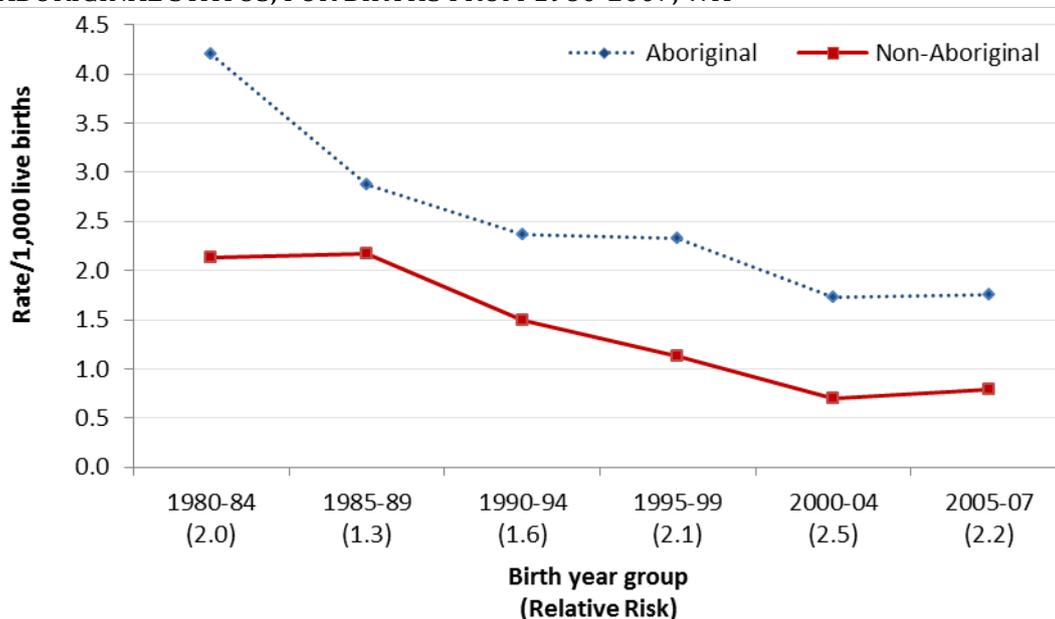
## Birth defects

Birth defects are implicated in a substantial proportion of infant deaths, although are only coded as the major cause of death when identified by the Coroner as the most likely underlying cause. While there has been a progressive decrease in the mortality rate due to birth defects since 1980-84, in both the Aboriginal and non-Aboriginal population, they were the leading cause of death among infants in Western Australia in 2005-07 (0.9 per 1,000 live births).

The data indicate that Aboriginal infants have generally been about twice as likely to die from birth defects as non-Aboriginal infants in Western Australia over the last three decades (Figure 6). These source of this disparity is likely to be multifaceted, and could include differences in antenatal screening for birth defects and the adequacy of clinical services in remote areas (where a higher proportion of Aboriginal women live), the propensity of parents to terminate a pregnancy, and the identification of birth defects.<sup>19</sup>

There was a general decrease over time in the rate of deaths caused by birth defects in all geographic locations, although this was more apparent among non-Aboriginal infants born in remote locations. For Aboriginal infants born in 2005-2007, the mortality rate due to birth defects was higher in rural and remote areas (2.7 and 1.7 per 1,000 live births, respectively) than metropolitan areas (0.5 per 1,000 live births). The rates for non-Aboriginal infants tended to be of a similar magnitude in each area of geographic remoteness (around 0.8 per 1,000 live births).

FIGURE 6: MORTALITY RATE FOR INFANT DEATHS CAUSED BY BIRTH DEFECTS, BY ABORIGINAL STATUS, FOR BIRTHS FROM 1980-2007, WA

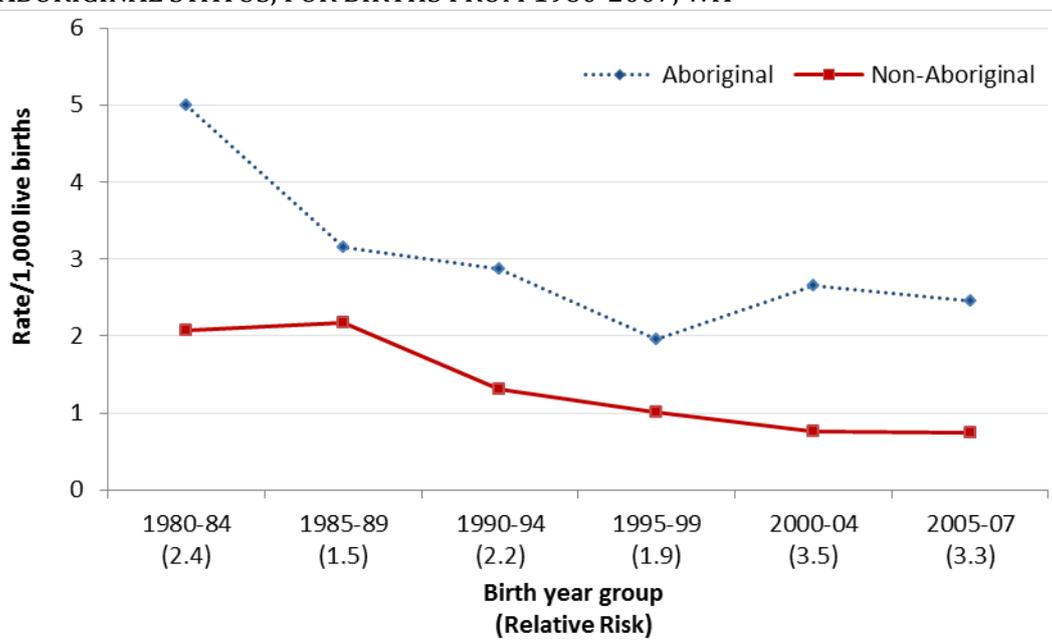


## Prematurity

The rate of infant mortality due to sequelae of prematurity has roughly halved for Aboriginal and non-Aboriginal infants over the course of the study period. While this is an encouraging overall trend, we note that the progress among Aboriginal infants has tapered

off in the last decade, with the rate in 2005-07 (2.5 per 1,000 live births) being marginally higher than in 1995-99 (2.0 per 1,000 live births). Given that the rate among non-Aboriginal infants has continued to decrease in the 2000s (to less than 1 per 1,000 live births), we have observed an increase in the disparity in deaths from prematurity in recent years—so that Aboriginal infants are at more than a 3-fold risk relative to non-Aboriginal infants (Figure 7).

FIGURE 7: MORTALITY RATE FOR INFANT DEATHS CAUSED BY PREMATURETY, BY ABORIGINAL STATUS, FOR BIRTHS FROM 1980-2007, WA



There were some subtle differences in the mortality rate from prematurity in each geographic location, although the disparities were not statistically significant. We note that the rate in 2005–07 was highest in the metropolitan area for both Aboriginal (3.2 per 1,000 live births) and non-Aboriginal infants (0.8 per 1,000 live births).

### *Sudden Infant Death Syndrome (SIDS) and unascertainable causes*

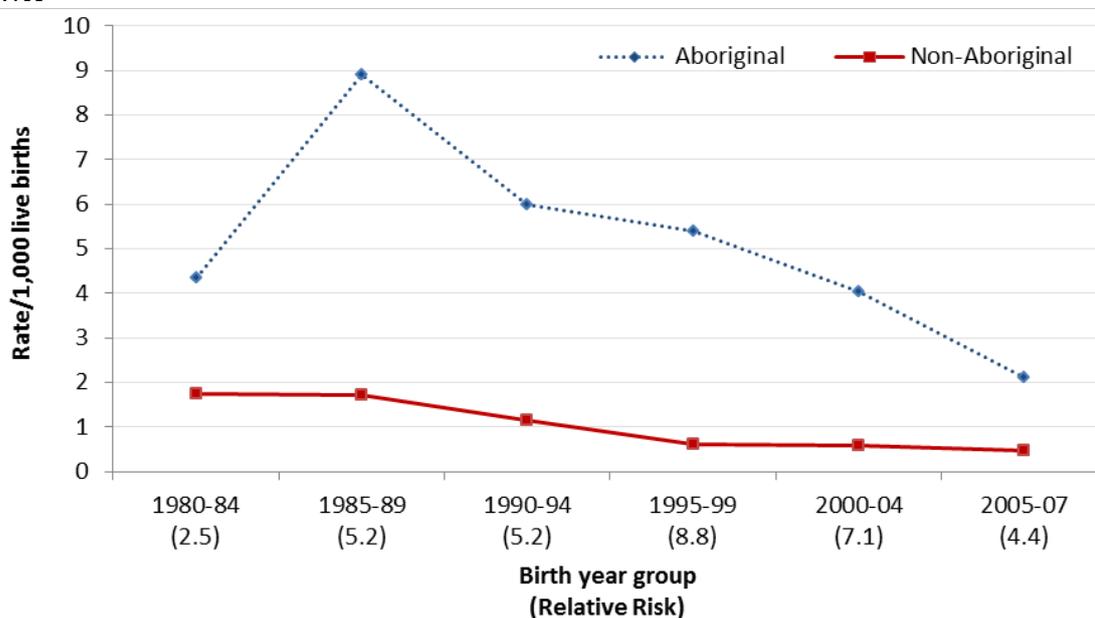
Figure 8 highlights that there have been substantial decreases in the rate of deaths classified as SIDS + unascertainable (see *Cause of death data* in the Methods chapter for more details on this classification). Part of this decrease is likely to be attributed to technical advancements in forensic science—which have enabled more deaths to be coded with a definitive cause. Notwithstanding, the trends since 1980 suggest that major programs aimed at reducing SIDS deaths have been effective. Both the Aboriginal and non-Aboriginal rates dropped significantly in the early 1990s, coinciding with the introduction of a major prevention campaign in Western Australia (and Australia) in 1991. This educational campaign aimed to modify infant care practices, and was particularly focused on letting health professionals and parents know about the risks of maternal smoking, prone sleeping and overheating, and the benefits of breastfeeding.<sup>22</sup>

Importantly, data in the most recent epochs suggest that SIDS + unascertainable deaths have dropped dramatically in the Aboriginal population between 2000-04 and 2005-07—from 4.0 per 1,000 live births to 2.1 per 1,000 live births. The halving of the rate may have

been influenced by the development and introduction of an Aboriginal-specific education and prevention program in 2005: the *Reducing the Risk of SIDS in Aboriginal Communities* program includes culturally appropriate information about how to protect children in the Aboriginal community against the risk of SIDS deaths and sleep accidents.<sup>23</sup>

The mortality rate for SIDS + unascertainable causes among non-Aboriginal children has also decreased in recent years but to a lesser extent, resulting in a narrowing of the gap for these causes of death. The relative risk for Aboriginal infants (compared with non-Aboriginal infants) peaked at 8.8 in 1995-99, and subsequently fell to 7.1 in 2000-04 and 4.4 in 2005-07 (Figure 8).

FIGURE 8: MORTALITY RATE FOR INFANT DEATHS CAUSED BY SIDS + UNASCERTAINABLE CAUSES, BY ABORIGINAL STATUS, FOR BIRTHS FROM 1980-2007, WA

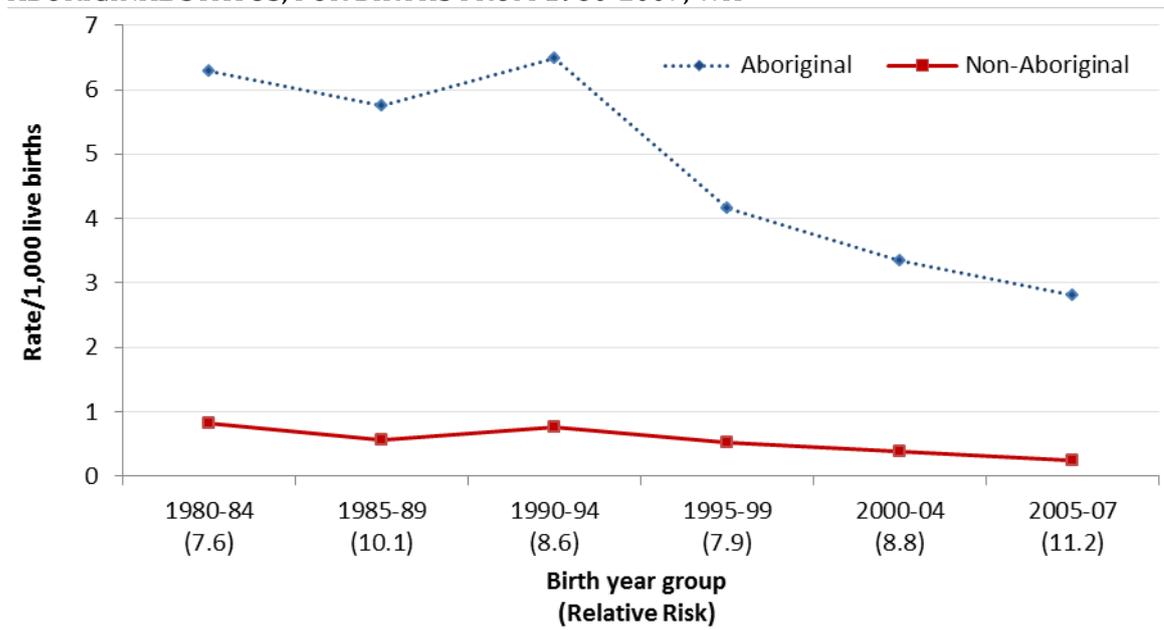


## Infection

Infection remains the leading cause of death among Aboriginal infants in 2005-07 despite the mortality rate for this cause decreasing by two-thirds over the study period. Figure 9 highlights that there has been a corresponding decrease in the non-Aboriginal mortality rate for this cause in this period (from 0.8 to 0.3 per 1,000 live births), resulting in a consistently high (7 to 11-fold) relative risk for death from this cause for Aboriginal infants since 1980.

There was some variability in the rate of infant mortality from infection between areas of geographic location, at least among Aboriginal infants. In 2005-07, the rate for Aboriginal infants was highest in remote areas (4.3 per 1,000 live births) when compared with infants in regional (2.5 per 1,000 live births) and metropolitan settings (1.6 per 1,000 live births). The figures were relatively similar across areas for non-Aboriginal infants (around 0.2 to 0.3 per 1,000 live births).

FIGURE 9: MORTALITY RATE FOR INFANT DEATHS CAUSED BY INFECTION, BY ABORIGINAL STATUS, FOR BIRTHS FROM 1980-2007, WA



### *Maternal smoking during pregnancy*

Smoking during pregnancy remains a significant public health problem despite the increased awareness of the myriad risks to maternal health and the health of the child in-utero and throughout childhood.<sup>24</sup> The most recent data from this study underscore the need for continued, and extensive, efforts to motivate, assist and support women to quit (and abstain from) smoking—particularly when pregnant. Strategies that involve household members and the wider community, and that support a smoke-free home are likely to be effective in reducing smoking in the antenatal period.<sup>25</sup>

This is particularly important in Aboriginal populations, as more than half (51%) of the mothers of Aboriginal children born in 2005–2007 stated that they smoked during their pregnancy. The corresponding proportion for non-Aboriginal children was 14%. Further, maternal smoking was indicated in 59% of Aboriginal infant deaths and 22% of non-Aboriginal infant deaths.

In addition to the greater likelihood of exposure to the ill effects of smoking in pregnancy, Aboriginal children who are exposed are far more likely to die in infancy than exposed non-Aboriginal children. The latest study data indicate that 13 of every 1,000 live Aboriginal births in 2005-7 (where maternal smoking was reported) had died before their first birthday compared with 4.6 per 1,000 live non-Aboriginal births (RR = 2.8; 95% CI: 1.9–4.3). The Aboriginal rate represents a significant reduction from the birth cohort in 2000-2004—from 22 to 13 per 1,000 live births in 2005-07.

## CHILD AND YOUTH DEATHS

This section presents data for those children and young people who were born in Western Australia from 1980-2007 (excluding stillbirths) and died in Western Australia before the end of 2008, with a particular focus on deaths in the most recent epoch (2005-08). We include cases that were at least one year of age at death but less than 25 years.

### ALL-CAUSE MORTALITY

There were 692 child and youth deaths between 2005 and 2008, inclusive, which accounted for 69% of all deaths under the age of 25 years in this period. Aboriginal children are over-represented in the child and youth mortality data—21% of all child and youth deaths in 2005-08 were identified as Aboriginal, whereas Aboriginal people account for only 5-6% of the population under 25 years of age in Western Australia.<sup>26</sup>

The overall mortality rate for persons aged 1-24 years was 2.9 per 10,000 person-years in 2005-08. This rate has remained relatively stable between 2000-2004 and 2005-2008 in the non-Aboriginal population (2.3 and 2.5 per 10,000 person-years, respectively), while the rate in the Aboriginal population increased, from 8.3 to 9.8 per 10,000 person-years over this period. The Aboriginal death rates were 3-4 times higher than those recorded for non-Aboriginal children and youth in the 2000s.

Table 5 provides an overview of child and youth mortality data by selected parameters.

#### *By gender*

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There were more male than female child and youth deaths, with male deaths accounting for 62% of Aboriginal and 71% of non-Aboriginal deaths in the 1-24 years age bracket in 2005-07. The mortality rate of 4.0 per 10,000 person-years for males was more than double the rate for females (1.9). The difference between male and female mortality in this age bracket is largely accounted for by the excess of male youth deaths associated with road traffic accidents and suicides.

The disparity between male and female mortality rates in this age bracket is larger in the non-Aboriginal population (RR = 2.3; 95% CI: 1.9-2.8) when compared with the Aboriginal population (RR = 1.3; 95% CI: 0.7-2.2).

#### *By maternal age at birth*

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The mortality rate was highest among children and youth born to teenage mothers—similar to the pattern for infant deaths—with progressively lower rates in the older maternal age groups. While this pattern was observed in both the Aboriginal and non-Aboriginal population, it was more pronounced in the non-Aboriginal population. As a result, while the Aboriginal mortality rate was higher at every maternal age group, the disparity between Aboriginal and non-Aboriginal rates was highest for children and youth born to mothers aged 30 years and above (RR = 4.5; compared with 2.2 for children born to teenage mothers).

TABLE 5: RECENT CHILD AND YOUTH DEATHS—CHARACTERISTICS BY ABORIGINAL STATUS, 2005-2008, WA

<i>Parameter<sup>a</sup></i>	<i>Aboriginal</i>			<i>Non-Aboriginal</i>			<i>TOTAL deaths</i>			<i>Relative Risk (95% CI)<sup>c</sup></i>
	<i>No.</i>	<i>%</i>	<i>Rate<sup>b</sup></i>	<i>No.</i>	<i>%</i>	<i>Rate<sup>b</sup></i>	<i>No.</i>	<i>%</i>	<i>Rate<sup>b</sup></i>	
Total child and youth deaths	144	100	9.8	548	100.0	2.5	692	100.1	2.9	3.9 (3.3–4.7)
Gender—										
Male	89	61.8	11.9	389	71.0	3.4	478	69.2	4.0	3.5 (2.7–4.3)
Female	55	38.2	7.6	158	28.8	1.5	213	30.8	1.9	5.2 (3.8–7.0)
Location at birth—										
Metropolitan	31	21.5	6.6	335	61.1	2.1	366	53.0	2.2	3.2 (2.2–4.7)
Rural	17	11.8	5.3	94	17.2	2.3	111	16.1	2.5	2.4 (1.4–4.0)
Remote	63	43.8	11.9	28	5.1	2.2	91	13.2	5.0	5.5 (3.5–8.5)
Unknown	33	22.9	—	91	16.6	—	124	17.9	—	
Maternal age (years)—										
Less than 20	44	30.6	10.0	53	9.7	4.5	97	14.0	6.0	2.2 (1.5–3.3)
20-29	80	55.6	8.6	324	59.1	2.4	404	58.5	2.8	3.6 (2.8–4.6)
30 and above	20	13.9	7.7	171	31.2	1.7	191	27.6	1.9	4.5 (2.8–7.2)
Age group (years)—										
1-4	22	15.3	7.9	67	12.2	1.8	89	12.9	2.2	4.5 (2.8–7.2)
5-12	19	13.2	3.7	49	8.9	0.7	68	9.8	0.8	5.6 (3.3–9.5)
13-16	15	10.4	6.0	71	13.0	1.9	86	12.4	2.2	3.2 (1.8–5.6)
17-24	88	61.1	20.6	361	65.9	5.1	449	65.0	6.0	4.0 (3.2–5.1)
Gestational age—										
Preterm	24	16.7	10.8	56	10.2	3.2	80	11.6	4.1	3.4 (2.1–5.5)
Term <sup>d</sup>	117	81.3	8.5	488	89.1	2.2	605	87.6	2.5	3.9 (3.2–4.8)
Cause of death (major categories)—										
Accidents/injuries	105	72.9	7.1	359	65.5	1.6	464	67.1	2.0	4.4 (3.5–5.4)
Cancers	3	2.1	0.2	67	12.2	0.3	70	10.1	0.3	0.7 (0.2–2.1)
Infection	11	7.6	0.7	28	5.1	0.1	39	5.6	0.2	5.9 (2.9–11.8)
Birth defects	5	3.5	0.3	25	4.6	0.1	30	4.3	0.1	3.0 (1.1–7.8)
Unknown/unascertainable	5	3.5	0.3	9	1.6	0.0	14	2.0	0.1	8.3 (2.8–24.8)
Other <sup>e</sup>	15	10.4	1.0	60	10.9	0.3	74	10.7	0.3	3.7 (2.1–6.6)

a. Missing values are generally excluded from the table, with the exception of cases with an unknown location at birth.

b. Per 10,000 person-years.

c. Risk of death for Aboriginal children/youth relative to non-Aboriginal children/youth.

d. Excludes children with a gestational age of 43 weeks or more.

e. Includes all remaining causes not classified into major categories 1–7 or code 990 (unknown and unascertainable).

### *By gestational age*

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About one in six (17%) Aboriginal persons that died aged 1-24 years in 2005–08 were born preterm (less than 37 weeks gestation). This compares with 10% of non-Aboriginal deaths of this age. The death rates for children and youth suggest that the complications of prematurity continue to be a risk factor beyond infancy. The death rate for those born preterm (4.1 per 10,000 person-years) was higher than the rate for those born term (2.5), with a similar effect observed in the Aboriginal and non-Aboriginal populations.

### *By geographic location*

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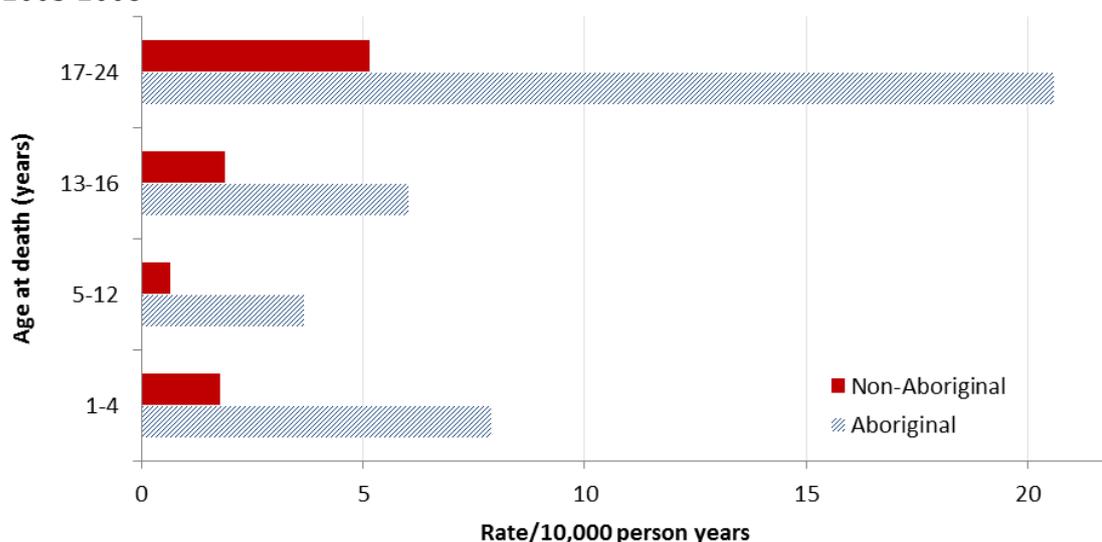
Overall, the child and youth mortality rate increased with the geographical remoteness of the person's residence at birth. In 2005–2008, the rate was 2.2 per 10,000 person-years for children and youth in metropolitan Perth, 2.5 in regional areas, and 5.0 in remote locations. This trend appeared to be driven by the profile of deaths in the Aboriginal population, which features an elevated mortality rate in remote locations (12 per 10,000 person-years). In contrast, the rate of death in childhood and young adulthood among non-Aboriginal people was similar in metropolitan, regional and remote areas (2.1 to 2.3 per 10,000 person-years).

## AGE-SPECIFIC MORTALITY

After infancy, death rates decline sharply through childhood. The under-five mortality rate in 2005–08 was 2.2 per 10,000 person-years, with a lower rate (0.8) recorded in the 5-12 years age group. These age groups typically have the lowest age-specific death rates in Australia.<sup>27</sup> Death rates begin to rise in older age groups, to 2.2 per 10,000 person-years among 13-16 year-olds and then further, to 6.0 among young people aged 17-24 years. This pattern is seen in both Aboriginal and non-Aboriginal populations, although the rates are of a greater magnitude in the Aboriginal population in all groups—and are in excess of 20 among Aboriginal youth aged 17-24 years (Figure 10).

Data from the Australian Bureau of Statistics (ABS) confirm that mortality rates have decreased in all age groups over time (infants, children, youth and adults), although the largest changes have been observed among children and youth age groups.<sup>27</sup>

FIGURE 10: AGE-SPECIFIC CHILDHOOD MORTALITY RATES, BY ABORIGINAL STATUS, 2005-2008



## CAUSE-SPECIFIC MORTALITY

The leading cause of death among children and youth in Western Australia in 2005-08 was the category of Accidents and injuries, which includes road traffic accidents, drowning, poisoning, suicides, homicide, asphyxia, drug overdose and other accidents and traumas. Deaths from this cause accounted for the majority (464 deaths or 67%) of all deaths in the 1-24 years age bracket. Cancers was the second leading cause of child and youth death (10%) in 2005-08, followed by infection (5.6%) (Table 6).

Accidents and injuries was the leading cause of death in both the Aboriginal (73%) and non-Aboriginal (66%) populations. Infection was the cause of a slightly greater proportion of Aboriginal (7.6%) than non-Aboriginal (5.1%) child and youth deaths, which is consistent with the findings on the causes of infant deaths. Cancers was the second leading cause in the non-Aboriginal population (12% of all non-Aboriginal child and youth deaths) but ranked third among Aboriginal deaths aged 1-24 years (2.1%).

TABLE 6: LEADING CAUSES OF CHILD AND YOUTH DEATHS, BY ABORIGINAL STATUS, 2005-2008, WA

<i>Cause of death</i>	<i>Aboriginal (%)</i>	<i>Non-Aboriginal (%)</i>	<i>Total (%)</i>
Accidents/injuries	72.9	65.5	67.1
Cancers	2.1	12.2	10.1
Infection	7.6	5.1	5.6
Birth defects	3.5	4.6	4.3
Unknown/unascertainable	3.5	1.6	2.0
Other <sup>a</sup>	10.4	10.9	10.7
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>

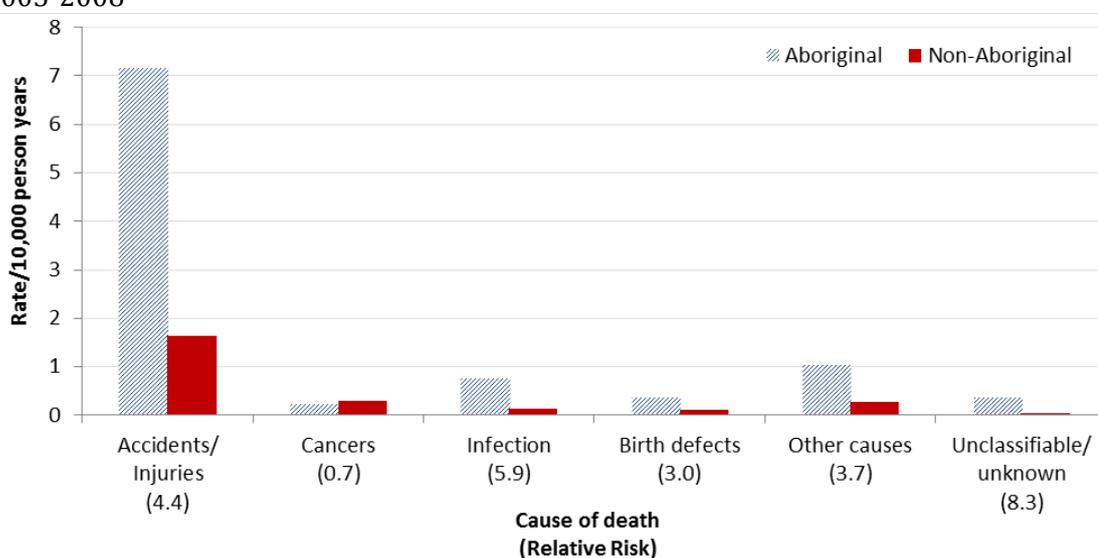
a. Includes all remaining causes not classified into major categories 1-7 or code 990 (unknown and unascertainable)

The rate of child and youth death was higher in the Aboriginal than non-Aboriginal population for all main causes, with the exception of Cancers. The largest disparity (in absolute terms) was evident in accident and injury deaths, which were reported at a rate

of 7.1 per 10,000 Aboriginal person-years and 1.6 per 10,000 non-Aboriginal person-years—this equates to a relative risk of 4.4. The mortality rates for all of the other leading causes were below 1 per 10,000 person-years in both populations. As a result, while the relative risks for Aboriginal children and youths are high for most other main causes, the absolute disparities are small in size (Figure 11).

A range of causes have been classified in this section as ‘Other’ causes of death, including cases awaiting a coronial finding. Neurological conditions were commonly recorded in this category, including the sequelae of *status epilepticus* and aspiration pneumonia—in both Aboriginal and non-Aboriginal populations. Diabetes-related deaths and deaths due to asthma were also included under this category although the numbers were relatively small.

FIGURE 11: CHILD MORTALITY RATES, BY CAUSE OF DEATH AND ABORIGINAL STATUS, 2005-2008



### Accidents and injuries

Accidents and injuries have been the leading cause of child and youth deaths over the course of the study period. Table 7 highlights that the rate of accident and injury deaths in 2005-08 was highest among youth aged 17-24 years, in both the Aboriginal (16 per 10,000 person-years) and non-Aboriginal populations (4.0). While there were fewer deaths from accidents and injuries in the younger age groups, the relative risk of dying from this cause was higher among those under-five (RR = 6.4) and 5-12 years (RR = 12.1).

TABLE 7: ACCIDENT AND INJURY MORTALITY RATES, BY ABORIGINAL STATUS, 2005-2008

Age group (years)	Rate per 10,000 person-years		Relative Risk
	Aboriginal	Non-Aboriginal	
1-4	5.0	0.8	6.4
5-12	1.9	0.2	12.1
13-16	5.2	1.0	5.0
17-24	15.9	4.0	4.0

The majority of accident and injury fatalities in the 1-24 years age bracket in 2005-08 were male—62% of Aboriginal and 71% of non-Aboriginal child and youth deaths. Among Aboriginal deaths, 57% were born in remote areas, 28% in the metropolitan area and 15% in regional areas. This represents a disproportionate number of Aboriginal deaths from this cause in remote areas, given that the highest proportion of Aboriginal children and youth reside in metropolitan Perth.<sup>28</sup> In contrast, close to three-quarters of non-Aboriginal accident and injury deaths of this age were born in metropolitan areas (73%), followed by regional areas (21%) and then remote areas (6.1%).

TABLE 8: ACCIDENT AND INJURY RELATED DEATHS—SPECIFIC CAUSES, BY ABORIGINAL STATUS, 2005-2008, WA

<i>Cause</i>	<i>Aboriginal (%)</i>	<i>Non-Aboriginal (%)</i>
Road traffic accidents	32	47
Suicide	41	28
Drug overdose	2	6
Drowning	3	6
Homicide	7	3
Suffocation/asphyxiation <sup>a</sup>	5	3
Other	10	7
<b>All deaths from accidents and injuries</b>	<b>100</b>	<b>100</b>

a. Includes inhalation/ingestion due to respiratory obstruction, industrial accident, accidental hanging, and mechanical asphyxiation. Does not include suffocation/asphyxiation from fire or non-accidental injury.

In 2005-08, accident and injury deaths involving children and youth were most commonly attributed to suicide in the Aboriginal population (41%) and to road traffic accidents in the non-Aboriginal population (47%). While the relative proportions attributed to these two specific causes are different in each of these population groups, they collectively account for about three-quarters of all accident and injury deaths in each population. Drug overdose, Drowning, Homicide and Suffocation/asphyxiation were also reported as leading specific causes of accident and injury related deaths (Table 8).

### *Suicide deaths*

The majority of child and youth suicides (73% of all suicide deaths) reported in 2005-08 involved hanging. Most of the remainder was the result of one of four methods: carbon monoxide poisoning (7%), gunshot (4%), suffocation (4%) and jumping from height (3%). Other methods each contributed only a small number of suicide deaths during the period.

Hanging accounted for the greatest proportion of suicide deaths for both populations (88% of Aboriginal and 67% of non-Aboriginal suicide deaths), although there was a greater variety of other methods in the non-Aboriginal population. Some of these other methods were not reported in Aboriginal populations, including carbon monoxide poisoning (10% of non-Aboriginal suicide deaths), suffocation (6%) and jumping from height (4%).

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## APPENDIX A: FULL CAUSE OF DEATH CLASSIFICATION

TABLE A1: MORTALITY CLASSIFICATION FOR STILLBIRTHS, NEONATAL, INFANT AND CHILDHOOD DEATHS (OF BIRTHS OF 400 GRAMS OR MORE), EXCLUDING ELECTIVE TERMINATIONS OF ANY GESTATION OR WEIGHT

<b>0</b>		<b>Normally formed fetuses (without recognised sufficient cause of death)</b>
	00	Without significant underlying antepartum condition recognised <i>With following underlying conditions: (see also 810-880)</i>
	10	Rhesus iso-immunisation
	20	Severe pre-eclampsia, eclampsia
	30	Maternal essential hypertension
	40	Maternal diabetes
	50	Maternal lupus related
	60	Uncomplicated multiple pregnancy (TTT - coded 830)
	70	Maternal epilepsy
	80	Maternal infections without evidence of fetal infection (e.g. giving rise to VPT birth)
	90	Other or multiple: e.g. severe maternal anaemia (203509)
<b>1</b>		<b>Intrapartum causes</b>
	110	Intrapartum fetal distress greater than 25 weeks without recorded sentinel event: includes cord complications NOS, meconium aspiration, malpresentations. (=unexplained cause first apparent in labour)
	120	Prematurity (death due to labour of normally formed, non-infected fetus less than 26 weeks)
	130	Intrapartum asphyxia with sentinel event (ruptured uterus N=8, 2h tonic spasm (N=1), amniotic fluid embolism (2)), true cord knot (2), traumatic exsanguination (88195), cord tightly around neck (346008), vasa praevia (336254), abruption
	131	Intrapartum asphyxia without sentinel event
	140	Obstructed labour, specified (not inferred from presentation or BW), birth trauma
	150	Cord prolapse in birth greater than 32 weeks
	160	Intrapartum complications of multiple delivery
	190	Unattended labour
<b>2</b>		<b>Significant Birth Defect(s)</b>
	200	Significant birth defect(s)
	250	Birth defects insufficient to cause death (previously coded 00 - unexplained but not normally formed)
<b>3</b>		<b>Prematurity</b>
	300	Frank immaturity of organ systems (does not apply to stillbirths, see 120) <i>includes sequelae of prematurity</i>
	310	Death from immaturity (less than 28 weeks) following delivery secondary to Ante Partum Haemorrhage
<b>4</b>		<b>Infection</b>
		<i>2<sup>nd</sup> digit denotes site</i>
	0	unknown

	1		chorioamnionitis (+/- funisitis)
	2		respiratory
	3		blood (septicaemia) and /or multiple sites
	4		brain
	5		peritonitis
	6		gastroenteritis
	7		myocarditis
	8		liver
	9		Other, eg. renal, skeletal, tissue
			<i>3<sup>rd</sup> digit denotes infectious agent</i>
	0		unknown
	1		Group B strep.
	2		Bacterial without a specified code (i.e. not GBS or Listeria)
	3		Toxoplasmosis
	4		Syphilis
	5		viral
	6		Listeria
	7		both bacterial and viral
	8		AIDS / Rubella (not congenital Rubella syndrome)
	9		other specified agent (other than virus or bacterial)
<b>5</b>			<b>Accidents and trauma (other than birth trauma (100-190))</b>
	510		Road traffic accidents (including antenatal accidents)
		511	Motor vehicle
		512	Motorcycle/pedal bike/trail bike/go cart
		513	Pedestrian
		514	Antenatal accidents
		515	Exited from vehicle not involved in crash (e.g. fell from vehicle)
		516	Boat accident - not drowned
	520		Drowning - place not stated
		521	pool
		522	Dam/water tank/drain/fishpond/lake/waterhole
		523	Sea/river
		525	Bathtub/bucket/ shower recess
	530		Poisoning
	540		Fire
	550		Non-accidental injury
		551	Homicide
		552	Suicide
	560		Suffocation/asphyxiation not covering in 550 or 540. Includes inhalation/ingestion due to respiratory obstruction; industrial accident; accidental hanging; mechanical asphyxiation
		561	Positional asphyxia
		562	Overlaying
	570		Peri-operative accident/following clinical surgical intervention
	580		Electrocution
	590		Accident/trauma NOS; could include NAI where this is questionable, (including antenatal), includes dehydration/exposure (accidental), including potential manslaughter; scalding; animal attack; plane/helicopter crash
		591	Drug overdose

		592	Train runover, slipped
<b>6</b>			<b>Cancers</b>
	600		Cancers
		612	leukaemia
<b>7</b>			<b>SIDS</b>
	700		SIDS
	790		Unconfirmed SIDS
<b>8</b>			<b>Other specific conditions</b>
	810		Major APH (before onset of labour) resulting in death before, during or after labour
	820		Acute feto-maternal haemorrhage (will be under-ascertained – also in 000)
	830		Lethal complications of twinning not covered elsewhere, e.g. twin-twin transfusion. (Delivery complications = 160; no recognised complication = 060)
	840		Neurological condition, 1y factor: e.g. Status epilepticus, impaired gag reflex not known to be due to classifiable cause, CP (DD to aspiration pneumonia), febrile convulsion
	850		Hydrops due to Rhesus iso-immunisation or specific congenital anomaly
	860		Recognised cause of asphyxia or trauma before onset of labour (under-estimated)
	870		Asthma
	880		Specific conditions originating <u>before</u> 28 days of life, e.g. hydrops of unknown aetiology and diseases of immaturity PPROM (preterm, prelabour rupture of membranes) and sequelae
	890		Specific conditions originating not specified above originating <u>after</u> 28 days of life, including consequences of chronic drug use
		891	Diabetes related
<b>9</b>			<b>Unknown, not classifiable above</b>
	910		Cause(s) not classifiable above
	990		Cause unknown/unascertainable
	991		No coroner's report (searched)
	992		Final diagnosis unknown
	993		Awaiting Coronial outcome

## APPENDIX B: SUPPLEMENTARY TABLES

TABLE B1: NUMBER AND PROPORTION OF LIVE BIRTHS, BY ABORIGINAL STATUS AND YEAR GROUP, FOR BIRTHS FROM 1980-2007, WA

<i>Birth year group</i>	<i>Aboriginal</i>		<i>Non-Aboriginal</i>		<i>TOTAL<sup>a</sup></i>
	<i>Number</i>	<i>%</i>	<i>Number</i>	<i>%</i>	
1980	1,141	5.5	19,494	94.5	20,635
1981	1,266	5.7	20,773	94.3	22,039
1982	1,213	5.5	20,983	94.5	22,196
1983	1,261	5.5	21,613	94.5	22,874
1984	1,314	5.8	21,478	94.2	22,792
<i>Total 1980-84</i>	<i>6,195</i>	<i>5.6</i>	<i>104,341</i>	<i>94.4</i>	<i>110,536</i>
1985	1,330	5.7	21,820	94.3	23,150
1986	1,360	5.7	22,338	94.3	23,698
1987	1,470	6.1	22,542	93.9	24,012
1988	1,586	6.3	23,393	93.7	24,979
1989	1,558	6.1	23,799	93.9	25,357
<i>Total 1985-89</i>	<i>7,304</i>	<i>6.0</i>	<i>113,892</i>	<i>94.0</i>	<i>121,196</i>
1990	1,690	6.5	24,148	93.5	25,838
1991	1,615	6.5	23,197	93.5	24,812
1992	1,573	6.3	23,581	93.7	25,154
1993	1,571	6.2	23,588	93.8	25,159
1994	1,570	6.2	23,666	93.8	25,236
<i>Total 1990-94</i>	<i>8,019</i>	<i>6.4</i>	<i>118,180</i>	<i>93.6</i>	<i>126,199</i>
1995	1,573	6.2	23,680	93.8	25,253
1996	1,546	6.1	23,836	93.9	25,382
1997	1,657	6.6	23,437	93.4	25,094
1998	1,623	6.4	23,889	93.6	25,512
1999	1,751	6.8	23,835	93.2	25,586
<i>Total 1995-99</i>	<i>8,150</i>	<i>6.4</i>	<i>118,677</i>	<i>93.6</i>	<i>126,827</i>
2000	1,723	6.9	23,294	93.1	25,017
2001	1,762	7.1	23,008	92.9	24,770
2002	1,781	7.2	22,827	92.8	24,608
2003	1,683	6.9	22,808	93.1	24,491
2004	1,709	6.7	23,628	93.3	25,337
<i>Total 2000-04</i>	<i>8,658</i>	<i>7.0</i>	<i>115,565</i>	<i>93.0</i>	<i>124,223</i>
2005	1,836	6.9	24,941	93.1	26,777
2006	1,923	6.8	26,532	93.2	28,455
2007	1,935	6.5	27,948	93.5	29,883
<i>Total 2005-07</i>	<i>5,694</i>	<i>6.7</i>	<i>79,421</i>	<i>93.3</i>	<i>85,115</i>
<b>Total births</b>	<b>44,020</b>	<b>6.3</b>	<b>650,076</b>	<b>93.7</b>	<b>694,096</b>

a. Includes births where Aboriginal status was not known or not stated.

TABLE B2: BIRTH STATISTICS, BY SELECTED CHARACTERISTICS AND ABORIGINAL STATUS, FOR BIRTHS FROM 1980-2007, WA

<i>Parameter<sup>a</sup></i>	<i>Aboriginal</i>				<i>Non-Aboriginal</i>				<i>All births<sup>b</sup></i>	
	<i>1980-2004</i>		<i>2005-2008</i>		<i>1980-2004</i>		<i>2005-2008</i>		<i>1980-2007</i>	
	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>
Total live births	38,326	100	5,694	100	570,655	100	79,421	100	694,096	100
Sex—										
Male	19,551	51	2,942	52	293,240	51	40,444	51	356,177	51
Female	18,775	49	2,752	48	277,415	49	38,975	49	337,917	49
Marital Status—										
Currently single	14,073	37	1,718	29	49,005	9	5,833	7	70,629	10
Married/defacto	24,072	63	3,906	66	521,218	91	73,399	92	622,595	90
Maternal age—										
Less than 20	10,554	28	1,335	23	27,802	5	3,178	4	42,869	6
20-29	21,905	57	3,144	55	318,683	56	33,082	42	376,814	54
30 and above	5,867	15	1,215	21	224,154	39	43,161	54	274,397	40
Residence at birth—										
Metropolitan	10,778	28	1,884	33	377,375	66	54,091	68	444,128	64
Rural	7,402	19	1,195	21	96,198	17	14,864	19	119,659	17
Remote	12,545	33	1,859	33	30,235	5	3,648	5	48,287	7
Unknown	7,601	20	756	13	66,847	12	6,818	9	82,022	12
Gestational Age—										
Preterm	5,430	14	879	15	41,672	8	6,527	8	54,508	8
Term	32,553	85	4,814	85	527,034	92	72,889	92	637,290	92
Plurality—										
Singleton	37,548	98	5,542	97	555,092	97	77,039	97	675,221	97
Multiple	778	2	152	3	15,563	3	2,382	3	18,875	3
Parity (previous live births)—										
0	11,459	30	1,774	31	231,997	41	34,123	43	279,353	40
1-2	16,242	42	2,297	40	289,407	51	38,910	49	346,856	50
3-4	7,548	20	1,060	19	42,284	7	5,375	7	56,267	8
≥5	2,999	8	563	10	5,324	1	1,013	1	9,899	1
Birth weight (grams)—										
Less than 2,500	4,685	12	852	15	31,989	6	4,621	6	42,147	6
2,500 or more	33,639	88	4,842	85	538,659	94	74,800	94	651,940	94

Smoking (>1988)—										
Yes	6,124	49	2,915	51	31,486	18	11,476	14	52,001	19
No	6,373	51	2,779	49	138,800	82	67,945	86	215,897	81

- a. Missing values are generally excluded from the table, with the exception of cases with an unknown location at birth.
- b. Includes births where Aboriginal status was not known or not stated.

TABLE B3: INFANT MORTALITY RATES (BY ABORIGINAL STATUS) AND RELATIVE RISK OF DEATH, FOR BIRTHS FROM 1980-2007, WA

<i>Birth year group</i>	<i>Rate per 1,000 live births</i>		<i>Relative risk<sup>a</sup></i>
	<i>Aboriginal</i>	<i>Non-Aboriginal</i>	
1980-84	24.2	8.0	3.0
1985-89	22.3	7.5	3.0
1990-94	18.8	5.5	3.4
1995-99	15.3	4.1	3.8
2000-04	14.0	3.2	4.4
2005-07	11.4	3.0	3.8

a. Relative risk of death (between Aboriginal and non-Aboriginal infants).

TABLE B4: NEONATAL AND POST-NEONATAL MORTALITY RATES, BY ABORIGINAL STATUS, FOR BIRTHS FROM 1980-2007

<i>Birth year group</i>	<i>Aboriginal</i>		<i>Non-Aboriginal</i>		<i>Total</i>	
	<i>Neonatal<sup>a</sup></i>	<i>Post-neonatal<sup>b</sup></i>	<i>Neonatal<sup>a</sup></i>	<i>Post-neonatal<sup>b</sup></i>	<i>Neonatal<sup>a</sup></i>	<i>Post-neonatal<sup>b</sup></i>
1980-84	15.0	12.9	4.9	3.7	5.5	4.2
1985-89	8.8	15.3	5.0	3.2	5.2	3.9
1990-94	8.0	12.8	3.4	2.6	3.7	3.2
1995-99	6.7	9.7	2.7	1.9	2.9	2.4
2000-04	6.7	8.4	2.0	1.5	2.3	2.0
2005-07	5.6	6.7	2.0	1.4	2.2	1.7

a. Per 1,000 live births.

b. Per 1,000 neonatal survivors.

## APPENDIX C: GLOSSARY

<i>Term</i>	<i>Study definition</i>
Aboriginal	The term 'Aboriginal' is used throughout this thesis to refer to the original inhabitants of the Australian continent—Aboriginal and Torres Strait Islander peoples. The term is used for the purpose of brevity and in preference to 'Indigenous'.
Birth Defect	Any defect probably of prenatal origin. The cause of death was classified as 'birth defect' if it was described on the death certificate and was the underlying and sufficient cause of death. In cases where the death was due to another cause and a birth defect was described on the death description, the death was coded as the underlying cause and the presence of a birth defect noted in a co-joining field
Indigenous	An Aboriginal and/or Torres Strait Islander person
Infant death	The death of a liveborn infant within the first year of life. Includes neonatal and post-neonatal deaths.
Live birth	The complete expulsion or extraction from its mother of a product of conception after 20 weeks gestation or 400 grams birthweight which after separation shows signs of life
Neonatal death	The death of a liveborn infant that occurred within the first 28 days of life
Non-Aboriginal	Includes all persons other than those who have been identified as an Aboriginal and/or Torres Strait Islander
Perinatal death	A stillborn or neonatal death
Person-years	Used as the denominator for the calculation of child and youth mortality rates. Person-years (or person-time) refers to the amount of time 'at-risk' of a particular study outcome—in this case, death—and enables us to calculate the incidence of that outcome over a period for a given population group
Post-neonatal death	The death of a liveborn infant after 28 days of life (and up to one year)
Prematurity	A birth where the gestation is less than 37 completed weeks
Relative risk	In the context of this report, relative risk refers to the increased or decreased likelihood of death in one population group (usually the Aboriginal population) relative to another population (usually the non-Aboriginal population)
SIDS	The sudden death of an infant under the age of one which remains unexplained after the performance of a complete post-mortem examination, including autopsy and a review of the case history
Stillbirth	The complete expulsion or extraction from its mother of a product of conception of at least 20 weeks gestation or 400 grams birthweight, after which separation does not show any signs of life

## APPENDIX D: ABBREVIATIONS

<i>Abbreviation</i>	<i>Meaning</i>
Aboriginal	Aboriginal and Torres Strait Islander
ABS	Australian Bureau of Statistics
ACPDCCYP	Advisory Council on the Prevention of Deaths of Children and Young People
CI	Confidence Interval (95%)
CMD	Child Mortality Database
CMR	Cumulative mortality rate
DoH DLB	Data Linkage Branch at the WA Department of Health
DoH WA	Western Australian Department of Health
e.g.	for example
HMDS	Hospital Morbidity Data System
ICD9	International Classification of Diseases, Version 9
ICD10	International Classification of Diseases, Version 10
i.e.	that is
MNF	Midwives' Notification Form
MNS	Midwives' Notification System
MOU	Memorandum of Understanding
MVAs	Motor vehicle accidents
N	Number of cases in each category or sub-category thereof
PSANZ	Perinatal Society of Australia and New Zealand
RBDM	Registry of Births, Deaths and Marriages
RG	Registrar-General
RR	Relative risk
SIDS	Sudden Infant Death Syndrome
TICHR	Telethon Institute for Child Health Research
WA	Western Australia
WADLS	WA Data Linkage System
WAAHEC	Western Australian Aboriginal Health Ethics Committee