Government of **Western Australia**
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The 16th Report of the Perinatal and Infant Mortality Committee of Western Australia, for births between 2014 and 2018

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The 16th Report of the Perinatal and Infant Mortality Committee of Western Australia, 2014–2018

Public and Aboriginal Health Division
Department of Health, Western Australia

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This Report would not have been possible without the assistance of Ms Maureen Hutchinson and Mr Alan Joyce. We would like to also acknowledge the contributions of the past members and investigators of the Perinatal and Infant Mortality Committee of Western Australia - Professor Karen Edmond, Dr Christopher Gunnell, Dr Ronald Hagan, Dr Keith Meadows, Dr Chhaya Mehrotra, Dr Patrick Pemberton, Dr Ian Taylor and Dr Andrew Wawryk.

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Acknowledgement of Country

WA Health acknowledges the Aboriginal people of the many traditional lands and language groups of Western Australia. It acknowledges the wisdom of Aboriginal Elders both past and present and pays respect to Aboriginal communities of today.

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Foreword

Chairman's Report

It is with pleasure that I submit, on behalf of the Committee, the 16th Report of the Perinatal and Infant Mortality Committee of Western Australia.

The Committee was re-established in October 2001 and this is its sixth Report. Previous Reports have covered triennial periods, but this Report is for the five-year period 2014 to 2018 inclusive. The period includes 174,050 births from which there were 1,164 stillbirths, 290 neonatal deaths and 158 post-neonatal deaths. When considered with data from the Committee's five previous Reports, there has been detailed investigation of 2,897 cases.

The primary purpose of the Committee is educational. Cases requiring investigation are identified by the Chief Health Officer and include stillbirths and infant deaths of at least 23 weeks gestation. These cases are then investigated in detail by one of the Committee's Investigators and the case presented to the Committee members in a de-identified format. De-identification includes removal of the names of the patient, the doctor(s) and the hospital. Each case is then classified using the system developed and recommended by the Perinatal Society of Australia and New Zealand (PSANZ). Medical preventability is also classified. There is then correspondence to all medical practitioners involved in each case informing them of the outcome of the Committee's deliberations. The contents of those communications are entirely confidential and cannot be released to any other person for any purpose.

The two decades experience of the Committee provides a valuable opportunity to reflect on the various aspects of perinatal care in Western Australia that have improved and those aspects which have been stubbornly resistant to change.

Overall, we have much to be proud of, and much to celebrate. The standard of health care in this field in Western Australia would rank as one of the highest in the world. Positive attitudes of members of our general community also provide reassurance that such high standards are well recognised. Such excellence, however, can never be taken for granted and the high standards set by the Perinatal, and Infant Mortality Committee are vital to our continuing quest for excellence, across the entire breadth of our State and its health care community.

One prominent aspect of good news has been improvements in newborn survival, in particular, after preterm birth, and largely the result of advances in neonatal care. Such improvements have not been matched by reductions in stillbirth rates that have plateaued over the last two decades. We are not alone. Similar unchanged rates of stillbirth are being observed across other jurisdictions in Australia and similar nations. Innovative research in this field is needed, and should be supported.

The two decades of review has also shown ongoing high rates of perinatal loss in Aboriginal people, both in the prenatal period and infancy. Some preventable aspects are medical, but much relates to the social determinants of health. It is hoped the data provided by the Committee can play a valuable role in helping our general community to rise to the challenge of overcoming the health inequalities in our First Nations people.

Preterm birth remains one of the major causes of death in young children. Across Australia, rates have been rising. The Committee has typically not focused on births at the very early gestational ages, although it is now becoming evident that much perinatal loss occurs at these

times. Additional resources may be required if the Committee seeks to extend its inquiries into these earlier age groups.

Another field requiring further attention is multiple pregnancy. Rates of multiple pregnancy are rising and bring new challenges in terms of higher rates of perinatal loss and preterm birth. Monochorionic twins, in particular, require specialised care and close monitoring. Recommendations for the contemporary management of multiple pregnancy can be found in this Report.

This Report marks the conclusion of my twenty years as Chair of the Committee. I would like to take this opportunity to thank, and express my sincere admiration, to the many people who contribute to the success of the Committee. Our members attend and contribute as volunteers. Never once have I heard a complaint. We are also served by wonderful investigators, each of whom brings to the task a wealth of experience and expertise. My thanks go to you all.

I would also like to express my gratitude to the many members of the Health Department for their unwavering support. Ms Sheila Klimczyk who is Secretary of the Committee, Ms Parveen Fathima and Dr Teresa Ballestas authors of this Report, Dr Andrew Robertson who is Chief Health Officer, and the many health care personnel across our State who work so hard to provide excellence in the care of pregnant women and their babies.

The new Chair will be Dr Michael Gannon who I am sure will lead the Committee admirably in its role as one of the key agencies providing review and education to improve the health of our community.

Respectively submitted

Professor John Newnham AM

Executive Summary

This is the 16th Report of the Western Australian Perinatal and Infant Mortality Committee (the Committee). This Report provides an overview of the epidemiology of stillbirths, neonatal deaths and post-neonatal deaths between 2014 and 2018 in Western Australia, with a summary of the findings and recommendations of the Committee.

Key findings

Incidence and trends

- Between 2014 and 2018, there were a total of 174,050 births, 1,164 stillbirths, 290 neonatal deaths and 158 post-neonatal deaths.
- Overall, the rates of perinatal and infant mortality were low. Since 1990-92, there has been a significant decrease in the neonatal mortality rate (from 3.9 to 1.7 per 1,000 live births) and post-neonatal mortality rate (from 2.9 to 0.9 per 1,000 live births) in 2014-18.
- The rate of stillbirths has remained unchanged for nearly three decades.
- The rates of stillbirth, neonatal and post-neonatal mortality for babies born to Aboriginal mothers continue to be higher than the comparable rates for babies born to non-Aboriginal mothers.

Risk factors

- The following factors were associated with increased odds of stillbirth in a multivariate model: Maternal age ≥35 years, maternal smoking during pregnancy, maternal ethnicity (Aboriginal, African and 'other'), nulliparity, multiple pregnancy, absence of antenatal care, complications during pregnancy, region of residence in Western Australia (Great Southern), lower socio-economic status and male sex of the baby.
- The factors significantly associated with increased odds of neonatal mortality were teen pregnancies, maternal smoking during pregnancy, maternal ethnicity (Aboriginal and African), multiple pregnancy, absence of antenatal care, complications during pregnancy and male sex of the baby.
- Maternal age <20 years, maternal smoking during pregnancy, maternal ethnicity (Aboriginal and 'other'), maternal body mass index (obese and underweight) and complications during pregnancy, were significantly associated with increased odds of post-neonatal mortality.
- Approximately half (51%) of all stillbirths and 30% of all neonatal deaths occurred among babies born between 20 to 23 weeks.
- The majority of stillbirths (76%) and neonatal deaths (52%) occurred among babies born with birthweight <1500 grams.

Causes of death

- Congenital abnormality was the most common cause of stillbirths (n=361; 31%) and neonatal deaths (n=91; 31%), and 'Other' causes (including Sudden Infant Death Syndrome (SIDS) and trauma, were the most common among post-neonatal deaths (n=87; 55%).
- Among babies born to Aboriginal mothers, unexplained antepartum death was the most common cause associated with stillbirths (n=21; 19%), spontaneous preterm among neonatal deaths (n=20; 46%) and 'Other' causes among post-neonatal deaths (n=29; 76%).
- Post-mortem investigations were conducted on just over half of all stillbirths (n=614; 53%) to ascertain cause(s) of death.
- Among neonatal deaths, nearly 34% (n=98) underwent post-mortem investigation and approximately 60% (n=96) of all post-neonatal deaths had a post-mortem investigation conducted.

Clinical preventability

- Of the investigated 476 stillbirths, the majority of cases (n=387) had virtually no evidence for medical preventability, 42 had low degree of evidence and 26 had high degree of evidence for medical preventability.
- The majority (n=166) of the investigated 192 neonatal deaths had virtually no evidence for medical preventability and an equal proportion of the cases (n=12) had low and high degree of evidence for medical preventability.
- Of the investigated 155 post-neonatal deaths, the majority (n=152) had virtually no evidence for medical preventability, one case had low degree of evidence and two cases had a high degree of evidence for medical preventability.

Recommendations

1. That the Department of Health, the Women and Newborn Health Service**,** and public and private maternity care providers across the State be made-aware that the rate of stillbirth remains largely unchanged, and that new strategies are required and will need support.

2. That the ongoing high rates of perinatal loss in Aboriginal people need all health services to provide evidence-based and culturally sensitive services with appropriate support.

3. Congenital anomalies (birth defects), including rare diseases, remain a major cause of perinatal loss. Some of these anomalies are preventable. The WA Birth Defects Registry (Western Australian Register of Developmental Anomalies) should be encouraged and supported to provide the health services with timely state-wide data enabling appropriate decision making in regard to preventative strategies.

4. Preterm birth remains one of the major causes of perinatal loss. Effective strategies are now available to prevent many cases of early preterm birth and health care practitioners and services are directed to the guidelines of the Australian Preterm Birth Prevention Alliance (APTBPA) to remain updated on the National program now underway to safely lower the rate of early birth across Australia (www.pretermalliance.com.au).

5. Perinatal autopsy is an important component in understanding the cause of perinatal loss and discovering how future loss may be avoided. Even though perinatal autopsy rates in Western Australia are relatively high, there remains much room for improvement. For example, umbilical cord accident is rarely a sufficient explanation for fetal death in utero. All health care practitioners need to be aware of the need for thorough investigation of perinatal and infant deaths and refer to the guideline included in Appendix 1.

6. Multiple pregnancy remains a significant cause of perinatal loss. Health care practitioners need to be aware of the current guidelines regarding diagnosis, monitoring and management of monochorionic and dichorionic pregnancies, which can be found at: King Edward Memorial Hospital - Clinical Guidelines (health.wa.gov.au).

7. All multiple pregnancies should be evaluated for chorionicity at 12 weeks gestation. Monochorionic twin pregnancies should undergo fortnightly ultrasound assessment from 16 weeks gestation onwards for specific complications of monochorionicity. Monochorionic twins have higher rates of perinatal mortality and should be managed in consultation with clinicians experienced in such pregnancies.

Introduction

In Western Australia, in accordance with the *Births, Deaths and Marriages Registration Act 1998*, it is mandatory to report and register all births occurring in the State with gestational age of 20 weeks or more. Under the *Health (Miscellaneous Provisions) Act 1911* (Section 336 and Section 336A), midwives, nurses and/or medical practitioners must notify the Chief Health Officer whenever any child of 20 weeks gestation or more is stillborn, or a child under 12 months-of-age dies from any cause whatsoever.

Under the *Health (Miscellaneous Provisions) Act 1911* (Part XIIIB), the Perinatal and Infant Mortality Committee (hereafter referred to as the Committee) is a privileged statutory Committee wherein, under the direction of the CHO, the members of the Committee are authorised to enquire into and report to the CHO on perinatal and infant mortality in the State. Members of the Committee comprise experts in the areas of obstetrics, perinatal care, neonatal paediatrics, clinical epidemiology, general medicine, perinatal pathology, rural medicine and midwifery.

The primary purpose of the Committee is educational. The Committee uses all notifications entered into the perinatal and infant mortality database to monitor and review the number of perinatal and infant deaths in the Western Australian population, for the purpose of examining trends and issues that could lead to improved clinical care and inform public health strategies. Another purpose of the Committee is to determine whether, in the opinion of the Committee, the stillbirth or death could have been prevented. To achieve this objective, the CHO appoints an investigator to examine all deaths requiring further investigation. The investigator prepares a de-identified report, which is discussed at the Committee meetings. Subsequently, the Committee makes a decision and provides constructive comments to the attending medical practitioner. A Report on the investigated cases is also submitted to the CHO. In 2017, the criteria for investigations by the Committee was changed to include all stillbirths and deaths from at least 23 weeks-of-age from the previous timeframe of at least 26 weeks-of-age and continued to exclude therapeutic medical terminations of pregnancy. Definitions used by the Committee (and in this Report) are provided in the Methods and Terminology section of this Report.

Since 2000, the Committee has identified areas for improvements, including better governance, increased funding and quality improvement of health services, better antenatal care, culturally appropriate services for Aboriginal people, continuous performance development of health professionals and safer homebirth services. All reports published by the Committee are available at: Perinatal and infant mortality committee (health.wa.gov.au)).

Since the 15th Report, there have been significant developments in the area of perinatal and infant health. In 2018, the Senate established the Select Committee on Stillbirth Research and Education to inquire and report on the future of stillbirth research and education in Australia. The Final Report, which includes 16 recommendations, was tabled on 4 December 2018 and is available from: Report – Parliament of Australia (aph.gov.au). The Australian Government agreed, in principle, to all recommendations, and significant funding has been committed to initiatives to reduce stillbirths. A National Stillbirth Action Plan was published in 2020 and is available from: https://www.health.gov.au/resources/publications/national-stillbirth-action-and-implementation-plan.

In addition, the APTBPA was established to safely lower the rate of preterm birth across Australia.

This is the 16th Report of the Committee for deaths occurring between 2014 and 2018. In lieu of the implementation of a revised classification system for 'cause of death', in 2019, this Report covers a 5 year period instead of the usual three. This Report provides an overview of the epidemiology of perinatal and infant deaths between 2014 and 2018, with a summary of the Committee findings and recommendations.

A Power BI dashboard has been developed to replicate the figures, tables and statistical analysis contained in the 16th PIMC Report. In addition, the dashboard presents information about deaths occurring in babies born since 2000 and the number of notifications received each three month period in the most recent three years. Data used by the dashboard will be updated frequently and will include summary information more recent than is possible to include in the static reports. The dashboard is available at: https://app.powerbi.com/view?r=eyJrIjoiNDZlNzVlNDYtNzQ0OS00ZDZmLWIyMTMtMDg0MzdjY2IwMmM5IiwidCI6IjVkMjZiZWI5LWQ3MzAtNDM0My1hMjUxLWQxNzBjYTg2Mzc3YyJ9.

The purpose of this work is to better inform clinicians and public health professionals in their efforts to improve perinatal and infant care in Western Australia.

Epidemiology

Trends in 2014-2018

Between 2014 and 2018, there were a total of 174,050 babies born in Western Australia. Of these, 1,164 (0.7%) were stillbirths representing a rate of 6.7 (95% CI: 6.3, 7.1) per 1,000 births (Table 1). Of the 172,886 live births, 290 (0.2%) died within 28 days of birth (neonatal period) and 158 (0.1%) died between 28 and 364 days after birth (post-neonatal period), representing a neonatal mortality rate of 1.7 (95% CI: 1.5, 1.9) per 1,000 live births and post-neonatal mortality rate of 0.9 (95% CI: 0.8, 1.1) per 1,000 live births, respectively, over the 5 year period. The perinatal mortality (stillbirths plus neonatal deaths) rate was 8.4 (95% CI: 7.9, 8.8) per 1,000 births and infant mortality (neonatal deaths plus post-neonatal deaths) rate was 2.6 (95% CI: 2.4, 2.8) per 1,000 live births.

During the period 2014-2018, approximately 5% (n=9,003) of all births were to women who identified as being Aboriginal (Table 1). The stillbirth rate among Aboriginal babies (12.2 per 1,000 births) was approximately two times higher (95% CI: 1.6, 2.3; p= <0.001) than the rate among non-Aboriginal babies (6.4 per 1,000 births). Neonatal mortality rate was 3.3 times higher (95% CI: 2.3, 4.6; p= <0.001) and post-neonatal mortality was nearly 6 times higher (95% CI: 3.9, 8.5; p= <0.001) among Aboriginal infants compared to the non-Aboriginal infants.

Table 1. Number and rate of births, stillbirths, neonatal and post-neonatal mortality by Aboriginal status of the mother in Western Australia, 2014-2018

	Aboriginal		Non-Aboriginal		Total	
	n	rate/1000 births* (95% CI)	n	rate/1000 births* (95% CI)	n	rate/1000 births* (95% CI)
Total births	9003	-	165047	-	174050	-
Live births	8893	-	163993	-	172886	-
Stillbirths	110	12.2 (10.0, 14.7)	1054	6.4 (6.0, 6.8)	1164	6.7 (6.3, 7.1)
Neonatal mortality	44	4.9 (3.6, 6.6)	246	1.5 (1.3, 1.7)	290	1.7 (1.5, 1.9)
Post-neonatal mortality	38	4.3 (3.0, 5.9)	120	0.7 (0.6, 0.8)	158	0.9 (0.8, 1.1)
Perinatal mortality	154	17.1 (14.5, 20.0)	1300	7.9 (7.5, 8.3)	1454	8.4 (7.9, 8.8)
Infant mortality	82	9.2 (7.3, 11.4)	366	2.2 (2.0, 2.5)	448	2.6 (2.4, 2.8)

*Rates for neonatal, post neonatal and infant mortality are reported as rate per 1,000 live births

Trends over time

The rate of stillbirths has remained unchanged since 1990 (correlation coefficient [r]= -0.29; p=0.44); Figure 1 and Supplementary Table 1. Compared to the 2011-2013 triennium, there was a 6% decrease (from 7.1 to 6.7 per 1,000 births) in the rate of stillbirths during the 2014-2018 period; however, this decrease was not statistically significant (rate ratio [RR]: 0.94, 95% CI: 0.85, 1.03).

The neonatal mortality rate declined significantly by 28% from 3.9 per 1,000 live births in 1990-1992 to 2.9 per 1,000 live births in 1999-2001 (RR: 0.72, 95% CI: 0.60, 0.86); Figure 1 and Supplementary Table 1. Following this decline, the neonatal mortality rate remained stable until the period 2011-2013 wherein the mortality rate decreased to 1.7 per 1,000 live births reflecting a further 40% decline in the mortality rate (RR: 0.60, 95% CI: 0.49, 0.74). There has been no change in the neonatal mortality rate for the period 2014-2018 compared to the 2011-2013 period (Figure 1 and Supplementary Table 1).

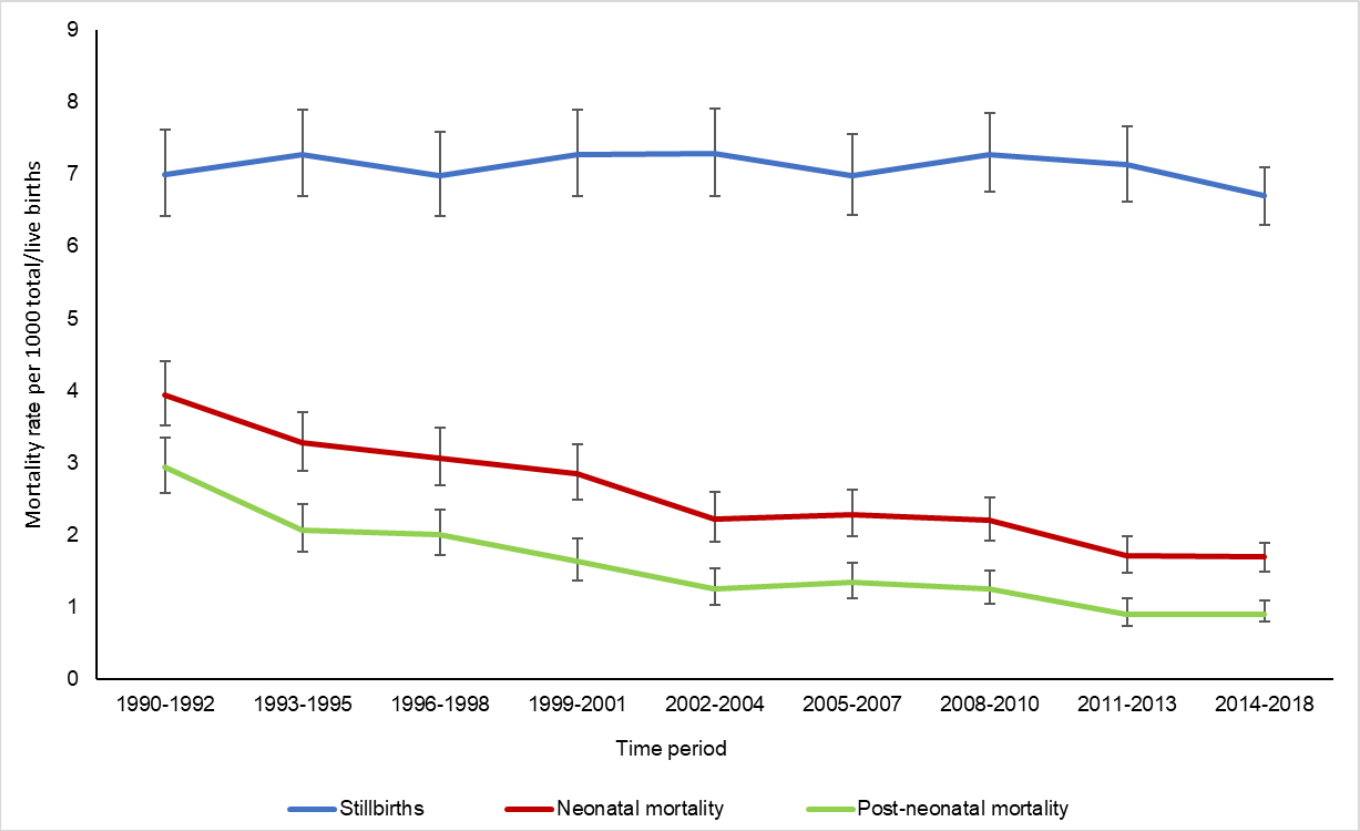


Figure 1. Stillbirths, neonatal and post-neonatal mortality rates in Western Australia, 1990-2018

The post-neonatal mortality rate declined significantly by 57% from 2.9 per 1,000 live births in 1990-1992 to 1.3 per 1,000 live births in 2002-2004 (RR: 0.43, 95% CI: 0.33, 0.55). Following this decline, the post-neonatal mortality rate remained stable until the period 2011-2013 wherein the mortality rate decreased to 0.7 per 1,000 live births, reflecting a further 28% decline in the mortality rate (RR: 0.72, 95% CI: 0.54, 0.97). There has been no change in the post-neonatal mortality rate for the period 2014-18 compared to the 2011-2013 period (Figure 1 and Supplementary Table 1).

Among the Aboriginal population, the stillbirth rate for Aboriginal babies has not changed significantly since 1990 (r= -0.11; p=0.77); Figure 2 and Supplementary Table 2. Although there was a 26% decrease (from 16.5 to 12.2 per 1,000 births) in the rate of stillbirths in the 2014-2018 period compared to the 2011-2013 triennium, this decrease was not statistically significant (RR: 0.74, 95% CI: 0.55, 1.00). The neonatal mortality rate in Aboriginal infants has significantly decreased from 9.3 (95% CI: 6.8, 12.6) per 1,000 live births in 1990-1992 to 4.9 (95% CI: 3.6, 6.6) per 1,000 live births in 2014-2018 (r= -0.83; p= <0.01); Figure 2. The post-neonatal mortality rate in Aboriginal infants has also significantly declined since 1990 (r= -0.94; p= <0.001); by 64% from 11.8 (95% CI: 9.0, 15.4) per 1,000 live births in 1990-1992 to 4.3 (95% CI: 3.0, 5.9) per 1,000 live births in 2014-2018 (Figure 2 and Supplementary Table 2). The neonatal and post-neonatal mortality rates for the period 2014-2018 were similar to the rates observed in 2011-2013.

Supplementary Table 3 lists the number and rate of stillbirths, neonatal and perinatal mortality in the different states in Australia for the period 2014-2018.

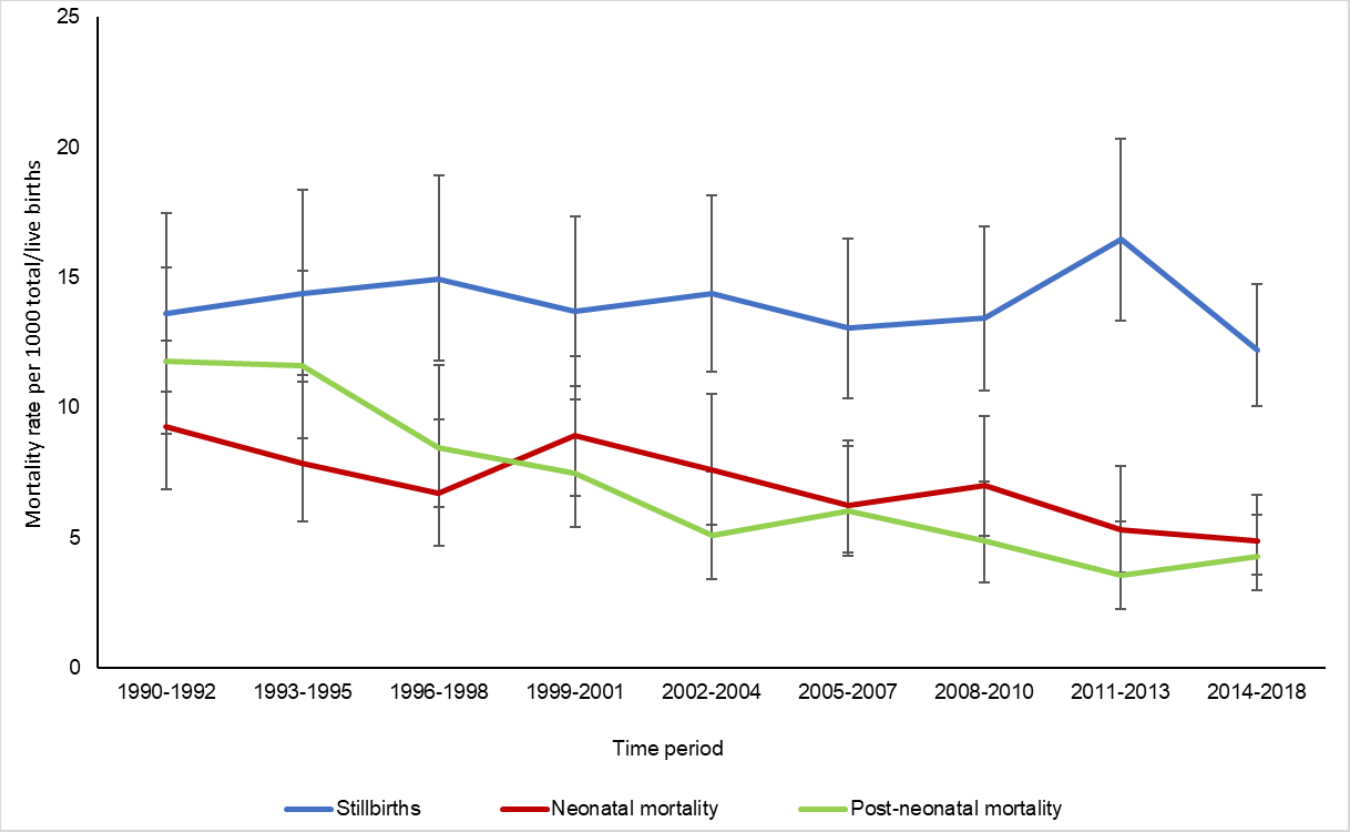


Figure 2. Stillbirths, neonatal and post-neonatal mortality rates in the Aboriginal population in Western Australia, 1990-2018

Despite the reductions observed, Aboriginal people still experience a much higher burden of perinatal and infant mortality than non-Aboriginal people. Although, compared to 2011-2013, the ratio between Aboriginal and non-Aboriginal rates decreased from 2.5 to 1.9 for stillbirths and from 3.5 to 3.3 for neonatal deaths and increased from 4.6 to 5.8 for post-neonatal deaths in 2014-2018, these changes in the gap were not significant. In fact, no significant changes have been observed in the gap for perinatal and infant mortality burden between Aboriginal and non-Aboriginal populations since 1992.

Risk Factors

Information on maternal socio-demographic, pregnancy/delivery-related and birth characteristics were available in the data. The association between potential risk factors with stillbirths, neonatal and post-neonatal deaths were assessed using multivariable logistic regression analyses.

Stillbirths

In the univariate analysis, there were multiple independent maternal socio-demographic and medical factors that were significantly associated with increased odds of stillbirth. These include maternal age ≥35 years, maternal smoking during pregnancy, maternal ethnicity (Aboriginal, South Asian, African and other), maternal obesity (body mass index [BMI] ≥30), nulliparity, multiple pregnancy, absence of antenatal care, complications during pregnancy, region of residence in Western Australia (Kimberley and Great Southern), lower socio-economic status and male sex of the baby (Table 2).

In the multivariate analysis, compared to mothers aged 30-34 years, mothers aged ≥35 years had 20% (aOR: 1.2, 95% CI:1.0, 1.5) higher odds of stillbirth (Table 2). Compared to babies born to mothers of Caucasian ethnicity, babies born to mothers of Aboriginal ethnicity (aOR: 1.4, 95% CI:1.1, 1.8), African ethnicity (aOR: 2.5, 95% CI:1.8, 3.5), and 'other' ethnicity (aOR: 1.4, 95% CI:1.1, 1.8) had increased odds of stillbirths. Smoking during pregnancy (aOR: 1.3, 95% CI: 1.0, 1.6), nulliparity (aOR: 1.5, 95% CI: 1.3, 1.7), multiple pregnancy (aOR: 3.1, 95% CI: 2.5, 3.8), complications during pregnancy (aOR: 2.7; 95% CI: 2.3, 3.1), absence of antenatal care (aOR: 13, 95% CI: 6.4,26.6) and male babies (aOR: 1.4, 95% CI:1.2, 1.6) were also associated with higher odds of stillbirths in the adjusted analysis. Among the regions, residence in the Great Southern region of Western Australia was associated with higher odds of stillbirth (aOR: 1.7, 95% CI:1.2, 2.6) compared to residence in the metropolitan Perth region of Western Australia, and babies born to mothers of the most disadvantaged socio-economic status had higher odds (aOR: 1.3, 95% CI: 1.0, 1.6) of stillbirth compared to babies born to mothers in the most advantaged socio-economic group (Table 2).

Although South Asian ethnicity was significantly associated with higher odds of stillbirth in the univariate model, it was not significant in the multivariate model (Table 2). Also, compared to mothers with a healthy BMI (18.5 to <25), mothers with BMI≥30 had 30% (OR: 1.3, 95% CI:1.1, 1.6) higher odds of stillbirth in the univariate analysis but the association was not significant in the multivariate model, especially when the model was adjusted for presence of any complications during pregnancy.

Table 2. Association (odds ratios and 95% confidence intervals) of maternal characteristics with stillbirths in Western Australia, 2014-2018

RISK FACTORS	STILLBIRTHS (N=1164)							
	n	%	rate per 1000 births (95% CI)		OR[a] (95% CI)		aOR[b] (95% CI)	
Maternal ethnicity								
Aboriginal	110	9.5	12.2	(10.0, 14.7)	**2.1**	**(1.7, 2.6)**	**1.4**	**(1.1, 1.8)**
Caucasian	701	60.2	5.9	(5.5, 6.4)		*Ref*		*Ref*
South East and East Asian	119	10.2	6.2	(5.1, 7.4)	1.0	(0.9, 1.3)	1.0	(0.8, 1.3)
South Asian	76	6.5	8.2	(6.4, 10.2)	**1.4**	**(1.1, 1.8)**	1.2	(0.9, 1.6)
African	52	4.5	15.0	(11.2, 19.7)	**2.6**	**(1.9, 3.4)**	**2.5**	**(1.8, 3.5)**
Maori	9	0.8	3.3	(1.5, 6.2)	0.6	(0.3, 1.1)	0.5	(0.2, 1.1)
Other	97	8.3	3.3	(1.5, 6.2)	**1.5**	**(1.2, 1.8)**	**1.4**	**(1.1, 1.8)**
Maternal age (years)								
<20	40	3.4	8.9	(6.4, 12.1)	**1.5**	**(1.0, 2.0)**	0.9	(0.6, 1.4)
20-24	150	12.9	7.0	(5.9, 8.2)	1.1	(0.9, 1.4)	1.0	(0.8, 1.2)
25-29	303	26.0	6.2	(5.5, 7.0)	1.0	(0.9, 1.2)	0.9	(0.8, 1.1)
30-34	379	32.6	6.2	(5.6, 6.8)		*Ref*		*Ref*
≥35	292	25.1	7.7	(6.8-8.6)	**1.3**	**(1.1, 1.5)**	**1.2**	**(1.0, 1.5)**
Body Mass Index (BMI)								
<18.5 (Underweight)	38	3.3	6.9	(4.9, 9.4)	1.4	(1.0, 1.9)	1.2	(0.9, 1.7)
18.5-24.9 (Healthy weight)	408	35.1	5.0	(4.6, 5.5)		*Ref*		*Ref*
25-29.9 (Overweight)	265	22.8	5.7	(5.0, 6.4)	1.1	(1.0, 1.3)	1.1	(0.9, 1.2)
≥30 (Obese)	228	19.6	6.6	(5.8, 7.6)	**1.3**	**(1.1, 1.6)**	1.1	(1.0, 1.3)
Missing	225	19.3	-		-		-	
Parity								
Nullipara	354	30.4	7.9	(7.1, 8.8)	**1.3**	**(1.1, 1.4)**	**1.5**	**(1.3, 1.7)**
Multipara	810	69.6	6.3	(5.8, 6.7)		*Ref*		*Ref*
Plurality								
Singleton	1037	89.1	6.1	(5.8, 6.5)		*Ref*		*Ref*
Multiple pregnancy	127	10.9	25.7	(21.4, 30.5)	**4.3**	**(3.6, 5.2)**	**3.1**	**(2.5, 3.8)**
Complications of pregnancy								
Yes	704	60.5	12.2	(11.3, 13.2)	**3.1**	**(2.8, 3.5)**	**2.7**	**(2.3, 3.1)**
No	460	39.5	4.0	(3.6, 4.3)		*Ref*		*Ref*
Smoking during pregnancy								
Yes	164	14.1	10.2	(8.7, 11.9)	**1.6**	**(1.4, 1.9)**	**1.3**	**(1.0, 1.6)**
No	1000	85.9	6.3	(5.9, 6.7)		*Ref*		*Ref*

RISK FACTORS	n	%	STILLBIRTHS (N=1164) rate per 1000 births (95% CI)		OR[a] (95% CI)		aOR[b] (95% CI)	
Antenatal care								
Yes	1,109	95.3	6.9	(6.5, 7.3)		*Ref*		*Ref*
No	22	1.9	73.8	(46.3, 111.8)	**11.8**	**(7.6, 18.3)**	**13**	**(6.4, 26.6)**
Missing	33	2.8	-		-		-	
Sex of the baby								
Male	617	53.0	6.9	(6.3, 7.4)	**1.5**	**(1.3, 1.6)**	**1.4**	**(1.2, 1.6)**
Female	517	44.4	6.1	(5.6, 6.7)		*Ref*		*Ref*
Indeterminate	30	2.6	-		-		-	
Region of residence								
Metropolitan Perth	888	76.3	6.5	(6.0, 6.9)		*Ref*		*Ref*
Kimberley	38	3.3	11.7	(8.3, 16.0)	**1.8**	**(1.3, 2.5)**	1.2	(0.8, 1.9)
Pilbara	35	3.0	7.6	(5.3, 10.5)	1.2	(0.8, 1.6)	1.1	(0.7, 1.7)
Midwest	33	2.8	7.7	(5.3, 10.8)	1.2	(0.8, 1.7)	1.0	(0.7, 1.5)
Wheatbelt	28	2.4	6.5	(4.3, 9.4)	1.0	(0.7, 1.5)	0.9	(0.6, 1.4)
Goldfields	32	2.8	7.0	(4.8, 9.9)	1.1	(0.8, 1.5)	1.1	(0.7, 1.6)
Great Southern	34	2.9	10.0	(6.9, 14.0)	**1.6**	**(1.1, 2.2)**	**1.7**	**(1.2, 2.6)**
South West	64	5.5	5.9	(4.5, 7.5)	0.9	(0.7, 1.2)	1.0	(0.8, 1.3)
Other[c]	12	1.0	-		-		-	
Socio-economic status[d]								
1 (most disadvantaged)	266	22.9	8.5	(7.5, 9.6)	**1.5**	**(1.2, 1.8)**	**1.3**	**(1.0, 1.6)**
2	222	19.1	6.9	(6.1, 7.9)	**1.3**	**(1.0, 1.6)**	1.1	(0.9, 1.4)
3	259	22.3	6.6	(5.8, 7.5)	1.2	(1.0, 1.4)	1.1	(0.9, 1.4)
4	253	21.8	5.8	(5.1, 6.6)	1.0	(0.8, 1.3)	1.0	(0.8, 1.2)
5 (least disadvantaged)	158	13.6	5.7	(4.9, 6.7)		*Ref*		*Ref*
Missing	6	0.5	-		-		-	

[a] OR: odds ratios;
[b] aOR: adjusted odd ratios – adjusted for all other variables in the model.
[c] 'other' includes records where maternal residence at the time of delivery was reported as not of WA.
[d] Based on Socio-economic Indexes for Areas (SEIFA) - Index of Relative Socio-economic Disadvantage.
Note: The rates and odds ratios in categories with small number of events (n<10) should be interpreted with caution.

Neonatal mortality

In the univariate analysis, maternal age <20 years, maternal ethnicity (Aboriginal, African and Maori), multiple pregnancy, complications during pregnancy, maternal smoking during pregnancy, absence of antenatal care, region of residence in Western Australia (Kimberley and Wheatbelt) and male sex of the baby were maternal sociodemographic and medical factors that were significantly associated with increased odds of neonatal mortality (Table 3).

In the adjusted model, babies born to African mothers had 2.4 times higher odds (95% CI: 1.2, 4.9) and Aboriginal mothers had double the odds (aOR: 1.9, 95% CI:1.1, 3.1) of neonatal death compared to babies born to Caucasian mothers. Teen pregnancies had slightly higher odds (aOR: 1.9, 95% CI:1.0, 3.6) of neonatal death compared to pregnancies in females aged 30-34 years. Multiple pregnancies, maternal smoking during pregnancy, complications of pregnancy and male sex of the baby were other factors associated with higher odds of neonatal deaths in the multivariate model (Table 3). Compared to babies born to mothers who accessed antenatal care, the odds of neonatal deaths were higher (aOR: 10.4, 95% CI: 3.0, 35.8) among babies born to mothers who did not access antenatal care.

No associations were observed between maternal BMI, parity, region of residence in Western Australia and socio-economic status and neonatal deaths in the multivariate model.

Table 3. Association (odds ratios and 95% confidence intervals) of maternal characteristics with neonatal mortality in Western Australia, 2014-2018

RISK FACTORS	NEONATAL DEATHS (N=290)							
	n	%	rate per 1000 births (95% CI)		OR[a] (95% CI)		aOR[b] (95% CI)	
Maternal ethnicity								
Aboriginal	44	15.2	4.9	(3.6, 6.6)	**3.7**	**(2.6, 5.1)**	**1.9**	**(1.1, 3.1)**
Caucasian	161	55.5	1.4	(1.2, 1.6)		*Ref*		*Ref*
South East and East Asian	27	9.3	1.4	(0.9, 2.1)	1.0	(0.7, 1.6)	1.1	(0.6, 1.6)
South Asian	15	5.2	1.6	(0.9, 2.7)	1.2	(0.7, 2.0)	1.4	(0.8, 2.4)
African	13	4.5	3.8	(2.0, 6.5)	**2.8**	**(1.6, 4.9)**	**2.4**	**(1.2, 4.9)**
Maori	8	2.8	2.9	(1.3, 5.7)	**2.1**	**(1.1, 4.4)**	2.0	(0.9, 4.4)
Other	22	7.6	2.0	(1.2, 3.0)	1.4	(0.9, 2.2)	1.6	(1.0, 2.6)
Maternal age (years)								
<20	17	5.9	3.8	(2.2, 6.1)	**3.0**	**(1.8, 5.0)**	**1.9**	**(1.0, 3.6)**
20-24	40	13.8	1.9	(1.3, 2.6)	1.5	(1.0, 2.1)	1.3	(0.8, 2.0)
25-29	88	30.3	1.8	(1.5, 2.2)	1.4	(1.0, 1.9)	1.4	(1.0, 1.9)
30-34	79	27.2	1.3	(1.0, 1.6)		*Ref*		*Ref*
≥35	66	22.8	1.8	(1.4, 2.2)	1.4	(1.0, 1.9)	1.2	(0.8, 1.7)
Body Mass Index (BMI)								
<18.5 (Underweight)	11	3.8	2.0	(1.0, 3.6)	1.4	(0.8, 2.7)	1.1	(0.6, 2.1)
18.5-24.9 (Healthy weight)	112	38.6	1.4	(1.1, 1.7)		*Ref*		*Ref*
25-29.9 (Overweight)	65	22.4	1.4	(1.1, 1.8)	1.0	(0.7, 1.4)	0.9	(0.7, 1.3)
≥30 (Obese)	54	18.6	1.6	(1.2, 2.1)	1.1	(0.8, 1.6)	0.9	(0.6, 1.3)

RISK FACTORS	NEONATAL DEATHS (N=290)							
	n	%	rate per 1000 births (95% CI)		OR[a] (95% CI)		aOR[b] (95% CI)	
Missing	48	16.6	-		-		-	
Parity								
Nullipara	80	27.6	1.8	(1.4, 2.2)	1.1	(0.9, 1.4)	1.0	(0.8, 1.5)
Multipara	210	72.4	1.6	(1.4, 1.9)		*Ref*		*Ref*
Plurality								
Singleton	249	85.9	1.5	(1.3, 1.7)		*Ref*		*Ref*
Multiple pregnancy	41	14.1	8.5	(6.1, 11.5)	**5.8**	**(4.1, 8.1)**	**3.5**	**(2.4, 5.1)**
Complications of pregnancy								
Yes	204	70.3	3.6	(3.1, 4.1)	**4.9**	**(3.8, 6.2)**	**4.1**	**(3.1, 5.5)**
No	86	29.7	0.7	(0.6, 0.9)		*Ref*		*Ref*
Smoking during pregnancy								
Yes	52	17.9	3.3	(2.4, 4.3)	**2.2**	**(1.6, 2.9)**	**1.6**	**(1.1, 2.3)**
No	238	82.1	1.5	(1.3, 1.7)		*Ref*		*Ref*
Antenatal care								
Yes	276	95.2	1.7	(1.5, 1.9)		*Ref*		*Ref*
No	5	1.7	18.1	(5.9, 42.3)	**10.7**	**(4.4, 26.2)**	**10.4**	**(3.0, 35.8)**
Missing	9	3.1	-		-		-	
Sex of the baby								
Male	182	62.8	2.0	(1.8, 2.4)	**1.7**	**(1.3, 2.1)**	**1.7**	**(1.3, 2.2)**
Female	107	36.9	1.3	(1.0, 1.5)		*Ref*		*Ref*
Indeterminate	1	0.3	-		-		-	
Region of residence								
Metropolitan Perth	211	72.8	1.5	(1.3, 1.8)		*Ref*		*Ref*
Kimberley	12	4.1	3.7	(1.9, 6.5)	**2.4**	**(1.4, 4.3)**	1.6	(0.8, 3.3)
Pilbara	9	3.1	2.0	(0.9, 3.7)	1.3	(0.7, 2.5)	0.7	(0.3, 1.8)
Midwest	11	3.8	2.6	(1.3, 4.6)	1.7	(0.9, 3.1)	1.2	(0.6, 2.6
Wheatbelt	13	4.5	3.0	(1.6, 5.2)	**2.0**	**(1.1, 3.5)**	1.6	(0.9, 3.1)
Goldfields	12	4.1	2.6	(1.4, 4.6)	1.7	(1.0, 3.1)	1.4	(0.7, 2.7)
Great Southern	4	1.4	1.2	(0.3, 3.0)	0.8	(0.3, 2.1)	0.8	(0.2, 2.5)
South West	13	4.5	1.2	(0.6, 2.1)	0.8	(0.4, 1.4)	0.8	(0.4, 1.4)
Other[c]	5	1.7	-		-		-	

RISK FACTORS	NEONATAL DEATHS (N=290)					
	n	%	rate per 1000 births (95% CI)	OR[a] (95% CI)	aOR[b] (95% CI)
Socio-economic status[d]					
1 (most disadvantaged)	63	21.7	2.0 (1.6, 2.6)	1.3 (0.9, 2.0)	0.9 (0.5, 1.4)
2	54	18.6	1.7 (1.3, 2.2)	1.2 (0.8, 1.7)	0.9 (0.6, 1.5)
3	67	23.1	1.7 (1.3, 2.2)	1.1 (0.8, 1.7)	1.2 (0.8, 1.8)
4	59	20.3	1.4 (1.0, 1.8)	0.9 (0.6, 1.3)	0.9 (0.6, 1.4)
5 (least disadvantaged)	42	14.5	1.5 (1.1, 2.1)	*Ref*	*Ref*
Missing	5	1.7	-	-	-

[a] OR: odds ratios;
[b] aOR: adjusted odd ratios – adjusted for all other variables in the model.
[c] 'other' includes records where maternal residence at the time of delivery was reported as not of WA.
[d] Based on Socio-economic Indexes for Areas (SEIFA) - Index of Relative Socio-economic Disadvantage.
Note: The rates and odds ratios in categories with small number of events (n<10) should be interpreted with caution.

Post-neonatal mortality

In the univariate model, maternal ethnicity (Aboriginal and Other), maternal age <25 years, maternal BMI (underweight and obese), complications of pregnancy, maternal smoking during pregnancy, region of residence in Western Australia (Pilbara, Midwest, Wheatbelt, Goldfields) and lower socio-economic status were maternal sociodemographic and medical factors significantly associated with higher odds of post-neonatal mortality (Table 4).

In the adjusted model, babies born to Aboriginal mothers had 2.6 times higher odds (95% CI: 1.6, 4.4) of post-neonatal death compared to babies born to Caucasian mothers. Maternal smoking during pregnancy was associated with nearly 4 times higher odds (aOR: 3.8, 95% CI:2.6, 5.7) of post-neonatal death. Babies born to underweight (aOR: 2.1, 95% CI:1.1, 4.2) or obese mothers (aOR: 1.7, 95% CI:1.1, 2.6) had approximately twice the odds of post-neonatal death than babies born to mothers with a healthy weight. Younger maternal age and complications of pregnancy were other factors associated with higher odds of post-neonatal deaths in the multivariate model (Table 4).

Parity, sex of the baby, region of residence in Western Australia and socio-economic status were not associated with post-neonatal deaths in the multivariate model.

Table 4. Association (odds ratios and 95% confidence intervals) of maternal characteristics with post-neonatal mortality in Western Australia, 2014-2018

RISK FACTORS	POST-NEONATAL DEATHS (N=158)							
	n	%	rate per 1000 births (95% CI)		OR[a] (95% CI)		aOR[b] (95% CI)	
Maternal ethnicity								
Aboriginal	38	24.1	4. 3	(3.0, 5.9)	**6.4**	**(4.3, 9.4)**	**2.6**	**(1.6, 4.4)**
Caucasian	80	50.6	0. 7	(0.5, 0.8)		*Ref*		*Ref*
South East and East Asian	11	7.0	0.6	(0.3, 1.0)	0.8	(0.5, 1.6)	1.2	(0.6, 2.4)
South Asian	6	3.8	0.6	(0.2, 1.4)	1.0	(0.4, 2.2)	1.5	(0.6, 3.5)
African	3	1.9	0. 9	(0.2, 2.6)	1.3	(0.4, 4.1)	1.7	(0.5, 5.4)
Maori	4	2.5	1. 5	(0.4, 3.7)	2.2	(0.8, 5.9)	1.3	(0.5, 3.6)
Other	16	10.1	1.4	(0.8, 2.3)	**2.1**	**(1.2, 3.6)**	**2.3**	**(1.3, 4.1)**
Maternal age (years)								
<20	13	8.2	2.9	(1.6, 5.0)	**4.4**	**(2.3, 8.2)**	**2.3**	**(1.1, 4.8)**
20-24	38	24.1	1.8	(1.3, 2.4)	**2.7**	**(1.7, 4.1)**	1.7	(1.0, 2.8)
25-29	46	29.1	1.0	(0. 7, 1.3)	1.4	(0.9, 2.2)	1.3	(0.9, 2.1)
30-34	41	25.9	0.7	(0.5, 0.9)		*Ref*		*Ref*
≥35	20	12.7	0.5	(0.3, 0.8)	0.8	(0.5, 1.4)	0.8	(0.5, 1.4)
Body Mass Index (BMI)								
<18.5 (Underweight)	10	6.3	1.8	(0.9, 3. 4)	**3.2**	**(1.6, 6.4)**	**2.1**	**(1.1, 4.2)**
18.5-24.9 (Healthy weight)	46	29.1	0.6	(0.4, 0.8)		*Ref*		*Ref*
25-29.9 (Overweight)	40	25.3	0. 9	(0.6, 1.2)	1.5	(1.0, 2.3)	1.4	(0.9, 2.1)
≥30 (Obese)	45	28.5	1.3	(1.0, 1.8)	**2.3**	**(1.5, 3.5)**	**1.7**	**(1.1, 2.6)**
Missing	17	10.8	-		-		-	

RISK FACTORS	n	%	POST-NEONATAL DEATHS (N=158) rate per 1000 births (95% CI)		OR[a] (95% CI)		aOR[b] (95% CI)	
Parity								
Nullipara	34	21.5	0. 8	(0.5, 1.1)		*Ref*		*Ref*
Multipara	124	78.5	1.0	(0.8, 1.2)	1.3	(0.9, 1.8)	1.3	(0.9, 2.0)
Plurality								
Singleton	153	96.8	0.9	(0.8, 1.1)		*Ref*		*Ref*
Multiple pregnancy	5	3.2	1.0	(0.3, 2.4)	1.1	(0.5, 2.8)	1.0	(0.4, 2.4)
Complications of pregnancy								
Yes	77	48.7	1.4	(1.1, 1.7)	**1.9**	**(1.4, 2.7)**	**1.9**	**(1.4, 2.7)**
No	81	51.3	0.7	(0.6, 0.9)		*Ref*		*Ref*
Smoking during pregnancy								
Yes	60	38.0	3.8	(2.9, 4.9)	**6.1**	**(4.4, 8.4)**	**3.8**	**(2.6, 5.7)**
No	98	62.0	0.6	(0.5, 0.8)		*Ref*		*Ref*
Sex of the baby								
Male	86	54.4	1.0	(0.8, 1. 2)	1.1	(0.8, 1.5)	1.1	(0.8, 1.5)
Female	72	45.6	0. 9	(0.7, 1.1)		*Ref*		*Ref*
Region of residence								
Metropolitan Perth	104	65.8	0.8	(0.6, 0.9)		*Ref*		*Ref*
Kimberley	5	3.2	1.6	(0.5, 3.6)	2.0	(0.8, 5.0)	0.4	(0.1, 1.2)
Pilbara	8	5.1	1.7	(0.8, 3.4)	**2.3**	**(1.1, 4.7)**	1.2	(0.5, 2.8)
Midwest	8	5.1	1.9	(0.8, 3.7)	**2.5**	**(1.2, 5.1)**	1.1	(0.5, 2.5)
Wheatbelt	10	6.3	2.3	(1.1, 4.3)	**3.1**	**(1.6, 5.9)**	2.0	(1.0, 4.0)
Goldfields	9	5.7	2.0	(0.9, 3.8)	**2.6**	**(1.3, 5.1)**	1.0	(0.4, 2.4)
Great Southern	3	1.9	0.9	(0.2, 2.6)	1.2	(0.4, 3.7)	0.8	(0.2, 3.1)
South West	10	6.3	0.9	(0.4, 1.7)	1.2	(0.6, 2.3)	1.0	(0.5, 2.1)
Other	1	0.6	-		-		-	
Socio-economic status[c]								
1 (most disadvantaged)	52	32.9	1.7	(1.3, 2.2)	**4.2**	**(2.2, 8.1)**	1.6	(0.8, 3.2)
2	32	20.3	1.0	(0.7, 1.4)	**2.6**	**(1.3, 5.2)**	1.2	(0.6, 2.5)
3	34	21.5	0.9	(0.6, 1.2)	**2.2**	**(1.1, 4.4)**	1.4	(0.7, 2.8)
4	28	17.7	0.6	(0.4, 0.9)	1.6	(0.8, 3.3)	1.1	(0.5, 2.3)
5 (least disadvantaged)	11	7.0	0.4	(0.2, 0.7)		*Ref*		*Ref*
Missing	1	0.6	-		-		-	

[a] OR: odds ratios;
[b] aOR: adjusted odd ratios – adjusted for all other variables in the model.
[c] 'other' includes records where maternal residence at the time of delivery was reported as not of WA.
[d] Based on Socio-economic Indexes for Areas (SEIFA) - Index of Relative Socio-economic Disadvantage.
Note: The rates and odds ratios in categories with small number of events (n<10) should be interpreted with caution.

Other Characteristics

Planned place of birth

In Western Australia, pregnant women have access to different options for birthing services, including hospitals, attached and free-standing birth services and homebirth services. During the period 2014-2018, almost all births (99.2%; n=172,577) in Western Australia were planned/booked in conventional labour wards in hospitals or birth centres while the remaining small proportion of mothers planned to give birth at home (0.7%; n=1,260). The number and rates of stillbirths and neonatal deaths for full term pregnancies by planned place of birth are reported in Table 5. During the period 2014-2018, the risk of stillbirths (RR: 1.6; 95% CI: 0.2, 5.9) and neonatal deaths (RR: 1.5; 95% CI: 0.0, 8.7) for full term pregnancies (≥37 weeks gestational age) were not significantly different among planned hospital births and planned homebirths.

Table 5. Number and rate of stillbirths and neonatal mortality for full term pregnancies (≥37 weeks gestational age) by intended/planned place of birth in Western Australia, 2014-2018

Intended/planned place of birth	Total births n	Live births n	Stillbirths		Neonatal mortality	
			n	Rate per 1000 births (95% CI)	n	Rate per 1000 live births (95% CI)
Hospital/birth centre[a]	156,841	156,683	158	1.0 (0.9, 1.2)	83	0.5 (0.4, 0.7)
Home[b]	1,249	1,247	2	1.6 (0.2, 5.8)	1	0.8 (0.0, 4.5)
Other[c]	120	119	1	8.3 (0.2, 46.4)	0	
Not stated	1	1	0		0	
Total	158,210	158,050	161	1.0 (0.9, 1.2)	84	0.5 (0.4, 0.7)

[a] Hospital includes non-maternity sites and clinics; birth centre includes free standing and hospital-based centres.
[b] Includes planned homebirths with the Community Midwifery Program and with privately funded midwives. It also includes intended homebirths that were transferred to hospitals.
[c] 'Other' includes births that were not planned homebirth, perhaps had no antenatal care, unacknowledged and /or undiagnosed pregnancy and arrived at hospital in labour or following birth enroute or unexpected, unplanned at home.

It should be noted that, of the above-mentioned deaths, where the intended/planned place of birth was hospital/birth centre, the actual place of birth for one stillbirth and the neonatal death was the hospital following emergency transfer to the hospital during labour.

Gestational age

During the period 2014-2018, approximately 9% of all births (n=15839) were preterm births (<37 weeks gestation);The proportion of preterm births was 86% (n=1003) among stillbirths, 71% (n=206) among neonatal deaths and 27% (n=43) among the post-neonatal deaths (Table 6). Consistent with published literature, compared to full-term births, preterm births were associated with higher rates of stillbirths, neonatal deaths and post-neonatal deaths (p<0.001).

Table 6. Number and rate of stillbirths, neonatal and post-neonatal mortality by gestational age in Western Australia, 2014-2018

Gestational age (weeks)	Total Births	Live Births	Stillbirths		Neonatal mortality		Post-neonatal mortality	
			n	Rate per 1000 births (95% CI)	n	Rate per 1000 live births (95% CI)	n	Rate per 1000 live births (95% CI)
20-23	719	126	593	824.8 (759.7, 893.9)	88	698.4 (560.1, 860.5)	4	31.7 (8.6, 81.3)
24-25	291	192	99	340.2 (276.5, 414.2)	36	187.5 (131.3, 259.6)	5	26.0 (8.5, 60.8)
26-31	1631	1470	161	98.7 (84.1, 115.2)	34	23.1 (16.0, 32.3)	11	7.5 (3.7, 13.4)
32-36	13,198	13,048	150	11.4 (9.6, 13.3)	48	3.7 (2.7, 4.9)	23	1.8 (1.1, 2.6)
≥37	158,211	158,050	161	1.0 (0.9, 1.2)	84	0.5 (0.4, 0.7)	115	0.7 (0.6, 0.9)

Note: The rates in categories with small number of events (n<10), should be interpreted with caution.

Birthweight

Low birthweight (<2.5 kg) was associated with higher rates of stillbirths and neonatal mortality compared to birthweight ≥2.5 kg. For the period 2014-2018, only very low birth weight (<1.5 kg) was significantly associated with a higher rate of post-neonatal deaths.

Table 7. Number and rate of stillbirths, neonatal and post-neonatal mortality by birthweight in Western Australia, 2014-2018

Birthweight (kgs)	Total Births	Live Births	Stillbirths		Neonatal mortality		Post-neonatal mortality	
			n	Rate per 1000 births (95% CI)	n	Rate per 1000 live births (95% CI)	n	Rate per 1000 live births (95% CI)
<1.5	2351	1469	882	375.2 (350.8, 400.8)	151	102.8 (87.0, 120.6)	17	11.6 (6.7, 18.5)
1.5 to <2.5	9885	9779	106	10.7 (8.8, 13.0)	42	4.3 (3.1, 5.8)	27	2.8 (1.8, 4.0)
2.5 to <3.0	28761	28679	82	2.9 (2.3, 3.5)	38	1.3 (0.9, 1.8)	55	1.9 (1.4, 2.5)
3.0 to <4.0	116607	116521	86	0.7 (0.6, 0.9)	55	0.5 (0.4, 0.6)	57	0.5 (0.4, 0.6)
≥4.0	16431	16425	6	0.4 (0.1, 0.8)	4	0.2 (0.1, 0.6)	2	0.1 (0.0, 0.4)
Missing	15	13	2	-	-	-		-

Note: The rates in categories with small number of events (n<10), should be interpreted with caution.

Alcohol consumption during pregnancy

Information on alcohol consumption during the first 20 weeks of pregnancy was available from 1 July 2017. The majority of women (95.3%; n=48137/50,521) who gave birth during the period 1 July 2017 to 31 Dec 2018 reported that they did not consume alcohol in the first 20 weeks of pregnancy, and only 2.8% (n=1419) reported that they had consumed alcohol in the first 20 weeks of pregnancy (Table 8). The rates of stillbirths and post-neonatal mortality were higher among babies born to mothers who reported consuming of alcohol during the first 20 weeks of pregnancy but were not statistically different (Table 8).

Table 8. Number and rate of stillbirths, neonatal and post-neonatal mortality by maternal alcohol consumption during first 20 weeks of pregnancy in Western Australia (1 July 2017 – 31 Dec 2018)

Alcohol consumption	Total Births N=50521	Live births N=50179	Stillbirths N=342		Neonatal mortality N=81		Post-neonatal mortality N=38	
			n	Rate per 1000 births (95% CI)	n	Rate per 1000 live births (95% CI)	n	Rate per 1000 live births (95% CI)
No	48137	47832	305	6.3 (5.6, 7.1)	73	1.5 (1.2, 1.9)	31	0.6 (0.4, 0.9)
Yes	1419	1406	13	9.2 (4.9, 15.7)	2	1.4 (0.2, 5.1)	3	2.1 (0.4, 6.2)
Unknown	965	941	24	-	6	-	4	-

Note: The rates in categories with small number of events (n<10) should be interpreted with caution.

Causes of Death

Accurate classification of the causes of perinatal deaths is essential for benchmarking and monitoring of these deaths to inform policy, practice and research for targeted prevention strategies. Furthermore, standardised classification enables the comparison of causes of perinatal death across and within countries. In Australia and New Zealand, the Perinatal Society of Australia and New Zealand (PSANZ) Classification System for Stillbirths and Neonatal deaths is recommended as the primary system to identify a single underlying cause of death for both stillbirths and neonatal deaths, and up to two associated factors which contributed to the death. The PSANZ system was first released in 2003, with the latest update (third revision) implemented in 2019.[1] This Report uses the second revision of the PSANZ system.

Perinatal Deaths

All notifications of stillbirths and neonatal deaths (perinatal deaths) in Western Australia are classified using the Perinatal Society of Australia and New Zealand Perinatal Death Classification (PSANZ-PDC). The Committee investigates and classifies all deaths with gestational age of 26 weeks or greater; from 2017, this was expanded to include all deaths with gestational age of 23 weeks or greater but continued to exclude therapeutic medical terminations of pregnancy. Notified perinatal deaths that do not meet the criteria to be investigated and classified by the Committee are classified by staff from the Department of Health, based on information provided by the notifying practitioner and/or the Death Certificate.

Table 9. PSANZ-PDC causes of perinatal mortality in Western Australia, 2014-2018

PSANZ-PDC cause of death	Stillbirths N=1164		Neonatal mortality N=290		Perinatal mortality N=1454	
	n (%)	rate per 1000 births (95% CI)	n (%)	rate per 1000 live births (95% CI)	n (%)	rate per 1000 births (95% CI)
1. Congenital abnormality	361 (31.0)	2.1 (1.9, 2.3)	91 (31.4)	0.5 (0.4, 0.6)	452 (31.1)	2.6 (2.4, 2.8)
2. Perinatal infection	117 (10.1)	0.7 (0.6, 0.8)	25 (8.6)	<0.1 (0.1, 0.2)	142 (9.8)	0.8 (0.7, 1.0)
3. Hypertension	38 (3.3)	0.2 (0.2, 0.3)	6 (2.1)	<0.1 (0.0, 0.1)	44 (3.0)	0.3 (0.2, 0.3)
4. Antepartum haemorrhage	85 (7.3)	0.5 (0.4, 0.6)	23 (7.9)	0.1 (0.1, 0.2)	108 (7.4)	0.6 (0.5, 0.7)
5. Maternal conditions	27 (2.3)	0.2 (0.1, 0.2)	5 (1.7)	<0.1 (0.0, 0.1)	32 (2.2)	0.2 (0.1, 0.3)
6. Specific perinatal conditions	112 (9.6)	0.6 (0.5, 0.8)	9 (3.1)	0.1 (0.0, 0.1)	121 (8.3)	0.7 (0.6, 0.8)
7. Hypoxic peripartum death	18 (1.6)	0.1 (0.1, 0.2)	21 (7.2)	0.1 (0.1, 0.2)	39 (2.7)	0.2 (0.2, 0.3)
8. Fetal growth restriction	55 (4.7)	0.3 (0.2, 0.4)	8 (2.8)	<0.1 (0.0, 0.1)	63 (4.3)	0.4 (0.3, 0.5)
9. Spontaneous preterm	115 (9.9)	0.7 (0.5, 0.8)	83 (28.6)	0.5 (0.4, 0.6)	198 (13.6)	1.1 (1.0, 1.3)
10. Unexplained antepartum death	234 (20.1)	1.3 (1.2, 1.5)	4 (1.4)	<0.1 (0.0, 0.1)	238 (16.4)	1.4 (1.2, 1.6)
11. No obstetric antecedent	2 (0.2)	<0.1 (0.0, 0.0)	15 (5.2)	0.1 (0.0, 0.1)	17 (1.2)	0.1 (0.1, 0.2)

For the period 2014-2018, congenital abnormality was the most common PSANZ-PDC cause of stillbirths (n=361, 31.0%) and neonatal deaths (n=91, 31.4%); Table 9. This was followed by unexplained antepartum death (n=234; 20.1%) among stillbirths and spontaneous preterm (n=83; 28.6%) among neonatal deaths.

Among the babies born to Aboriginal mothers, unexplained antepartum death (n=21, 19.1%), spontaneous preterm (n=20, 18.2%) and congenital abnormality (n=19, 17.3%) were the most common PSANZ-PDC causes of stillbirth (Table 10). Spontaneous preterm (n=20, 45.5%), congenital abnormality (n=7, 15.9%) and perinatal infection (n=7, 15.9%) were the most common causes of neonatal mortality among Aboriginal babies.

Table 10. PSANZ-PDC causes of perinatal mortality among babies born to Aboriginal mothers in Western Australia, 2014-2018

PSANZ-PDC cause of death	Stillbirths N=110		Neonatal mortality N=44		Perinatal mortality N=154	
	n (%)	rate per 1000 births (95% CI)	n (%)	rate per 1000 live births (95% CI)	n (%)	rate per 1000 births (95% CI)
1. Congenital abnormality	19 (17.3)	2.1 (1.3, 3.3)	7 (15.9)	0.8 (0.3, 1.6)	26 (16.9)	2.9 (1.9, 4.2)
2. Perinatal infection	14 (12.7)	1.6 (0.9, 2.6)	7 (15.9)	0.8 (0.3, 1.6)	21 (13.6)	2.3 (1.4, 3.6)
3. Hypertension	3 (2.7)	0.3 (0.1, 1.0)	0	-	3 (1.9)	0.3 (0.1, 1.0)
4. Antepartum haemorrhage	10 (9.1)	1.1 (0.5, 2.0)	2 (4.5)	0.2 (0.0, 0.8)	12 (7.8)	1.3 (0.7, 2.3)
5. Maternal conditions	8 (7.3)	0.9 (0.4, 1.8)	2 (4.5)	0.2 (0.0, 0.8)	10 (6.5)	1.1 (0.5, 2.0)
6. Specific perinatal conditions	6 (5.5)	0.7 (0.2, 1.5)	0	-	6 (3.9)	0.7 (0.2, 1.5)
7. Hypoxic peripartum death	3 (2.7)	0.3 (0.1, 1.0)	2 (4.5)	0.2 (0.0, 0.8)	5 (3.2)	0.6 (0.2, 1.3)
8. Fetal growth restriction	5 (4.5)	0.6 (0.2, 1.3)	2 (4.5)	0.2 (0.0, 0.8)	7 (4.5)	0.8 (0.3, 1.6)
9. Spontaneous preterm	20 (18.2)	2.2 (1.4, 3.4)	20 (45.5)	2.2 (1.4, 3.5)	40 (26.0)	4.4 (3.2, 6.1)
10. Unexplained antepartum death	21 (19.1)	2.3 (1.4, 3.6)	0	-	21 (13.6)	2.3 (1.4, 3.6)
11. No obstetric antecedent	1 (0.9)	0.1 (0.0, 0.6)	2 (4.5)	0.2 (0.0, 0.8)	3 (1.9)	0.3 (0.1, 1.0)

Infant Deaths

The Perinatal Society of Australia and New Zealand Neonatal Death Classification (PSANZ-NDC) system further classifies neonatal deaths by the condition present in the child in the neonatal period leading to the death of the child. As there is no official classification system available specifically for post-neonatal deaths, all infant deaths are classified using the PSANZ-NDC in conjunction with the PSANZ-PDC for consistency.

Overall, for the period 2014-2018, congenital abnormality (n=131, 29.2%), 'other' causes (n=104, 23.2%) and extreme prematurity (n=63, 14.1%) were the most common PSANZ-NDC causes of infant mortality in Western Australia (Table 11). More than half of the deaths among the post-neonatal deaths were attributed to 'other' causes (n=87; 55.1%) which include trauma and SIDS.

Table 11. PSANZ-NDC causes of infant mortality in Western Australia, 2014-2018

PSANZ PDC cause of death	Neonatal mortality N=290*		Post-neonatal mortality N=158		Infant mortality N=448	
	n (%)	rate per 1000 births (95% CI)	n (%)	rate per 1000 live births (95% CI)	n (%)	rate per 1000 births (95% CI)
1. Congenital abnormality	91 (31.4)	0.5 (0.4, 0.6)	40 (25.3)	0.2 (0.2, 0.3)	131 (29.2)	0.8 (0.6, 0.9)
2. Extreme prematurity	62 (21.4)	0.4 (0.3, 0.5)	1 (0.6)	0.0 (0.0, 0.0)	63 (14.1)	0.4 (0.3, 0.5)
3. Cardio-respiratory disorders	36 (12.4)	0.2 (0.1, 0.3)	8 (5.1)	0.0 (0.0, 0.1)	44 (9.8)	0.3 (0.2, 0.3)
4. Infection	25 (8.6)	0.1 (0.1, 0.2)	13 (8.2)	0.1 (0.0, 0.1)	38 (8.5)	0.2 (0.2, 0.3)
5. Neurological	51 (17.6)	0.3 (0.2, 0.4)	4 (2.5)	0.0 (0.0, 0.1)	55 (12.3)	0.3 (0.2, 0.4)
6. Gastrointestinal	7 (2.4)	0.0 (0.0, 0.1)	5 (3.2)	0.0 (0.0, 0.1)	12 (2.7)	0.1 (0.0, 0.1)
7. Other#	17 (5.9)	0.1 (0.1, 0.2)	87 (55.1)	0.5 (0.4, 0.6)	104 (23.2)	0.6 (0.5, 0.7)

*One neonatal death did not have PSANZ NDC code recorded.
#'Other' include trauma and Sudden Infant Death Syndrome

Among the babies born to Aboriginal mothers, the leading PSANZ NDC causes of infant mortality were 'other' (n=32; 39.0%), infection (n=14; 17.1%) and extreme prematurity (n=13; 15.9%).

Table 12. Approximately three fourths of all post-neonatal deaths among Aboriginal babies were attributed to 'other' (n=29; 76.3%) and approximately 30% (n=13) of all neonatal deaths were attributed to extreme prematurity (Table 12).

Table 12. PSANZ-NDC causes of infant mortality among babies born to Aboriginal mothers in Western Australia, 2014-2018

PSANZ PDC cause of death	Neonatal mortality N=290*		Post-neonatal mortality N=158		Infant mortality N=448	
	n (%)	rate per 1000 births (95% CI)	n (%)	rate per 1000 live births (95% CI)	n (%)	rate per 1000 births (95% CI)
1. Congenital abnormality	7 (15.9)	0.8 (0.3, 1.6)	1 (2.6)	0.1 (0.0, 0.6)	8 (9.8)	0.9 (0.4, 1.8)
2. Extreme prematurity	13 (29.5)	1.5 (0.8, 2.5)	0	-	13 (15.9)	1.5 (0.8, 2.5)
3. Cardio-respiratory disorders	5 (11.4)	0.6 (0.2, 1.3)	1 (2.6)	0.1 (0.0, 0.6)	6 (7.3)	0.7 (0.2, 1.5)
4. Infection	9 (20.5)	1.0 (0.5, 1.9)	5 (13.2)	0.6 (0.2, 1.3)	14 (17.1)	1.6 (0.9, 2.6)
5. Neurological	7 (15.9)	0.8 (0.3, 1.6)	1 (2.6	0.1 (0.0, 0.6)	8 (9.8)	0.9 (0.4, 1.8)
6. Gastrointestinal	0	-	1 (2.6)	0.1 (0.0, 0.6)	1 (1.2)	0.1 (0.0, 0.6)
7. Other[#]	3 (6.8)	0.3 (0.1, 1.0)	29 (76.3)	3.3 (2.2, 4.7)	32 (39.0)	3.6 (2.5, 5.1)

[#]'Other' include trauma and Sudden Infant Death Syndrome

Post-mortem Investigations

Approximately 53% (n=614) of all stillbirths underwent post-mortem investigation to ascertain causes of death and 36% (n=418) of all stillbirths did not have a post-mortem investigation. Post-mortem information was not reported for 132 (11.3%) stillbirths.

Among neonatal deaths, 98 (33.8%) underwent post-mortem investigation, 154 (53.1%) did not have a post-mortem conducted, and information on whether post-mortem was conducted was not reported for 38 (13.1%) deaths.

Approximately 60% of all post-neonatal deaths (n=96) had a post-mortem investigation conducted, 24.1% (n=38) did not have a post-mortem and information was not reported for the rest.

Cases Investigated by the Committee

The PSANZ recommends that investigation be undertaken following all perinatal deaths to identify the primary cause of death to help the families to understand why their baby died and to aid in the planning of future pregnancies. In Western Australia, following notification of all stillbirths, neonatal deaths and deaths of infants aged less than 12 months, the Chief Health Officer directs the Committee to investigate all perinatal and infant deaths of at least 26 weeks gestation. In 2017, the criteria for investigations by the Committee was changed to include all stillbirths and deaths from at least 23 weeks-of-age but continued to exclude therapeutic medical terminations of pregnancy. Apart from accurately identifying the definitive cause of death, the aim of the investigation is to also determine whether, in the opinion of the Committee, the perinatal or infant death, could have been prevented.

Over the period 2014-2018, the Committee investigated 823 deaths, including 476 stillbirths (57.8%), 192 neonatal deaths (23.3%) and 155 post-neonatal deaths (18.8%).

Perinatal Deaths

All investigated perinatal deaths (n=668) were classified using the PSANZ-PDC system of classification. Among the investigated stillbirths, the main PSANZ PDC causes of death were unexplained antepartum death (n= 144, 30.3%), specific perinatal conditions (n= 68; 14.3%) and congenital abnormality (n=58, 12.2%; Table 13). Congenital abnormality (n=83, 43.2%) was the most common PSANZ PDC cause of death among the investigated neonatal deaths, followed by spontaneous preterm (n= 27, 14.1%) and hypoxic peripartum death (n= 21, 10.9%). Overall, the main PSANZ-PDC causes of death among the investigated perinatal deaths were unexplained antepartum death (n= 144, 21.6%), congenital abnormality (n=141, 21.1%) and specific perinatal conditions (n= 76; 11.4%; Table 13).

Table 13. PSANZ-PDC causes of death among investigated cases of perinatal deaths in Western Australia, 2014-2018

PSANZ PDC cause of death	Stillbirths N=476		Neonatal mortality N=192		Perinatal mortality N=668	
	n	%	n	%	n	%
1. Congenital abnormality	58	12.2	83	43.2	141	21.1
2. Perinatal infection	41	8.6	8	4.2	49	7.3
3. Hypertension	28	5.9	3	1.6	31	4.6
4. Antepartum haemorrhage	48	10.1	15	7.8	63	9.4
5. Maternal conditions	23	4.8	4	2.1	27	4.0
6. Specific perinatal conditions	68	14.3	8	4.2	76	11.4
7. Hypoxic peripartum death	14	2.9	21	10.9	35	5.2
8. Fetal growth restriction	40	8.4	8	4.2	48	7.2
9. Spontaneous preterm	12	2.5	27	14.1	39	5.8
10. Unexplained antepartum death	144	30.3	0	-	144	21.6
11. No obstetric antecedent	0	-	15	7.8	15	2.2

For the investigated cases of perinatal deaths, the breakdown of the PSANZ-PDC causes of death by categories are reported in Supplementary Table 5. In brief, in the top three most common causes of death, 'other specified placental pathology' (n=61) was the most common category among the unexplained antepartum deaths, 'abnormality of cardiovascular system' (n=38) among deaths due to congenital abnormalities and 'twin-twin transfusion' (n=28) among deaths due to specific perinatal conditions.

Of the 668 perinatal deaths investigated, seven of these deaths occurred in babies with gestational age of 23-25 weeks in the period 2014-2016 and three deaths with gestational age of 22 weeks in the period 2017-2018. Unfortunately, there was one death (stillbirth with gestational age of 26 weeks) that was not investigated.

Infant Deaths

During the period 2014-2018, the Committee investigated and classified 347 infant deaths using the PSANZ-NDC system of classification. The most common PSANZ-NDC causes of death among the investigated neonatal deaths were congenital abnormality (n=83, 43.2%), neurological conditions (n=41, 21.4%) and cardio-respiratory disorders (n= 21, 10.9%); Table 14. More than half of all post-neonatal deaths (n=87, 56.1%) were classified as having died due to 'other' conditions (which include SIDS and trauma) and a quarter of all post-neonatal deaths were caused by congenital abnormality (n=29, 25.2%); Table 14.

Table 14. PSANZ-NDC causes of death among investigated cases of infant deaths in Western Australia, 2014-2018

PSANZ PDC cause of death	Neonatal mortality N=192		Post-neonatal mortality N=155		Infant mortality N=347	
	n	%	n	%	n	%
1. Congenital abnormality	83	43.2	39	25.2	122	35.2
2. Extreme prematurity	9	4.7	1	0.6	10	2.9
3. Cardio-respiratory disorders	21	10.9	7	4.5	28	8.1
4. Infection	14	7.3	13	8.4	27	7.8
5. Neurological	41	21.4	4	2.6	45	13.0
6. Gastrointestinal	7	3.6	4	2.6	11	3.2
7. Other	17	8.9	87	56.1	104	30.0

Congenital abnormality (n=122, 35.2%), other (n=104, 30.0%) and neurological conditions (n=45, 13.0%) were the most common PSANZ-NDC causes of death among the investigated infant deaths.

The most common PSANZ-PDC causes of death among the investigated infant deaths were congenital abnormality (n=126, 36.3%), no obstetric antecedent (n=115, 33.1%) and spontaneous preterm (n=31, 8.9%);

Table 15. The breakdown of the PSANZ-NDC causes of death by categories for the investigated cases of infant deaths are reported in Supplementary Table 6.

Table 15. Investigated cases of infant deaths by cause of death classification systems (PSANZ-PDC and PSANZ-NDC) in Western Australia, 2014-2018

PSANZ-PDC	PSANZ-NDC							
	1.Congenital abnormality	2.Extreme prematurity	3.Cardio-respiratory disorders	4.Infection	5.Neurological	6.Gastro-intestinal	7.Other	TOTAL
1. Congenital abnormality	119	1	2	2	0	2	0	**126**
2. Perinatal infection	0	2	1	6	0	0	0	**9**
3. Hypertension	0	1	2	0	0	0	2	**5**
4. Antepartum haemorrhage	0	1	1	1	11	2	0	**16**
5. Maternal conditions	0	0	0	0	3	0	1	**4**
6. Specific perinatal conditions	1	0	1	1	5	1	0	**9**
7. Hypoxic peripartum death	0	0	3	0	19	1	0	**23**
8. Fetal growth restriction	1	0	8	0	0	0	0	**9**
9. Spontaneous preterm	1	5	10	4	6	4	1	**31**
10. Unexplained antepartum death	0	0	0	0	0	0	0	**0**
11. No obstetric antecedent	0	0	0	13	1	1	100	**115**
TOTAL	**122**	**10**	**28**	**27**	**45**	**11**	**104**	**347**

When PSANZ-PDC and PSANZ-NDC were cross tabulated, it was observed that the majority of neonatal deaths had an antenatal factor i.e. congenital abnormality (Table 16).

Table 16. Investigated cases of neonatal deaths by cause of death classification systems (PSANZ-PDC and PSANZ-NDC) in Western Australia, 2014-2018

PSANZ-PDC	PSANZ-NDC							
	1.Congenital abnormality	2.Extreme prematurity	3.Cardio-respiratory disorders	4.Infection	5.Neurological	6.Gastro-intestinal	7.Other	TOTAL
1. Congenital abnormality	80	1	1	1	0	0	0	**83**
2. Perinatal infection	0	1	1	6	0	0	0	**8**
3. Hypertension	0	1	1	0	0	0	1	**3**
4. Antepartum haemorrhage	0	1	1	1	10	2	0	**15**
5. Maternal conditions	0	0	0	0	3	0	1	**4**
6. Specific perinatal conditions	1	0	1	1	5	0	0	**8**
7. Hypoxic peripartum death	0	0	3	0	17	1	0	**21**
8. Fetal growth restriction	1	0	7	0	0	0	0	**8**
9. Spontaneous preterm	1	5	6	4	6	4	1	**27**
10. Unexplained antepartum death	0	0	0	0	0	0	0	**0**
11. No obstetric antecedent	0	0	0	1	0	0	14	**15**
TOTAL	**83**	**9**	**21**	**14**	**41**	**7**	**17**	**192**

In contrast, the majority of post-neonatal deaths were caused by post-natal factors, especially SIDS (Table 17 and Supplementary Table 6).

Table 17. Investigated cases of post-neonatal deaths by cause of death classification systems (PSANZ-PDC and PSANZ-NDC) in Western Australia, 2014-2018

PSANZ-PDC	PSANZ-NDC							
	1.Congenital abnormality	2.Extreme prematurity	3.Cardio-respiratory disorders	4.Infection	5.Neurological	6.Gastro-intestinal	7.Other	TOTAL
1. Congenital abnormality	39	0	1	1	0	2	0	**43**
2. Perinatal infection	0	1	0	0	0	0	0	**1**
3. Hypertension	0	0	1	0	0	0	1	**2**
4. Antepartum haemorrhage	0	0	0	0	1	0	0	**1**
5. Maternal conditions	0	0	0	0	0	0	0	**0**
6. Specific perinatal conditions	0	0	0	0	0	1	0	**1**
7. Hypoxic peripartum death	0	0	0	0	2	0	0	**2**
8. Fetal growth restriction	0	0	1	0	0	0	0	**1**
9. Spontaneous preterm	0	0	4	0	0	0	0	**4**
10. Unexplained antepartum death	0	0	0	0	0	0	0	**0**
11. No obstetric antecedent	0	0	0	12	1	1	86	**100**
TOTAL	**39**	**1**	**7**	**13**	**4**	**4**	**87**	**155**

The investigated cases of infant deaths included 9 deaths that occurred in babies with gestational ages lower than the recommended age for investigation (seven deaths occurred in babies with gestational age of 23-25 weeks in 2016 and two deaths with gestational age of 22 weeks in 2017). The deaths in 2016 (all with 23 weeks gestation) were reported in 2017 and therefore, included for investigation by the Committee; the two deaths in 2017 were neonatal deaths and therefore investigated. The PSANZ-NDC causes of death associated with these cases were cardio-respiratory disorders (n=3), neurological (n=3), gastrointestinal (n=2) and extreme prematurity (n=1). There was one case of infant death in 2018 that, despite meeting the age recommendation of 23 weeks gestational age, was not investigated.

Preventable Factors

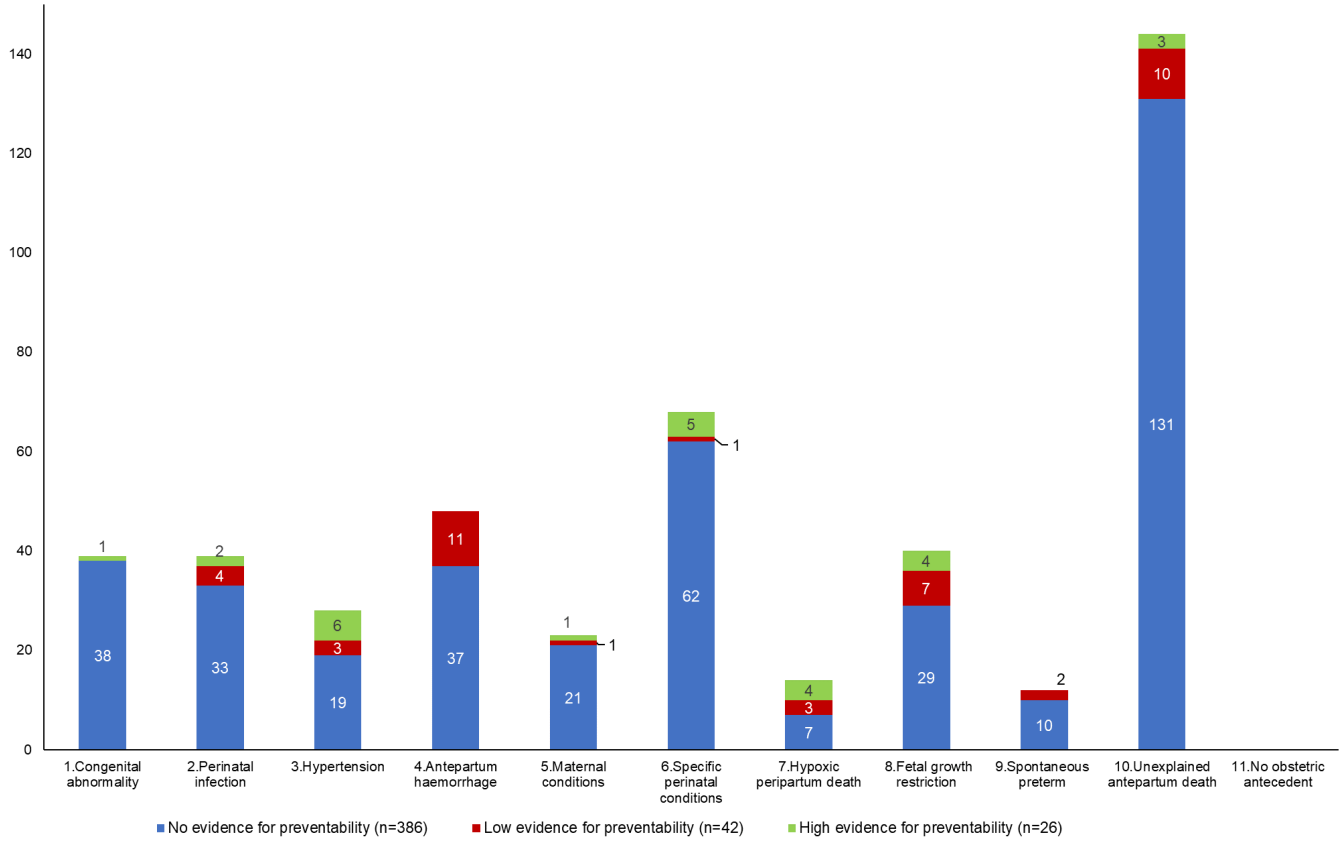
All investigated deaths were classified using a preventability scale to identify cases with possible preventable medical factors. A medical preventability score of one indicates no evidence for medical preventability, a score between two and three indicates low degree of evidence and a score between four and six indicates a high degree of evidence for medical preventability.

Medical preventability of stillbirths

Of the investigated 476 stillbirths, the majority of cases (n=387, 81.3%) had virtually no evidence for medical preventability, 42 (8.8%) had low degree of evidence and 26 (5.5%) had high degree of evidence for medical preventability. Twenty one (4.4%) of the stillbirths were not classified as the preventability evidence could not be coded appropriately.

Of those stillbirths found to have high degree of evidence for medical preventability, the most common PSANZ-PDC causes of deaths were maternal hypertension (n=6), specific perinatal condition (n=5), hypoxic peripartum death (n=4) and fetal growth restriction (n=4); Figure 3.

Figure 3. PSANZ-PDC causes of death by evidence of preventability among investigated stillbirths in Western Australia, 2014-2018

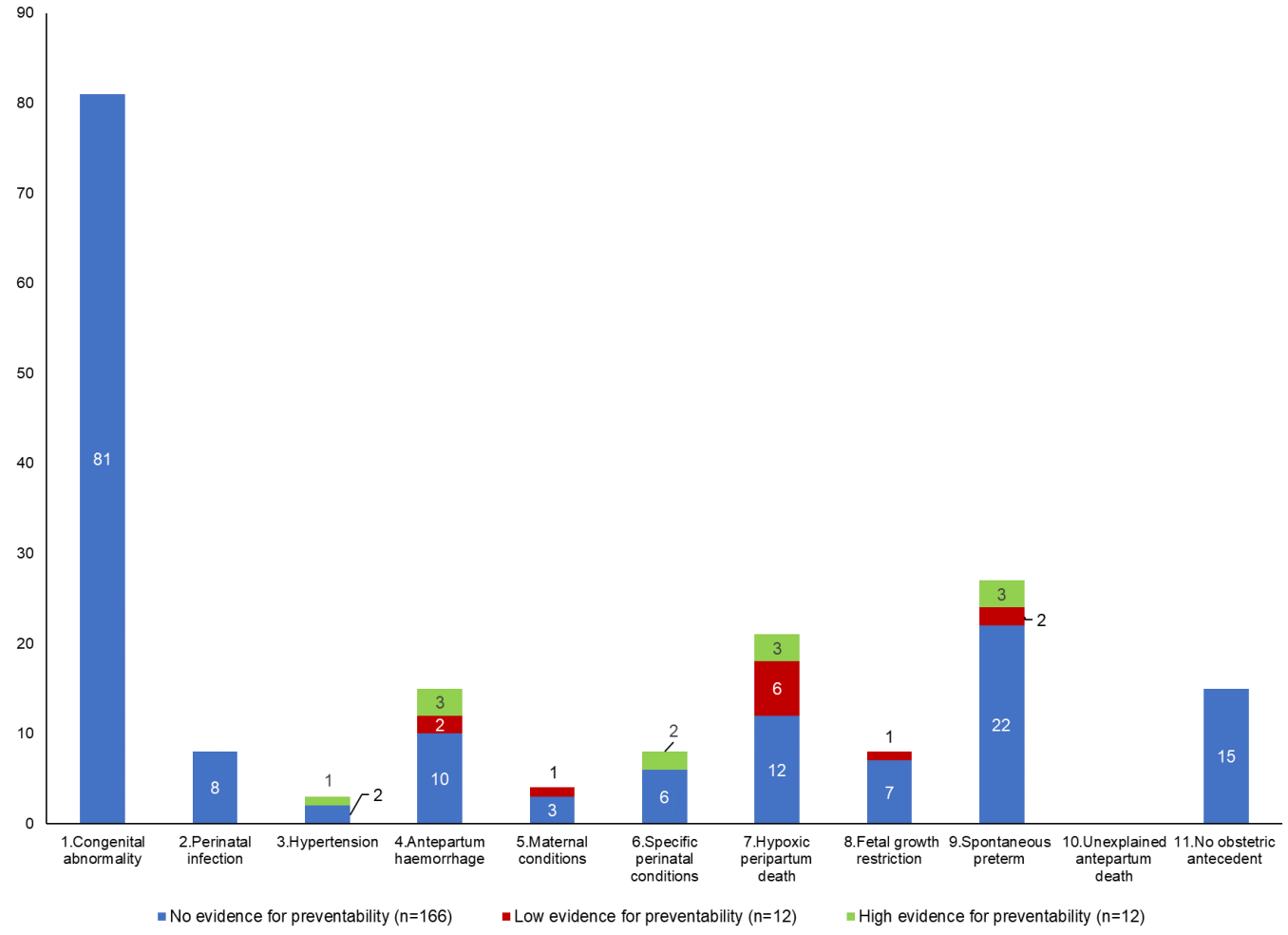


Medical preventability of neonatal deaths

The majority (n=166, 86.5%) of the investigated 192 neonatal deaths had virtually no evidence for medical preventability and equal proportions of the cases (n=12, 6.3%) had either low or high degree of evidence for medical preventability. Two (1.0%) of the neonatal deaths were not classified as the preventability evidence could not be coded appropriately.

Of the neonatal deaths found to have high degree of evidence for medical preventability, the PSANZ-PDC causes of deaths were antepartum haemorrhage (n=3), hypoxic peripartum death (n=3), spontaneous preterm (n=3), specific perinatal condition (n=2) and maternal hypertension (n=1); Figure 4.

Figure 4. PSANZ-PDC causes of death by evidence of preventability among investigated neonatal deaths in Western Australia, 2014-2018

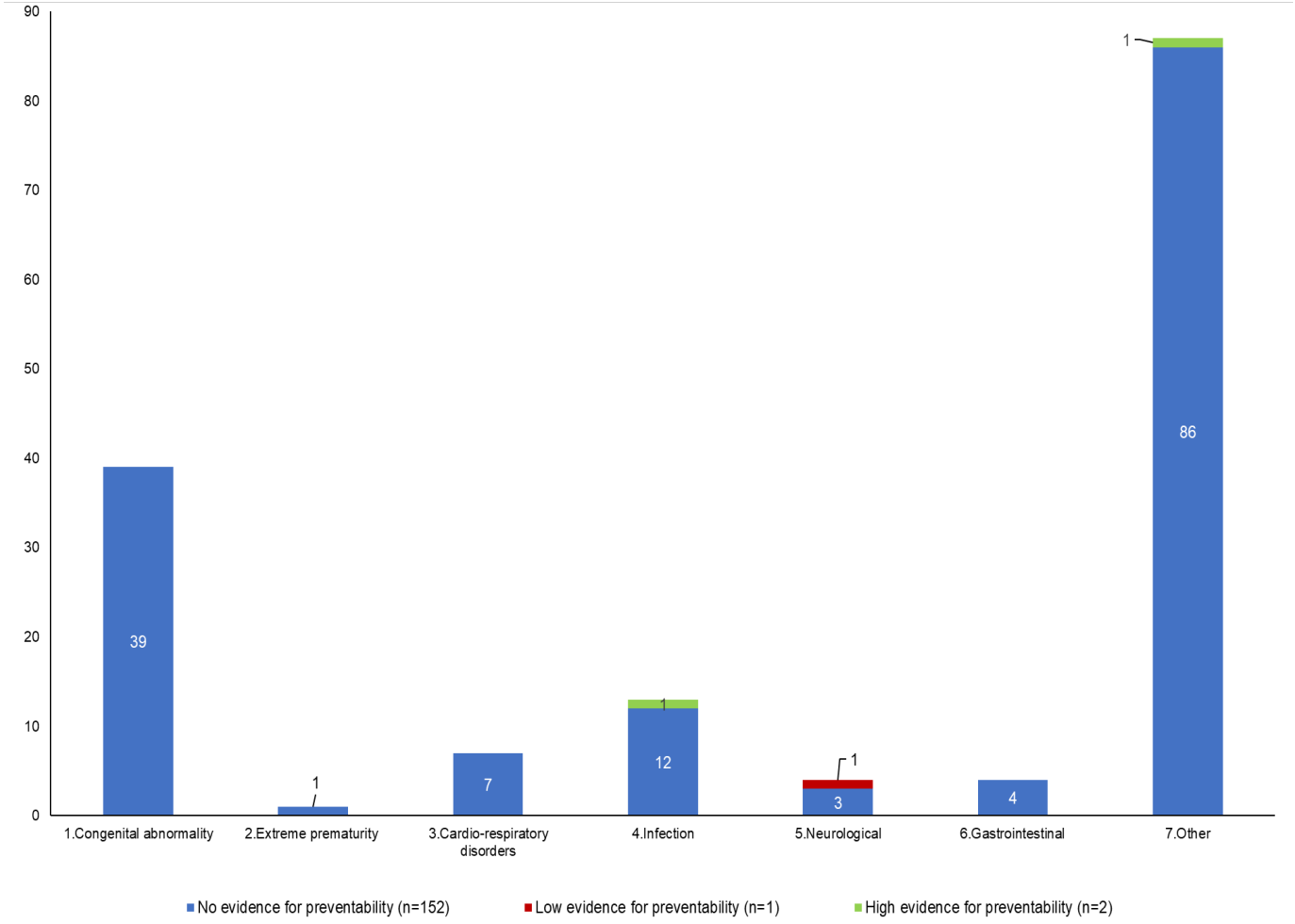


Medical preventability of post-neonatal deaths

The majority (n=152, 98.1%) of the investigated 155 post-neonatal deaths had virtually no evidence for medical preventability, one case (0.7%) had low degree of evidence and two cases (1.3%) had a high degree of evidence for medical preventability.

The PSANZ-NDC causes of deaths for the two post-neonatal deaths, with high degree of evidence for medical preventability, were infection (bacterial) and other (trauma); Figure 5.

Figure 5. PSANZ-NDC causes of death by evidence of preventability among investigated post-neonatal deaths in Western Australia, 2014-2018



Methods and terminology

Methods

Data sources: Western Australian Midwives Notification System (MNS) and the Perinatal and Infant Mortality dataset.

Cohort: The birth cohort for this Report included all births between 1 January 2014 and 31 December 2018 (inclusive), identified from the MNS. All notifications of perinatal and infant deaths in the same time period, as recorded on the perinatal and infant mortality dataset, were linked to this cohort. This Report does not include births/deaths less than 20 weeks gestation and less than 400g birth weight.

Data analysis: Data from the Perinatal and Infant Mortality dataset were linked to data from the MNS. Deaths of Western Australian residents that occurred in other states were not included. Deaths of non-residents were not included in mortality rates, unless the case was born in Western Australia. All data cleaning and analysis were analysed using SAS 8.1, unless otherwise stated.

Perinatal death rates were calculated based on all Western Australian births during the calendar year of reporting irrespective of the year in which the death occurred. The infant mortality rate was calculated based on the number of infants born during the calendar year of reporting, who subsequently died within 364 days irrespective of which calendar year the death occurred.

Proportions, rates, rate ratios and the related exact 95% confidence intervals were calculated using EpiBasic version 4.4. Where appropriate, categories were aggregated to provide more reliable statistics. Logistic regression analyses were used to calculate odds ratios and ascertain whether a particular risk factor, such as race, smoking, health region, socio-economic status had a statistically significant association with the outcome of interest (e.g. stillbirth).

Terminologies used in this report

Birthweight: The first naked weight recorded for the infant following birth, to the nearest five whole grams. Usually obtained within the first hour of birth.

Complications of pregnancy includes:
001=Threatened abortion (<20 weeks)
002=Threatened pre-term labour
003=Urinary tract infection
004=Pre-eclampsia
005=Antepartum haemorrhage APH-placenta praevia
006=Antepartum haemorrhage APH-abruption
007=Antepartum haemorrhage APH-other
008=Pre-labour rupture of membranes
009=Gestational Diabetes 010 (no longer used)
011=Gestational hypertension
012=Pre-eclampsia superimposed on essential hypertension

Ethnic status: Self-reported ethnic origin of the woman giving birth as recorded on the Midwives Notification database.

> ***Aboriginal*:** Women who self-report ethnic origin as Aboriginal and/or Torres Strait Islander, which usually includes descendants of people originating from Australia or the Torres Strait Islands. Please note that, within Western Australia, in recognition that Aboriginal people are the original inhabitants of Western Australia, the term Aboriginal is used in preference to Aboriginal and Torres Strait Islander. No disrespect is intended to our Torres Strait Islander colleagues and community.
>
> ***Caucasian*:** Women who self-report ethnic origin as Caucasian.
>
> ***South East and East Asian***: Women who self-report ethnic origin as South East or East Asian (i.e. Vietnamese, Malaysian, Cambodian, Chinese, Japanese).
>
> ***South Asian*:** Women who self-report ethnic origin as Indian, which usually includes descendants of people originating in the area of the Indian subcontinent, Pakistan.
>
> ***African*:** Women who self-report ethnic origin as African, which usually includes descendants of people from Africa i.e. Nigerian, Somalian.
>
> ***Polynesian:*** Women who self-report ethnic origin as Polynesian, which usually includes descendants of people from the Pacific Island areas excluding New Zealand i.e. Samoa, Tonga, Cook Islands, Hawaii.
>
> ***Maori*:** Women who self-report ethnic origin as Maori, which usually includes people of New Zealand origin.
>
> ***Other*:** Women who self-report any ethnic origin not elsewhere specified in this list or who is unable to specify any ethnic origin. May include women from Mediterranean or middle eastern areas. May include women reporting more than one ethnic origin other than Aboriginal or Torres Strait Islander.

Gestational age: The duration of pregnancy in completed weeks from the first day of the last normal menstrual period.

Infant death: The death within a year of birth of a live born infant.

Livebirth: The complete expulsion or extraction from its mother of an infant irrespective of duration of pregnancy, which, after birth, takes a breath or shows any other signs of life.

Mortality rates:

> ***Stillbirth rate***: The number of stillbirths per 1,000 total births in a defined time period.
>
> ***Neonatal mortality***: The number of neonatal deaths per 1,000 live births in a defined time period.
>
> ***Perinatal mortality***: The number of stillbirths and neonatal deaths per 1,000 total births in a defined time period.
>
> ***Post-neonatal mortality rate***: The number of post-neonatal deaths per 1,000 live births in a defined time period
>
> ***Infant mortality rate***: Number of deaths of infants per 1,000 live births in a defined time period.

Neonatal death: The death of a live born infant within 28 days of birth.

Nulliparous: Never having completed a pregnancy beyond 20 weeks gestation prior to the current pregnancy.

Multiparous: Having completed one or more pregnancies beyond 20 weeks gestation.

Perinatal death: A stillbirth (fetal death) or neonatal death.

Post-neonatal death: The death of a live born infant from 28 to 364 days after birth.

Stillbirth or Fetal death: The complete expulsion or extraction from its mother of an infant weighing at least 400 grams birthweight or at least 20 weeks gestation, which shows no sign of life from the time of birth.

Sudden Infant Death Syndrome: The sudden and unexplained death of an otherwise healthy infant less than one year-of-age, with onset of the fatal episode apparently occurring during sleep. The diagnosis of SIDS is made if the infant's death remains unexplained even after a thorough investigation, including performance of a complete autopsy and review of the circumstances of death, including the clinical history.

Term Infants: Infants born at gestational age of 37 weeks or greater.

Unbooked births: Are not planned homebirths or hospital births, and include women who perhaps had no antenatal care, unacknowledged/undiagnosed pregnancy, and arrived at hospital in labour or following birth enroute or unexpected, unplanned at home.

Appendix 1. The Perinatal Autopsy (Post-mortem)

Author: Dr Disna Abeysuriya

"It is every parent's right to be offered a post-mortem examination of their child, and equally their right to refuse."

Perinatal post-mortem (autopsy) examination is the examination of the body of the baby, with the aim to understand why the baby died. A post-mortem examination is the only certain method of determining and recording the cause of death. It involves an external and internal examination of the deceased. Some tissue samples are usually retained for laboratory analysis. Photographs and radiology are also attended to.

In Western Australia, we have among the highest rate in the country for perinatal post-mortem examinations of around 57% per cent. A higher rate of autopsy examinations might help reduce the number of unexplained deaths. During the Perinatal and Infant Mortality Committee meetings, the post-mortem examination contributes useful information for the assessment of the causes of death.

The Guidelines for health-care professionals applicable to all perinatal deaths at King Edward Memorial Hospital are available from: https://www.wnhs.health.wa.gov.au/-/media/Files/Hospitals/WNHS/For-health-professionals/Clinical-guidelines/OG/WNHS,-d-,OG,-d-,PerinatalLoss.pdf.

Is the autopsy still useful?

The post-mortem examination significantly affects the overall understanding of the cause of a perinatal death. It has been shown in several studies that the information gained from autopsy changed the diagnosis or provided important additional findings. A change in diagnosis or additional findings were found in 22-76%. The placenta is an essential part of the autopsy and studies have shown that the placenta attributes as a cause or cause contributing to stillbirth in 11-65%. The post-mortem findings are therefore useful in correct classification of perinatal deaths.

Some publications have examined whether the post-mortem examination is still useful or can be supplanted by other investigations, such as MRI scans. Although MRI can be useful in some neurological conditions, the overwhelming consensus is that the full post-mortem examination still provides more information than available from other techniques.

Some studies have also shown that, in general, parents are more likely to express regret at not having an autopsy than to express regret at having an autopsy on their baby. Many wish to understand as much as possible why the tragedy occurred.

Coronial autopsies

Under the *Coroners Act (1996)* a death is reportable to the Coroner if the death is unexpected, unnatural or violent, or occurs in other prescribed circumstances (e.g. under anaesthesia, is a maternal death). The aim is to determine the cause of death. Under the Act, reportable deaths must be reported to a Coroner (see *Coroners Act 1996*); and the Coroner may request an autopsy. It is worth discussing any case with the Office of the State Coroner (contact details are on the Death in Hospital Form), if there is any doubt about whether the death is reportable or not. These autopsies do not require consent from next-of-kin, although there are legal means for the parents to object to the examination. The coronial post-mortem examination usually takes place at the State mortuary on the Queen Elizabeth II site with the Coroner's pathologists

although, for perinatal deaths, it is common for the post-mortem examination to be conducted at Perth Children's Hospital (PCH) with specialist Paediatric Perinatal Pathologists in collaboration with the State Coroner's pathologists and may include medical photographs and radiology.

Non-coronial, consented autopsies
All perinatal autopsies are performed at PCH by a specialist perinatal/paediatric pathologist. Cases are transferred from all over the State and, when requested, usually returned within two to three working days. The Perinatal Pathology technician is available for advice, including what forms are required, what information is required on forms, transport system and logistics and other information.

Perinatal Pathology will collect mementoes of every baby/fetus that is in Perinatal Pathology. This includes mementoes, such as hand/footprints and social photographs. With parental consent, stillborn babies less than 28 weeks gestation can be cremated, with individual ashes. Contact details for Perinatal Pathology (08) 6458 2730.

The autopsy - full or limited?
The autopsy involves examination of the body, external and internal, including cranial contents, the abdomen and the thorax. The placenta is a particularly important part of any perinatal examination. Some parents will ask for a limited post-mortem, where only a particular system is examined.

Some parents consent to an external examination, where no incisions are made, and the baby is not examined internally. This includes visual examination, weight, measurements of external growth parameters, radiology, photographs and examination of the placenta.

No whole major organ is retained (i.e. brain, heart, lungs, liver or kidneys) without specific consent. In cases of abnormal Central Nervous System development or a complicated cardiac or lung defect, it is useful to obtain consent for retention of those organs for a better examination. The organs will be returned at a later date.

Unless there is an objection, small pieces of the major organs are routinely taken for histology. Small samples may be taken for other investigations (e.g. microbiology, metabolic, electron microscopy, microarray, specific gene panels) as appropriate.

The Consent for Autopsy (non-coronial)
The current law in Western Australia with the recent rules of practice means that the consent form (PathWest consent form for post-mortem examination >20 weeks gestation) is detailed, covering the full or limited examination, clearly indicating parents' wishes. If an organ is to be retained, there needs to be a plan, if there is a delay in burial of the body, allowing the return (usually 2 weeks or so) of the organ. The organ can be cremated and returned or donated for research or teaching. There are places to indicate consent for tissue to be retained for teaching or research.

The Consent Form must be signed by a parent. The referring clinician must provide clinical information and witness the consent signature. The human tissue act officer for the institution needs to sign that there is satisfactory evidence of parental consent and the post-mortem coordinator also signs the form.

The Autopsy Report (non-coronial)
A written report listing the provisional anatomic diagnosis is available within two to three working days and a full report, including ancillary investigations and conclusions usually within 6-8 weeks. A plain language report can be issued to be given to the parents after discussion with the clinician.

Interpreting the autopsy report
The pathophysiology of perinatal death is complicated, and much research is needed in this area. The best way to investigate a perinatal death undoubtedly involves a review of all the clinical investigations, together with the pathology reports. Sometimes the autopsy finds a complete explanation of the cause of death, but frequently, there is only a partial explanation, such as unexpected growth restriction or placental abnormality.

There are also a number of cases where, to the frustration of all concerned, no significant abnormalities are identified at autopsy. Recently, diseases such as obstetric cholestasis are being recognised, with a high incidence of stillbirth at term, with no post-mortem features. The post-mortem examination is not good at detecting transient physiological mechanisms. The purpose of the autopsy is to exclude many potential recurrent conditions.

Other forms (babies 20 weeks gestation and greater)
The following certificate/forms for all stillbirths or neonatal deaths need to be completed as appropriate:

BDM 201 Medical Certificate for Stillbirth or Neonatal Death
Form 7 Certificate of medical practitioner
PathWest Consent for Cremation - Stillborn baby < 28 weeks gestation

The Perinatal Loss Service
King Edward Memorial Hospital has a multi-disciplinary Perinatal Loss Service, consisting of two obstetricians, one fetal medicine specialist, neonatologist, pathologist, geneticist, midwife, social worker, psychologist and chaplain. The aim is to support and counsel parents, investigate, if appropriate, using protocols, and to provide consultancy, guidance and advice for health professionals. Telehealth facilities are sometimes used for rural hospital links. The contact person is Clinical Midwife Consultant: 6458 2222 pager 3430, or phone 0416 019 020. Perinatal Loss Clinic is available for appointments, referral is required.

Information and Support
More information available at PathWest - (health.wa.gov.au)

Perinatal Society of Australia and New Zealand (PSANZ) Perinatal Pathology guidelines at: Clinical-Practice-Guidelines-for-Care-Around-Stillbirth-and-Neonatal-Death2-2.pdf (stillbirthcre.org.au).

We are grateful to the health professionals who have spent their time counselling parents to obtain consent and provide feedback, to allow this service to work.

Appendix 2: Current information on Co-Sleeping

Authors: Carrington Shepherd, Jenny Bourke and Helen Leonard

Providing a safe sleeping environment is recognised as a primary strategy for the prevention of Sudden Unexpected Death in Infancy (SUDI), which includes SIDS and fatal sleep accidents. Ensuring that a baby sleeps in their own safe sleep place, is a central feature of creating a safe sleeping environment, with messages typically recommending that babies sleep in a safe cot in the parents' room.

> It should be noted that a range of terms are used in messaging related to safe infant sleep. These terms encompass the inter-related practices of co-sleeping, bed-sharing, sofa-sleeping, sidecar crib sleeping and same room cot sleeping, among others[2], but there is no common definition for many of these terms, resulting in some inconsistent use and confusion among parents and healthcare professionals when interpreting recommendations.[3] Co-sleeping, for example, is typically defined as an infant being asleep on the same sleep surface as another person, but it has also been used to describe an infant sleeping in the same room without sharing a sleep surface.[4]

It has long been acknowledged that safe sleep practices are one of a range of interacting risk and protective factors to SUDI. The Triple Risk Model, for example, proposed that intrinsic factors (e.g. gender, prematurity and exposure to smoking) and extrinsic factors (e.g. positional sleeping, soft bedding, mild infections and bed sharing) pose a risk to SIDS, especially in the earlier post-neonatal period.[5] Meta-analytic evidence has shown that bed-sharing results in a three-fold overall increased risk of SIDS - with substantially higher-risks for infants under 12 weeks-of-age (ten-fold risk) and with a mother who smoked (6-fold risk).[6]

For the past three decades, SUDI-reduction campaigns have focused on the identified risk factors that are modifiable. The international *Back to Sleep* campaign in the early 1990s promoted the placement of babies on their backs for all sleeping, while, in Australia, the *Reduce the Risks* campaign launched by SIDS and Kids (now Red Nose) in 1991 additionally focused on maintaining a smoke-free environment, moderating baby's body temperature and promoting breastfeeding. Safe infant sleep (and care) practices have remained a feature of all subsequent public health promotion activities in Australia and are embedded in the current recommendations provided by Red Nose to parents for reducing the risk of SIDS:

- Sleep baby on the back from birth, not on the tummy or side
- Sleep baby with head and face uncovered
- Keep baby smoke free before birth and after
- Provide a safe sleeping environment night and day
- Sleep baby in their own safe sleeping place in the same room as an adult care-giver for the first six to twelve months
- Breastfeed baby

Coronial investigations have also been important in shaping change in safe sleeping practices in infancy. In Western Australia specifically, a 2008 Coronial inquest led to the development of a state-wide policy on co-sleeping/bed-sharing in order to reduce the risk of SIDS deaths. A subsequent evaluation of the policy described the conflict felt by many health professionals in advising against bed-sharing in line with the directive, but knowing that, for cultural reasons, belief in the benefits of bonding or simply fatigue, co-sleeping would occur.[7] This evaluation highlighted educational opportunities to provide advice about co-sleeping that included how to do it more safely, particularly in situations where parents are unlikely to adhere to the directive,

e.g. cultural reasons. It has been suggested that the ethical dilemma faced by health professionals could involve families receiving messages on both breastfeeding and bed-sharing tailored to their specific circumstances and risk factors, rather than a risk elimination approach that includes advice against any bed-sharing.[2]

These (and other) public health and policy initiatives, along with child death investigations and research, have collectively led to substantial improvements in the rate of sleep-related deaths in Australia[8], with an 83% reduction in SIDS deaths recorded between 1985 and 2005.[9] Although the rates have remained relatively static in subsequent years, SIDS remains one of the leading causes of post-neonatal deaths in Australia.[10]

While gains have been made in the reduction of sleep-related deaths in Australia, there remains to be disparities in the rates of SUDI between some population groups. In Western Australia, for example, the rate among Aboriginal and Torres Strait Islander populations in 2014-16 was around seven times higher than that reported in non-Aboriginal groups.[11] Evidence suggests that the initial National risk reduction education campaigns may have been less impactful on Aboriginal SUDI rates,[11] which raised concerns that generic health promotion and safe sleeping messages were not reaching Aboriginal communities.

In response to the high rates of SUDI among the Aboriginal population, Red Nose had already commenced its *Reducing the Risk of SUDI in Aboriginal Communities* (RROSIAC) program in Western Australia, in 2005.[8] This culturally sensitive safe sleeping education program aimed at the prevention of SIDS and SUDI was developed in consultation with Indigenous communities and continues to be delivered in regional and remote locations across Western Australia, servicing healthcare staff and communities. It aims to train and educate Aboriginal families, and those working with families in the infancy period about SUDI, including the range of risk factors and harm minimisation strategies. This model of best practice research working with Indigenous communities also guided the delivery of the Pepi-Pod program in Queensland.[12] These safe sleep spaces were developed in New Zealand for vulnerable families to negate the risks posed by co-sleeping and later successfully trialled in Queensland.[13] The Pepi-pod is a plastic tub with air slots, its own mattress and linen, designed to sit on an adult mattress to create a zone of physical protection around the baby and others in the bed. It provides safety, convenience and portability. The Pepi-pods are now being trialled with vulnerable Aboriginal families in the Kimberley region along with safe sleep education.[14] Preliminary evidence suggests that this initiative has been well received by the community, with Red Nose planning to expand its Pepi-Pod initiative as part of its harm minimisation strategies and education around co-sleeping and SUDI.[11]

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Appendix 3: Supplementary Tables

Supplementary Table 1. Number and rate of stillbirths, neonatal and post-neonatal mortality by time period in Western Australia, 1990-2018

Time period*	Total births	Live births	Stillbirths		Neonatal mortality		Post-neonatal mortality	
			n	rate/1000 births (95% CI)	n	rate/1000 live births (95% CI)	n	rate/1000 live births (95% CI)
1990-1992	76352	75818	534	7.0 (6.4, 7.6)	299	3.9 (3.5, 4.4)	223	2.9 (2.6, 3.4)
1993-1995	76207	75653	554	7.3 (6.7, 7.9)	248	3.3 (2.9, 3.7)	157	2.1 (1.8, 2.4)
1996-1998	76528	75994	534	7.0 (6.4, 7.6)	233	3.1 (2.7, 3.5)	153	2.0 (1.7, 2.4)
1999-2001	75939	75387	552	7.3 (6.7, 7.9)	215	2.9 (2.5, 3.3)	124	1.6 (1.4, 2.0)
2002-2004	74995	74449	546	7.3 (6.7, 7.9)	166	2.2 (1.9, 2.6)	94	1.3 (1.0, 1.5)
2005-2007	85723	85125	598	7.0 (6.4, 7.6)	195	2.3 (2.0, 2.6)	115	1.4 (1.1, 1.6)
2008-2010	93158	92480	678	7.3 (6.8, 7.8)	204	2.2 (1.9, 2.5)	116	1.3 (1.0, 1.5)
2011-2013	100460	99744	716	7.1 (6.6, 7.7)	171	1.7 (1.5, 2.0)	91	0.9 (0.7, 1.1)
2014-2018	174050	172886	1164	6.7 (6.3, 7.1)	290	1.7 (1.5, 1.9)	158	0.9 (0.8, 1.1)

*Note that 2014-2018 is a 5-year reporting period while the rest are 3-year reporting periods.

Supplementary Table 2. Number and rate of stillbirths, neonatal and post-neonatal mortality by time period in babies born to Aboriginal mothers in Western Australia, 1990-2018

Time period*	Total births	Live births	Stillbirths		Neonatal mortality		Post-neonatal mortality	
			n	rate/1000 births (95% CI)	n	rate/1000 live births (95% CI)	n	rate/1000 live births (95% CI)
1990-1992	4479	4418	61	13.6 (10.6, 17.5)	41	9.3 (6.8, 12.6)	52	11.8 (9.0, 15.4)
1993-1995	4375	4312	63	14.4 (11.3, 18.4)	34	7.9 (5.6, 11.0)	50	11.6 (8.8,15.3)
1996-1998	4548	4480	68	15.0 (11.8, 18.9)	30	6.7 (4.7, 9.5)	38	8.5 (6.2, 11.6)
1999-2001	4889	4822	67	13.7 (10.8, 17.4)	43	8.9 (6.6, 12.0)	36	7.5 (5.4, 10.3)
2002-2004	4796	4727	69	14.4 (11.4, 18.2)	35	7.4 (5.3-10.3)	25	5.3 (3.6-7.8)
2005-2007	5357	5287	70	13.1 (10.4, 16.5)	33	6.2 (4.4, 8.8)	32	6.1 (4.3, 8.5)
2008-2010	5204	5134	70	13.5 (10.7, 17.0)	36	7.2 (5.2, 9.9)	25	4.7 (3.1, 6.9)
2011-2013	5154	5069	85	16.5 (13.4, 20.3)	27	5.3 (3.7, 7.7)	18	3.6 (2.2, 5.6)
2014-2018	9003	8893	110	12.2 (10.0, 14.7)	44	4.9 (3.6, 6.6)	38	4.3 (3.0, 5.9)

*Note that 2014-2018 is a 5-year reporting period while the rest are 3-year reporting periods.

Supplementary Table 3. Number and rate of stillbirths, neonatal and perinatal mortality by state in Australia, 2014-2018

State*	Total births	Live births	Stillbirths		Neonatal mortality		Perinatal mortality	
			n	rate/1000 births (95% CI)	n	rate/1000 live births (95% CI)	n	rate/1000 births (95% CI)
Australian Capital Territory	31869	31599	270	8.5 (7.5, 9.5)	94	3.0 (2.4, 3.6)	364	11.4 (10.3, 12.7)
New South Wales	483700	480849	2851	5.9 (5.7, 6.1)	971	2.0 (1.9, 2.2)	3822	7.9 (7.7, 8.2)
Northern Territory	19619	19433	186	9.5 (8.2, 10.9)	90	4.6 (3.7, 5.7)	276	14.1 (12.5, 15.8)
Queensland	309254	307239	2015	6.5 (6.2, 6.8)	858	2.8 (2.6, 3.0)	2873	9.3 (9.0, 9.6)
South Australia	99783	99086	697	7.0 (6.5, 7.5)	203	2.0 (1.8, 2.4)	900	9.0 (8.4, 9.6)
Tasmania	28602	28409	193	6.7 (5.8, 7.8)	96	3.4 (2.7, 4.1)	289	10.1 (9.0, 11.3)
Victoria	397999	394621	3378	8.5 (8.2, 8.8)	1036	2.6 (2.5, 2.8)	4414	11.1 (10.8, 11.4)
Western Australia	174050	172886	1164	6.7 (6.3, 7.1)	290	1.7 (1.5, 1.9)	1454	8.4 (7.9, 8.8)
Australia	1544877	1534118	10759	7.0 (6.8, 7.1)	3625	2.4 (2.3, 2.4)	14384	9.3 (9.2, 9.5)

*Note: The data for each state (except Western Australia) and Australia are preliminary data only from the National Perinatal Data collection, as presented in the 'Australia's mother and babies 2019' data tables, Australian Institute of Health and Welfare (available from https://www.aihw.gov.au/reports/per/101/australias-mothers-babies/data). The data for Western Australia presented in the above table are final (from this report) and therefore, the numbers for all states will not add up to the aggregate for Australia.

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