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# Disparities between Aboriginal and non-Aboriginal perinatal mortality rates in Western Australia from 1980 to 2015

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## Abstract

**Background:** Perinatal mortality rates are typically higher in Aboriginal than non-Aboriginal populations of Australia.

**Objectives:** This study aimed to examine the pattern of stillbirth and neonatal mortality rate disparities over time in Western Australia, including an evaluation of these disparities across gestational age groupings.

**Methods:** All singleton births (≥20 weeks gestation) in Western Australia between 1980 and 2015 were included. Linked data were obtained from core population health datasets of Western Australia. Stillbirth and neonatal mortality rates and percentage changes in the rates over time were calculated by Aboriginal status and gestational age categories.

**Results:** From 1980 to 2015, data were available for 930 926 births (925 715 livebirths, 5211 stillbirths and 2476 neonatal deaths). Over the study period, there was a substantial reduction in both the Aboriginal (19.6%) and non-Aboriginal (32.3%) stillbirth rates. These reductions were evident in most gestational age categories among non-Aboriginal births and in Aboriginal term births. Concomitantly, neonatal mortality rates decreased in all gestational age windows for both populations, ranging from 32.1% to 77.5%. The overall stillbirth and neonatal mortality rate differences between Aboriginal and non-Aboriginal birth decreased by 0.6 per 1000 births and 3.9 per 1000 livebirths, respectively, although the rate ratios (RR 2.51, 95% CI 2.14, 2.94) and (RR 2.94, 95% CI 2.24, 3.85), respectively reflect a persistent excess of Aboriginal perinatal mortality across the study period.

**Conclusions:** Despite steady improvements in perinatal mortality rates in Western Australia over 3½ decades, the gap between Aboriginal and non-Aboriginal rates remains unchanged in relative terms. There is a continuing, pressing need to address modifiable risk factors for preventable early mortality in Aboriginal populations.

KEYWORDS

aboriginal, neonatal mortality, perinatal mortality, stillbirth, trend, Western Australia

  

## 1 | BACKGROUND

Despite substantial improvement in medical care over many decades, perinatal death (stillbirth and neonatal death) remains a global pressing public health concern. For instance, in 2015, over 2.1 million stillbirths and 2.6 million neonatal deaths were documented globally, with the majority occurring in low- and middle-income countries.[1,2] The consequences of perinatal death are well documented, and can include long-term psychological trauma and financial difficulties for parents.[3,4]

Stillbirths account for the majority of perinatal deaths[5] although there is substantial variation in stillbirth rates among developed countries.[6,7] This suggests that more stillbirths can be prevented and that current perinatal mortality rates in most developed countries—including Australia—could be reduced. While Australia has a relatively low perinatal death rate, considerable effort is required to be comparable to the rates achieved by other developed nations. For example, countries such as Iceland, Denmark and Finland consistently record fewer third trimester stillbirths at around two per 1000 births compared to about three stillbirths per 1000 births in Australia.[6,8] Recent global data demonstrate a significant decreasing trend in the overall stillbirth rate (from 1995 to 2015) for developed nations.[2,9] However, in Australia, over the last two decades, the perinatal mortality rate has not changed appreciably. In particular, the stillbirth rate has been static between 1995 and 2001 and slightly increased between 2002 and 2014.[10]

Disaggregated data highlight that some population subgroups are at a distinctly higher risk of perinatal death within Australia—including those born preterm and births to Aboriginal and/or Torres Strait Islander (hereafter Aboriginal) women.[10] Gestational age at birth is strongly linked with the perinatal mortality rate, and a recent Australian analysis showed a shift in gestational age-specific risk of stillbirth despite a relatively static overall stillbirth rate. These changes reflect a shift in the distribution of reproductive health indicators over time—including rates of smoking in pregnancy, obesity and maternal age, among others—and highlight the importance of examining stillbirth risks by pregnancy stage.[11] Further, perinatal mortality rate disparities in Australian data are likely to reflect differential access to quality care, and the social, economic and environmental processes that pose risks to Aboriginal health outcomes from preconception through early life.[12] Notwithstanding, there is limited and inconsistent evidence on whether, and to what degree, gaps are closing over time and interventions to affect change have been successful. For example, while a recent study[13] showed a 57.3% reduction (between 1995 and 2011) in stillbirth rate gap between Aboriginal and non-Aboriginal women in the state of Queensland, there has been no change in stillbirth and neonatal mortality rate gaps in Western Australia over this time.[14]

This study aims to provide a more comprehensive and nuanced examination of the pattern of inequalities in perinatal mortality in Western Australia, using a long time series and with consideration of gestational age. A greater understanding of the scale of risk among population sub-groups will support the consideration of tailored or targeted interventions for those at excess risk.

### Synopsis

#### Study Question

This study aimed to examine the pattern of stillbirth and neonatal mortality rate disparities over time in Western Australia, including an evaluation of these disparities across gestational age groupings.

#### What's Already Known

Discrete and relatively short-term data show that the rate of adverse birth outcomes including perinatal mortality rates are higher in Aboriginal than non-Aboriginal populations of Western Australia.

#### What This Study Adds

We used total Western Australia population-level data to estimate the overall and ethnicity-specific perinatal mortality trends in each gestational age window over 3 ½ decades. The perinatal mortality rate gap between the Aboriginal and non-Aboriginal births has improved in absolute terms, but remained unchanged in relative terms.

## 2 | METHODS

### 2.1 | Data sources and study population

Our main analysis included all singleton births of at least 20 weeks' gestation in Western Australia between 1980 and 2015. Late pregnancy terminations (≥20 weeks' gestation) for foetal anomalies were only included in supplemental and sensitivity analyses. Data were obtained from core population health datasets[15] that are routinely linked by the Data Linkage Branch (DLB) of the Western Australia Government Department of Health (DoH)—which includes the Midwives' Notification System (MNS), Birth and Death Registries, Western Australian Register of Developmental Anomalies (WARDA) and an Aboriginal status flag (ASF) created from a number of core datasets held by the DoH using algorithms developed by the 'Getting our Story Right' collaboration.[16] Overall ethical approval for the project was obtained from the Western Australian Aboriginal Health Ethics Committee (project 797) and the Western Australian DoH Human Research Ethics Committee (project 2016/51).

The MNS records the circumstances of all births of 20 weeks' or more gestation, with information received from attending practitioners since 1980 and was used as the primary data source to establish the cohort. The MNS dataset includes maternal ethnicity origin (Caucasian, Aboriginal, Asian, Indian, African, Polynesian, Maori and Other) and baby characteristics (date of birth, plurality, gestational age, birthweight and status [liveborn or stillborn]).

Additional demographic information was obtained from the Birth Register while childhood deaths were identified using the Death Register. The WARDA, which includes records of developmental anomalies for all stillbirths, livebirths and children under the age of 6 years, was used to identify any major birth defects.

These datasets were linked together by the DLB by probabilistic linkage method[17] using common identifiers including name, address and birthdate, and the data (with identifying fields removed) were securely transferred to the research team.

## 2.2 | Study variables

Births to women recorded as Aboriginal were categorized as Aboriginal in this study, with all other ethnicity origins combined and grouped as non-Aboriginal. The ASF provides an alternative method of identifying Aboriginal study participants and has been used in sensitivity analyses; it was derived using a multi-stage median approach to create a single consistent status for each individual, designed to maximize the use of available information without allowing undue influence of individual datasets with multiple records per individual.[16] Notably, while the ethnicity variable in the MNS identifies births to Aboriginal mothers, the ASF uses information on the Aboriginal status of both parents to determine the status of the child. Gestational age at birth was grouped into 20-27 weeks [extremely preterm], 28-31 weeks [very preterm], 32-36 weeks [moderate to late preterm] and ≥37 weeks [term]) according to the WHO classification.[18] While the stillbirth risk is known to increase after 41 weeks' of gestion,[19] we had insufficient numbers to group these separately. Due to the small number of neonatal deaths in very preterm and moderate to late preterm gestational age groups, these were collapsed together during the analysis. Stillbirth (foetal death at or after 20 weeks' gestation) was identified based on the birth status variable in the MNS. Similarly, neonatal death (death of a liveborn infant within 28 days of birth) was determined using the age of death variable in Death Registry. The proportion of babies who were small for gestational age (SGA; below the 10th percentile) and severe SGA (below the 3rd percentile) were determined following the Australian national birthweight percentiles estimated using infants born between 1997 and 2007.[20] The Australian Bureau of Statistics' Socio-economic Index for Areas (SEIFA) was used to measure area-level socio-economic (SES) disadvantage of the mother's place of residence at the time of birth. The SEIFA index ranks the relative level of disadvantage of areas using the attributes of all persons in each Collection District (the smallest available geographical area) and includes measures of income, educational attainment, employment status, occupational skill and housing. Quintiles were determined based on the distribution of values for all Australian Collection Districts.[21]

## 2.3 | Statistical analysis

Chi-square and *t* tests were used to compare the distribution of maternal and infant characteristics by Aboriginal status. The rates of stillbirth and neonatal mortality from 1980 to 2015 were estimated over four nine-year periods (1980-1988, 1989-1997, 1998-2006 and 2007-2015). Stillbirth rates were calculated as the number of stillbirths in each period divided by the total number of births (live-birth + stillbirth) in that period multiplied by 1000. Similarly, neonatal mortality rates were calculated as the number of neonatal deaths in each period divided by the number of livebirths in that period multiplied by 1000. Gestational age-specific rates were calculated as the number of stillbirths or neonatal deaths in each gestational age window divided by the number of ongoing pregnancies (foetuses at risk) at the beginning of the gestational age window multiplied by 1000.[22,23] *P* trend was used to examine changes in the rate of stillbirth and neonatal mortality over time.[24] Percentage reductions were calculated as the difference in rates between two periods (eg stillbirth rate in 1989-1997 minus stillbirth rate in 1980-1988 divided by stillbirth rate in 1980-1988 multiplied by 100), and the average annual reductions were estimated as the sum of percentage reductions across the three periods (1980-1988 to 1989-1997, 1989-1997 to 1998-2006 and 1998-2006 to 2007-2015) divided by the total number of years. Rate ratios (RR) and their 95% confidence intervals (CI) were calculated (via *csi* command) as Aboriginal stillbirth or neonatal mortality rate divided by the non-Aboriginal rate.

Supplemental and sensitivity analyses were performed by including late pregnancy terminations for foetal anomalies and using Aboriginal status based on the ASF instead of reported ethnicity in the MNS. Stata version 15 (StataCorp. 2017) was used for all analyses.

# 3 | RESULTS

There was a total of 937 218 singleton births between 1980 and 2015. Of these, 5218 (0.6%) had missing either Aboriginal status (n = 1208) or gestational age (n = 4010) so were excluded from the analyses. In addition, 1074 births following pregnancy terminations for foetal anomalies (0.1%) were only included in sensitivity analyses, thus leaving 930 926 births in the main analyses (925 715 livebirths, 5211 stillbirths and 2476 neonatal deaths) (Table 1).

Aboriginal babies were more likely to be stillborn, born preterm, be SGA and die in the neonatal period but less likely to have any major birth defect than non-Aboriginal babies. Aboriginal mothers were significantly more likely to be younger at delivery, multiparous, have started antenatal care after 12 weeks of gestation, have smoked during pregnancy and live in an area within the lowest SES quintile than non-Aboriginal mothers. Most of these variations were unchanged over time. The number of livebirths and pregnancy terminations for foetal reasons increased substantially over time, while the number of neonatal deaths and the proportion of SGA infants decreased over the study period (Table 1 and Table S1).

Between 1980 and 2015, there was a reduction in stillbirth and neonatal mortality rates, although the rate of reduction was lower for stillbirth (Figure 1A). From 1980-1988 to 2007-2015, the stillbirth rate decreased by 30.4%, from 6.9 to 4.8 per 1000 births (*P* trend < .001) with the average annual reduction of 0.9%. The rate of

**TABLE 1** Maternal and infant characteristics by Aboriginal status, Western Australia, 1980-2015

| | Overall N = 930 926 | Aboriginal status[a] | |
|---|---|---|---|
| | | Aboriginal N = 52 983 | Non-Aboriginal N = 877 943 |
| | n (%) | n (%) | n (%) |
| Maternal characteristics | | | |
| Age at birth (years) | | | |
| ≤24 | 231 305 (24.9) | 31 675 (59.8) | 199 630 (22.7) |
| 25-29 | 299 060 (32.1) | 12 155 (22.9) | 286 905 (32.7) |
| 30-34 | 265 069 (28.5) | 6227 (11.8) | 258 842 (29.5) |
| 35+ | 135 477 (14.6) | 2926 (5.5) | 132 551 (15.1) |
| Mean (SD) | 28.5 (5.8) | 23.9 (5.8) | 28.8 (5.4) |
| Parity | | | |
| 0 | 376 304 (40.4) | 15 489 (29.2) | 360 815 (41.1) |
| 1 | 314 099 (33.7) | 12 612 (23.8) | 301 487 (34.3) |
| ≥2 | 240 435 (25.8) | 24 882 (47.0) | 215 553 (24.6) |
| First antenatal care visit | | | |
| ≤12 weeks of gestation | 108 041 (61.2) | 3803 (44.2) | 104 238 (62.0) |
| >12 weeks of gestation | 68 608 (38.8) | 4792 (55.8) | 63 816 (38.0) |
| SES quintiles | | | |
| 1st (most disadvantaged) | 176 509 (19.7) | 30 885 (60.5) | 145 624 (17.3) |
| 2nd | 187 645 (21.0) | 11 063 (21.7) | 176 582 (21.0) |
| 3rd | 186 046 (20.8) | 5522 (10.8) | 180 524 (21.4) |
| 4th | 183 525 (20.5) | 2688 (5.3) | 180 837 (21.5) |
| 5th (least disadvantaged) | 160 218 (17.9) | 932 (1.8) | 159 286 (18.9) |
| Smoking during pregnancy (1997-2015) | | | |
| No | 433 421 (84.2) | 14 866 (50.4) | 66 581 (86.3) |
| Yes | 81 447 (15.8) | 15 123 (49.6) | 418 298 (13.7) |
| Infant characteristics | | | |
| Gestational age group (weeks) | | | |
| 20-27 | 5074 (0.6) | 740 (1.4) | 4334 (0.5) |
| 28-31 | 5785 (0.6) | 778 (1.5) | 5007 (0.6) |
| 32-36 | 54 373 (5.8) | 6003 (11.3) | 48 370 (5.5) |
| ≥37 | 865 694 (93.0) | 45 462 (85.8) | 820 232 (93.4) |
| Small for gestational age (<10th centiles) | | | |
| No | 842 536 (90.5) | 43 985 (83.1) | 798 551 (91.0) |
| Yes | 88 053 (9.5) | 8967 (16.9) | 79 086 (9.0) |
| Small for gestational age (<3rd centiles) | | | |
| No | 903 402 (97.1) | 49 587 (93.8) | 853 815 (97.3) |
| Yes | 26 604 (2.9) | 3302 (6.2) | 23 302 (2.7) |
| Congenital anomalies | | | |
| No | 889 926 (95.6) | 50 811 (95.9) | 839 115 (95.6) |
| Yes | 41 000 (4.4) | 2172 (4.1) | 38 828 (4.4) |
| Stillbirth | | | |
| No | 925 715 (99.4) | 52 357 (98.8) | 873 358 (99.5) |
| Yes | 5211 (0.6) | 626 (1.2) | 4585 (0.5) |
| Neonatal death | | | |
| No | 923 239 (99.7) | 52 020 (99.4) | 871 219 (99.8) |
| Yes | 2476 (0.3) | 337 (0.6) | 2139 (0.2) |

Abbreviations: SD, standard deviation; SES, socio-economic status.

[a] $\chi^2$ and *t* tests were used to compare groups and all *P*-values were < .001, some column totals may not add up to 930 926 because of missing information or design, for example, information on smoking during pregnancy was only available since 1997 and on first antenatal care visit since 2010.

neonatal mortality decreased by 67.4%, an average annual reduction of 2.6%, from 4.6 per 1000 livebirth in 1980-1988 to 1.5 per 1000 livebirths in 2007-2015 (*P* trend <0.001). When the analyses were restricted to third trimester (≥28 weeks) births, similar trends were observed for neonatal death, but the average annual reduction rate increased to 1.5% for stillbirth (Figure 1B).

Over the study period, the stillbirth rate reduction for births to Aboriginal women was 19.6% (13.8-11.1 per 1000 births, *P* trend = 0.04), while for births to non-Aboriginal women the decrease was 32.3% (6.5-4.4 per 1000 births, *P* trend < 0.001) (Table 2). In Aboriginal births, a decreasing trend of stillbirth was observed for the gestational age groups at 28 weeks and above but was only statistically significant for births ≥37 weeks of gestation while the estimates for 28-36 weeks of gestation were based on small numbers. A significant decreasing trend of stillbirth was found for non-Aboriginal births at all gestational age groupings, except for the 20-27 weeks group, with the rate reduction ranging from 43.9% (for ≥37 weeks) to 47.2% (for 32-36 weeks). The overall stillbirth rate difference between Aboriginal and non-Aboriginal births decreased from 7.3 per 1000 births in 1980-1988 to 6.7 per 1000 births in 2007-2015. However, as shown in Figure 2A, the stillbirth RR (Aboriginal vs non-Aboriginal) has gradually increased from (RR 2.11, 95% CI 1.78, 2.51) in 1980-1988 to (RR 2.51, 95% CI 2.14, 2.94) in 2007-2015.

Between 1980 and 2015, the neonatal mortality rates decreased in both Aboriginal and non-Aboriginal births as well as in all gestational age groups within each population group (Aboriginal and non-Aboriginal). During the study period, the neonatal mortality rate reduced by 63.0% in Aboriginal births (10.8 to 4.0 per 1000 livebirths, *P* trend < .001) and by 67.4% in non-Aboriginal births (4.3 to 1.4 per 1000 livebirths, *P* trend < 0.001). In other words, between 1980-1988 and 2007-2015, about seven Aboriginal neonatal deaths and approximately three non-Aboriginal neonatal deaths per 1000 livebirths were averted. For Aboriginal births, the rate reductions in 20-27, 28-36 and ≥37 weeks of gestation were 32.1%, 71.5% and 77.5%, respectively. The corresponding figures for non-Aboriginal births were 66.2%, 71.2% and 66.8%. The overall neonatal mortality rate difference between Aboriginal and non-Aboriginal births reduced from 6.5 (1980-1988) to 2.6 (2007-2015) neonatal deaths per 1000 livebirth (Table 2). The neonatal mortality RR (Aboriginal vs non-Aboriginal) increased considerably between 1989-1997 and 1998-2006, from (RR 2.26, 95% CI 1.79, 2.84) to (RR 3.30, 95% CI 2.60, 4.18) but showed a decline in subsequent period (Figure 2B).

There were no notable differences in the sensitivity analysis when the Aboriginal status identified based on the ASF was used instead of ethnicity in MNS (relative difference <16% for all rates in Table 2; data not shown). As expected, when births following pregnancy terminations for foetal anomalies were included, the stillbirth rates substantially increased for 20-27 weeks of gestation and the increasing trend of stillbirth rates reached statistical significance in both Aboriginal and non-Aboriginal births (Table S2).

## 4 | COMMENT

### 4.1 | Principal findings

In this large population-based linked data study, both Aboriginal and non-Aboriginal perinatal mortality rates consistently showed marked improvements over 36 years, although the relative reductions have been greater for non-Aboriginal births and in neonatal

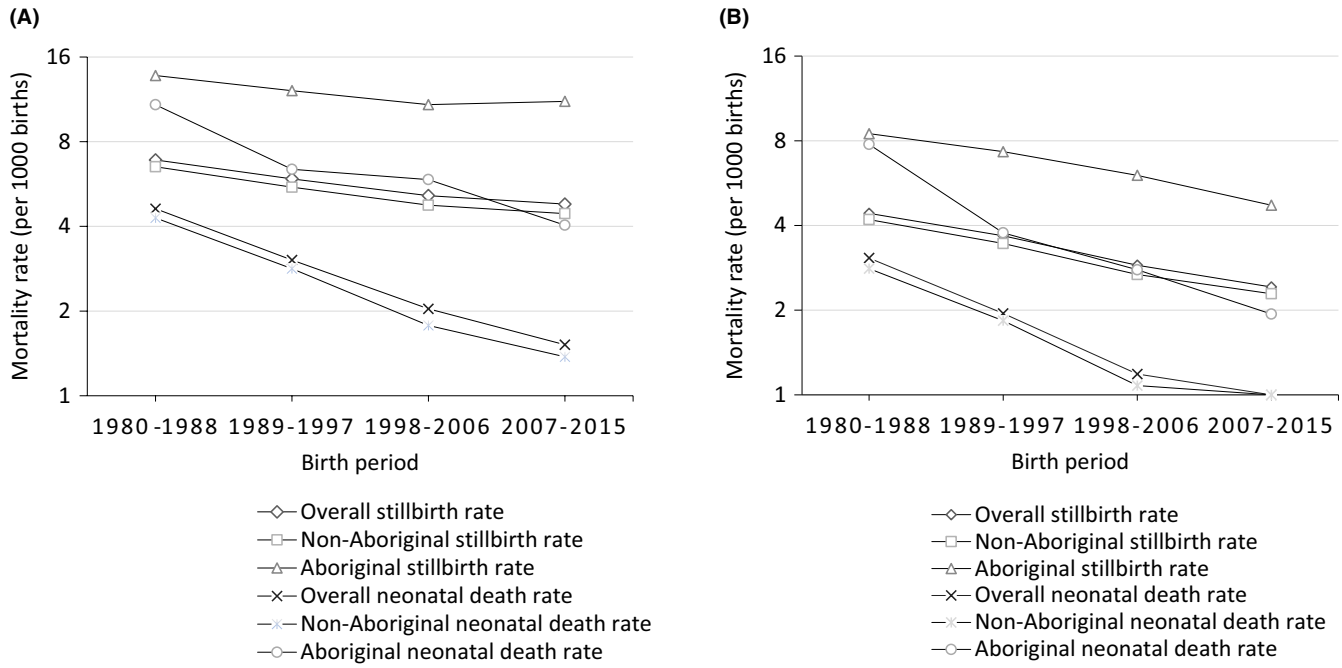


**FIGURE 1** Stillbirth and neonatal mortality rates, Western Australia, 1980-2015; (A) included all singleton births of at least 20 weeks' gestation and (B) included all singleton births of 28 or more weeks' gestation

**TABLE 2** Stillbirth and neonatal mortality rates by Aboriginal status and gestational age, Western Australia, 1980-2015

| | Year of birth | | | | |
|---|---|---|---|---|---|
| | 1980-1988 | 1989-1997 | 1998-2006 | 2007-2015 | |
| | Rate per 1000 (n) | Rate per 1000 (n) | Rate per 1000 (n) | Rate per 1000 (n) | *P* trend |
| Stillbirth rate[a] (N = 930 926) | | | | | |
| Aboriginal | | | | | |
| 20-27 weeks | 5.4 (56) | 4.9 (64) | 4.9 (70) | 6.5 (99) | 0.196 |
| 28-31 weeks | 1.7 (17) | 1.6 (21) | 1.1 (16) | 1.1 (17) | 0.155 |
| 32-36 weeks | 2.5 (25) | 2.8 (36) | 2.3 (32) | 1.7 (25) | 0.099 |
| ≥37 weeks | 5.1 (45) | 3.3 (37) | 3.0 (37) | 2.2 (29) | <0.001 |
| Third trimester (≥28 weeks) | 8.5 (87) | 7.3 (94) | 6.0 (85) | 4.7 (71) | <0.001 |
| Aboriginal overall | 13.8 (143) | 12.1 (158) | 10.8 (155) | 11.1 (170) | 0.043 |
| Non-Aboriginal | | | | | |
| 20-27 weeks | 2.3 (446) | 2.1 (435) | 2.1 (440) | 2.2 (580) | 0.318 |
| 28-31 weeks | 0.9 (173) | 0.7 (138) | 0.6 (123) | 0.5 (133) | <0.001 |
| 32-36 weeks | 1.4 (270) | 1.1 (222) | 0.8 (164) | 0.8 (201) | <0.001 |
| ≥37 weeks | 2.0 (352) | 1.8 (359) | 1.4 (273) | 1.1 (276) | <0.001 |
| Third trimester (≥28 weeks) | 4.2 (795) | 3.5 (719) | 2.7 (560) | 2.3 (610) | <0.001 |
| Non-Aboriginal overall | 6.5 (1241) | 5.5 (1154) | 4.8 (1000) | 4.4 (1190) | <0.001 |
| Neonatal mortality rate[a] (N = 925 715) | | | | | |
| Aboriginal | | | | | |
| 20-27 weeks | 3.1 (32) | 2.6 (34) | 3.1 (44) | 2.1 (32) | 0.211 |
| 28-36 weeks | 3.0 (31) | 1.4 (18) | 0.9 (12) | 0.9 (13) | <0.001 |
| ≥37 weeks | 5.4 (48) | 2.7 (30) | 2.2 (27) | 1.2 (16) | <0.001 |
| Third trimester (≥28 weeks) | 7.8 (79) | 3.8 (48) | 2.8 (39) | 1.9 (29) | <0.001 |
| Aboriginal overall | 10.8 (111) | 6.4 (82) | 5.9 (83) | 4.0 (61) | <0.001 |
| Non-Aboriginal | | | | | |
| 20-27 weeks | 1.5 (281) | 1.0 (208) | 0.7 (147) | 0.5 (134) | <0.001 |
| 28-36 weeks | 1.2 (224) | 0.7 (147) | 0.4 (79) | 0.3 (91) | <0.001 |
| ≥37 weeks | 1.7 (306) | 1.2 (234) | 0.7 (146) | 0.6 (142) | <0.001 |
| Third trimester (≥28 weeks)[b] | 2.8 (530) | 1.8 (381) | 1.1 (225) | 0.9 (233) | <0.001 |
| Non-Aboriginal overall | 4.3 (811) | 2.8 (589) | 1.8 (372) | 1.4 (367) | <0.001 |

[a]Gestational age-specific rates were calculated as the number of stillbirths or neonatal deaths in each gestational age window divided by the number of ongoing pregnancies (foetuses at risk) at the beginning of the gestational age window multiplied by 1000.
[b]Third trimester (≥28 weeks), Aboriginal and non-Aboriginal overall rates were calculated as the total number of stillbirths or neonatal deaths divided by the total number of births (for stillbirth) or livebirths (for neonatal death) multiplied by 1000.

mortality more than in stillbirths. We observed a decreasing trend over time in all gestational age categories for Aboriginal and non-Aboriginal births, with the exception of 20-27 weeks. These trends did not reach statistical significance for Aboriginal births at 28-31 and 32-36 weeks, possibly reflecting the low number of stillbirths in these groups. Although more pronounced for non-Aboriginal births, the neonatal mortality rate has significantly decreased over the study period in both Aboriginal and non-Aboriginal populations and all gestational age windows, with the exception of Aboriginal births at 20-27 weeks' gestation. Additionally, the overall perinatal mortality rate disparity between Aboriginal and non-Aboriginal births has decreased over time in absolute measures, particularly in the neonatal mortality period, but remained unchanged in relative terms.

## 4.2 | Strengths of the study

The use of robust, total population data from multiple sources over a 36-year period underscore the strengths of this study. While identifying Aboriginal people in administrative data is a vexed issue, there are a number of high-quality methods for ascertaining Aboriginal status in Western Australia. We have applied two of these in our analyses and note strong consistency between the results from both.

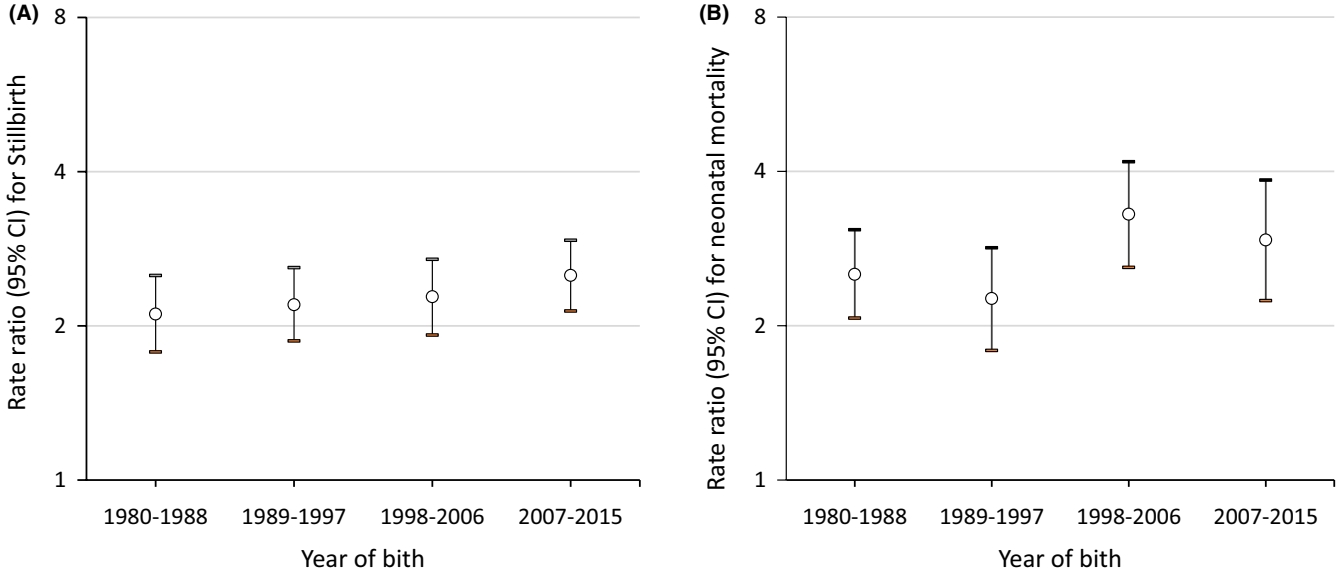


**FIGURE 2** Stillbirth and neonatal mortality rate ratio (Aboriginal vs non-Aboriginal), Western Australia, 1980-2015; (A) stillbirth and (B) neonatal mortality

### 4.3 | Limitations of the data

However, there are some limitations: first, data collected for administrative purposes can contain errors and inconsistencies, including item-level missingness and issues of misclassification. For instance, Aboriginal women may choose to not identify as Aboriginal because of a number of factors,[25] and thus, the proportion of Aboriginal women could have been underestimated. However, we found similar results when the Aboriginal status identified based on the ASF was used instead of that reported in the MNS dataset. Administrative sources also do not contain information on all variables of interest.

### 4.4 | Interpretation

Worldwide, improvements in health services and global initiatives have brought a considerable reduction in the overall perinatal mortality rate.[26-28] In agreement with this, the findings of this study demonstrated that the overall perinatal mortality rate in Western Australia has almost halved between 1980 and 2015, mainly due to the substantial decline in the neonatal death rate. This might have been due to the continued improvements and availability of quality maternity and neonatal care, increase in the number of pregnancy terminations prior to 20 weeks' gestation or a decline in the prevalence of known risk factors such as smoking.[29,30] The overall third trimester stillbirth rate (2.4 per 1000 births) observed between 2007 and 2015 was similar to the national rate (2.5 per 1000 births in 2014)[10] but was much lower than the estimate reported for developed nations in 2015 (3.4 per 1000 births).[2]

However, in line with previous reports,[10,13,31] we found that the Aboriginal perinatal mortality rate was higher than the non-Aboriginal rate across all study periods. Moreover, the stillbirth and neonatal mortality disparities between Aboriginal and non-Aboriginal births remained unchanged in relative terms, although there were improvements in absolute terms. Notably, the absolute improvements in the gaps in the stillbirth and neonatal mortality rates between the two populations could have been partly due to the increase in high-risk populations in the comparison group such as African and Indian migrants (between 0% and 5% of total births in each time period). However, excluding births to these populations did not change the trends in non-Aboriginal births (data not shown). The interplay of various cultural, sociodemographic, medical and lifestyle factors are likely to contribute to the persistently greater risk of perinatal mortality among Aboriginal births. Maternal characteristics, in particular, have been shown to elevate the risk of stillbirth and are generally more prevalent in Aboriginal populations[32]—including smoking during pregnancy, obesity, diabetes, hypertension and teenage pregnancy.[33] Our data highlight, consistently, that around half of Aboriginal women reported smoking during pregnancy while an approximate two-thirds reduction (from 21.1% to 7.7%) was observed for their non-Aboriginal counterparts between 1998 and 2015. These trends are likely to reflect the implementation of effective smoking cessation interventions (including financial incentives) aimed at the general population and pregnant women.[34-36] Few programs, however, have targeted Aboriginal women specifically and available initiatives have been ineffective.[37,38] Given that smoking and other maternal risk factors are modifiable, effective interventions addressing these factors may reduce the overall rate of stillbirth and narrow the perinatal mortality gap between Aboriginal and non-Aboriginal population.[6]

Further, relative socio-economic disadvantage has been shown to be associated with perinatal death[10,39] and might also partly explain the persistent disparity in the rate of perinatal mortality between Aboriginal and non-Aboriginal populations. Our findings support existing research highlighting the deep-rooted disadvantage faced by Aboriginal populations, including in the earliest stages of life.[40] This

disadvantage has persisted across generations despite the long-term remedial efforts of governments, and emphasises that Aboriginal disadvantage is complex and engrained in the processes that began with the exclusion, dispossession and marginalisation of Aboriginal peoples in Australia during colonisation.[41] While the mechanisms by which SES impacts on perinatal wellbeing are multifaceted,[42] improvements in maternal education and financial wellbeing are likely to lead to improved antenatal care pathways and lifestyle changes. This can, in turn, support a reduction in the perinatal mortality inequalities that are a feature of this study, although there is no generational short-cut in the time required to effect meaningful, population-level change.[43]

Sub-optimal access to, and use of, responsive and appropriate antenatal care services has long been considered a critical issue in achieving equitable outcomes for Aboriginal women and their babies.[44] Aboriginal women are typically confronted with a number of barriers to quality antenatal care services which extend beyond the individual constraints of socio-economic circumstances and location, to the cultural safety, security and competence of mainstream care providers and health practitioners.[45] While Aboriginal community-controlled health services provide an important means of access to appropriate antenatal care in some areas, continued efforts are required to ensure that mainstream antenatal care providers have the capacity to respond to the needs of Aboriginal women.[44,46]

The findings of the current study highlight that most stillbirths were contributed by extremely preterm and term births, and the proportion has increased substantially over time for extremely preterm births but decreased slightly for births at term. The findings underscore the importance of disaggregating perinatal mortality rates by gestational age and the need to focus intervention efforts at these gestational windows. Given the deleterious effects of extreme preterm birth and its increasing prevalence over time,[47] prenatal care focusing on early identification of high-risk pregnancies and prevention of preterm labour may help to reduce the rate of preterm stillbirth. Moreover, foetal deaths at term without birth defects deserve critical attention and rigorous investigation as these are more likely to be avoidable through clinical intervention. Over 80% of term stillbirths occur prior to labour,[10] when important risks (such as abnormal foetal growth) often go undetected.[48] SGA, for example, is present in twice as many Aboriginal than non-Aboriginal births and a key stillbirth risk factor,[10,49] although the standard Australian birthweight percentiles may not be appropriate for the Aboriginal population.[20] While labour induction may prevent term stillbirths,[50] identifying high-risk pregnancies is challenging.

## 5 | CONCLUSIONS

The findings of this study demonstrate that the perinatal mortality rate has declined for Aboriginal and non-Aboriginal populations in the last 3½ decades, although the rate of the reduction was greater for non-Aboriginal births and neonatal mortality. The majority of stillbirths in Western Australia occurred at extremely preterm gestations (20-27 weeks). The perinatal mortality rate gap between the Aboriginal and non-Aboriginal births has improved in absolute terms, particularly for neonatal mortality, but remained unchanged in relative terms. There is a continuing, pressing need to address modifiable risk factors of preventable perinatal deaths, particularly stillbirth in Aboriginal populations.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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