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Time trends, projections, and spatial distribution of low birthweight in Australia, 2009–2030: Evidence from the National Perinatal Data Collection

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Abstract

Introduction: Infants with low birthweight (LBW, birthweight <2500 g) have increased in many high-resource countries over the past two decades. This study aimed to investigate the time trends, projections, and spatial distribution of LBW in Australia, 2009–2030.

Methods: We used standard aggregate data on 3 346 808 births from 2009 to 2019 from Australia's National Perinatal Data Collection. Bayesian linear regression model was used to estimate the trends in the prevalence of LBW in Australia.

Results: Wefound that the prevalence of LBW was 6.18% in 2009, which has increased to 6.64% in 2019 (average annual rate of change, AARC = +0.76%). If the national trend remains the same, the projected prevalence of LBW in Australia will increase to 7.34% (95% uncertainty interval, UI = 6.99, 7.68) in 2030. Observing AARC across different subpopulations, the trend of LBW was stable among Indigenous mothers, whereas it increased among non-Indigenous mothers (AARC = +0.81%). There is also an increase among the most disadvantaged mothers (AARC = +1.08%), birthing people in either of two extreme age groups (AARC = +1.99% and +1.53% for <20 years and ≥40 years, respectively), and mothers who smoked during pregnancy (AARC = +1.52%). Spatiotemporal maps showed that some of the Statistical Area level 3 (SA3) in Northern Territory and Queensland had consistently higher prevalence for LBW than the national average from 2014 to 2019.

Conclusion: Overall, the prevalence of LBW has increased in Australia during 2009–2019; however, the trends vary across different subpopulations. If trends persist, Australia will not achieve the Sustainable Development Goals (SDGs) target of a 30% reduction in LBW by 2030. Centering and supporting the most vulnerable subpopulations is vital to progress the SDGs and improves perinatal and infant health in Australia.

KEYWORDS
Australia, low birthweight, mother, social and behavioral factors, time trends

1 | INTRODUCTION

Low birthweight (LBW)—defined as newborns weighing less than 2500 g—is an important marker of infant health because of its close relationship with infant morbidity, mortality, and lifelong poor health.[1,2] It is widely recognized that babies born with LBW are at an increased risk of adult-onset chronic diseases such as obesity, diabetes, and cardiovascular diseases.[3–7] Low birthweight is associated with poor cognitive function and lower academic performance in children and adolescents.[8,9] Thus, the World Health Assembly (WHA) set the target of a 30% reduction in the number of LBW babies between 2012 and 2025, which has also been reiterated in the 2030 Sustainable Development Goals (SDGs).[10,11] Since then, monitoring LBW trends has been an essential component of the Global Nutrition Monitoring Framework approved by member states at the WHA.[1,11]

Australia is one of the LBW prevalent countries among OECD (Organisation for Economic Co-operation and Development) countries, ranking 19th of 36 OECD countries in 2017.[12,13] According to the Australian Institute of Health and Welfare's (AIHW) National Perinatal Data Collection, 6.5% of liveborn babies in Australia were LBW in 2017.[12,13] However, the proportion of LBW varies across different population groups. This is attributed to risk factors such as maternal age, nutritional status, smoking habits, illness during pregnancy, Indigenous status, area of residence, socioeconomic status and use of health services.[1,14] As a result, the proportion of LBW is significantly higher in some population groups than the national average. For example, in Australia, twice as many babies of Indigenous mothers were of LBW (11.9%) compared with babies of non-Indigenous mothers (6.2%).[15]

The proportion of LBW infants has increased over the past two decades in many OECD countries, mainly due to increased preterm births.[16] There are several reasons for this rise, including increased multiple pregnancies, mainly due to increased infertility treatment, a rise in average maternal age, and increased induction of labor and caesarean birth.[17] In Australia, the national-level proportion of LBW babies over the 10 years to 2015 slightly increased, and the proportion remained between 6.1% and 6.5%.[15] However, little is known about the temporal trend in LBW across different population groups in Australia.

We found only a few studies that provided trends in birthweight in Australia.[18–21] However, those studies predominantly focus on Indigenous populations or a single state or territory context.[18,20] Furthermore, most of those studies examined changes in mean birthweight, high birthweight, or changes in large for gestational age. For example, Diouf et al.[18] conducted a study to see trends in maternal and neonatal characteristics of Indigenous mothers using data from the Western Australian Midwives Notification System (WA MNS) from 1986 to 2009 and reported that there were no significant changes in suboptimal birthweight during the study period. Two other studies on trends in birthweight were conducted in 2009: one in New South Wales (NSW) during 1990–2005 using the NSW Midwives Data Collection and another in Queensland during 1988–2005 using Queensland Perinatal Data Collections.[19,21] Both studies reported that mean birthweight increased during the study period.[19,21] Only limited research has focused on trends in LBW, but these did not sufficiently explore trends in different risk population groups. For example, Kildea et al.[20] conducted a study using routinely collected hospital data in NSW from 1998 to 2009 to examine maternal and neonatal outcomes, including LBW in NSW. However, this study only focused on the trend in population group by Indigenous status and did not consider other risk population groups. Furthermore, none of the studies assessed the future trend in the proportion of LBW.

Therefore, we aimed in this study to investigate the spatiotemporal trend in LBW in Australia. This was assessed across eight social and health-related population groups by Indigenous status, socioeconomic status, geographic remoteness, State or Territory of residence, maternal age, maternal smoking status during pregnancy, maternal body mass index (BMI), and hospital sector. Projections up to 2030 were also made to understand the likely future direction of LBW throughout the SDGs time frame. Spatial distribution of LBW was also assessed to understand which geographic regions are more vulnerable for LBW, using AIHW's National Perinatal Data Collection (NPDC) during 2009–2019.

2 | METHODS

2.1 | Data sources

This study used the NPDC, a national population-based cross-sectional collection of data on pregnancy and childbirth.[22] These data are based on births reported to the perinatal data collection in each state and territory in Australia. State and territory health authorities provide standard de-identified data to the AIHW to form the NPDC. Information is included in the NPDC for both live births and stillbirths, where gestational age is at least 20 weeks or birthweight is at least 400 g, except in Victoria and Western Australia, where births are included if gestational age is at least 20 weeks or, if gestation is unknown, birthweight is at least 400 g. This study used publicly available standard aggregate data on 3 346 808 births from 2009 to 2019. These data cover around 99% of all births in Australia over this period.

2.2 | Measurements

Low birthweight was the outcome of this study. Low birthweight was defined by the World Health Organization (WHO) as the weight of an infant at the birth of less than 2500 g (5.5 pounds) irrespective of the infant's gestational age.[2] The eight most common social and health determinants of LBW, which were consistently collected over time in the NPDC, were included in this study for subgroup analysis. Those factors were as follows: maternal Indigenous status, maternal socioeconomic status, geographic remoteness, and maternal state or territory of usual residence, maternal age, maternal smoking during pregnancy, maternal BMI, and health care utilization (Table S1).

2.3 | Statistical analysis

We estimated the national and state/territory level prevalence of LBW and the prevalence of LBW across different subpopulations by different social and health-related factors in Australia. The prevalence of LBW is expressed as a proportion of total live births. The Bayesian regression model was built in this study using the *rjags* package in R (version 4.1.0).[23] A detailed description of the technique has been presented in supplementary text and elsewhere.[24] Using this Bayesian regression model, the average annual rate of change (AARC) in the prevalence of LBW was estimated and reported in three different periods: 2009–2019, 2020–2030, and 2009–2030. A spatiotemporal trend was observed at the statistical area 3 (SA3) geographic level using available data from 2014 to 2019. Using the earliest available collections at SA3 level data (2014), we categorized the prevalence of LBW into four groups based on the percentile of the prevalence: lower than the 25th percentile was the first quartile (prevalence <5%), the 25–50th percentile was the second quartile (5%–7%), the 50th to 75th percentile was the third quartile (7%–9%), and higher than the 75th percentile was the fourth quartile (>9%). Figure 2 shows the maps that were created using ArcGIS 10.1 to see the spatiotemporal distribution of LBW in Australia.

3 | RESULTS

3.1 | Prevalence of LBW

In the latest available data (2019), the prevalence of LBW in Australia was 6.64% (95% uncertainty interval, UI, 6.55, 6.73), which varies across different states and territories, with the highest prevalence in Northern Territory (8.56% 95% UI, 7.68, 9.52), and the lowest in NSW (6.25%; 95% UI, 6.10, 6.41) (Table 1). Substantial variation in the prevalence of LBW is also observed across different subpopulations within the country. Among various social groups, the higher prevalence was observed among Indigenous mothers (11.66%; 95% UI, 11.14, 12.2), lived in a very remote area (10.54%; 95% UI, 9.41, 11.79), and were socioeconomically most disadvantaged (7.98%; 95% UI, 7.76, 8.2) than the national prevalence. Similarly, higher prevalence was observed among mothers at the extreme of age: teens (<20 years, 10.31%; 95% UI, 9.55, 11.13) and older

TABLE 1 Prevalence and time trend of LBW in Australia, 2009–2030

Indicators	Observed prevalence of LBW in (95%UI)			AARC in % (95% UI)			Predicted prevalence at 2030 (95% UI)
	Earliest (2009)[a]	Latest (2019)	Difference	2009–19	2020–2030	2009–2030	
Overall	6.18 (6.1, 6.27)	6.64 (6.55, 6.73)	0.46	0.76 (0.48, 1.04)	0.83 (0.53, 1.13)	0.8 (0.51, 1.09)	7.34 (6.99, 7.68)
State and territory							
Australian Capital Territory	6.56 (5.95, 7.22)	7.29 (6.67, 7.96)	0.73	0.58 (−0.77, 1.85)	0.63 (−0.86, 2)	0.61 (−0.82, 1.93)	8.16 (6.4, 10.24)
New South Wales	5.61 (5.46, 5.75)	6.25 (6.1, 6.41)	0.64	1.02 (0.6, 1.45)	1.12 (0.66, 1.57)	1.07 (0.63, 1.51)	7.15 (6.62, 7.71)
Northern Territory	9.17 (8.3, 10.12)	8.56 (7.68, 9.52)	−0.61	−0.22 (−1.34, 1.01)	−0.25 (−1.49, 1.1)	−0.23 (−1.41, 1.06)	8.51 (6.9, 10.59)
Queensland	6.56 (6.37, 6.76)	6.93 (6.73, 7.14)	0.37	0.6 (0.12, 1.1)	0.66 (0.13, 1.2)	0.63 (0.12, 1.15)	7.37 (6.74, 8.03)
South Australia	6.77 (6.42, 7.13)	6.74 (6.39, 7.1)	−0.03	−0.02 (−0.79, 0.64)	−0.02 (−0.87, 0.7)	−0.02 (−0.83, 0.67)	6.92 (6.05, 7.78)
Tasmania	6.25 (5.68, 6.88)	7.1 (6.46, 7.8)	0.85	0.94 (−0.76, 2.47)	1.01 (−0.84, 2.65)	0.97 (−0.8, 2.56)	8.81 (6.46, 11.48)
Victoria	6.27 (6.1, 6.45)	6.63 (6.45, 6.8)	0.36	0.68 (0.28, 1.07)	0.74 (0.31, 1.16)	0.71 (0.3, 1.11)	7.26 (6.76, 7.76)
Western Australia	6.17 (5.91, 6.44)	6.81 (6.55, 7.09)	0.64	1.05 (0.6, 1.5)	1.14 (0.66, 1.63)	1.09 (0.63, 1.57)	7.63 (7.03, 8.26)
Indigenous status							
Yes	11.99 (11.4, 12.61)	11.66 (11.14, 12.2)	−0.33	−0.26 (−0.94, 0.33)	−0.28 (−1.05, 0.36)	−0.27 (−0.99, 0.34)	11.47 (10.2, 12.71)
No	5.94 (5.85, 6.03)	6.4 (6.31, 6.49)	0.46	0.81 (0.66, 0.97)	0.88 (0.72, 1.06)	0.85 (0.69, 1.02)	7.11 (6.92, 7.31)
Socioeconomic status							
Q1 (most disadvantage)	7.43 (7.23, 7.63)	7.98 (7.76, 8.2)	0.55	1.08 (0.61, 1.57)	1.22 (0.69, 1.77)	1.16 (0.66, 1.68)	9.2 (8.51, 9.93)
Q2	6.5 (6.31, 6.7)	6.87 (6.67, 7.09)	0.37	0.8 (0.38, 1.19)	0.91 (0.43, 1.34)	0.86 (0.41, 1.28)	7.7 (7.2, 8.16)
Q3	5.98 (5.79, 6.17)	6.48 (6.29, 6.67)	0.5	1.12 (0.03, 2.18)	1.27 (0.03, 2.45)	1.21 (0.03, 2.33)	7.64 (6.41, 9)
Q4	5.72 (5.53, 5.91)	6.18 (5.99, 6.37)	0.46	1.03 (0.32, 1.81)	1.17 (0.36, 2.05)	1.11 (0.34, 1.95)	7.19 (6.39, 8.19)
Q5 (least disadvantage)	5.32 (5.14, 5.51)	5.62 (5.42, 5.82)	0.3	0.55 (−0.21, 1.34)	0.63 (−0.24, 1.51)	0.6 (−0.22, 1.44)	6.09 (5.33, 6.9)
Remoteness area							
Major cities	6.05 (5.95, 6.15)	6.53 (6.42, 6.63)	0.48	0.92 (0.33, 1.54)	1.04 (0.38, 1.74)	0.99 (0.36, 1.65)	7.42 (6.66, 8.21)
Inner cities	6.43 (6.22, 6.65)	6.67 (6.45, 6.9)	0.24	0.75 (−0.13, 1.59)	0.85 (−0.15, 1.8)	0.81 (−0.15, 1.71)	7.45 (6.39, 8.53)
Outer regional	6.75 (6.46, 7.06)	6.88 (6.56, 7.21)	0.13	0.79 (−0.24, 1.87)	0.9 (−0.27, 2.11)	0.85 (−0.25, 2.01)	7.86 (6.58, 9.36)
Remote	7.5 (6.79, 8.28)	7.87 (7.09, 8.74)	0.37	0.64 (−1.6, 2.73)	0.71 (−1.85, 3.05)	0.68 (−1.74, 2.92)	8.19 (5.62, 11.17)
Very remote	8.7 (7.76, 9.73)	10.54 (9.41, 11.79)	1.84	1.81 (−0.78, 4.78)	1.99 (−0.9, 5.07)	1.91 (−0.85, 4.95)	14.35 (9.05, 22.3)
Maternal age (year)							
<20	8.62 (8.13, 9.14)	10.31 (9.55, 11.13)	1.69	1.99 (0.89, 3.02)	2.13 (0.97, 3.19)	2.06 (0.93, 3.11)	12.86 (10.61, 15.21)
20–24	6.66 (6.43, 6.91)	7.68 (7.39, 7.97)	1.02	1.16 (0.58, 1.8)	1.27 (0.64, 1.95)	1.21 (0.61, 1.88)	8.54 (7.68, 9.47)
25–29	5.82 (5.66, 5.98)	6.08 (5.92, 6.25)	0.26	0.57 (0.28, 0.84)	0.62 (0.31, 0.92)	0.59 (0.3, 0.88)	6.61 (6.3, 6.91)

(Continues)

TABLE 1 (Continued)

Indicators	Observed prevalence of LBW in (95%UI)			AARC in % (95% UI)			Predicted prevalence at 2030 (95% UI)
	Earliest (2009)[a]	Latest (2019)	Difference	2009–19	2020–2030	2009–2030	
30–34	5.62 (5.47, 5.77)	6.2 (6.06, 6.34)	0.58	0.97 (0.61, 1.33)	1.06 (0.67, 1.45)	1.02 (0.64, 1.39)	7.03 (6.56, 7.49)
35–39	6.48 (6.28, 6.69)	6.69 (6.49, 6.89)	0.21	0.62 (0.23, 1.05)	0.68 (0.25, 1.15)	0.65 (0.24, 1.1)	7.36 (6.86, 7.93)
≥40	7.64 (7.18, 8.14)	9.18 (8.71, 9.68)	1.54	1.53 (0.59, 2.43)	1.65 (0.64, 2.6)	1.59 (0.61, 2.51)	11.4 (9.63, 13.19)
Smoking status							
Yes	10.83 (10.54, 11.13)	12.22 (11.86, 12.6)	1.39	1.52 (0.98, 2.04)	1.63 (1.06, 2.17)	1.58 (1.02, 2.11)	15.36 (13.95, 16.79)
No	5.29 (5.2, 5.38)	5.96 (5.87, 6.05)	0.67	1.21 (0.92, 1.51)	1.32 (1.01, 1.65)	1.27 (0.97, 1.58)	7.02 (6.68, 7.4)
Body mass index							
Underweight	11.45 (10.73, 12.21)	12 (11.24, 12.8)	0.55	0.74 (−1.29, 2.66)	0.82 (−1.5, 2.92)	0.78 (−1.41, 2.81)	13.03 (9.23, 17.59)
Normal weight	6.27 (6.12, 6.43)	6.71 (6.55, 6.87)	0.44	0.92 (0.15, 1.63)	1.04 (0.17, 1.85)	0.99 (0.16, 1.76)	7.51 (6.59, 8.4)
Overweight	5.42 (5.22, 5.62)	6.07 (5.87, 6.27)	0.65	1.65 (0.63, 2.58)	1.87 (0.72, 2.9)	1.78 (0.68, 2.77)	7.63 (6.46, 8.87)
Obese	5.42 (5.2, 5.65)	6.21 (5.99, 6.44)	0.79	1.95 (1.46, 2.44)	2.2 (1.65, 2.74)	2.1 (1.57, 2.62)	7.96 (7.35, 8.58)
Hospital sector							
Public	7.13 (7.01, 7.24)	7.34 (7.23, 7.45)	0.21	0.37 (0.1, 0.59)	0.41 (0.11, 0.65)	0.39 (0.1, 0.62)	7.71 (7.36, 8.01)
Private	4.47 (4.34, 4.61)	5 (4.85, 5.16)	0.53	1.23 (0.67, 1.82)	1.35 (0.74, 2)	1.29 (0.71, 1.92)	5.92 (5.37, 6.52)

A Earliest data collection year for 'Hospital sector' was 2010, and for 'Socioeconomic status', 'Remoteness area'and 'Body mass index' were 2012. Abbreviations: AARC, annual average rate of change; LBW, low birthweight; UI, uncertainty interval.

(≥40 year, 9.18%; 95% UI, 8.71, 9.68), mothers who had low BMI (12.0%; 95% UI, 11.24, 12.8) and smoked during pregnancy (12.22%; 95% UI, 11.86, 12.6) (Table 1).

3.2 | Time trend in the prevalence of LBW

Examining the trend and AARC, the overall prevalence of LBW has slightly increased in Australia during 2009–2019. The prevalence of LBW was 6.18% in 2009 and had increased to 6.64% in 2019 (AARC, +0.76%; 95% UI, 0.48, 1.04). If the national trend remains the same, the projected prevalence of LBW in Australia will increase to 7.34% (95% UI, 6.99, 7.68) by 2030. We observed that trends in the prevalence of LBW varied across different states and territories. Half of the states and territories which are most populous experienced an increase in the prevalence of LBW. Among them, the highest rate of increase was observed in Western Australia (AARC +1.05%; 95%UI, 0.6, 1.5), followed by NSW (AARC +1.02; 95% UI, 0.6, 1.45), Victoria (AARC +0.68; 95% UI, 0.28, 1.07), and Queensland (AARC +0.6; 95%UI, 0.12, 1.1). (Table 1, Figures 1 and 4). However, there were no significant changes in the prevalence of LBW in other less populous states and territories (Table 1, Figures 1 and 4). Observing the absolute number of total birth and LBW during 2009–2019, we found that the annual number of LBW experienced an increasing trend in Australia (Table S2 and Figure S1).

The prevalence of LBW did not change significantly among Indigenous mothers during the study period. In this subpopulation, the prevalence of LBW in 2009 was 11.99%, declining slowly with an AARC of −0.26% and remaining at 11.66% in 2019 (Table 1, Figures 2 and 4). On the contrary, the prevalence of LBW among non-Indigenous mothers was 5.94% in 2009 and increased to 6.4% (AARC

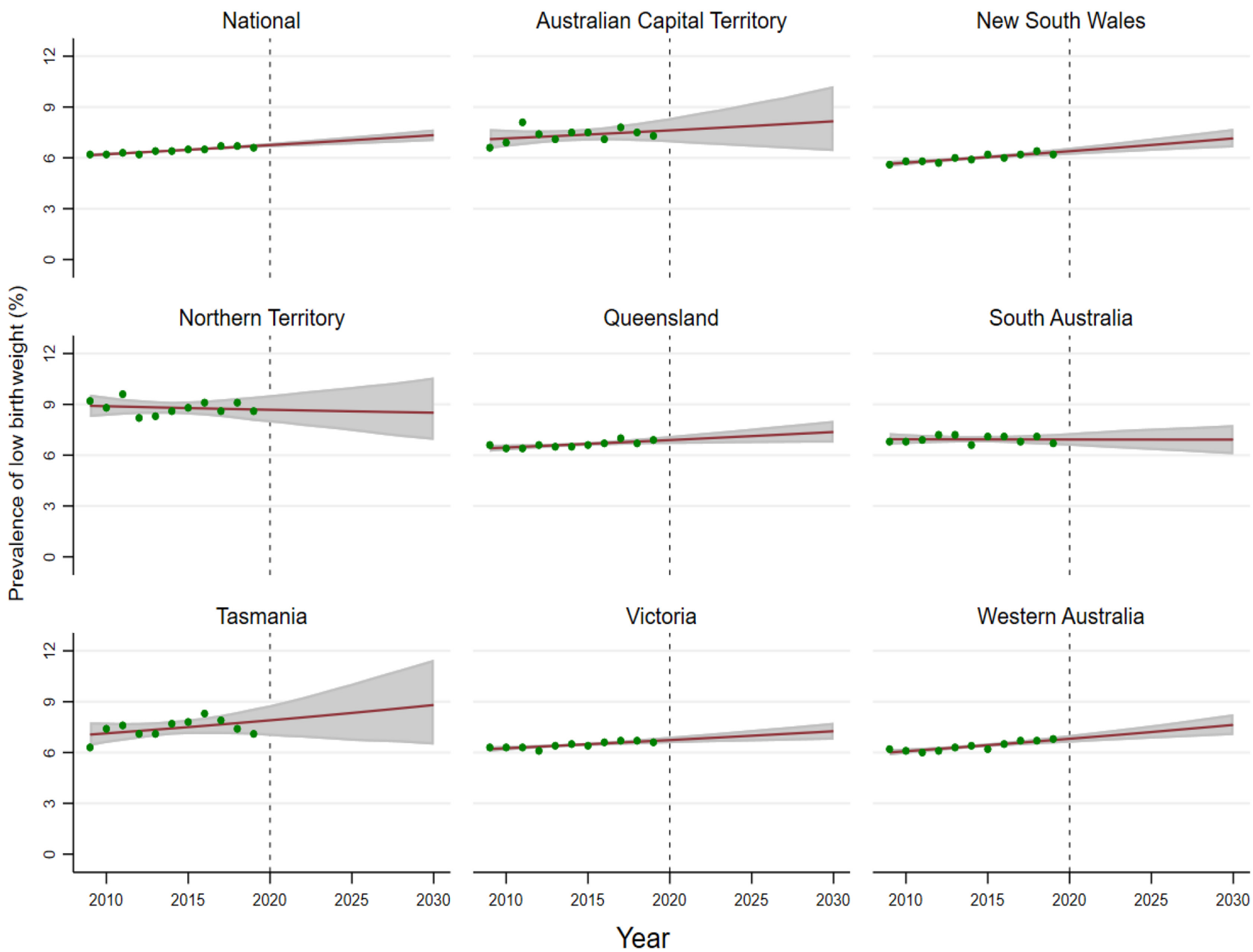

FIGURE 1 Trends in (2009–2019) and projection (2020–2030) in the prevalence of LBW in Australia, categorized by states and territories. Dots represented recorded observed prevalence estimates. Solid lines show the posterior mean estimates (line after dashed lines represent projected future prevalence). The shaded area represents the 95% uncertaintyintervals [Color figure can be viewed at wileyonlinelibrary.com]

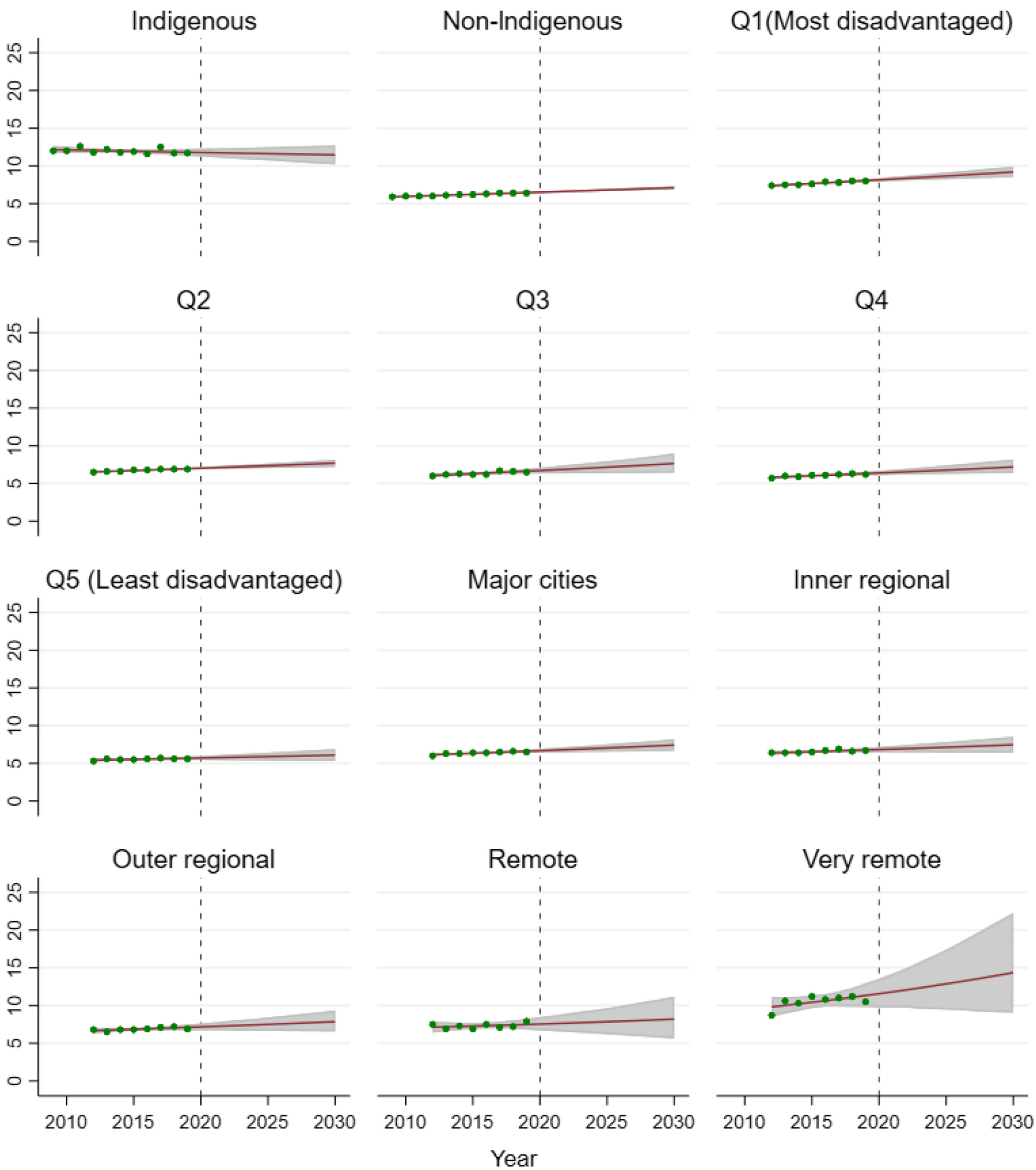

FIGURE 2 Trends in (2009–2019) and projection (2020–2030) in the prevalence of LBW in Australia, categorized by social factors. Dots represented recorded observed prevalence estimates. Solid lines show the posterior mean estimates (line after dashed lines represent projected future prevalence). The shaded area represents the 95% uncertainty intervals [Color figure can be viewed at wileyonlinelibrary.com]

+0.81%; 95% IU, 0.66, 0.97) (Table 1, Figures 2 and 4). If this persists, the projected prevalence of LBW in 2030 will be 7.11% (95% UI, 6.92, 7.31) among non-Indigenous mothers in Australia (Table 1).

The socioeconomically disadvantaged subpopulation experienced an increase in the prevalence of LBW during 2009–2019. For example, the prevalence of LBW increased to 7.98% in 2019 from 7.43% in 2009 among the most disadvantaged mothers (AARC +1.08; 95% UI, 0.61, 1.57) for mothers in the first quartile of the ABS Socio-Economic Indexes for Areas (SEIFA Index) (Table 1, Figures 2 and 4). In addition, a trend in LBW was observed among mothers who lived in very remote areas, although this was not statistically significant (AARC +1.81; 95%UI, −0.78, 4.78) (Table 1, Figures 2 and 4).

Several high-risk subpopulations experienced statistically significant changes in the prevalence of LBW over time. For example, an increasing trend was observed for teenage mothers (AARC +1.99; 95%UI, 0.89, 3.02 and older mothers ≥40 years) (AARC +1.53; 95%UI, 0.59, 2.43), as well as mothers who had smoked during pregnancy (AARC +1.52; 95%UI, 0.98, 2.04) (Table 1, Figures 3 and 4). In another high-risk subpopulation of underweight mothers, we found that the trend of LBW was stable (AARC −0.26%; 95% UI, −0.94, 0.33), while the prevalence remained high at 12.0% in 2019 (Table 1, Figures 3 and 4).

3.3 | Geographic distribution of the prevalence of LBW

The spatial distribution of annual LBW during 2014–2019 is presented in Figure 5. In 2019, the high burden (4th quartile) SA3 was mostly concentrated in Northern Territory, followed by Queensland, Western Australia, and NSW. Our spatiotemporal maps showed that some of the SA3 in Northern Territory and Queensland had a consistently high prevalence of LBW from 2014 to 2019 (Figure 5).

4 | DISCUSSION

In this study, we examined the time trends, projections, and geographic distribution of LBW in Australia. The key findings are that the overall prevalence of LBW has slightly increased in Australia during 2009–2019; however, the trends vary across different subpopulations. Furthermore, the spatiotemporal distribution of LBW showed that some of the SA3 in Northern Territory and Queensland were consistently highly prevalent for LBW from 2014 to 2019. These findings are important to inform policymakers on recent and future trends and variation in the trends in LBW across different subpopulations to prioritize interventions to reduce LBW in Australia.

Observing AARC over the decade, 2009–2019, we found that the overall prevalence of LBW has slightly increased in Australia. Studies conducted in other high-income countries reported that LBW has increased in their population.[16,25] For example, Erasun et al.[25] analyzed trends of LBW rates during 2000–2015 in OECD countries and reported that LBW rates increased around 20% in Southern Europe and to a lesser extent in Eastern Europe (7%) and Asian or Oceanian countries (5%). There are several reasons for the rise in LBW in high-income countries, including a growing number of multiple pregnancies, mainly with the rise in infertility treatment and a rise in average maternal age.[17] Increased use of clinical intervention, such as induction of labor and caesarean delivery, may also help to explain the increase in LBW babies due to earlier gestation at delivery and increased survival of babies with LBW.[14] If the observed rate of change continues in Australia, the projected prevalence of LBW will be 7.34% in 2030, around 1% more babies with LBW annually at the end of the SDGs era. About 300 000 babies are born in Australia annually (Table S1 and Figure S1). One percent increase in LBW represents 3000 more babies with LBW each year, and a corresponding increase in demand for health care for managing short-term and long-term LBW complications. Preterm or infants with LBW have been estimated to account for half of infant hospitalization costs and one-quarter of pediatric costs in the United States.[26] The prospective Longitudinal Study of Australian Children showed the mean additional nonhospital-based health care cost per child was A$ 306 to A$ 362 for children at any perinatal risk (including babies born with LBW) compared with those not at risk. This additional spending totalled A$ 32M at the population level.[27] An increasing number of babies with LBW points to a large and growing health care burden for Australia and a need for health systems planning.

In this study, we found that the prevalence of LBW was almost two times higher among Indigenous mothers than non-Indigenous mothers and that this high prevalence of LBW among Indigenous mothers remained stable during the study period. Significant disparities in the prevalence of LBW among Indigenous and non-Indigenous mothers have previously been reported in the literature. For example, Kildea et al.[20] reported that the LBW rates among babies born to Indigenous mothers were stable during 1998–2009 in NSW. It is likely that barriers linked to systemic or institutional racism contributed to the exclusion of Indigenous mothers from accessing culturally appropriate health care and support.[28] The failure to reduce this gap between Indigenous and non-Indigenous cohorts may be attributable to Indigenous women experiencing inappropriate birth services, with higher rates of spontaneous onset of labor and noninstrumental vaginal birth, and lower epidurals for pain relief in labor, assisted births (both forceps and vacuum extraction), perineal trauma, and caesarean births.[20]

Concerning AARC in subpopulations, the socioeconomically disadvantaged subpopulation experienced a

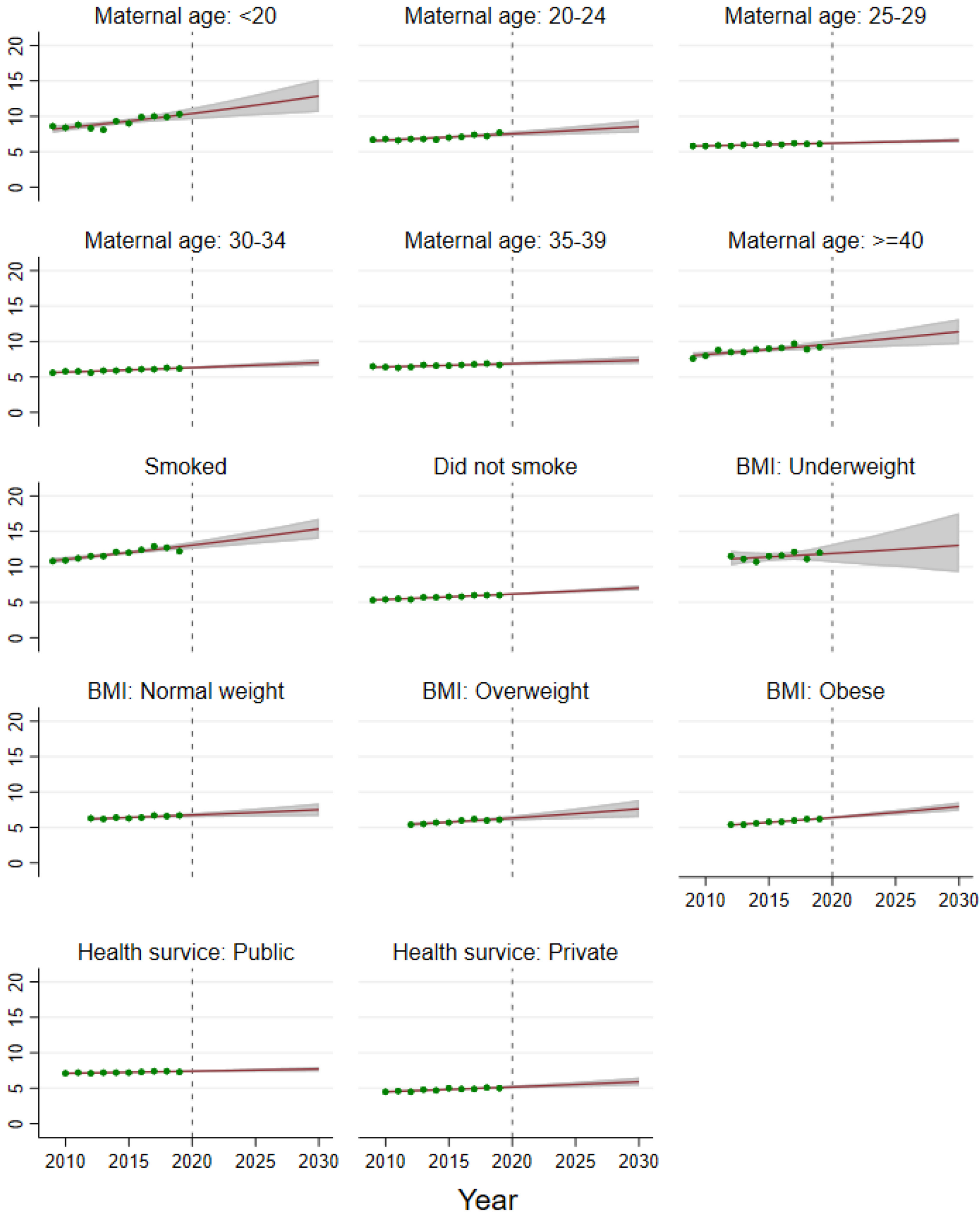

FIGURE 3 Trends in (2009–2019) and projection (2020–2030) in the prevalence of LBW in Australia, categorized by health and lifestyle-related factors. Dots represented recorded observed prevalence estimates. Solid lines show the posterior mean estimates (line after dashed lines represent projected future prevalence). The shaded area represents the 95% uncertainty intervals [Color figure can be viewed at wileyonlinelibrary.com]

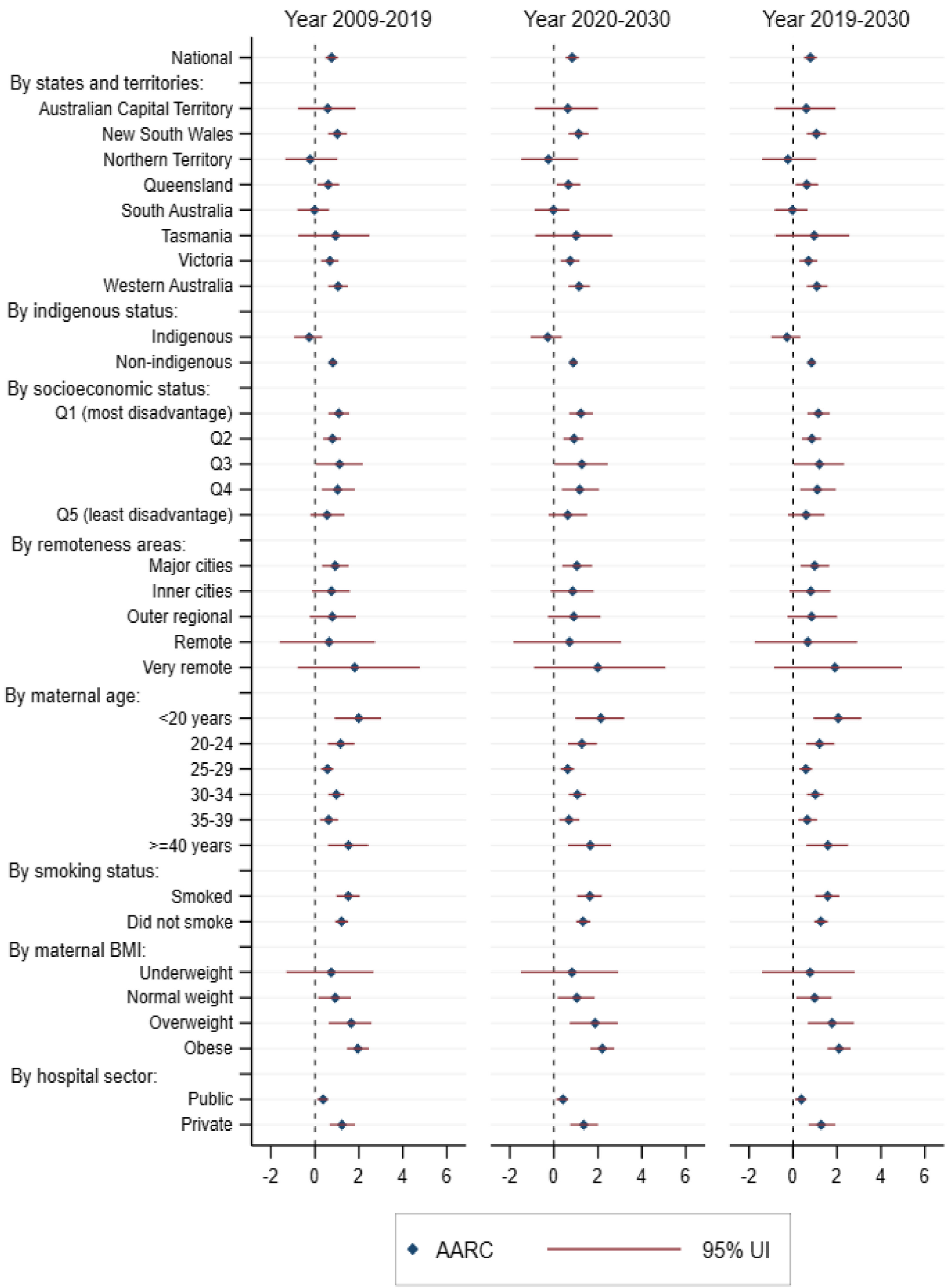

FIGURE 4 Estimated AARC across different group and different time. AARC, annual average rate of change, LBW, low birthweight, UI, uncertainty interval [Color figure can be viewed at wileyonlinelibrary.com]

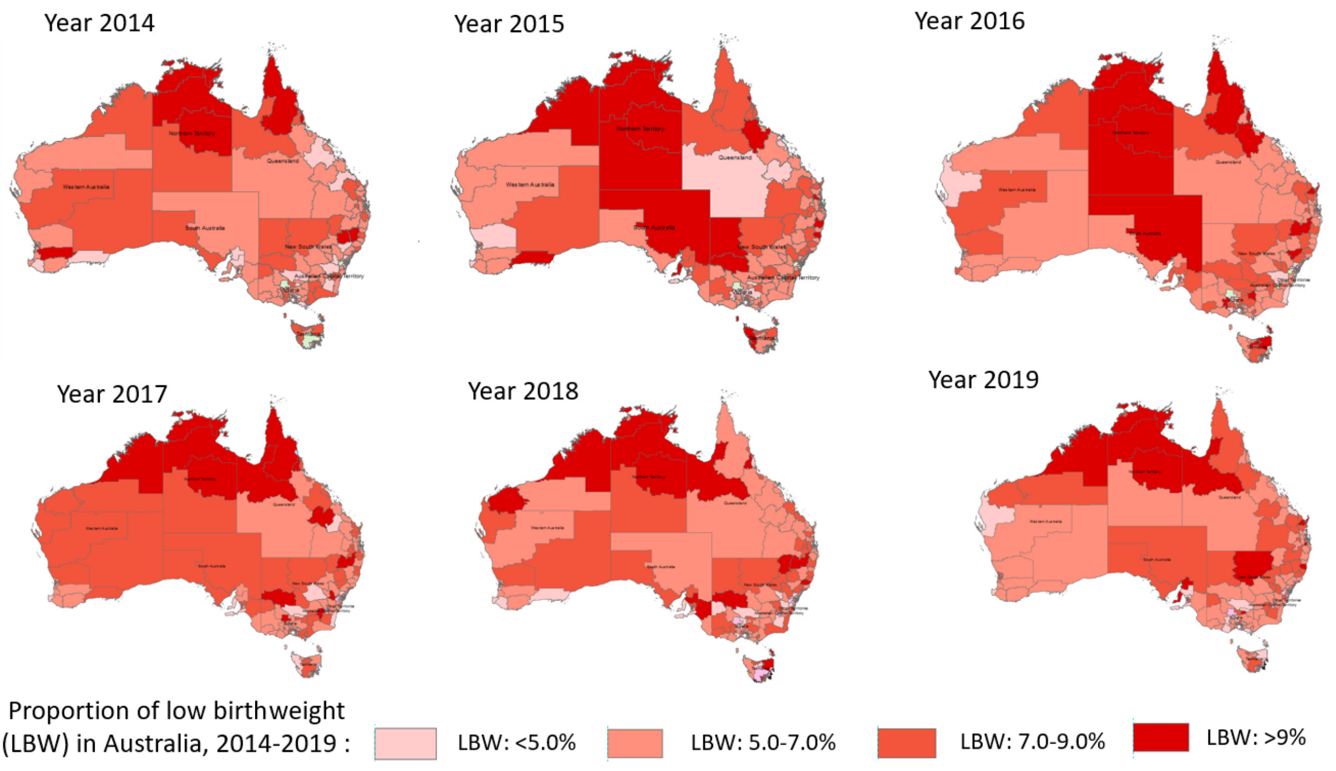

FIGURE 5 Spatial distribution of LBW in Australia, 2014–2019 (SA 3 level). LBW, low birthweight [Color figure can be viewed at wileyonlinelibrary.com]

significantly higher increasing trend in LBW than the national trend. For example, we found that the socioeconomically most disadvantaged mothers experienced +1.08% ARRC. Increasing economic inequality may contribute to this increasing trend.[29] Despite the lack of research on LBW trends across socioeconomic and other maternal characteristics groups, several studies have shown that socioeconomic disadvantage remains one of the dominant determinants of LBW and small-for-gestational-age birth (SGA) in developed countries, including Australia. For example, Beard et al.[30] conducted a study using data from NSW to examine trends in disparity in SGA across socioeconomic and maternal factors and reported that from 1994 to 2004, the odds of SGA increased from 1.7 to 2.2 in mothers living in the most disadvantaged areas than those in the least disadvantaged areas.

Some high-risk subpopulations have experienced a significantly increasing trend in LBW in Australia. For example, we found that the prevalence of LBW increased at a +1.52% annual rate among mothers who smoked during pregnancy. Although the increasing trend among this group is not fully understood, an increase in the proportion of pregnant women who smoked after the first trimester of pregnancy may be a possible reason. A register-based cohort study of 1.4 million births from the Finnish Medical Birth Register showed that continued smoking after the first trimester increases the risk of LBW. The effects were attenuated when smoking was ceased during the first trimester.[31] According to AIHW, although the overall prevalence of smoking has declined among pregnant women in Australia,[32] of women who smoke, the proportion who continued to smoke after 20 weeks of pregnancy increased from 70.8% in 2011 to 75.1% in 2019.[33] Furthermore, the quantity of cigarettes smoked by mothers may also be a factor. While fewer women smoke, those still smoking continue for longer and perhaps smoke more heavily. Hence, the LBW data may reflect higher exposure to cigarette smoke in these women or higher degrees of psychosocial distress being soothed by smoking, thereby contributing to LBW.

Mothers at the two extremes of ages (teen and older) also experienced an increasing trend in LBW over time. AIHW reported that the number of mothers aged ≥40 years who gave birth increased from 11 647 in 2009 to 13 440 in 2019.[34] The older mother usually faces more medical and obstetric complications (diabetes mellitus, chronic hypertension, placenta praevia, multiple pregnancies, preterm labor, fetal distress, retained placenta, postpartum hemorrhage, and endometritis), leading to adverse pregnancy outcomes associated with LBW.[35] Although the number of teenage mothers in Australia has fallen steadily over time, from 11 767 (4.0%) in 2009 to 5678 (1.9%) in 2019,[36] the prevalence of LBW among teenage mothers has significantly increased over time. The increasing trend of LBW among teenage mothers could be explained by the socioeconomic characteristics of the teenage mother. It is reported that teenage mothers in Australia were more likely to live in remote and socioeconomically disadvantaged areas,[36] where the prevalence of LBW has also been found to increase over time. However, further study is needed to better understand the reasons behind this upward trend of LBW among this subpopulation.

Apart from inequities in the trend in LBW across social and health-related dimensions, this study also identified geographic disparities in the prevalence of LBW in Australia. For example, some Northern Territory and Queensland geographic areas were consistently highly prevalent for LBW from 2014 to 2019. Understanding why LBW is persistently high in those areas and addressing those issues could help to reduce the high burden of LBW in those areas. However, health-related policies and programs that focus on the overall population may not address the needs of specific subpopulations. Furthermore, in some subpopulations, the rate of increase in the prevalence of LBW is substantially higher than the average national rate of increase. If this upward trend is continued, the target of a 30% reduction in the prevalence of LWB in Australia will not be achieved. Thus, our findings on disparities in the LBW trends across different subpopulations within Australia need to be considered when designing interventions for high-risk groups, focusing on mitigating the many elements of inequality between social, cultural, and geographic characteristics such that progress may be made in reducing LBW in Australia.

Our study has some limitations. First, our analysis is ecological, so causality cannot be invoked. Second, this study used yearly aggregated data at the national and subpopulation levels provided by AIHW. Thus, we were unable to explore the trend interactions across multiple groups. For example, we cannot see the trends in risk subpopulations, such as Indigenous mothers who smoked during pregnancy. Future studies, using individual-level perinatal data, would address this limitation. Finally, our predictions are univariate projections. As LBW is influenced by a range of other factors, the projected prevalence of LBW may be influenced by many factors outside the scope of this study (e.g., changes in maternal health and characteristics of the population over time, climate change, and policy changes). Given the importance of LBW in long-term health, this requires ongoing surveillance.

Despite these limitations, this study provides a broad overview of recent and future trends in LBW and disparities in trends across different subpopulations in Australia. In conclusion, the prevalence of LBW has slightly increased in Australia during 2009–2019; however, the trends vary across different subpopulations. Non-Indigenous populations experienced an increasing trend in the prevalence of LBW. The disadvantaged (mothers who lived in remote and disadvantaged communities) and high-risk (e.g., smoked during pregnancy, extreme age group: aged <20 and 40+ years) subpopulations also experienced a significant increasing trend in the prevalence over time. Some of the high-burden subpopulations (i.e., Indigenous mothers and underweight mothers) experienced no statistically significant change in the prevalence of LBW over time but no improvement in high rates of LBW. If those trends persist, Australia may not achieve the global goals of a 30% reduction in LBW by 2030. Social and health-related inequities in the trends of LBW can be mitigated by centering and supporting subpopulations with interventions specifically designed to address LBW. This is essential to improve perinatal, infant, and long-term offspring health in Australia to meet 2030 agenda of SDGs.

ETHICAL CONSIDERATIONS

The AIHW follows Australian research ethics guidelines with data, including the National Statement on Ethical Conduct in Human Research, the Australian Code for the Responsible Conduct of Research, and the Privacy Act 1988 (Cwlth). We used de-identified, publicly available, aggregated AIHW data in this study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available in Australian Institute of Health and Wellbeing at https://www.aihw.gov.au/. These data were derived from the following resources available in the public domain: - Australia's mothers and babies, https://www.aihw.gov.au/reports-data/population-groups/mothers-babies/data.

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SUPPORTING INFORMATION

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

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