

No official identity: a data linkage study of birth registration of Aboriginal children in Western Australia

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Evidence of identity and proof of Australian citizenship is essential to access many rights, including obtaining a passport or driver's licence and opening bank accounts. For most Australians, a birth certificate is the first documentary evidence of identity. However, a birth certificate can only be obtained once the birth has been registered, and the births of many Australians, particularly Aboriginal Australians, are not registered when they are babies. In 2012, 1% of all new birth registrations in Australia were for people born in 2005 or earlier; that is, the person being registered was already 6 years of age or older.¹ For Aboriginal and Torres Strait Islander Australians (hereafter referred to as Aboriginal), the proportion was 8%. In Western Australia (WA), delayed registrations were even more common at 15% for Aboriginal people, nine times that of non-Aboriginal Western Australians (1.7%).¹

In WA, the paperwork to register a birth is supplied to the parents by the hospital or midwife and it includes certification of the birth from a doctor or midwife. If the paperwork is lost, a replacement must be requested from the hospital or midwife. If only one parent has signed the form, that parent must provide a written explanation of why the other parent has not signed. It is a legal requirement that an application for birth registration is made to the WA Registry of Births, Deaths and Marriages ('the Registry') within 60 days of birth. Birth registration is free, but obtaining a birth certificate costs \$47.² Births must be registered with the state or territory in which they occurred.

Abstract

Objective: Evidence of identity, particularly a birth certificate, is essential to access many rights. However, the births of many Aboriginal Australians are not registered when they are infants. We examined factors related to birth registration among Western Australian children born to Aboriginal mothers.

Methods: All births to Aboriginal mothers in the Midwives Notification System in Western Australia (WA) from 1980 to 2010 were linked to birth registrations. Associations between registration and maternal and child characteristics were examined for children aged under 16 years in 2012.

Results: Among 49,694 births between 1980 and 2010, 18% of those aged under 16 years had unregistered births, compared to 3% of those aged 16–32 years. Unregistered births were most strongly associated with young maternal age at first birth (adjusted odds ratio [AOR] 5.22; 95%CI 3.07–8.86; for 16 years or younger vs 30 years or older, among non-smokers), remoteness (AOR 2.17; 95%CI 1.87–2.52; very remote vs major cities), mothers whose own birth was unregistered (AOR 3.00; 95%CI 1.78–5.07) and no private hospital insurance (AOR 0.19; 95%CI 0.11–0.31; insured vs uninsured).

Conclusions: Unregistered births are common among WA Aboriginal children, particularly in disadvantaged families.

Implications: Assistance before discharge from hospital may increase birth registrations.

Key words: birth registration, Indigenous, linked data

It is not known how many Aboriginal people in Western Australia today have not had their births registered, or why their births were not registered. Given the importance of birth registration and to inform strategies to increase the proportion of Aboriginal births registered, in this study we examined factors associated with birth registration for babies born to Aboriginal mothers in WA from 1980 to 2010.

Methods

This study was approved by the Western Australian Aboriginal Health Ethics Committee (Ref 306 – 08/10) and the Western Australian Department of Health Ethics Committee (Ref 2010/42).

Study cohort and data sources

The study sample comprised all children born alive in WA from 1980 to 2010, whose mothers were recorded as Aboriginal and/or Torres Strait Islander on their own Midwives

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Submitted: September 2015; Revision requested: December 2015; Accepted: March 2016

The authors have stated they have no conflict of interest.

Notification System (MNS) record or the record of a sibling with the same mother (49,694 people). All births of infants of 20 weeks or more gestation and/or 400 grams or more birthweight must be notified to the WA Department of Health by attending midwives or medical officers. Information in the MNS includes details of the birth and medical conditions affecting the pregnancy.

While the MNS has all births that were attended or had follow-up care provided by a midwife or doctor, birth registration records only include those children where the parent/s have lodged an application to register the birth. Registration records contain demographic information about the child and parents.

The parents and siblings of the study sample were identified in the Family Connections System. The Family Connections System links family members who are resident in WA, primarily using birth, death and marriage records.³ Children whose mother was not identified in the Family Connections System were excluded (45 children).

Birth registration records, inpatient hospital records (Hospital Morbidity Data System [HMDS]) and the Mental Health Information System (MHIS) up to 30 June 2011 were available for the study sample and their parents and siblings. Probabilistic linkage of the records was undertaken by the Data Linkage Branch in the Department of Health Western Australia (DOHWA).

Study factors

Each infant's date of birth and sex, as well as whether their mother smoked during the pregnancy ('maternal smoking during pregnancy', comprehensively available from 1998 onwards) and their mother's marital status at the time of the birth were obtained from the MNS. Census Collection Districts (CDs) and postcodes from the MNS and HMDS were mapped to one of the remoteness categories (Major Cities, Inner Regional, Outer Regional, Remote or Very Remote) of the Accessibility/Remoteness Index of Australia Plus (ARIA+) using correspondence files from the ABS. Similarly, the infant's CD or postcode was mapped to the ABS Socio-Economic Indexes for Areas (SEIFA) Index of Relative Socio-Economic Advantage and Disadvantage. Quintiles of socioeconomic status were created using the entire population of Western Australia (WA) and the cut-points of those quintiles were used to assign our

sample to socioeconomic categories. Further details about the assignment of remoteness and socioeconomic status are in the Supplementary Information (available with the online version of this article).

For each child, the age at which their mother had her first child ('maternal age at first birth') was obtained by identifying her first child through the Family Connections System and the dates of birth shown on her children's records. As we did not have birth records for births outside Western Australia, those births were not included in the calculation of the mother's age at first birth.

The hospital in which the child's birth took place, or to which the mother was admitted within a week of the birth with a diagnosis that the birth was outside hospital, was categorised as tertiary, public metropolitan, private metropolitan or (public or private) rural hospital. In 1980–2010, 1% of births did not link to a hospital admission and the hospital category was coded as 'no hospital admission'.

Whether the child's mother had private hospital insurance at the time of the child's birth, an individual level marker of socioeconomic status, was obtained from the HMDS. This information was recorded in the HMDS from 1999 onwards.

Maternal alcohol use, drug use and mental health conditions were identified from the HMDS, MHIS and MNS. Where a diagnosis was recorded for a hospital admission or mental health episode within a year of the child's birth, or on the MNS birth record, the mother was categorised as positive for alcohol or drug use or mental health conditions for that birth. Additionally, if a child had any hospital diagnosis of being affected by alcohol or drugs as a foetus or newborn, the mother was also categorised as positive for alcohol or drug use. The Supplementary Information (available online) lists the codes of the International Classification of Diseases, 9th and 10th Revisions (ICD-9-CM, ICD-10-AM) used. For alcohol and drug use, we modified the diagnoses used by Derrington et al., excluding codes for chronic diseases associated with long-term, past abuse, as we were interested in ongoing use around the time of birth.⁴ For mental health, we used the diagnoses used by O'Donnell et al., excluding the alcohol and drug-related codes.⁵

For most mothers, information was available about whether their own birth was registered and a variable 'mother's birth registered' was

created. As smoking during pregnancy was not comprehensively recorded on the MNS prior to 1998, private hospital insurance on the HMDS was not recorded until 1999, and the birth registration status of mothers born prior to 1980 or outside WA was not known, categories of 'missing' were created for these variables.

Analysis

To estimate the trends in birth registration over time, a joinpoint regression model was fitted to the proportion of unregistered births for each year of birth from 1980 to 2010.⁶ Joinpoint regression analysis also identifies years when the linear trend significantly changes (joinpoints). Joinpoint 4.1.1.1 was used.⁷ Additional information about the joinpoint regression appears in the Supplementary Material (available online).

To examine associations between a range of demographic factors and registration of births, logistic regression was used with a generalised estimating equation (GEE) approach to allow for lack of independence among siblings and to estimate the intra-family correlation. We restricted the analysis to the 26,404 people who were born on 25 April 1996 or later, as these children were under 16 years old when the birth registration data was extracted. This age group was more likely to be dependent on their parents to register their births and less likely to have strong incentives to seek birth registration, such as applying for a driver's licence.

Factors examined were: year of birth (input as a continuous variable, with the slope free to change at the joinpoints identified by joinpoint regression analysis); sex; maternal age at birth of first child (16 years or younger, 17–19, 20–24, 25–29 and 30 years or older); maternal relationship status at the time of birth (married/de facto, never married, divorced/widowed/separated, missing); socioeconomic status (by quintile); remoteness (major cities, inner regional, outer regional, remote or very remote); hospital category for birth (tertiary, public metropolitan, private metropolitan, rural, no hospital record); smoking during pregnancy (yes, no, unknown); alcohol-related diagnosis within a year of the birth (yes, no); drug-related diagnosis within a year of the birth (yes, no); mental health diagnosis within a year of the birth (yes, no); private hospital insurance at time of birth (yes, no, unknown); and mother's own birth registered (yes, no, unknown).

Variables that were significant in univariate GEE analysis at $p < 0.05$ were entered simultaneously. As they remained significant and there was no evidence of collinearity, all variables were retained. All two-way interactions were tested individually and retained if they remained significant at $p < 0.05$ in the presence of the other interactions. Checks for collinearity were conducted (see Supplementary Information, available online). The intraclass correlation coefficient (ICC) was obtained from an intercept-only GEE logistic regression model with the working correlation matrix specified as exchangeable. It represents the agreement in birth registration status for siblings with the same mother.

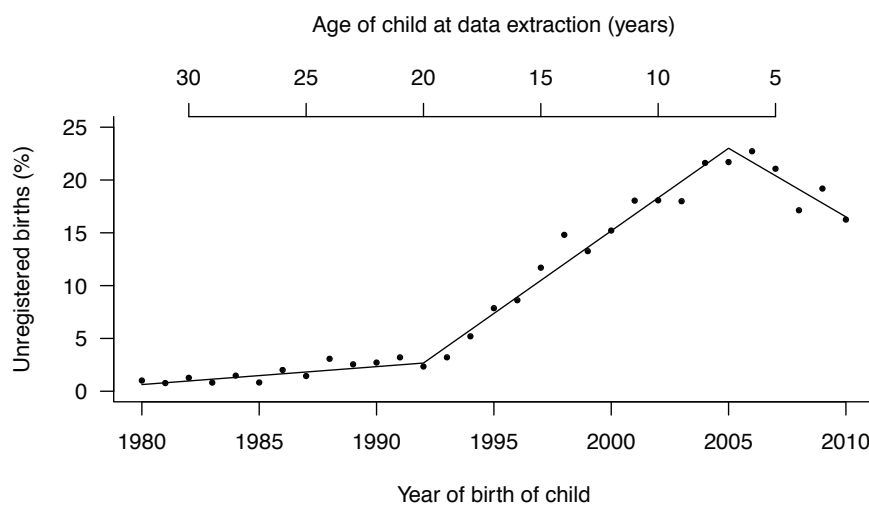
The Aboriginal status of some mothers was not consistently recorded across the midwives' records of all of their children. To assess the impact of this, we conducted two sensitivity analyses; first, we excluded all children whose MNS record listed their mother as non-Aboriginal (2,615/26,404 [9.9%] children), and second, we excluded all families where the mother was recorded as non-Aboriginal on at least one child's record (5,503/26,404 [20.8%] children).

Results

Of 49,694 children born to Aboriginal mothers from 1980 to 2010, 5,272 (11%) did not link to a birth registration. The proportion of unregistered births varied greatly by year of birth (Figure 1). Changes in trend were found by joinpoint analysis at 1992 and 2005. Those who were born in or before 1992 were at least 19 years old at the time the data was extracted and they had the highest level of birth registration. Children born in the mid-2000s, who were around 7 years old when the registration data was extracted, were the most likely to have unregistered births.

Among those who were aged under 16 years, 18% of births were unregistered (Table 1). Unregistered births were more common with mothers who were teenagers when they had their first child, lived in more socioeconomically deprived and remote areas, gave birth in a rural hospital, smoked during pregnancy, had an alcohol-related diagnosis around the time of the birth, did not have private hospital insurance and whose mother's own birth was not registered. The gender of the child, mother's relationship status at the time of birth, and drug and mental health-related diagnoses around the

Figure 1: Percentage of births to Aboriginal mothers that were not registered by 24 April 2012 by year of birth in Western Australia, 1980-2010 (points), with fitted trends from joinpoint regression analysis (lines).



time of birth were not associated with birth registration. The proportion with private insurance was very low at 3%, and maternal smoking during pregnancy was high (49% of those with known smoking status). Both were constant over the study period.

In the fully adjusted model, which included the factors listed in Tables 2a and 2b, the mother's age at the birth of her first child remained a strong predictor of whether the birth was registered. The effect was particularly strong for mothers who did not smoke during the pregnancy; the odds of an unregistered birth were five times higher for mothers who had their first child at 16 years or younger, compared to 30 years or older (odds ratio (OR) 5.22, 95% Confidence Interval (CI) 3.07-8.86). The offspring of mothers who did not have a registered birth themselves also had much higher odds of unregistered births (OR 3.00, 95%CI 1.78-5.07). Children whose mother had private hospital insurance at the time of their birth had much lower odds of unregistered birth than those without insurance (OR 0.19, 95%CI 0.11-0.31). The effect of living in remote and very remote areas remained in the fully adjusted model. While the effect of areas of lower socioeconomic status and alcohol-related hospital diagnoses within a year of the birth also remained, the size of the effect was small (OR ratios less than 1.25) after allowing for other measures of disadvantage.

In an unadjusted model, the odds of birth registration for children whose mother's own birth registration status was unknown were significantly lower than for those children whose mothers had registered births

(unadjusted OR 0.70, 95%CI 0.64-0.76). Those children in the 'unknown' category tended to be older, as their mothers were older; the main reason for unknown birth registration status was that the mother was born prior to 1980. In the adjusted model, which included the child's year of birth, the 'unknown' and 'yes' categories had similar odds (adjusted OR 1.04, 95%CI 0.95-1.15).

There was a significant interaction between the category of hospital the child was born in and year of birth from 2006 to 2010. Generally, the odds of unregistered birth increased with year of birth, but after 2005 the odds decreased among children born in rural hospitals and, to a lesser extent, in tertiary hospitals, while continuing to rise in public and private metropolitan hospitals. This relationship can be seen in a graph of unregistered births by year of birth by hospital category in Figure 2.

In the sensitivity analyses, using different definitions of Aboriginal status, the same patterns were seen. However, the odds ratios tended to be closer to unity, the p -values were higher and the proportion of children with unregistered births was higher (18.8% when all children whose MNS record listed their mother as non-Aboriginal were excluded and 20.2% when all families where the mother was recorded as non-Aboriginal on at least one child's record were excluded). We examined stillbirths separately and found that stillborn babies were more likely to have their births registered than live-born babies; 95% of stillborn babies between 1980 and 2010 had a birth registration.

Table 1: Characteristics of births to Aboriginal mothers in Western Australia by birth registration status, for children under 16 years

	Unregistered n (row %)	Registered n (row %)	p-value	Total N (column %)
All	4,628 (18)	21,776 (82)	-	26,404 (100)
Child's sex			0.94	
Male	2,335 (17)	11,060 (83)		13,395 (51)
Female	2,293 (18)	10,716 (82)		13,009 (49)
Maternal age at first birth (years)			<0.001	
16 or lower	1,375 (24)	4,358 (76)		5,733 (22)
17-19	2,168 (19)	9,129 (81)		11,297 (43)
20-24	907 (14)	5,776 (86)		6,683 (25)
25-29	129 (7)	1,641 (93)		1,770 (7)
30 or higher	49 (5)	872 (95)		921 (3)
Maternal relationship status			0.29	
Never married	1,400 (18)	6,307 (82)		7,707 (29)
Married/de facto	3,108 (17)	14,908 (83)		18,016 (68)
Widowed/divorced/separated	115 (18)	530 (82)		645 (2)
Missing	5 (14)	31 (86)		36 (0)
Socioeconomic status			<0.001	
Q1 (Most advantaged)	290 (13)	1,872 (87)		2,162 (8)
Q2	529 (15)	3,111 (85)		3,640 (14)
Q3	761 (17)	3,767 (83)		4,528 (17)
Q4	1,181 (16)	6,045 (84)		7,226 (27)
Q5 (Most disadvantaged)	1,867 (21)	6,981 (79)		8,848 (34)
Remoteness			<0.001	
Major cities	1,025 (11)	8073 (89)		9,098 (34)
Inner regional	210 (12)	1,553 (88)		1,763 (7)
Outer regional	596 (14)	3,549 (86)		4,145 (16)
Remote	930 (18)	4,102 (82)		5,032 (19)
Very remote	1,867 (29)	4,499 (71)		6,366 (24)
Hospital category for birth			<0.001	
Tertiary	1,150 (16)	6,199 (84)		7,349 (28)
Public metropolitan	368 (10)	3,264 (90)		3,632 (14)
Private metropolitan	70 (6)	1,102 (94)		1,172 (4)
Rural	3,010 (21)	11,114 (79)		14,124 (53)
No hospital admission ^a	30 (24)	97 (76)		127 (0)
Maternal smoking during pregnancy			<0.001	
Yes	2,591 (22)	9,003 (78)		11,594 (44)
No	1,742 (14)	10,311 (86)		12,053 (46)
Unknown ^b	295 (11)	2,462 (89)		2,757 (10)
Alcohol diagnosis			<0.001	
Yes	380 (26)	1,108 (74)		1,488 (6)
No	4,248 (17)	20,668 (83)		24,916 (94)
Drug diagnosis			0.15	
Yes	358 (18)	1,648 (82)		2,006 (8)
No	4,272 (17)	20,140 (83)		24,398 (92)
Any mental health diagnosis			0.63	
Yes	377 (15)	2,066 (85)		2,443 (9)
No	4,251 (18)	19,710 (82)		23,961 (91)
Private hospital insurance			<0.001	
Yes	<5 ^d (0)	560 (100)		<565 ^d (2)
No	4,057 (19)	17,231 (81)		21,288 (81)
No hospital admission/Unknown ^c	<571 ^d (12)	3,985 (88)		<4,556 ^d (17)
Mother's birth registered			<0.001	
No	37 (54)	32 (46)		69 (0)
Yes	3,355 (19)	14,098 (81)		17,453 (66)
Unknown ^e	1,236 (14)	7,646 (86)		8,882 (34)

a: Hospital category and private hospital insurance was categorised as 'no hospital admission' for births outside hospital and no maternal admission within a week of the birth or a failure to link the Midwives Notification System record to the hospital birth record.

b: Data on maternal smoking during pregnancy was not comprehensively available until 1998.

c: Data on private hospital insurance was not recorded until 1999.

d: Exact cell counts suppressed to confidentialise the data.

e: Mother born prior to 1980 or outside WA.

The birth registration status of children with the same mother was moderately correlated, with an intraclass correlation coefficient (ICC) of 0.48.

Discussion

Almost one-in-five children with Aboriginal mothers born in Western Australia from 1996 to 2010 did not have a birth registration record by 2012. Unregistered children were significantly more likely to have mothers who were teenagers when they had their first child, who lived in remote and very remote areas, who did not have private hospital insurance and whose own births were not registered. There is evidence that registration rates have increased in regional and remote areas in recent years.

The high number of unregistered births suggests there are significant barriers in the registration process for many Aboriginal families. An ICC of 0.48 indicates a relatively high level of consistency in birth registration status among siblings. This, along with our finding that children were less likely to have registered births if their mother's birth was unregistered, may indicate that these barriers persist over time in some families.

Completion of the birth registration process relies on the parents recognising its value, their level of literacy and the practical means of returning a completed registration form to the Registry, while coping with the demands of caring for a newborn baby. The factors most strongly associated with unregistered births are indicators of disadvantage and/or remoteness. Highly disadvantaged parents may not fully access some services that require a birth certificate, such as obtaining a driver's licence or passport, and may place a lower value on birth registration. Parents may also not see the value in registering a birth if they are unable to afford the fee for a birth certificate at that time. Highly disadvantaged parents are also more likely to have lower levels of literacy, leading to greater difficulty completing an application for birth registration and, when necessary, a written explanation of why one parent did not sign the form. Obtaining assistance from Registry staff to complete the form may be more difficult in very remote areas.

We found that adults were much more likely to have registered births than children, which may be due to people registering their own births when they were older, independent

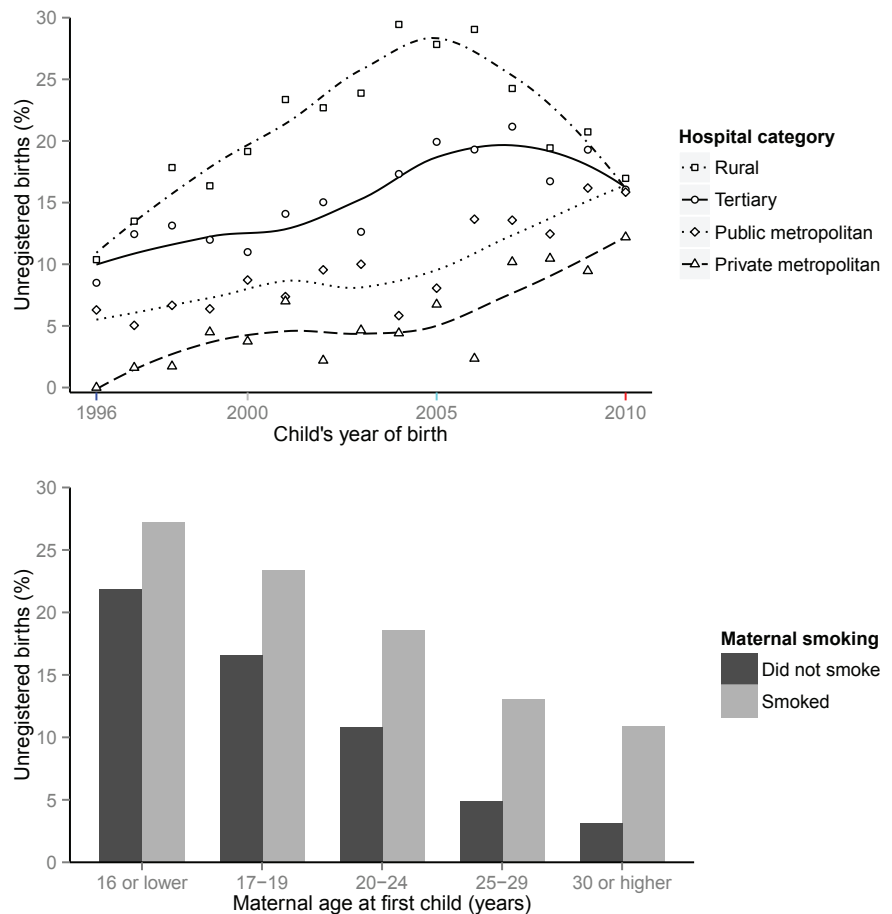
of their mothers and facing difficulties in accessing services without a birth certificate.

The indications of increased birth registration from 2006 to 2010 among the 53% of children born in rural hospitals may be due to the increasing focus on unregistered births in recent years. For example, several programs are run in remote WA to assist Aboriginal people to obtain driver's licences (including the prerequisite birth certificate).⁸ Additionally, since 1 July 2007, parents could only receive the Baby Bonus (a government payment on the birth of a child, which ended in 2014), parental leave pay or family tax benefits if they stated on their application that they had applied for the child's birth to be registered.^{9,10}

Our finding that unregistered births are common for Aboriginal children in WA for children from 1 to 15 years agrees with studies of birth registrations in Queensland and New South Wales, which studied young children only.^{11,12} The Queensland study found that 17% of birth records for Aboriginal babies born from July 2010 to June 2012 did not link to a birth registration record by June 2014 and births to mothers living in remote and very remote areas in Queensland were more than twice as likely to be unregistered.¹¹ The NSW study estimated that 29% of Aboriginal children born 2001 to 2005 had unregistered births at the end of 2005.¹²

A limitation of this study is that the linkage of the MNS and birth registration records was probabilistic, so it is likely that some registered births were incorrectly categorised as unregistered, because the MNS record failed to link to the birth registration record. However, we examined linkage in the opposite direction and found that only 56 birth registration records from 25 April 1996 to 31 December 2010 with the mother listed as Aboriginal did not link to a MNS record, compared to 4,628 MNS records which did not link to a birth registration record during the same time period. This suggests that linkage failures between the two data sources are rare. Additionally, the studies in Queensland and NSW and the work of the ABS on delays in birth registration all support our finding that unregistered births are not uncommon for Aboriginal children. Another limitation is that we have not included children with non-Aboriginal mothers and Aboriginal fathers because we do not know the identity of the fathers of many children, as the birth was not registered or the registration did not include details of

Figure 2: Percentage of births to Aboriginal mothers in Western Australia that were not registered by 24 April 2012 by (1) year of birth and hospital category (with Loess smoothers) and (2) maternal age at first child and maternal smoking during pregnancy.



the father. For the same reason, we did not examine associations between the fathers and birth registration. We also could not investigate associations with delays in birth registration, as we did not have the date of birth registration. Another limitation was possible measurement error for some factors of interest. The strengths of this study include that it was population-based and had 30 years of births available to examine trends over time. Additionally, by using family relationships, we were able to include a wide range of information about the mother and to allow for correlations within families.

Several international conventions to which Australia is a signatory stipulate that all children have the right to be registered immediately after birth.¹³ However, it is increasingly clear that an unacceptably high number of Aboriginal children do not obtain this right.

Difficulties proving identity can lead to serious and wide-ranging social and economic impacts. These include barriers

to securing employment, obtaining a tax file number and even joining organised sports activities if a child cannot prove their age. Lack of a birth certificate has also been linked to unlicensed driving and subsequent incarceration in WA.⁸

In its current form, the birth registration system does not adequately help the most disadvantaged become registered, so changes are necessary in order to increase Aboriginal birth registration rates. In the short term, as almost all births take place in hospital in WA, assistance completing the birth registration form before the mother and child leave the hospital may increase registration, in addition to expanded catch-up registration programs. This assistance could be particularly targeted towards providing additional support to mothers who are teenagers, which may in turn increase the prospects of registration for their subsequent births.

In the longer term, more fundamental changes to the current birth registration

Table 2a: Odds of unregistered birth compared to registered birth for 26,404 children born to Aboriginal mothers from 25 April 1996 to 31 December 2010 in Western Australia (interaction terms in Table 2b).

	Unadjusted		Fully adjusted	
	Odds ratio (95% CI)	p-value ^e	Odds ratio (95% CI)	p-value
Child's year of birth (per year increase)				
1996-2005	1.11 (1.10-1.13)	<0.001	1.14 (1.12-1.16)	<0.001
2005-2010	0.96 (0.94-0.98)	<0.001	— ^a	
Maternal age at first birth (years)		<0.001		
16 or younger	5.24 (3.72-7.38)		— ^a	
17-19	3.84 (2.74-5.39)		—	
20-24	2.48 (1.76-3.50)		—	
25-29	1.32 (0.89-1.97)		—	
30 or older	1.00 (ref)		—	
Socioeconomic status		<0.001		<0.001
Q1 (Most advantaged)	0.73 (0.60-0.89)		0.82 (0.66-1.02)	
Q2	0.81 (0.72-0.91)		0.76 (0.67-0.86)	
Q3	0.79 (0.71-0.87)		0.77 (0.69-0.86)	
Q4	0.90 (0.83-0.98)		0.91 (0.83-0.99)	
Q5 (Most disadvantaged)	1.00 (ref)		1.00 (ref)	
Remoteness		<0.001		<0.001
Major cities	1.00 (ref)		1.00 (ref)	
Inner regional	0.95 (0.78-1.14)		0.88 (0.72-1.08)	
Outer regional	1.15 (1.01-1.31)		0.94 (0.80-1.12)	
Remote	1.66 (1.48-1.86)		1.45 (1.23-1.69)	
Very remote	2.71 (2.44-3.01)		2.17 (1.87-2.52)	
Hospital category		<0.001		
Tertiary	1.00 (ref)		— ^a	
Public metropolitan	0.77 (0.67-0.87)		—	
Rural	1.36 (1.24-1.49)		—	
Private metropolitan	0.53 (0.42-0.67)		—	
No hospital admission ^b	1.31 (0.77-2.21)		—	
Maternal smoking during pregnancy		<0.001		
No	1.00 (ref)		— ^a	
Yes	1.39 (1.29-1.50)		—	
Unknown ^c	0.63 (0.55-0.72)		—	
Alcohol-related hospital admission	1.36 (1.18-1.56)	<0.001	1.15 (1.00-1.32)	0.040
Private hospital insurance		<0.001		<0.001
No	1.00 (ref)		1.00 (ref)	
Yes	0.09 (0.07-0.13)		0.19 (0.11-0.31)	
No hospital admission ^b /Unknown ^d	0.60 (0.54-0.66)		1.29 (1.10-1.52)	
Mother's birth registered		<0.001		0.003
Yes	1.00 (ref)		1.00 (ref)	
No	4.86 (2.88-8.19)		3.00 (1.78-5.07)	
Unknown ^c	0.70 (0.64-0.76)		1.04 (0.95-1.15)	

The fully adjusted model includes the main effects of year of birth, maternal age at first birth, socioeconomic status, remoteness, hospital category, maternal smoking during pregnancy, alcohol-related hospital admission, private hospital insurance, mother's birth registered, as well as interactions between year of birth and hospital category and between maternal age at first birth and maternal smoking during pregnancy.

a: Odds ratios displayed in Table 3.

b: Births outside hospital and no maternal admission within a week of the birth or a failure to link to the hospital birth record.

c: Data on maternal smoking during pregnancy was not comprehensively available until 1998.

d: Data on private hospital insurance was not recorded until 1999. Mother born prior to 1980 or outside WA.

e: p-value for unadjusted generalized estimating equation (GEE) logistic regression model.

Table 2b: Odds of unregistered birth compared to registered birth for 26,404 children born to Aboriginal mothers from 25 April 1996 to 31 December 2010 in WA for interaction terms in fully adjusted model

	Odds ratio (95% CI)	p-value
Year of birth and hospital category interaction		<0.001
Per year increase in 2005-2010 (reference 1996-2005)		
Tertiary	0.96 (0.92-1.00)	
Public metropolitan	1.11 (1.04-1.18)	
Private metropolitan	1.14 (1.01-1.28)	
Rural	0.92 (0.89-0.95)	
No hospital admission ^a	0.87 (0.59-1.29)	
Hospital category in 1996-2005		
Tertiary	1.00 (ref)	
Public metropolitan	0.70 (0.58-0.84)	
Private metropolitan	0.68 (0.49-0.95)	
Rural	1.19 (1.04-1.36)	
No hospital admission ^a	1.05 (0.58-1.91)	
Hospital category in 2005-2010		
Tertiary	1.00 (ref)	
Public metropolitan	0.81 (0.69-0.94)	
Private metropolitan	0.81 (0.61-1.06)	
Rural	1.14 (1.01-1.29)	
No hospital admission ^a	0.96 (0.56-1.64)	
Maternal age at first birth and smoking during pregnancy interaction		<0.001
Maternal age (non-smokers)		
16 or younger	5.22 (3.07-8.86)	
17-19	4.18 (2.47-7.04)	
20-24	2.57 (1.52-4.37)	
25-29	1.48 (0.80-2.73)	
30 or older	1.00 (ref)	
Maternal age (smokers)		
16 or younger	2.45 (1.62-3.68)	
17-19	1.89 (1.27-2.83)	
20-24	1.48 (0.98-2.23)	
25-29	1.02 (0.62-1.68)	
30 or older	1.00 (ref)	
Maternal age (unknown smoking^b)		
16 or younger	4.16 (1.52-11.37)	
17-19	2.63 (0.97-7.15)	
20-24	1.28 (0.45-3.66)	
25-29	0.58 (0.15-2.32)	
30 or older	1.00 (ref)	
Smoking during pregnancy by maternal age (ref: no smoking)		
16 or younger	1.22 (1.06-1.41)	
17-19	1.18 (1.06-1.32)	
20-24	1.50 (1.27-1.75)	
25-29	1.79 (1.11-2.90)	
30 or older	2.60 (1.46-4.65)	
Unknown smoking^b during pregnancy by maternal age (ref: no smoking)		
16 or younger	1.12 (0.85-1.47)	
17-19	0.89 (0.70-1.12)	
20-24	0.70 (0.47-1.05)	
25-29	0.55 (0.20-1.56)	
30 or older	1.41 (0.50-3.97)	

Table 2b notes: The fully adjusted model includes the main effects of year of birth, maternal age at first birth, socioeconomic status, remoteness, hospital category, maternal smoking during pregnancy, alcohol-related hospital admission, private hospital insurance, mother's birth registered, as well as interactions between year of birth and hospital category and between maternal age at first birth and maternal smoking during pregnancy.

a: Births outside hospital and no maternal admission within a week of the birth or a failure to link to the hospital birth record.

b: Data on maternal smoking during pregnancy was not comprehensively available until 1998.

system may be required in order to increase the birth registration rates of children of Aboriginal mothers towards that of the non-Aboriginal population in Western Australia. Some states and territories (e.g. Northern Territory) have much lower rates of delayed birth registration than Western Australia, suggesting their systems have fewer barriers to birth registration.

Western Australia's data linkage system routinely links birth registrations and the Midwives Notification System, providing a simple mechanism for tracking progress towards the goal of universal birth registration for Aboriginal children.

Acknowledgements

We thank staff at the Western Australian Data Linkage Branch and the data custodians of the Midwives Notification System, Birth Registrations, Hospital Morbidity Data System and Mental Health Information System for access to, and linkage of, the data. This work was conducted as part of the Western Australian Aboriginal Intergenerational Fetal Growth Study (WAAIFS), which is funded by the National Health and Medical Research Council (NHMRC) (Grand ID 1007878). AG is supported by a PhD scholarship from Bellberry Limited.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary Figure 1: Method used to assign measures of remoteness (ARIA+) and socioeconomic status (SEIFA) based on the mother's residential address at the time of the child's birth.

Supplementary Table 1: Codes of the International Classification of Diseases, 9th and 10th Revisions (ICD-9-CM, ICD-10-AM) used to identify alcohol and drug use and mental health conditions.

Supplementary Table 2: Linear trends from joinpoint regression in the percentage of births to Aboriginal mothers that were not registered by 24 April 2012 by year of birth in Western Australia, 1980-2010.

Supplementary Table 3: Variance inflation factors (VIFs) for each variable in the fully-adjusted regression model.