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Complete List of Authors:	Strobel, Natalie; The University of Western Australia, School of Paediatrics and Child Health Peter, Sue; Princess Margaret Hospital for Children McAuley, Kimberley; University of Western Australia, School of Paediatrics and Child Health McAullay, Daniel; The University of Western Australia, School of Paediatrics and Child Health; Edith Cowan University - Mount Lawley Campus, Kurongkurl Katitjin, Centre for Indigenous Australian Education and Research Marriott, Rhonda; Murdoch University Edmond, Karen; University of Western Australia, School of Paediatrics and Child Health
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The effect of socio-economic disadvantage, remoteness, and Indigenous status on hospital utilisation on Western Australian preterm infants under 12 months of age: a population based data linkage study

Running title: Risk factors on hospital utilisation for preterm infants

Natalie A. Strobel[1], Sue Peter[2], Kimberley E. McAuley[1], Daniel R. McAullay[1,3], Rhonda Marriott[4], Karen M. Edmond[1]

[1]School of Paediatrics and Child Health, University of Western Australia, Perth, Western Australia, Australia

[2]Princess Margaret Hospital for Children, Perth, WA

[3]Kurongkurl Katitjin, Centre for Indigenous Australian Education and Research, Edith Cowan University, Perth, Western Australia, Australia

[4]School of Psychology and Exercise Science, Murdoch University, Perth, Western Australia, Australia

Corresponding author

Natalie A Strobel

School of Paediatrics and Child Health

The University of Western Australia

35 Stirling Highway

Crawley

Western Australia

Australia 6009

E-mail: natalie.strobel@uwa.edu.au

Phone: +61 8 9340 7507

ABSTRACT

Objectives

Our primary objective was to determine the risk of hospital admission and emergency department presentation in Indigenous and non-Indigenous preterm infants aged 1-11 months (postneonates) in Western Australia. Secondary objectives were to assess risk in the poorest infants from remote areas and to determine the causes of hospital utilisation.

Design

Prospective population-based linked dataset.

Setting and participants

All preterm babies born in Western Australia during 2010 and 2011.

Main outcome measures

All cause hospitalisations and emergency department presentations.

Results

There were 6.9% (4,211/61,254) preterm infants, 13.1% (433/3,311) Indigenous preterm infants and 6.5% (3,778/57,943) non-Indigenous preterm infants born in Western Australia. Indigenous preterm postneonates had a greater risk of hospital admission (aOR 1.33, 95% CI 1.05, 1.68) and emergency department presentation (aOR 1.83, 95% CI 1.44, 2.33) compared to non-Indigenous preterm infants. The most disadvantaged preterm postneonates (44.0%) had a greater risk of being hospitalised compared to the most advantaged infants (29.7%) (aOR 1.48, 95%CI 1.10, 1.99). The most remote postneonate preterm infants (40.2%) had a greater risk of hospitalisation compared to the least remote preterm infants (29.2%) (aOR 1.42, 95% CI 1.06, 1.90).

Conclusions

In Australia, preterm infants have high hospital utilisation in their first year of life and infants living in disadvantaged areas, remote area infants and Indigenous infants are at increased risk. Our data highlights the need for improved post discharge care for preterm infants.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- To the best of our knowledge, this is the first study to investigate the effect of risk factors on hospital utilisation, and the burden of preventable hospital admissions in Indigenous preterm infants under 12 months of age.
- This study uses population based data for all Western Australian preterm infants born 2010-2011 and high quality administrative data sets to determine hospital use for these infants.
- The sample size was sufficient to determine the differences in hospital use between Indigenous preterm infants, socio-economic status and remoteness for preterm infants.
- Environmental factors and maternity education were unable to be assessed.

INTRODUCTION

In 2010, it was estimated globally that 15 million babies, 11.1% of all livebirths worldwide, were born preterm (less than 37 weeks gestation).[1] Preterm infants are at a greater risk of experiencing serious health complications than fullterm infants. Complications include respiratory infections, anaemia, vision and hearing loss, and developmental delay.[1] Infants with complications from prematurity need many more health and social services than full term infants and infants without these complications.[2,3] This places a high economic, health and social burden on families and health systems.[4]

In 2013 8.6% of all babies born in Australia were preterm; most with a gestational age of between 32–36 completed weeks.[5] These data are similar to other developed countries. However, during 2013, 14% of babies born to Australian Aboriginal and Torres Strait Islander (hereafter referred to as Indigenous) mothers were preterm.[5] This high preterm risk has changed little over the last decade.[6] These data are also comparable to many of the poorest countries in the world where the most recent data indicate that approximately 12% of babies are born preterm.[7]

Despite the high risks, there has been little focus on understanding hospital utilisation patterns and what follow up care is needed for high risk preterm Aboriginal infants, especially the poorest infants who live in remote areas. This is particularly important because mothers who carry a higher burden of ill health and social dysfunction have a higher risk of delivering a preterm or low birth weight infant.[8,9] These mothers often have more difficulties accessing the health system and adhering to medication regimens.[8]

Western Australia (WA) has a large de-identified prospective longitudinal population based data system involving the probabilistic systematic record linkage of total population administrative health datasets.[10] Data are available for birth cohorts and include information on maternal and infant characteristics, hospital admission and emergency department presentations including length of stay, cause of hospital admission, Indigenous status and socio economic status. Our study was designed to assess differentials in risk of all-cause hospital admission and emergency department presentation for Indigenous and non-Indigenous preterm infants (born <37 weeks) during their first 12 months of life. Our primary objective was to determine the risk of hospital admission and emergency department presentation in Indigenous and non-Indigenous infants aged 1-11 months (postneonates). Secondary objectives were to assess risk in the poorest infants from remote areas and to determine the causes of hospital utilisation. We also separately assessed risk in infants in the first month of life (neonates) as the burden and drivers of health service utilisation are likely to be different in these children compared to older children.

METHODS

Study setting and database access

All live births occurring at <37 weeks gestational age in WA from 1 January 2010 to 31 December 2011 were included in this study. Prospective population based linked data from the WA Midwives' Notification System, Hospital Morbidity Data System, Emergency Department Data Collection, the Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD),[11] and the Accessibility/ Remoteness Index of Australia (ARIA)[12] were obtained from the Department of Health of Western Australia (DOHWA).

The Midwives' Notification System includes clinical (infant weight, gestational age, apgar score, multiple birth, gravidity) and socio demographic (baby's gender, mother's age,

Indigenous status, socioeconomic status, remoteness index) data on all WA live births and stillbirths of more than 20 weeks' gestation or birth weight greater than 400g which are reported by trained midwives within 48 hours of delivery. The Hospital Morbidity Data System and Emergency Department Data Collection include data on all completed hospital admissions and emergency department presentations to all public hospitals in WA. These data are entered by trained medical records staff following the occasion of service. The Australian Bureau of Statistics (ABS) Index of Relative Socio-Economic Disadvantage (IRSD) divides postcodes based on the 2006 Australian national census data into quintiles from most deprived (1) to least deprived (5).[11] The Accessibility/ Remoteness Index of Australia (ARIA) was developed by the Department of Health and Aged Care and is maintained by the Australian Institute of Health and Welfare.[12] This index classifies geographic location on the basis of isolation and distance from service centres and health care facilities. ARIA data are split into five categories from least remote (1) (major cities) to most remote (5) (remote area communities).

The databases were systematically linked by DOHWA data linkage staff using probabilistic matching and de-identified. The final databases included date of hospital admission, date of emergency department presentation, hospital length of stay, maternal ethnicity, maternal age, gravidity, infant age, infant birth weight, gestational age, infant sex, multiple birth, and infant health status at birth (Apgar score). ISRD quintile, ARIA level and health region from the Midwives Notification System were also included.

Inclusion criteria

Infants were classified as Indigenous if the mother was recorded in the Midwives Notification System as Aboriginal and/or Torres Strait Islander.[13] All other infants were classified as non-

Indigenous. To avoid clustering within multiple births the population was limited to singleton babies.

Definitions

Specific cut points were used to define preterm; 'extremely preterm' <28 weeks gestation; 'very preterm' (births between 28 - <32 weeks gestation); and 'moderate preterm' (births between 32 - <37 weeks gestation).[1] Postneonates were defined as infants aged 1-11 months and neonates were aged 0-<1 month. A hospital admission was defined as any (one or more) admission to a WA hospital ward for care including all neonatal nurseries. It excluded the normal hospital stay after birth for well babies. An emergency department presentation was defined as any (one or more) presentation to the emergency department regardless of whether the child was admitted to hospital. 'Low socio economic status' was defined as the two lowest IRSD quintiles (IRSD 1-2). 'Remote residence' was defined as the two most remote ARIA categories (ARIA 4-5).

Primary cause of hospitalisation and emergency department presentations were classified using the International Classification of Disease Version 10 (ICD-10) classification system by medical record staff. Each admission only received one diagnostic code.[14] All hospital admissions were classified with a primary cause of hospitalisation but secondary diagnoses or comorbidity data were not available. No data on cause of emergency department presentation were available. Preventable causes were defined according to the AIHW,[15] and adapted for use with infants.[16] Diseases of the respiratory system, digestive system, skin and subcutaneous tissue, ear and mastoid process, infectious and parasitic diseases, nutritional diseases, and injury and poisoning were classified as 'preventable'. Perinatal conditions (e.g. prematurity, hypoxic-ischaemic encephalopathy), congenital malformations, chromosomal abnormalities and all other conditions were classified as 'non-preventable'.

Sample size and data analysis

Our primary outcome measure was the proportion of Indigenous and non-Indigenous preterm infants aged under 12 months who had at least one hospital admission from 2010-2012. We calculated that our study population of 4,211 infants would provide 90% power to detect at least a 10% difference in hospital admission risk between Indigenous and non-Indigenous infants. We assumed a 5% significance level, a hospital admission risk of 40% and that the ratio between Indigenous to non-Indigenous infants would be approximately 1:9.

Crude and adjusted logistic regression models were used to examine the effect of Indigenous status, socio economic status and remoteness on hospital admissions and emergency department presentations in postneonates aged 1-11 months and neonates aged 0-<1 month. Odds ratios (ORs) and 95% confidence intervals (95% CI) were calculated. Multivariable logistic regression models were constructed *a priori* to adjust for the effect of important explanatory variables: maternal characteristics (maternal age, gravidity), infant factors (gender of child, birth weight), Indigenous status, socioeconomic status (ISRD) and remoteness (ARIA). Data analyses were conducted using STATA 13.1 (StataCorp, USA).

Ethics

Approvals were obtained from the WA Department of Health Human Research Ethics Committee, the University of Western Australia Human Research Ethics Committee, and the Western Australian Aboriginal Health Ethics Committee (WAAHEC).

RESULTS

During 2010-2011 in WA there were 62,965 live births, 98.3% (61,254) were singletons and 6.9% (4,211) of these infants were preterm. 13.1% (433/3,311) of the preterm infants were classified as Indigenous and 6.5% (3,778/57,943) were classified as non-Indigenous (Table

1). 37.2% (161) of preterm Indigenous infants were classified in the most disadvantaged quintile compared to 3.5% (132) non-Indigenous infants. 38.6% (167) of preterm Indigenous infants lived in the most remote area (ARIA 5) compared to 3.6% (134) of non-Indigenous infants (Table 1).

Overall, there were a total of 6,192 hospital admissions in 3,177 preterm infants and 5,657 emergency presentations in 2,220 preterm infants from 0-11 months. 75.4% (3,177) of preterm infants had at least one hospital admission from 0-11 months and 57.2% (2,220) of infants had at least one emergency department presentation.

Sixty nine percent (69.2%; 2914/ 4211) of preterm infants had at least one hospital admission in the neonatal period (from 0-<1month) and 3.9% (163/4211) of preterm infants had at least one emergency department presentation (Webappendix 1 and 2). Neonates with a gestational age under 32 weeks (95.0%; 472) had a 10 fold greater risk of hospital admission compared to neonates with a gestational age between 32-37 weeks (65.8%, 2442) (aOR 9.7, 95% CI 6.46,14.6) (Webappendix 1 and 2). Indigenous infants did not have an increased risk of neonatal hospital admission (aOR 0.76, 95% CI 0.58, 0.98). There were no other obvious differences in neonatal hospital utilisation by socio demographic status (Webappendix 1 and 2).

There were 2,692 hospital admissions in 1,402 preterm infants and 5,443 emergency presentations in 2,163 preterm infants during the postneonatal (1-11 months) period. 33.3% (1,402) of preterm infants had at least one hospital admission in the postneonatal period and 51.4% (2,163) of infants had at least one emergency department presentation.

Indigenous postneonates were 1.3 times more likely to have at least one hospital admission compared to non-Indigenous infants (aOR 1.33, 95% CI 1.05, 1.68) (Table 2). Indigenous infants were nearly twice as likely to have an emergency department presentation compared to non-Indigenous infants (aOR 1.83, 95% CI 1.44, 2.33) (Table 2). Postneonatal Indigenous infants were also 2.1 times more likely to have at least three hospitalisations compared to non-Indigenous infants (aOR 2.10, 95% CI 1.44, 3.06) (Table 2). Indigenous infants were 2.5 times more likely to present at the emergency department at least three times during the postneonatal period compared to non-Indigenous infants (aOR 2.45, 95% CI 1.92, 3.12) (Table 2).

There appeared to be a strong effect of socio economic status on hospital utilisation in post neonates. The most disadvantaged (ISRD 1) preterm postneonates (129, 44.0%) after the first month of life had a 1.5 fold risk of being hospitalised if they had a low socio economic status (ISRD 1) compared to the most advantaged (ISRD 5) infants (442, 29.7%) (aOR 1.48, 95%CI 1.10-1.99). There was also some evidence of a dose response with increased risk of hospital admission with increased levels of disadvantage (p value for trend = 0.030) (Table 3). The most disadvantaged (ISRD 1) preterm postneonates (217, 74.0%) were 2.3 times more likely to present to emergency compared to the most advantaged (ISRD 5) infants (674, 45.5%) (aOR 2.31, 95%CI 1.71, 3.14). There also appeared to be some evidence of a dose response with increased risk of emergency department presentation with increased levels of disadvantage (p value for trend = <0.001) (Table 3). The sample size was not sufficient to assess the effect of socio economic status in Indigenous and non-Indigenous infants separately (Webappendix 3 and 4).

There was also a strong effect of geographic location on the hospital utilisation of preterm infants. The most remote (ARIA 5) postneonate preterm infants (121, 40.2%) had a 1.4 fold increased risk of hospitalisation compared to the least remote (ARIA 1) preterm infants (526, 29.2%) (aOR 1.42, 95% CI 1.06, 1.90) (Table 3). There was some evidence of a dose response with increased risk of hospital admission with increased levels of remoteness (p value for trend = <0.001) (Table 3). The most remote (ARIA 5) postneonatal preterm infants (219, 72.8%) were also 2.2 times more likely to present to emergency than non-remote (ARIA 1) preterm infants (833, 46.2%) (aOR 2.20, 95% CI 1.63, 2.95) (Table 3). There was also some evidence of a dose response with increased risk of emergency department presentation with increased levels of remoteness (p value for trend = <0.001) (Table 3). The sample size was not sufficient to assess the effect of remoteness in Indigenous and non-Indigenous infants separately (Webappendix 3 and 4).

Preterm postneonates with gestational age under 32 weeks (66.8%; 332) had a nearly 5 fold greater risk of hospital admission compared to infants with a gestational age 32-37 weeks (aOR 4.9, 95% 3.96, 5.95) (Table 3). There was a week effect of gestational age on emergency department presentation (aOR 1.20, 95% 1.01, 1.49). There were no marked effects of other socio demographic characteristics on hospital utilisation in preterm postneonates (Table 3).

Overall, preterm Indigenous infants were 44% more likely to be hospitalised for a ‘preventable’ condition compared to non-Indigenous infants during the postneonatal period (aOR 1.44, 95% 1.01, 2.07) (Table 5). Indigenous infants were also 1.7 times more likely to be hospitalised for infectious and parasitic diseases than non-Indigenous infants (aOR 1.70, 95% CI 1.05, 2.76) (Table 5). The most common preventable condition was respiratory

disease (46.5%, 93) in Indigenous infants. Risk of respiratory disease was 1.5 fold greater in Indigenous compared to non-Indigenous infants (aOR 1.45, 95% 1.02, 2.07)] (Table 5). There was no difference in 'non-preventable' hospitalisations between Indigenous and non-Indigenous infants (aOR 0.99, 95% CI 0.69, 1.49) (Table 4).

COMMENTS

In our WA population based study, over 51% of preterm infants presented to a hospital emergency department and 33% were admitted between 1-11 months of age. Risk of hospital utilisation was 1.3 fold greater in Indigenous compared to non-Indigenous post neonates and almost 15% had three or more hospital admissions in the first year of life. Preterm postneonates located in the poorest and most remote areas of WA had 1.5-2 fold greater risk of hospital use compared to postneonates living in less poor and urban areas. We found no striking socio demographic determinants of hospital use in infants in the first month of life.

In the past 10 years there have been a number of studies showing that preterm infants are at greater risk of hospitalisation admissions and emergency presentations than term infants.[2,17] Despite this, few have investigated whether preterm infants from vulnerable families have an increased risk of hospital utilisation compared to the general population. Hispanic and African American preterm infants have been reported to have a greater risk of hospital admission and emergency presentations compared to white preterm infants.[17] Bar-Zeev et al reported that 60% of Indigenous preterm infants were readmitted to hospital in the Top End of the Northern Territory of Australia in the first year of life compared to only 44% of term infants.[18] However, there have been no published reports of the differences in hospital utilisation between Australian Indigenous and non-Indigenous preterm infants in the last 10 years.

Population based studies in infants of all gestational ages have shown increased risk of hospital admissions,[19,20] length of stay,[20] and emergency presentations[21] in socially disadvantaged infants compared to the least disadvantaged. We reported that the most disadvantaged preterm postneonates had a 1.5-2.3 fold greater risk of hospital admissions and emergency department presentations compared to infants from the most advantaged areas. Although preterm infants are more likely to be born to families who are socially disadvantaged,[8] we located no other studies that examined how socioeconomic status may influence subsequent hospital use in preterm infants. Preterm postneonates infants living in remote areas in our study had a 1.5-2 fold greater risk of presenting to the emergency department and hospital admission compared to the least remote infants. Population based studies have reported that infants located in remote areas have an increased risk of readmission [19] and emergency department presentation[21] in the first six weeks after birth. However, we were unable to locate other studies that examined the effect of geographic location on hospital use in preterm infants.

Over the last 10 years there has been significant Australian Federal government funding to improve access to urban, rural and remote paediatric services including building hospitals, clinics and Aboriginal Community Controlled Health Services (ACCHS).[22,23] There has also been an increase in staffing levels of all health care providers in rural and remote areas and major investments in specialist outreach services and care coordination. In Western Australia, there is free antenatal care and culturally appropriate midwifery and post discharge care for disadvantaged mothers and infants, home visits within 72 hours of discharge,[24] regular medical and developmental follow-up of all preterm infants,[25] and universal and targeted surveillance and screening programs.[26], [24] It is highly likely that these initiatives have improved health status and subsequent morbidity and mortality risks.

However our study shows that important inequities remain in service use in remote areas, in poor families and in Indigenous families.

We also reported that 55% of hospital admissions were preventable and that hospitalisations were nearly 1.5 fold higher in Indigenous infants. The most common causes of hospitalisation were respiratory, and infectious and parasitic diseases. Respiratory disease has previously been cited as the most common cause for hospital admissions for Indigenous infants up 12 months in the Northern Territory[18] and Western Australia,[21] however no other studies appear to have examined the burden of preventable hospital admissions in preterm infants under 12 months of age. Cause of emergency presentations was not assessed in this study due to no data being available, however existing evidence suggests that many emergency presentations may also be the result of potentially avoidable conditions.[16,27] Our data indicate that more can be done to improve health services and reduce hospital use in preterm infants in Western Australia. We are also aware that the underlying socio economic determinants of health such as education and employment are also important determinants of health service use and many improvements are needed in these areas.

Our study had some limitations. Our study was observational and could only report associations and did not provide proof of causality. Indigenous status can be missing or misclassified which may result in an under-estimation of risk.[28,29] Despite this our results show a highly significant effect of Indigenous status on hospital utilisation and it is unlikely that any misclassification would have biased the results. Where available we adjusted for all potential confounding factors. However, we were unable to adjust for measures of maternal illness or education or any underlying social conditions (e.g. housing and infrastructure) that may have played a role in hospital utilisation, particularly preventable causes of hospital

use.[30] Within Australia socioeconomic data are primarily based on AIHW IRSD quintiles which can cause misclassification when applied at an individual level.[11] However, we did show strong associations between hospital utilisation and socioeconomic status and any differential misclassification would have biased towards the null. Small sample size for Indigenous pre-term infants in some of the sub-analyses could have resulted in a type II error as a result of reduced power to detect true differences. There were also insufficient data to analyse emergency presentations for neonates aged 0- <1 month. We consider that the low emergency department presentations in the neonatal period were due to the policy of direct ward admission for unwell young preterm infants in Western Australia.[24,26]

There are strengths related to the data collections we used. The cause specific hospitalisation data were limited to primary cause of hospitalisation. These data are considered to be highly accurate,[10,31] because the Hospital Morbidity Data System uses the World Health Organisation ICD 10 coding system[14] and highly trained coders. The Midwives' Notification System uses clear definitions that are based on Australian standard definitions[5] and is reported to have a very high level of completion and clinical certainty. [32,33] Our emergency department presentations were also recorded in a clearly defined patient administration system ('EDIS').[34,35] This system is considered by Emergency Department staff to be highly reliable though formal documentation of its accuracy is not available. In contrast, the accuracy of cause specific emergency department data has been questioned[27], which is why we did not include cause specific emergency department data in this study. Lastly, we controlled for confounding effects of multiple births by restricting the analysis to singleton births.

Our study has implications for policy and program development. Despite investments in maternal and child health services we reported that preterm infants had high hospital utilisation rates and that important risk groups were infants living in disadvantaged areas,

remote area infants and Indigenous infants. Our data highlight the need for improved post discharge care of preterm infants, particularly in remote regions and for poor, Indigenous infants. This includes preventive programs focused on improving skills of families and service providers in caring for small infants and care coordination programs. The WA government has provided recent funding to improve post discharge care and care coordination for Indigenous children across WA. These interventions have the potential to improve hospital utilisation and long term health outcomes of these vulnerable infants and reducing long term burden on families. We will continue to monitor impacts and will report trends in subsequent papers.

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Contributorship statement

Conceived and designed the experiments: SP KE DM RM. Performed the experiments: NS KM. Analysed the data: NS KM KE. Contributed reagents/materials/analysis tools: NS. Wrote the paper: NS SP KM DM RM KE.

Competing interests

The authors have no competing interests to declare.

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Data sharing statement

Data are available from the Western Australia Department of Health Data

Linkage Branch with ethical approval through the Western Australia Department of

Health Human Research Ethics Committee (Ref 2013/33). To maintain confidentiality and security, interested individuals may apply for access to linked data by contacting the Western Australian Data Linkage Branch. Contact details are DataServices@health.wa.gov.au; +61-8-9222 2370. The computing code is available on request from the corresponding author.

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Table 1 Socio demographic characteristics in the study population, 2010-2011

Characteristics	Total number of infants	Number of Indigenous infants	Number of non-Indigenous infants	OR 95% CI	P value
	n = 4211	n = 433	n = 3778		
Prematurity					
<28wk	186 (4.4%)	28 (6.5%)	158 (4.2%)	1.58 (1.05-2.40)	0.030
28<32wk	311 (7.4%)	45 (10.4%)	266 (7.0%)	1.53 (1.10-2.14)	0.012
32<37wk	3714 (88.2%)	360 (83.1%)	3354 (88.8%)	0.62 (0.48-0.82)	0.001
Socio-economic status (IRSD)					
Most disadvantaged 1	293 (7.0%)	161 (37.2%)	132 (3.5%)	17.09 (13.13-22.22)	<0.001
2	646 (15.3%)	58 (13.4%)	588 (15.6%)	0.86 (0.64-1.15)	0.299
3	537 (12.8%)	56 (12.9%)	481 (12.7%)	1.04 (0.77-1.40)	0.793
4	1143 (27.1%)	75 (17.3%)	1068 (28.3%)	0.54 (0.42 -0.70)	<0.001
Least disadvantaged 5	1486 (35.3%)	65 (15.0%)	1421 (37.6%)	0.30 (0.23-0.39)	<0.001
Data missing	106 (2.5%)	18 (4.2%)	88 (2.3%)		
Geographic location (ARIA)					
Least remote 1	1802 (42.8%)	84 (19.4%)	1718 (45.5%)	0.29 (0.23-0.37)	<0.001
2	1559 (37.0%)	82 (18.9%)	1477 (39.1%)	0.37 (0.29-0.47)	<0.001
3	327 (7.8%)	58 (13.4%)	269 (7.1%)	2.07 (1.52-2.80)	<0.001
4	116 (2.8%)	24 (5.5%)	92 (2.4%)	2.40 (1.51-3.81)	<0.001
Most remote 5	301 (7.1%)	167 (38.6%)	134 (3.6%)	17.87 (13.76-23.20)	<0.001
Data missing	106 (2.5%)	18 (4.2%)	88 (2.3%)		
Maternal Age					
<20 yrs	243 (5.8%)	87 (18.4%)	156 (4.1%)	5.84 (4.39-7.76)	<0.001
20-24 yrs	671 (15.9%)	135 (31.6%)	536 (14.2%)	2.74 (2.19-3.42)	<0.001
25-29 yrs	1115 (26.5%)	109 (27.3%)	1006 (26.6%)	0.93 (0.74-1.17)	0.516
30-34 yrs	1207 (28.7%)	57 (12.9%)	1150 (30.4%)	0.35 (0.26-0.46)	<0.001
35+ yrs	975 (23.2%)	45 (9.8%)	930 (24.6%)	0.36 (0.26-0.49)	<0.001
Gravidity					
0	1358 (32.2%)	95 (21.9%)	1263 (33.4%)	0.56 (0.44-0.71)	<0.001
1	1121 (26.6%)	90 (20.8%)	1031 (27.3%)	0.70 (0.55-0.89)	<0.001
2	736 (17.5%)	65 (15.0%)	671 (17.8%)	0.82 (0.62-1.08)	0.154
≥3	996 (23.7%)	183 (42.3%)	813 (21.5%)	2.67 (2.17-3.28)	<0.001
Child sex					
Male	2316 (55.0%)	226 (52.2%)	2090 (55.3%)	0.88 (0.72-1.08)	0.216
Female	1895 (45.0%)	207 (47.8%)	1688 (44.7%)	1.13 (0.93-1.38)	0.216
Birth weight					
Low birth weight (<2500g)	1983 (47.1%)	258 (46.2%)	1725 (45.7%)	0.57 (0.47-0.70)	<0.001
Normal birth weight (≥2500g)	2228 (52.9%)	175 (53.8%)	2053 (54.3%)	1.75 (1.43-2.15)	<0.001
APGAR 5 score					
< 7 (abnormal)	259 (6.2%)	31 (5.1%)	228 (6.0%)	1.20 (0.81-1.76)	0.369
≥7 (healthy)	3951 (93.8%)	402 (94.9%)	3549 (93.9%)	0.83 (0.56-1.23)	0.357
Data missing	1 (0.0%)	0 (0.0%)	1 (0.0%)		

Table 2 Hospital utilisation in Indigenous and non Indigenous preterm infants aged 1-11 months, 2010-2011

	Number of Indigenous infants with at least one hospital admission or emergency department presentation (%) n=433	Number of non-Indigenous infants with at least one hospital admission or emergency department presentation (%) n=3,778	OR (95% CI)	p value	aOR* (95% CI)	p value
All cause hospitalisations						
≥ 1	200 (46.2%)	1202 (32.8%)	1.84 (1.50,2.25)	<0.001	1.33 (1.05,1.68)	0.017
≥ 2	105 (24.3%)	418 (11.1%)	2.57 (2.02,3.28)	<0.001	1.76 (1.32,2.35)	<0.001
≥ 3	62 (14.3%)	184 (4.9%)	3.26 (2.40,4.44)	<0.001	2.10 (1.44,3.06)	<0.001
All cause emergency department presentations						
≥ 1	313 (72.3%)	1850 (49.0%)	2.72 (2.18,3.39)	<0.001	1.83 (1.44,2.33)	<0.001
≥ 2	239 (55.2%)	985 (26.1%)	3.49 (2.85,4.28)	<0.001	2.23(1.77,2.80)	<0.001
≥ 3	177 (40.9%)	567 (15.0%)	3.92 (3.17,4.84)	<0.001	2.45 (1.92,3.12)	<0.001

* Adjusted for IRSD (Index of Relative Socio-Economic Disadvantage), maternal age, gravidity, gender of child, birth weight

Table 3 Hospital utilisation in preterm infants aged 1-11 months by socio demographic characteristics, 2010-2011

Characteristics	Number of infant			All cause hospitalisations 1-11 months of age			All cause emergency department presentations 1-11 months of age		
	Total n=4211	Indigenous n=433	Non-Indigenous n=3778	Number of infants with at least one hospital admission	Number of Indigenous infants with at least one hospital admission	Number of non-Indigenous infants with at least one hospital admission	Number of infants with at least one emergency department presentation	Number of Indigenous infants with at least one emergency department presentation	Number of non-Indigenous infants with at least one emergency department presentation
				n=1402 (33.3%)	n=200 (46.2%)	n=1202 (31.8%)	n=2163 (51.4%)	n=313 (72.3%)	n=1850 (49.0%)
Prematurity									
<28wk	186 (4.4%)	28 (6.5%)	158 (4.2%)	112 (60.2%)	18 (64.3%)	94 (59.5%)	97 (52.2%)	18 (64.3%)	79 (50.0%)
28<32wk	311 (7.4%)	45 (10.4%)	266 (7.0%)	220 (70.7%)	34 (75.6%)	186 (69.9%)	185 (59.5%)	36 (80.0%)	149 (56.0%)
32<37wk	3714 (88.2%)	360 (83.1%)	3354 (88.8%)	1070 (28.8%)	148 (41.1%)	922 (27.5%)	1881 (50.7%)	259 (71.9%)	1622 (48.4%)
Socio-economic status (IRSD)									
Lowest (most deprived) 1	293 (7.0%)	161 (37.2%)	132 (3.5%)	129 (44.0%)	82 (50.9%)	47 (35.6%)	217 (74.0%)	124 (77.0%)	93 (70.5%)
2	646 (15.3%)	58 (13.4%)	588 (15.6%)	214 (33.1%)	25 (43.1%)	189 (32.1%)	325 (50.3%)	38 (65.5%)	287 (48.8%)
3	537 (12.8%)	56 (12.9%)	481 (12.7%)	195 (36.3%)	25 (44.6%)	170 (35.3%)	314 (58.5%)	42 (75.0%)	272 (56.6%)
4	1143 (27.1%)	75 (17.3%)	1068 (28.3%)	383 (33.5%)	31 (41.3%)	352 (33.0%	577 (50.5%)	50 (66.7%)	527 (49.3%)
Highest (least deprived) 5	1486 (35.3%)	65 (15.0%)	1421 (37.6%)	442 (29.7%)	26 (40.0%)	416 (29.3%)	674 (45.4%)	45 (69.2%)	629 (44.3%)
Data missing	106 (2.5%)	18 (4.2%)	88 (2.3%)	39 (36.8%)	11 (61.1%)	28 (31.8%)	56 (52.8%)	14 (77.8%)	42 (47.7%)
Remoteness (ARIA)									
Least remote 1	1802 (42.8%)	84 (19.4%)	1718 (45.5%)	526 (29.2%)	31 (36.9%)	495 (28.8%)	833 (46.2%)	52 (61.9%)	781 (45.5%)
2	1559 (37.0%)	82 (18.9%)	1477 (39.1%)	533 (34.2%)	38 (46.3%)	495 (33.5%)	762 (48.9%)	57 (69.5%)	705 (47.7%)
3	327 (7.8%)	58 (13.4%)	269 (7.1%)	144 (44.0%)	32 (55.2%)	112 (41.6%)	221 (67.6%)	44 (75.9%)	177 (65.8%)
4	116 (2.8%)	24 (5.5%)	92 (2.4%)	39 (33.6%)	7 (29.2%)	32 (34.8%)	72 (62.1%)	19 (79.2%)	53 (57.6%)
Most remote 5	301 (7.1%)	167 (38.6%)	134 (3.6%)	121 (40.2%)	81 (48.5%)	40 (29.9%)	219 (72.8%)	127 (76.1%)	92 (68.7%)
Data missing	106 (2.5%)	18 (4.2%)	88 (2.3%)	39 (36.8%)	11 (61.1%)	28 (31.8%)	56 (52.8%)	14 (77.8%)	42 (47.7%)
Maternal Age									
<20 yrs	243 (5.8%)	87 (18.4%)	156 (4.1%)	102 (42.0%)	47 (54.0%)	55 (35.3%)	164 (67.5%)	65 (74.7%)	99 (63.5%)
20-24 yrs	671 (15.9%)	135 (31.6%)	536 (14.2%)	237 (35.3%)	60 (44.4%)	177 (33.0%)	419 (62.4%)	99 (73.3%)	320 (59.7%)
25-29 yrs	1115 (26.5%)	109 (27.3%)	1006 (26.6%)	360 (32.3%)	41 (37.6%)	319 (31.7%)	570 (51.1%)	83 (76.2%)	487 (48.4%)
30-34 yrs	1207 (28.7%)	57 (12.9%)	1150 (30.4%)	387 (32.1%)	31 (54.4%)	356 (31.0%)	574 (47.6%)	34 (59.7%)	540 (47.0%)
35+ yrs	975 (23.2%)	45 (9.8%)	930 (24.6%)	316 (32.4%)	21 (46.7%)	295 (31.7%)	436 (44.7%)	32 (71.1%)	404 (43.4%)

Gravidity									
0	1358 (32.2%)	95 (21.9%)	1263 (33.4%)	429 (31.6%)	54 (56.8%)	375 (29.7%)	666 (49.0%)	77 (81.0%)	589 (46.6%)
1	1121 (26.6%)	90 (20.8%)	1031 (27.3%)	354 (31.6%)	38 (42.2%)	316 (30.7%)	573 (51.1%)	66 (73.3%)	507 (49.2%)
2	736 (17.5%)	65 (15.0%)	671 (17.8%)	255 (34.7%)	27 (41.5%)	228 (34.0%)	374 (50.8%)	47 (72.3%)	327 (48.7%)
≥3	996 (23.7%)	183 (42.3%)	813 (21.5%)	361 (36.6%)	81 (44.3%)	283 (34.8%)	550 (55.2%)	123 (67.2%)	427 (52.5%)
Child sex									
Male	2316 (55.0%)	226 (52.2%)	2090 (55.3%)	808 (34.9%)	111 (49.1%)	697 (33.4%)	1217 (52.6%)	167 (73.9%)	1050 (50.24%)
Female	1895 (45.0%)	207 (47.8%)	1688 (44.7%)	594 (31.4%)	89 (43.0%)	505 (29.9%)	946 (49.9%)	146 (70.5%)	800 (47.4%)
Birth weight									
Low birth weight (<2500g)	1983 (47.1%)	258 (46.2%)	1725 (45.7%)	864 (43.6%)	142 (55.0%)	722 (41.9%)	1057 (53.3%)	194 (75.2%)	863 (50.0%)
Normal birth weight (≥2500g)	2228 (52.9%)	175 (53.8%)	2053 (54.3%)	538 (24.2%)	58 (33.1%)	480 (23.4%)	1106 (49.6%)	119 (68.0%)	987 (48.1%)
APGAR 5 score									
< 7 (abnormal)	259 (6.2%)	31 (5.1%)	228 (6.0%)	106 (40.9%)	15 (48.4%)	91 (39.9%)	136 (52.5%)	24 (67.7%)	115 (50.4%)
≥7 (healthy)	3951 (93.8%)	402 (94.9%)	3549 (93.9%)	1295 (32.8%)	185 (46.0%)	1110 (31.3%)	2026 (51.3%)	292 (72.6%)	1734 (48.9%)
Data missing	1 (0.0%)	0 (0.0%)	1 (0.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)

Table 4: Risk of hospital utilisation in preterm infants aged 1-11 months by socio demographic characteristics, 2010-2011

Characteristics		At least one all cause hospitalisations 1-11 months					At least one all cause emergency department presentations 1-11 months				
	Total number of infants 4211	**Number of infants* 1402 (33.3%)**	unadjusted OR (95% CI)	*p value*	multivariable OR (95% CI)**	*p value*	**Number of infants* 2163 (51.4%)**	unadjusted OR (95% CI)	*p value*	multivariable OR (95% CI)**	*p value*
Indigenous status											
Indigenous	433 (10.3%)	200 (46.1%)	1.84 (1.50,2.25)	<0.001	1.33 (1.05,1.68	0.017	313 (72.2%)	2.72 (2.18,3.39)	<0.001	1.83 (1.44,2.33)	<0.001
Non-Indigenous	3778 (89.7%)	1202 (31.8%)	1.00		1.00		1850 (49.0%)	1.00		1.00	
Prematurity* **											
<28wk	186 (4.4%)	112 (60.2%)	3.74 (2.76,5.06)	<0.001	3.63 (2.66, 4.93)	<0.001	97 (52.2%)	1.06 (0.79,1.43)	0.689	1.03 (0.76,1.40)	0.841
28<32wk	311 (7.4%)	220 (70.7%)	5.97 (4.63,7.70)	<0.001	5.87 (4.52, 7.61)	<0.001	185 (59.5%)	1.43 (1.13,1.81)	0.003	1.36 (1.07, 1.74)	0.013
32<37wk	3714 (88.2%)	1070 (28.8%)	1.00		1.00		1881 (50.7%)	1.00		1.00	
Socio-economic status (IRSD)											
Lowest (most deprived) 1	293 (7.0%)	129 (44.0%)	1.86 (1.44,2.40)	<0.001	1.48 (1.10,1.99)	0.009	217 (74.0%)	3.44 (2.60,4.55)	<0.001	2.31 (1.71, 3.14)	<0.001
2	646 (15.3%)	214 (33.1%)	1.17 (0.96,1.43)	0.120	1.08 (0.88,1.32)	0.483	325 (50.3%)	1.22 (1.01,1.47)	0.035	1.09 (0.91,1.32)	0.352
3	537 (12.8%)	195 (36.3%)	1.35 (1.09,1.66)	0.005	1.28 (1.03,1.59)	0.028	314 (58.5%)	1.70 (1.39,2.07)	<0.001	1.50 (1.23,1.84)	<0.001
4	1143 (27.1%)	383 (33.5%)	1.19 (1.01,1.40)	0.039	1.15 (0.97,1.37)	0.118	577 (50.5%)	1.23 (1.05,1.43)	0.009	1.13 (0.96,1.32)	0.140
Highest (least deprived) 5	1486 (35.3%)	442 (29.7%)	1.00		1.00		674 (45.4%)	1.00		1.00	
Remoteness (ARIA)											
Least remote 1	1802 (42.8%)	526 (29.2%)	1.00		1.00		833 (46.2%)	1.00		1.00	
2	1559 (37.0%)	533 (34.2%)	1.26 (1.09,1.46)	0.002	1.26 (1.08,1.47)	0.003	762 (48.9%)	1.11 (0.97,1.27)	0.125	1.01 (0.88,1.16)	0.872
3	327 (7.8%)	144 (44.0%)	1.91 (1.50,2.43)	<0.001	1.82 (1.41,2.34)	<0.001	221 (67.6%)	2.43 (1.89,3.11)	<0.001	2.08 (1.61,2.68)	<0.001
4	116 (2.8%)	39 (33.6%)	1.23 (0.82,1.83)	0.311	1.24 (0.82,1.88)	0.316	72 (62.1%)	1.90 (1.29,2.80)	0.001	1.58 (1.07,2.34)	0.023
Most remote 5	301 (7.1%)	121 (40.2%)	1.63 (1.27,2.10)	<0.001	1.42 (1.06,1.90)	0.020	219 (72.8%)	3.11 (2.37,4.07)	<0.001	2.20 (1.63,2.95)	<0.001
Maternal Age											
<20 yrs	243 (5.8%)	102 (42.0%)	1.52 (1.14,2.02)	0.004	1.36 (0.99,1.86)	0.056	164 (67.5%)	1.98 (1.48,2.66)	<0.001	1.81 (1.33,2.47)	<0.001
20-24 yrs	671 (15.9%)	237 (35.3%)	1.15 (0.94,1.40)	0.188	1.11 (0.90,1.38)	0.324	419 (62.4%)	1.59 (1.31,1.93)	<0.001	1.50 (1.22,1.83)	<0.001
25-29 yrs	1115 (26.5%)	360 (32.3%)	1.00		1.00		570 (51.1%)	1.00		1.00	
30-34 yrs	1207 (28.7%)	387 (32.1%)	0.99 (0.83,1.18)	0.908	1.05 (0.87,1.26)	0.614	574 (47.6%)	0.87 (0.74,1.02)	0.086	0.91 (0.77,1.08)	0.294
35+ yrs	975 (23.2%)	316 (32.4%)	1.01 (0.84,1.21)	0.952	0.98 (0.80,1.19)	0.827	436 (44.7%)	0.77 (0.65,0.92)	0.003	0.79 (0.66,0.94)	0.010
Gravidity											
0	1358 (32.2%)	429 (31.6%)	0.87 (0.72,1.05)	0.155	0.74 (0.61,0.91)	0.004	666 (49.0%)	0.93 (0.78,1.11)	0.439	0.83 (0.69,1.00)	0.056
1	1121 (26.6%)	354 (31.6%)	0.87 (0.71,1.06)	0.169	0.83 (0.67,1.02)	0.073	573 (51.1%)	1.01 (0.84,1.22)	0.899	0.97 (0.80,1.17)	0.731
2	736 (17.5%)	255 (34.7%)	1.00		1.00		374 (50.8%)	1.00		1.00	
≥3	996 (23.7%)	361 (36.6%)	1.09 (0.89,1.33)	0.415	0.99 (0.80,1.22)	0.896	550 (55.2%)	1.19 (0.99,1.44)	0.069	1.14 (0.94,1.40)	0.185
Child sex											
Male	2316 (55.0%)	808 (34.9%)	1.17 (1.03,1.34)	0.015	1.29 (1.12,1.48)	<0.001	1217 (52.6%)	1.11 (0.98,1.25)	0.090	1.13 (0.99,1.28)	0.065
Female	1895 (45.0%)	594 (31.4%)	1.00		1.00		946 (49.9%)	1.00		1.00	
Birth weight											
Low birth weight (<2500g)	1983 (47.1%)	864 (43.6%)	2.43 (2.13,2.77)	<0.001	2.44 (2.14,2.80)	<0.001	1057 (53.3%)	1.16 (1.03,1.31)	0.018	1.14 (1.00,1.29)	0.048
Normal birth weight (≥2500g)	2228 (52.9%)	538 (24.2%)	1.00		1.00		1106 (49.6%)	1.00		1.00	
APGAR 5 score											

< 7 (abnormal)	259 (6.2%)	106 (40.9%)	1.42 (1.10,1.84)	0.007	0.68 (0.51,0.92)	0.011	136 (52.5%)	1.05 (0.82,1.35)	0.701	0.91 (0.69,1.19)	0.489
≥7 (healthy)	3951 (93.8%)	1295 (32.8%)	1.00		1.00		2026 (51.3%)	1.00		1.00	

*Number of infants with at least one hospitalisation or emergency department presentation
** Adjusted for Indigenous status, IRSD (Index of Relative Socio-Economic Disadvantage), maternal age, gravidity, gender of child, birth weight
***Prematurity was not adjusted for birth weight due to collinearity

Table 5 ICD 10 classification of primary cause of hospital admissions in preterm infants aged 1-11 months by Indigenous status, 2010-2011

Primary cause of hospital admission	Total number of infants n=1402	Number of Indigenous infants n=200	Number of non-Indigenous infants n=1202	OR (95% CI; p value)	aOR** (95% CI; p value)
Preventable causes					
Respiratory system	435 (31.0%)	93 (46.5%)	342 (28.5%)	2.19 (1.61,2.96; <0.001)	1.45 (1.02,2.07; 0.038)
Infectious and parasitic diseases	157 (11.2%)	34 (17.0%)	123 (10.2%)	1.80 (1.19,2.72; 0.005)	1.70 (1.05,2.76; 0.031)
Digestive system	186 (13.3%)	23 (11.5%)	163 (13.6%)	0.83 (0.52,1.32; 0.427)	0.84 (0.49,1.43; 0.510)
Skin and subcutaneous tissue	31 (2.2%)	6 (3.0%)	25 (2.1%)	1.46 (0.59,3.60; 0.415)	1.84 (0.65,5.25; 0.254)
Ear and mastoid process	42 (3.0%)	12 (6.0%)	30 (2.5%)	2.49 (1.25,4.96; 0.009)	2.54 (1.11,5.79; 0.027)
Nutritional diseases	13 (0.9%)	1 (0.5%)	12 (1.0%)	0.50 (0.06,3.85; 0.505)	0.52 (0.06,4.65; 0.559)
Injury and poisoning	56 (4.0%)	11 (5.5%)	45 (3.7%)	1.50 (0.76,2.94; 0.243)	1.41 (0.65,3.10; 0.386)
Total preventable causes	**766 (54.6%)**	**132 (66.0%)**	**634 (52.8%)**	**1.74 (1.27,2.38; 0.001)**	**1.44 (1.01,2.07; 0.046)**
Non preventable causes					
Perinatal conditions	499 (35.6%)	74 (37.0%)	425 (35.4%)	1.07 (0.79,1.46; 0.653)	0.91 (0.62,1.34; 0.623)
Congenital malformations, deformations and chromosomal abnormalities	119 (8.5%)	8 (4.0%)	111 (9.2%)	0.41 (0.20,0.85; 0.017)	0.65 (0.30,1.41; 0.275)
Other	415 (29.6%)	63 (31.5%)	352 (29.3%)	1.11 (0.80,1.53; 0.525)	1.22 (0.84,1.77; 0.294)
Total non preventable causes	**893 (63.7%)**	**123 (61.5%)**	**770 (64.1%)**	**0.90 (0.66,1.22; 0.486)**	**0.99 (0.69,1.42; 0.951)**

*Infant have been counted only once per condition. Infant may be included in more than one condition if they had multiple admissions in their first year of life

OR = odds ratio, aOR = adjusted odds ratio, 95% CI = 95% confidence interval

** Adjusted for IRSD (Index of Relative Socio-Economic Disadvantage), maternal age, gravidity, sex of child, birth weight

SUPPORTING INFORMATION

Tables provided – Webappendix 1-4

Webappendix 1 Hospital utilisation in preterm infants aged 0-<1 month by socio demographic characteristics, 2010-2011

Characteristics	Number of infants			All cause hospitalisations 0-<1 month of age			All cause emergency department presentations 0-<1 month of age		
	Total n=4211	Indigenous n=433	Non-Indigenous n=3778	Number of infants with at least one hospital admission	Number of Indigenous infants with at least one hospital admission	Number of non-Indigenous infants with at least one hospital admission	Number of infants with at least one emergency department presentation	Number of Indigenous infants with at least one emergency department presentation	Number of non-Indigenous infants with at least one emergency department presentation
				n=2914 (69.2%)	n=284 (65.6%)	n=2630 (69.6%)	n=163 (3.9%)	n=23 (5.3%)	n=140 (3.7%)
Prematurity									
<28wk	186 (4.4%)	28 (6.5%)	158 (4.2%)	167 (89.8%)	25 (89.3%)	142 (89.9%)	n.p.	n.p.	n.p.
28<32wk	311 (7.4%)	45 (10.4%)	266 (7.0%)	305 (98.1%)	44 (97.8%)	261 (98.1%)	n.p.	n.p.	n.p.
32<37wk	3714 (88.2%)	360 (83.1%)	3354 (88.8%)	2442 (65.8%)	215 (59.7%)	2227 (66.4%)	157 (4.2%)	21 (5.8%)	136 (4.1%)
Socio-economic status (IRSD)									
Lowest (most deprived) 1	293 (7.0%)	161 (37.2%)	132 (3.5%)	195 (66.6%)	106 (65.8%)	89 (67.4%)	18 (6.1%)	11 (6.8%)	7 (5.3%)
2	646 (15.3%)	58 (13.4%)	588 (15.6%)	457 (70.7%)	42 (72.4%)	415 (70.6%)	24 (3.7%)	n.p.	24 (4.1%)
3	537 (12.8%)	56 (12.9%)	481 (12.7%)	338 (62.9%)	37 (66.1%)	301 (62.6%)	17 (3.2%)	n.p.	14 (2.9%)
4	1143 (27.1%)	75 (17.3%)	1068 (28.3%)	766 (67.0%)	45 (60.0%)	721 (67.5%)	46 (4.0%)	n.p.	42 (3.9%)
Highest (least deprived) 5	1486 (35.3%)	65 (15.0%)	1421 (37.6%)	1081 (72.8%)	44 (67.7%)	1037 (73.0%)	56 (3.8%)	5 (7.7%)	51 (3.6%)
Data missing	106 (2.5%)	18 (4.2%)	88 (2.3%)	77 (72.6%)	10 (55.6%)	67 (76.1%)	n.p.	n.p.	n.p.
Remoteness (ARIA)									
Least remote 1	1802 (42.8%)	84 (19.4%)	1718 (45.5%)	1298 (72.0%)	52 (61.9%)	1246 (72.5%)	60 (3.3%)	5 (6.0%)	55 (3.2%)
2	1559 (37.0%)	82 (18.9%)	1477 (39.1%)	1059 (67.9%)	63 (76.8%)	996 (67.4%)	70 (4.5%)	n.p.	66 (4.5%)
3	327 (7.8%)	58 (13.4%)	269 (7.1%)	225 (68.8%)	35 (60.3%)	190 (70.6%)	8 (2.4%)	n.p.	6 (2.2%)
4	116 (2.8%)	24 (5.5%)	92 (2.4%)	70 (60.3%)	14 (58.3%)	56 (60.9%)	9 (7.8%)	n.p.	7 (7.6%)
Most remote 5	301 (7.1%)	167 (38.6%)	134 (3.6%)	185 (61.5%)	110 (65.9%)	75 (56.0%	14 (4.7%)	10 (6.0%)	n.p.
Data missing	106 (2.5%)	18 (4.2%)	88 (2.3%)	77 (72.6%)	10 (55.6%)	67 (76.1%)	n.p.	n.p.	n.p.
Maternal Age									
<20 yrs	243 (5.8%)	87 (18.4%)	156 (4.1%)	167 (68.7%)	57 (65.5%)	110 (70.5%)	13 (5.3%)	6 (6.9%)	7 (4.5%)
20-24 yrs	671 (15.9%)	135 (31.6%)	536 (14.2%)	423 (63.0%)	82 (60.7%)	341 (63.6%)	39 (5.8%)	9 (6.7%)	30 (5.6%)
25-29 yrs	1115 (26.5%)	109 (27.3%)	1006 (26.6%)	751 (67.4%)	71 (65.1%)	680 (67.6%)	47 (4.2%)	5 (4.6%)	42 (4.2%)
30-34 yrs	1207 (28.7%)	57 (12.9%)	1150 (30.4%)	860 (71.3%)	39 (68.4%)	821 (71.4%)	42 (3.5%)	n.p.	40 (3.5%)
35+ yrs	975 (23.2%)	45 (9.8%)	930 (24.6%)	713 (73.1%)	35 (77.8%)	678 (72.9%)	22 (2.3%)	n.p.	21 (2.3%)
Gravidity									
0	1358 (32.2%)	95 (21.9%)	1263 (33.4%)	980 (72.2%)	67 (70.5%)	913 (72.3%)	45 (3.3%)	5 (5.3%)	40 (3.2%)
1	1121 (26.6%)	90 (20.8%)	1031 (27.3%)	755 (67.4%)	58 (64.4%)	697 (67.6%)	41 (3.7%)	6 (6.7%)	35 (3.4%)
2	736 (17.5%)	65 (15.0%)	671 (17.8%)	502 (68.2%)	35 (53.9%)	467 (69.6%)	36 (4.9%)	6 (9.2%)	30 (4.5%)

≥3	996 (23.7%)	183 (42.3%)	813 (21.5%)	677 (68.0%)	124 (67.8%)	553 (68.0%)	41 (4.1%)	6 (3.3%)	35 (4.3%)
Child sex									
Male	2316 (55.0%)	226 (52.2%)	2090 (55.3%)	1613 (69.7%)	140 (62.0%)	1473 (70.5%)	91 (3.9%)	6 (2.7%)	85 (4.1%)
Female	1895 (45.0%)	207 (47.8%)	1688 (44.7%)	1301 (68.7%)	144 (69.6%)	1157 (68.5%)	72 (3.8%)	17 (8.2%)	55 (3.3%)
Birth weight									
Low birth weight (<2500g)	1983 (47.1%)	258 (46.2%)	1725 (45.7%)	1753 (88.4%)	218 (84.5%)	1535 (89.0%)	117 (5.9%)	10 (3.9%)	107 (6.2%)
Normal birth weight (≥2500g)	2228 (52.9%)	175 (53.8%)	2053 (54.3%)	1161 (52.1%)	66 (37.7%)	1095 (53.3%)	46 (2.1%)	13 (7.4%)	33 (1.6%)
APGAR 5 score									
< 7 (abnormal)	259 (6.2%)	31 (5.1%)	228 (6.0%)	226 (87.3%)	27 (87.1%)	199 (87.3%)	9 (3.5%)	n.p.	7 (3.1%)
≥7 (healthy)	3951 (93.8%)	402 (94.9%)	3549 (93.9%)	2687 (68.0%)	257 (63.9%)	2430 (68.5%)	154 (3.9%)	21 (5.2%)	133 (3.7%)
Data missing	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.

n.p. = Not publishable due to confidentiality restrictions

Webappendix 2: Risk of hospital admission in preterm infants aged 0-<1 month by socio demographic characteristics, 2010-2011

Characteristics		All cause hospital admissions 0-<1 month of age				
	Total number of infants	Number of infants with at least one hospital admission	unadjusted OR (95% CI)	*p value*	multivariable OR (95% CI)*	*p value*
Indigenous status						
Indigenous	433 (10.3%)	284 (65.6%)	0.83 (0.67,1.03)	0.086	0.76 (0.58,0.98)	0.036
Non-Indigenous	3778 (89.7%)	2630 (69.6%)	1.00		1.00	
Prematurity**						
<28wk	186 (4.4%)	167 (89.8%)	4.57 (2.83,7.39)	<0.001	4.55 (2.81, 7.36)	<0.001
28<32wk	311 (7.4%)	305 (98.1%)	26.5 (11.8,59.6)	<0.001	26.12 (11.6, 58.81)	<0.001
32<37wk	3714 (88.2%)	2442 (65.8%)	1.00		1.00	
Socio-economic status (IRSD)						
Lowest (most deprived) 1	293 (7.0%)	195 (66.6%)	0.75 (0.57,0.97)	0.032	0.84 (0.61,1.17)	0.300
2	646 (15.3%)	457 (70.7%)	0.91 (0.74,1.11)	0.343	0.85 (0.68,1.07)	0.164
3	537 (12.8%)	338 (62.9%)	0.64 (0.52,0.78)	<0.001	0.61 (0.48,0.77)	<0.001
4	1143 (27.1%)	766 (67.0%)	0.76 (0.64,0.90)	0.001	0.76 (0.63,0.91)	0.004
Highest (least deprived) 5	1486 (35.3%)	1081 (72.8%)	1.00		1.00	
Remoteness (ARIA)						
Least remote 1	1802 (42.8%)	1298 (72.0%)	1.00		1.00	
2	1559 (37.0%)	1059 (67.9%)	0.82 (0.71,0.95)	0.010	0.89 (0.75,1.04)	0.147
3	327 (7.8%)	225 (68.8%)	0.86 (0.66,1.11)	0.235	0.93 (0.70,1.23)	0.604
4	116 (2.8%)	70 (60.3%)	0.59 (0.40,0.87)	0.008	0.74 (0.48,1.14)	0.173
Most remote 5	301 (7.1%)	185 (61.5%)	0.62 (0.48,0.80)	<0.001	0.76 (0.56,1.04)	0.088
Maternal Age						
<20 yrs	243 (5.8%)	167 (68.7%)	1.07 (0.79,1.44)	0.679	0.89 (0.63,1.26)	0.526
20-24 yrs	671 (15.9%)	423 (63.0%)	0.83 (0.68,1.01)	0.063	0.76 (0.61,0.95)	0.017
25-29 yrs	1115 (26.5%)	751 (67.4%)	1.00		1.00	
30-34 yrs	1207 (28.7%)	860 (71.3%)	1.20 (1.01,1.43)	0.042	1.22 (1.00,1.48)	0.047
35+ yrs	975 (23.2%)	713 (73.1%)	1.32 (1.09,1.59)	0.004	1.31 (1.06,1.62)	0.013
Gravidity						
0	1358 (32.2%)	980 (72.2%)	1.21 (0.99,1.47)	0.057	1.00 (0.81,1.25)	0.966
1	1121 (26.6%)	755 (67.4%)	0.96 (0.79,1.17)	0.700	0.88 (0.70,1.09)	0.241
2	736 (17.5%)	502 (68.2%)	1.00		1.00	
≥3	996 (23.7%)	677 (68.0%)	0.99 (0.81,1.21)	0.918	0.85 (0.67,1.06)	0.152
Child sex						
Male	2316 (55.0%)	1613 (69.7%)	1.05 (0.92,1.19)	0.488	1.28 (1.11,1.48)	0.001
Female	1895 (45.0%)	1301 (68.7%)	1.00		1.00	
Birth weight						
Low birth weight (<2500g)	1983 (47.1%)	1753 (88.4%)	7.00 (5.97,8.23)	<0.001	7.70 (6.51,9.11)	<0.001
Normal birth weight (≥2500g)	2228 (52.9%)	1161 (52.1%)	1.00		1.00	
APGAR 5 score						
< 7 (abnormal)	259 (6.2%)	226 (87.3%)	3.22 (2.22,4.67)	<0.001	1.40 (0.92,2.13)	0.116
≥7 (healthy)	3951 (93.8%)	2687 (68.0%)	1.00		1.00	

*Adjusted for Indigenous status, IRSD (Index of Relative Socio-Economic Disadvantage), maternal age, gravidity, gender of child, birth weight
**Prematurity was not adjusted for birth weight due to collinearity

Webappendix 3. Risk of hospital admission in preterm Indigenous and non-Indigenous infants aged 0-<1month by socio economic status, 2010-2011

	Total				Indigenous			Non Indigenous		
	Total infant n=4211	Infants with at least one hospital admission n=2914	Unadjusted OR (95% CI)	Multivariable OR (95% CI)*	Total Indigenous infant n=433	Indigenous infants with at least one hospital admission n=284 (65.6%)**	Multivariable OR (95% CI)*	Total non-Indigenous infant n=3778	Non-Indigenous infants with at least one hospital admission n=2630 (69.6%)**	Multivariable OR (95% CI)*
Most disadvantaged 1	293 (7.0%)	195 (66.6%)	0.75 (0.57-0.97)	0.72 (0.54-0.98)	161 (37.2%)	106 (65.8%)	0.88 (0.44-1.75)	132 (3.5%)	89 (67.4%)	0.81 (0.53-1.24)
2	646 (15.3%)	457 (70.7%)	0.91 (0.74-1.11)	0.85 (0.68-1.06)	58 (13.4%)	42 (72.4%)	1.11 (0.47-2.60)	588 (15.6%)	415 (70.6%)	0.82 (0.65-1.04)
3	537 (12.8%)	338 (62.9%)	0.64 (0.52-0.78)	0.61 (0.48-0.77)	56 (12.9%)	37 (66.1%)	0.77 (0.32-1.81)	481 (12.7%)	301 (62.6%)	0.59 (0.46-0.75)
4	1143 (27.1%)	766 (67.0%)	0.76 (0.64-0.90)	0.76 (0.63-0.91)	75 (17.3%)	45 (60.0%)	0.62 (0.28-1.35)	1068 (28.3%)	721 (67.5%)	0.77 (0.63-0.93)
Least disadvantaged 5	1486 (35.3%)	1081 (72.7%)	1.00	1.00	65 (15.0%)	44 (67.7%)	1.00	1421 (37.6%)	1037 (73.0%)	1.00
Data missing	106 (2.5%)	77 (72.6%)	-	-	18 (4.2%)	10 (55.6%)	-	88 (2.3%)	67 (76.1%)	-
P value trend	-	-	0.021	0.010	-	-	0.690	-	-	0.013

* Adjusted for maternal age, gravidity, gender of child, birth weight

**Risk of hospital admission in Indigenous compared to non-Indigenous infants aged 0-<1m: OR 0.83 (0.67-1.03); aOR 0.76 (0.58-0.98)

Webappendix 4 Effect of socio economic quintile and geographic location on hospital utilisation in Indigenous and non-Indigenous preterm infants aged 1-11 months, 2010-2011

	Indigenous			Non Indigenous		
	Total no of Indigenous infants n=433	Number of Indigenous infants with at least one hospital admission n=200	aOR* (95% CI)	Total no of non-Indigenous infants n=3778	Number of non-Indigenous infants with at least one hospital admission n=1202	aOR* (95% CI)
Socio economic status (IRSD)						
Most disadvantaged 1	161 (37.2%)	82 (50.9%)	1.63 (0.88,2.99)	132 (3.5%)	47 (35.6%)	1.30 (0.88,1.93)
2	58 (13.4%)	25 (43.1%)	1.13 (0.54,2.38)	588 (15.6%)	189 (32.1%)	1.07 (0.86,1.33)
3	56 (12.9%)	25 (44.6%)	1.10 (0.51,2.36)	481 (12.7%)	170 (35.3%)	1.29 (1.03,1.63)
4	75 (17.3%)	31 (41.3%)	1.01 (0.50,2.03)	1068 (28.3%)	352 (33.0%)	1.15 (0.96,1.38)
Least disadvantaged 5	65 (15.0%)	26 (40.0%)	1.00	1421 (37.6%)	416 (29.3%)	1.00
			P value trend 0.056			P value trend 0.132
Geographic location (ARIA)						
Most remote 4-5	191 (44.1%)	88 (46.1%)	1.67 (0.97,2.89)	226 (6.0%)	72 (31.9%)	1.29 (0.94,1.75)
3	58 (13.4%)	32 (55.2%)	2.11 (1.04,4.26)	269 (7.1%)	112 (41.6%)	1.79 (1.35,2.36)
2	82 (18.9%)	38 (46.3%)	1.54 (0.81,2.92)	1477 (39.1%)	495 (33.5%)	1.24 (1.06,1.46)
Least remote 1	84 (19.4%)	31 (36.9%)	1.00	1718 (45.5%)	495 (28.8%)	1.00
			P value trend 0.086			P value trend <0.001
		Number of Indigenous infants with at least one emergency department presentation n=313			Number of non-Indigenous infants with at least one emergency department presentation n=1850	
Socio economic status (ISRD)						
Most disadvantaged 1	161 (37.2%)	124 (77.0%)	1.48 (0.77,2.83)	132 (3.5%)	93 (70.5%)	2.77 (1.87,4.09)
2	58 (13.4%)	38 (65.5%)	0.84 (0.39,1.81)	588 (15.6%)	287 (48.8%)	1.11 (0.91,1.35)
3	56 (12.9%)	42 (75.0%)	1.23 (0.54,2.79)	481 (12.7%)	272 (56.6%)	1.50 (1.21,1.85)
4	75 (17.3%)	50 (66.7%)	0.82 (0.40,1.69)	1068 (28.3%)	527 (49.3%)	1.14 (0.97,1.33)
Least disadvantaged 5	65 (15.0%)	45 (69.2%)	1.00	1421 (37.6%)	628 (44.3%)	1.00
			P value trend 0.128			P value trend <0.001
Geographic location (ARIA)						
Most remote 4-5	191 (44.1%)	146 (76.4%)	2.16 (1.23,3.79)	226 (6.0%)	145 (64.2%)	1.99 (1.49,2.67)
3	58 (13.4%)	44 (75.9%)	1.89 (0.89,4.02)	269 (7.1%)	177 (65.8%)	2.11 (1.61,2.78)
2	82 (18.9%)	57 (69.5%)	1.44 (0.75,2.77)	1477 (39.1%)	705 (47.7%)	0.99 (0.86,1.14)
Least remote 1	84 (19.4%)	52 (61.9%)	1.00	1718 (45.5%)	781 (45.5%)	1.00
			P value trend 0.007			P value trend <0.001

IRSD = Index of Relative Socio-Economic Disadvantage ARIA = Accessibility/ Remoteness Index of Australia, OR = odds ratio, aOR = adjusted odds ratio, 95% CI = 95% confidence interval
* Adjusted for maternal age, gravidity, sex of child, birth weight

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Cross-sectional page 6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*8-9*
Bias	9	Describe any efforts to address potential sources of bias	7 – multiple births
Study size	10	Explain how the study size was arrived at	8-9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	9
		(*c*) Explain how missing data were addressed	N/A limited missing data
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods	

		taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	N/A
Results			**Page #**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Table 3; Webappendix 1
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*N/A*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	*N/A*
		Cross-sectional study—Report numbers of outcome events or summary measures	Table 3; Webappendix 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Specified under all tables.
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Tabe 2; 4;5 and webappendix 2-4
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The effect of socio-economic disadvantage, remoteness, and Indigenous status on hospital utilisation for Western Australian preterm infants under 12 months of age: a population based data linkage study

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The effect of socio-economic disadvantage, remoteness, and Indigenous status on hospital utilisation for Western Australian preterm infants under 12 months of age: a population based data linkage study

Running title: Risk factors for hospital utilisation for preterm infants

Natalie A. Strobel[1], Sue Peter[2], Kimberley E. McAuley[1], Daniel R. McAullay[1,3], Rhonda Marriott[4], Karen M. Edmond[1]

[1]School of Paediatrics and Child Health, University of Western Australia, Perth, Western Australia, Australia

[2]Princess Margaret Hospital for Children, Perth, WA

[3]Kurongkurl Katitjin, Centre for Indigenous Australian Education and Research, Edith Cowan University, Perth, Western Australia, Australia

[4]School of Psychology and Exercise Science, Murdoch University, Perth, Western Australia, Australia

Corresponding author

Natalie A Strobel

School of Paediatrics and Child Health

The University of Western Australia

35 Stirling Highway

Crawley

Western Australia

Australia 6009

E-mail: natalie.strobel@uwa.edu.au

Phone: +61 8 9340 7507

ABSTRACT

Objectives

Our primary objective was to determine the incidence of hospital admission and emergency department presentation in Indigenous and non-Indigenous preterm infants aged post discharge from birth hospital to 11 months in Western Australia. Secondary objectives were to assess incidence in the poorest infants from remote areas and to determine the primary causes of hospital utilisation in preterm infants.

Design

Prospective population-based linked dataset.

Setting and participants

All preterm babies born in Western Australia during 2010 and 2011.

Main outcome measures

All-cause hospitalisations and emergency department presentations.

Results

There were 6.7% (4,127/61,254) preterm infants, 12.7% (419/3,311) Indigenous preterm infants and 6.4% (3,708/57,943) non-Indigenous preterm infants born in Western Australia. Indigenous preterm infants had a higher incidence of hospital admission (aIRR 1.26, 95% CI 1.15, 1.39) and emergency department presentation (aIRR 1.84, 95% CI 1.60, 2.18) compared to non-Indigenous preterm infants. The most disadvantaged preterm infants (8.0/1000 person days) had a greater incidence of emergency presentation compared to the most advantaged infants (3.1/1000 person days) (aIRR 1.62, 95%CI 1.35, 1.93). The most remote preterm infants (8.0/1000 person days) had a greater incidence of emergency presentation compared to the least remote preterm infants (3.0/1000 person days) (aIRR 1.81, 95% CI 1.51, 2.15).

Conclusions

In Australia, preterm infants have high hospital utilisation in their first year of life. Infants living in disadvantaged areas, remote area infants and Indigenous infants are at increased risk. Our data highlights the need for improved post-discharge care for preterm infants.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- To the best of our knowledge, this is the first study to investigate the effect of risk factors on hospital utilisation and the burden of hospital admissions in Indigenous preterm infants under 12 months of age.
- This study uses population based data for all Western Australian preterm infants born 2010-2011 and high quality administrative datasets to determine hospital use for these infants.
- The sample size was sufficient to determine the differences in hospital use between Indigenous preterm infants, socio-economic status and remoteness for preterm infants.
- Environmental factors and maternal education were unable to be assessed.

INTRODUCTION

In 2010, it was estimated globally that 15 million babies, 11.1% of all livebirths worldwide, were born preterm (less than 37 weeks gestation).[1] Preterm infants are at a greater risk of experiencing serious health complications than fullterm infants. Complications include respiratory infections, anaemia, vision and hearing loss, and developmental delay.[1] Infants with complications from prematurity need many more health and social services than full term infants and infants without these complications.[2,3] This places a high economic, health and social burden on families and health systems.[4]

In 2013 8.6% of all babies born in Australia were preterm; most with a gestational age of between 32–36 completed weeks.[5] These data are similar to other developed countries. However, during 2013, 14% of babies born to Australian Aboriginal and Torres Strait Islander (hereafter referred to as Indigenous) mothers were preterm.[5] This high preterm risk has changed little over the last decade.[6] These data are comparable to many of the poorest countries in the world where the most recent data indicate that approximately 12% of babies are born preterm.[7]

Despite the high risks, there has been little focus on understanding hospital utilisation patterns and what follow-up care is needed for high risk preterm Aboriginal infants, especially the poorest infants who live in remote areas. This is particularly important because mothers who carry a higher burden of ill health and social dysfunction have a higher risk of delivering a preterm or low birth weight infant.[8,9] These mothers often have more difficulties accessing the health system and adhering to medication regimens.[8]

Western Australia (WA) has a large de-identified prospective longitudinal population based data system involving the probabilistic systematic record linkage of total population administrative health datasets.[10] Data are available for birth cohorts and include information on maternal and infant characteristics, hospital admission and emergency department presentations including length of stay, cause of hospital admission, Indigenous status and socio-economic status.

Our study was designed to assess differentials in incidence of all-cause hospital admission and emergency department presentation for Indigenous and non-Indigenous preterm infants (born <37 weeks) during their first 12 months of life. Our primary objective was to determine the incidence of hospital admission and emergency department presentation in Indigenous and non-Indigenous infants from time of discharge from birth hospital to 11 months (0-11 months). Secondary objectives were to assess incidence in the poorest infants from remote areas and to determine the primary causes of hospital utilisation in preterm infants.

METHODS

Study setting and database access

All live births occurring at <37 weeks gestational age in WA from 1 January 2010 to 31 December 2011 were included in this study. Prospective population based linked data from the WA Midwives' Notification System, Hospital Morbidity Data System, Emergency Department Data Collection, Death Registrations, the Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD)[11] and the Accessibility/ Remoteness Index of Australia (ARIA)[12] were obtained from the Department of Health of Western Australia (DOHWA).

The Midwives' Notification System includes clinical (infant weight, gestational age, Apgar score, multiple birth, gravidity) and socio demographic (baby's gender, mother's age, Indigenous status, socio-economic status, remoteness index) data on all WA live births and stillbirths of more than 20 weeks' gestation or birth weight greater than 400g which are reported by trained midwives within 48 hours of delivery. The Hospital Morbidity Data System and Emergency Department Data Collection include data on all completed hospital admissions and emergency department presentations to all public hospitals in WA. These data are entered by trained medical records staff following the occasion of service. Death Registrations are linked monthly and include date and cause of death. The Australian Bureau of Statistics (ABS) Index of Relative Socio-Economic Disadvantage (IRSD) divides statistical local areas based on the 2006 Australian national census data into quintiles from most deprived (1) to least deprived (5).[11] The Accessibility/ Remoteness Index of Australia (ARIA) was developed by the Department of Health and Aged Care and is maintained by the Australian Institute of Health and Welfare.[12] This index classifies geographic location on the basis of isolation and distance from service centres and health care facilities. ARIA data are split into five categories from least remote (1) (major cities) to most remote (5) (remote area communities).

The databases were systematically linked by DOHWA data linkage staff using probabilistic matching and de-identified. The final database included date of hospital admission, date of emergency department presentation, hospital length of stay, maternal ethnicity, maternal age, gravidity, infant age, infant birth weight, gestational age, infant sex, multiple birth, and infant health status at birth (Apgar score). ISRD quintile, ARIA level and health region from the Midwives Notification System were also included.

Inclusion and exclusion criteria

Infants were classified as Indigenous if the mother was recorded in the Midwives Notification System as Aboriginal and/or Torres Strait Islander.[13] All other infants were classified as non-Indigenous. To avoid clustering within multiple births the population was limited to singleton babies. We excluded infants who died in the first year of life.

Definitions

Specific cut points were used to define preterm; 'extremely preterm' (<28 weeks gestation); 'very preterm' (births between 28 - <32 weeks gestation); and 'moderate preterm' (births between 32 - <37 weeks gestation).[1] The small for gestational age index was calculated as small for gestational age 'SGA' (<10th percentile for weight); appropriate for gestational age 'AGA' (10-90th percentile for weight); large for gestational age 'LGA' (>90th percentile).[14]

We defined the 'person time at risk' as the number of days between discharge from the birth hospital to 11 months of chronological age. This excluded the stay in hospital after birth for both well and unwell babies. Hospital admissions were defined as the number of admissions of infants to a WA hospital ward for care during the period between discharge from the birth hospital to 11 months. Between hospital transfers were included as one admission. Emergency department presentations were defined as the number of presentations of infants to a WA hospital emergency department (regardless of whether the child was admitted) during the period between discharge from the birth hospital to 11 months. The frequency of emergency department presentations was defined as the count of presentations to any emergency department regardless of whether the child was admitted to hospital. 'Low socio-economic status' was defined as the two lowest IRSD quintiles (IRSD 1-2). 'Remote residence' was defined as the two most remote ARIA categories (ARIA 4-5).

Primary cause of hospitalisation and emergency department presentations were classified using the International Classification of Disease Version 10 (ICD-10) classification system by medical record staff. Each admission only received one diagnostic code.[15] All hospital admissions were classified with a primary cause of hospitalisation but secondary diagnoses or comorbidity data were not available. No data on cause of emergency department presentation were available. Causes of hospitalisation were defined according to the AIHW,[16] and adapted for use with infants.[17] Diseases were categorised as the respiratory system, digestive system, skin and subcutaneous tissue, ear and mastoid process, infectious and parasitic diseases, nutritional diseases, and injury and poisoning, perinatal conditions (e.g. prematurity, hypoxic-ischaemic encephalopathy), congenital malformations, chromosomal abnormalities and all other conditions.

Sample size and data analysis

Our primary outcome measure was the incidence of hospital admissions between discharge from the birth hospital to 11 months of chronological age in Indigenous and non-Indigenous preterm infants from 2010-2011.

Incidence of hospital utilisation was calculated as the number of events (hospital admissions or emergency presentations) between discharge from birth hospital to 11 months of chronological age divided by the total days at risk between discharge from the birth hospital to 11 months. All incidence rates were expressed as 1000 person days. We also calculated median and interquartile range (IQR, 25th to 75th percentile) estimates.

Crude incident rate ratios (IRR), adjusted incident rate ratios (aIRR) and 95% confidence intervals (95% CI) were calculated using negative binomial regression analysis to assess the association between hospital admissions and emergency presentations for preterm infants

and Indigenous status, socio-economic status and remoteness.[18,19] Potential confounders were included in the models *a priori* to adjust for the effect of important explanatory variables. We identified factors that are known to be associated with both the exposure and the outcome and were not a causal step in the pathway. We only included variables from the Midwives' Notification System: maternal characteristics (maternal age, gravidity), infant factors (gender of child, birth weight), Indigenous status, and socio-economic status (ISRD). Data analyses were conducted using STATA 13.1 (StataCorp, USA).

We calculated that our study population of 4,127 infants would provide 90% power to detect at least a 10% difference in hospital admission incidence between Indigenous and non-Indigenous infants. We assumed a 5% significance level, a hospital admission incidence of 5.0 per 1000 person days and that the ratio between Indigenous to non-Indigenous infants would be approximately 1:9.

Ethics

Approvals were obtained from the WA Department of Health Human Research Ethics Committee, the University of Western Australia Human Research Ethics Committee, and the Western Australian Aboriginal Health Ethics Committee (WAAHEC).

RESULTS

During 2010-2011 in WA there were 62,965 live births, 98.3% (61,254) were singletons and 6.9% (4,211) of these infants were preterm. Of these, 2.0% (84/4211) preterm infants died in the first year of life and were removed from the preterm cohort (Webappendix A). 12.7% (419/3,311) of the preterm infants were classified as Indigenous and 6.4% (3,708/57,943)

were classified as non-Indigenous (Table 1). 37.2% (156) of preterm Indigenous infants were classified in the most disadvantaged quintile compared to 3.5% (131) non-Indigenous infants. 38.7% (162) of preterm Indigenous infants lived in the most remote area (ARIA 5) compared to 3.6% (134) of non-Indigenous infants (Table 1).

The median (IQR) length of stay during the birth admission was 93 days (IQR 64-115) for infants with gestational age < 28 weeks; 33 days (IQR 22-48) for infants with gestational age 28 to <32 weeks and 5 days (IQR 3-9) for infants with gestational age 32 to <37 weeks. Webappendix A provides further detail of the length of hospital stay in birth hospital.

Overall, there were a total 5,224 hospital admissions in 3,047 preterm infants and 5,651 emergency presentations in 2,214 preterm infants during the period between discharge from birth hospital to 11 months of chronological age. 2,229 (42.7%) were elective admissions, 2,951 (56.5%) were emergency admissions and the remaining 44 (0.8%) were unknown. 73.8% (3,047) of preterm infants had at least one hospital admission from and 53.6% (2,214) of infants had at least one emergency department presentation between discharge from birth hospital to 11 months (Webappendix B).

Indigenous preterm infants had a higher incidence of emergency department presentation (aIRR 1.84, 95% CI 1.60, 2.18) and hospital admission (aIRR 1.26, 95% CI 1.15, 1.39) compared to non-Indigenous preterm infants even after adjusting for confounding factors (Table 2). Preterm infants with gestational age under 32 weeks had a greater incidence of hospital admission (6.6/1000 person days) compared to infants with a gestational age 32-37 weeks (3.3/1000 person days) (aIRR 1.97, 95% CI 1.81, 2.13) (Table 2). There was also an increased incidence of emergency department presentations for infants with a gestational

age under 32 weeks (aIRR 1.62, 95% CI 1.41, 1.85). Length of stay for birth admissions over 28 days were significantly associated with subsequent hospital admissions (aIRR 1.99, 95% CI 1.82-2.18) and emergency department presentations (aIRR 1.72, 95% CI 1.49-1.99) compared to stays less than 14 days (Webappendix C). There were no marked effects of other socio demographic characteristics on hospital utilisation in preterm infants (Table 2).

The most disadvantaged (ISRD 1) preterm infants had an increased incidence of presenting to emergency department (8.0/1000 person days) compared to the most advantaged (ISRD 5) preterm infants (3.1/1000 person days) (aIRR 1.62, 95%CI 1.35, 1.93) (Table 2). There also appeared to be some evidence of a dose response with increased incidence of emergency department presentation with increased levels of disadvantage overall (p value for trend = <0.001) (Table 2) and for non-Indigenous preterm infants (p value for trend = <0.001) but not Indigenous infants (p value for trend = <0.251) (Table 3). The most disadvantaged preterm infants had higher but not significant incidence of hospital admissions (4.6/1000 person days) compared to the most advantaged infants (3.4/1000 person days) (aIRR 1.09, 95%CI 0.97-1.24). There was no obvious trend (p value for trend = 0.800) (Table 2 and 3).

There was an increased incidence of emergency department presentation for the most remote preterm infants (7.9/1000 person days) compared to non-remote preterm infants (3.0/1000 person days) (aIRR 1.81, 95% CI 1.51, 2.15) (Table 2). There was also some evidence of a dose response for increased incidence of emergency department presentation with increased levels of remoteness overall (p value for trend = <0.001) (Table 2) and for Indigenous (p value for trend = <0.001) and non-Indigenous (p value for trend = <0.001) preterm infants (Table 3). Remote area preterm infants had a higher but not significant

incidence of hospitalisation (4.2/1000 person days) compared to the least remote preterm infants (3.3/1000 person days) (aIRR 1.10, 95% CI 0.97, 1.24) (Table 2). There was also some evidence of a dose response with increased risk of hospital admission with increased levels of remoteness overall (p value for trend = 0.006) and for Indigenous (p value for trend = 0.010) and non-Indigenous (p value for trend = 0.033) preterm infants (Table 2 and 3).

Overall, the distribution of causes were similar in Indigenous and non Indigenous infants (Table 4). Indigenous infants appeared more likely to be hospitalised for respiratory disease (5.6/1000 person days) than non-Indigenous infants (3.7/1000 person days) (Table 4). Indigenous infants appeared more likely to be hospitalised for congenital malformations (5.1/1000 person days) than non-Indigenous infants (3.6/1000 person days) (Table 4). However, numbers were too small to perform statistical tests.

COMMENTS

In our WA population based study, 54% of preterm infants presented to a hospital emergency department and 74% were admitted in the time between discharge from birth hospital to11 months of chronological age. Incidence of hospital admission and emergency department presentation was 1.2-1.8 fold greater in Indigenous compared to non-Indigenous infants. Preterm infants located in the poorest and most remote areas of WA had significantly greater hospital utilisation compared to preterm infants living in less poor and urban areas.

In the past 10 years there have been a number of studies showing that preterm infants are at greater risk of hospital admissions and emergency presentations than term infants.[2,20] Despite this, few have investigated whether preterm infants from vulnerable families have an increased risk of hospital utilisation compared to the general population. Hispanic and

African American preterm infants have been reported to have a greater risk of hospital admission and emergency presentation compared to white preterm infants.[20] Bar-Zeev et al reported that 60% of Indigenous preterm infants were readmitted to hospital in the Top End of the Northern Territory of Australia in the first year of life compared to only 44% of Indigenous term infants.[21] However, there have been no published reports of the differences in hospital utilisation between Australian Indigenous and non-Indigenous preterm infants in the last 10 years.

Population based studies in infants of all gestational ages have shown increased risk of hospital admissions,[22,23] length of stay,[23] and emergency presentations[24] in socially disadvantaged infants compared to the least disadvantaged. We reported that the most disadvantaged preterm infants had a 60% greater incidence of emergency department presentations compared to infants from the most advantaged areas. Although preterm infants are more likely to be born to families who are socially disadvantaged,[8] we located no other studies that examined how socio-economic status may influence subsequent hospital use in preterm infants. Preterm infants living in remote areas in our study had a 1.1-1.8 fold greater risk of presenting to the emergency department and hospital admission compared to the least remote infants. Population based studies have reported that infants located in remote areas have an increased risk of readmission [22] and emergency department presentation[24] in the first six weeks after birth. However, we were unable to locate other studies that examined the effect of geographic location on hospital use in preterm infants.

We also showed that length of stay for the birth admission was significantly associated with subsequent hospital admissions and emergency department presentations. Length of hospital stay can be seen as a proxy for the health status and 'unwellness' of the child during

the hospital admission. It has been shown in many studies to have a clear influence on subsequent hospital utilisation.[25,26]

Over the last 10 years there has been significant Australian Federal Government funding to improve access to urban, rural and remote paediatric services including building hospitals, clinics and Aboriginal Community Controlled Health Services (ACCHS).[27,28] There has also been an increase in staffing levels of all health care providers in rural and remote areas and major investments in specialist outreach services and care coordination. In Western Australia, there is free antenatal care and culturally appropriate midwifery and post-discharge care for disadvantaged mothers and infants, home visits within 72 hours of discharge,[29] regular medical and developmental follow-up of all preterm infants,[30] and universal and targeted surveillance and screening programs.[29,31] It is highly likely that these initiatives have improved health status and subsequent morbidity and mortality risks. However our study shows that important inequities remain in service use in remote areas, in poor families and in Indigenous families.

The most common causes of hospitalisation were respiratory, and infectious and parasitic diseases in Indigenous and non-Indigenous preterm infants. Respiratory disease has previously been cited as the most common cause for hospital admissions for Indigenous infants up 12 months in the Northern Territory[21] and Western Australia.[24] For all preterm infants under 12 months of age, respiratory and infectious conditions have repeatedly been shown to be the main cause of admission.[26,32] Many of these conditions are preventable by improving coverage of routine childhood vaccines such as pneumococcal and rotavirus vaccines and also through improving housing and education levels in families. Cause of emergency presentations was not assessed in this study due to no data being available,

however existing evidence suggests that many emergency presentations may also be the result of potentially avoidable conditions.[17,33] Our data indicate that more can be done to improve health services and reduce hospital use in preterm infants in Western Australia. We are also aware that the underlying socio-economic determinants of health such as education and employment are also important determinants of health service use and many improvements are needed in these areas.

Our study had some limitations. Our study was observational and could only report associations and did not provide proof of causality. Indigenous status can be missing or misclassified which may result in an under-estimation of risk.[34,35] Despite this, our results show a highly significant effect of Indigenous status on hospital utilisation and it is unlikely that any misclassification would have biased the results. Where available we adjusted for all potential confounding factors. However, we were unable to adjust for measures of maternal illness or education or any underlying social conditions (e.g. housing and infrastructure) that may have played a role in hospital utilisation, particularly preventable causes of hospital use.[36] Within Australia socio-economic data are primarily based on AIHW IRSD quintiles which can cause misclassification when applied at an individual level.[11] However, we did show strong associations between hospital utilisation and socioeconomic status and any differential misclassification would have biased towards the null. We did not adjust for geographical clustering as we only had data on statistical local areas which were used to create the IRSD categories. However, we adjusted for IRSD level and repeated all analyses using the statistical local areas data and there were no differences in any of our analyses. Small sample size for Indigenous pre-term infants in some of the sub-analyses could have resulted in a type II error as a result of reduced power to detect true differences. We did not have the mode of separation variable in our data therefore we are unable to m whether a baby was discharged home or transferred to another hospital following the length of stay at

the birth hospital. However, our length of stay data are similar to previously reported data from New South Wales (Australia) which were published earlier in 2016 (Median length of stay for infants < 28 weeks gestation 87 (IQR 31) and median length of stay for infants 28-23 weeks gestation 47 (IQR 23).[26]

There are strengths related to the data collections we used. The cause specific hospitalisation data were limited to primary cause of hospitalisation. These data are considered to be highly accurate,[10,37] because the Hospital Morbidity Data System uses the World Health Organisation ICD 10 coding system[15] and highly trained coders. The Midwives' Notification System uses clear definitions that are based on Australian standard definitions[5] and is reported to have a very high level of completion and clinical certainty. [38,39] Our emergency department presentations were also recorded in a clearly defined patient administration system ('EDIS').[40,41] This system is considered by Emergency Department staff to be highly reliable though formal documentation of its accuracy is not available. In contrast, the accuracy of cause specific emergency department data has been questioned,[33] which is why we did not include cause specific emergency department data in this study. Lastly, we controlled for confounding effects of multiple births by restricting the analysis to singleton births.

Our study has implications for policy and program development. Despite investments in maternal and child health services we reported that preterm infants had high hospital utilisation rates and that important risk groups were infants living in disadvantaged areas, remote area infants and Indigenous infants. Our data highlight the need for improved post-discharge care of preterm infants, particularly in remote regions and for poor, Indigenous infants. This includes preventive programs focused on improving skills of families and

service providers in caring for small infants and care coordination programs. The WA government has provided recent funding to improve post-discharge care and care coordination for Indigenous children across WA. These interventions have the potential to improve hospital utilisation and long term health outcomes of these vulnerable infants and reduce long term burden on families. We will continue to monitor impacts and will report trends in subsequent papers.

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Contributorship statement

Conceived and designed the experiments: SP KE DM RM. Performed the experiments: NS KM. Analysed the data: NS KM KE. Contributed reagents/materials/analysis tools: NS. Wrote the paper: NS SP KM DM RM KE.

Competing interests

The authors have no competing interests to declare.

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Data sharing statement

Data are available from the Western Australia Department of Health Data Linkage Branch with ethical approval through the Western Australia Department of Health Human Research Ethics Committee (Ref 2013/33). To maintain confidentiality and security, interested individuals may apply for access to linked data by contacting the Western Australian Data

Linkage Branch. Contact details are DataServices@health.wa.gov.au; +61-8-9222 2370.

The computing code is available on request from the corresponding author.

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Table 1 Socio-demographic characteristics in preterm infants in the study population, 2010-2011

Characteristics	Total number of infants n = 4127	Number of Indigenous infants n = 419	Number of non-Indigenous infants n = 3708	OR 95% CI	P value
Infant					
Prematurity					
<28wk	135 (3.3%)	20 (4.8%)	115 (3.1%)	1.57 (0.96, 2.55)	0.070
28<32wk	301 (7.3%)	45 (10.7%)	256 (6.9%)	1.62 (1.16, 2.27)	0.005
32<37wk	3691 (89.4%)	354 (84.5%)	3337 (90.0%)	0.61 (0.46, 0.81)	0.001
Child sex					
Male	2268 (55.0%)	218 (52.0%)	2050 (55.3%)	0.88 (0.72, 1.07)	0.204
Female	1859 (45.0%)	201 (48.0%)	1658 (44.7%)	1.14 (0.93, 1.40)	0.204
Birth weight					
Low birth weight (<2500g)	1910 (46.3%)	246 (58.7%)	1664 (44.9%)	1.75 (1.42, 2.14)	<0.001
Normal birth weight (≥2500g)	2217 (53.7%)	173 (41.3%)	2044 (55.1%)	0.57 (0.47, 0.70)	<0.001
Small for gestational age					
SGA (<10th percentile)	324 (7.9%)	46 (11.0%)	278 (7.5%)	1.52 (1.09-2.12)	0.013
AGA (10th-90th percentile)	3,331 (80.7%)	331 (79.0%)	3,000 (80.9%)	0.89 (0.69-1.14)	0.348
LGA (>90th percentile)	472 (11.4%)	42 (10.0%)	430 (11.6%)	0.85 (0.61-1.19)	0.338
APGAR 5 score					
< 7 (abnormal)	205 (5.0%)	25 (6.0%	180 (4.9%)	1.24 (0.80, 1.90)	0.334
≥7 (healthy)	3921 (95.0%)	394 (94.0%)	3527 (95.1%)	0.80 (0.52, 1.24)	0.321
Data missing	n.p.	n.p.	n.p.		
Maternal					
Maternal Age					
<20 yrs	235 (5.7%)	83 (19.8%)	152 (4.1%)	5.78 (4.32, 7.72)	<0.001
20-24 yrs	656 (15.9%)	128 (30.6%)	528 (14.2%)	2.65 (2.11, 3.33)	<0.001
25-29 yrs	1090 (26.4%)	108 (25.8%)	982 (26.5%)	0.96 (0.77, 1.21)	0.755
30-34 yrs	1187 (28.8%)	55 (13.1%)	1132 (30.5%)	0.34 (0.26, 0.46)	<0.001
35+ yrs	959 (23.2%)	45 (10.7%)	914 (24.7%)	0.37 (0.27, 0.51)	<0.001
Gravidity					
0	1327 (32.2%)	91 (21.7%)	1236 (33.3%)	0.55 (0.44, 0.71)	<0.001
1	1106 (26.8%)	87 (20.8%)	1019 (27.5%)	0.69 (0.54, 0.89)	0.003
2	720 (17.5%)	63 (15.0%)	657 (17.7%)	0.82 (0.62, 1.09)	0.171
≥3	974 (23.6%)	178 (42.5%)	796 (21.5%)	2.70 (2.19, 3.33)	<0.001
Area					
Socio-economic status					
Most disadvantaged 1	287 (7.0%)	156 (37.2%)	131 (3.5%)	17.0 (13.0, 22.1)	<0.001
2	633 (15.3%)	55 (13.1%)	578 (15.6%)	0.84 (0.62, 1.13)	0.242
3	528 (12.8%)	54 (12.9%)	474 (12.8%)	1.03 (0.76, 1.40)	0.832
4	1115 (27.0%)	74 (17.7%)	1041 (28.1%)	0.56 (0.43, 0.73)	<0.001
Least disadvantaged 5	1459 (35.4%)	62 (14.8%)	1397 (37.7%)	0.29 (0.22, 0.38)	<0.001
Data missing	105 (2.5%)	18 (4.3%)	87 (2.4%)		
Geographic location					
Major city	1767 (42.8%)	82 (19.6%)	1685 (45.4%)	0.30 (0.23, 0.38)	<0.001
Inner regional	1529 (37.1%)	81 (19.3%)	1448 (39.1%)	0.38 (0.30, 0.49)	<0.001
Outer regional	319 (7.7%)	56 (13.4%)	263 (7.1%)	2.07 (1.52, 2.82)	<0.001
Remote	111 (2.7%)	20 (4.8%)	91 (2.5%)	2.04 (1.24, 3.34)	0.005
Very remote	296 (7.2%)	162 (38.7%)	134 (3.6%)	17.64 (13.55, 22.96)	<0.001
Data missing	105 (2.5%)	18 (4.3%)	87 (2.4%)		

n.p. = Not publishable due to small numbers and confidentiality restrictions

Table 2: Rate of hospital utilisation in preterm infants post discharge from birth hospital to 11 months by socio demographic characteristics, 2010-2011

Characteristics	Events	Time at risk	(Events/Risk)*1000	All cause hospitalisations post discharge -11 months unadjusted IRR (95% CI)	*p value*	multivariable IRR (95% CI)*	*p value*
Infant							
Indigenous status							
Indigenous	736	147694	4.98	1.46 (1.34-1.59)	<0.001	1.26 (1.15-1.39)	<0.001
Non-Indigenous	4488	1311830	3.42	1.00		1.00	
Prematurity**							
<28wk	309	37324	8.28	2.54 (2.23-2.89)	<0.001	2.47 (2.17-2.82)	<0.001
28<32wk	591	99643	5.93	1.81 (1.65-1.99)	<0.001	1.77 (1.61-1.95)	<0.001
32<37wk	4324	1322556	3.27	1.00		1.00	
Child sex							
Male	3001	802670	3.74	1.11 (1.04-1.17)	0.001	1.17 (1.10-1.24)	<0.001
Female	2223	656854	3.38	1.00		1.00	
Birth weight							
Low birth weight (<2500g)	3161	660523	4.79	1.86 (1.75-1.97)	<0.001	1.86 (1.76-1.98)	<0.001
Normal birth weight (≥2500g)	2063	799001	2.58	1.00		1.00	
SGA index							
SGA (<10th percentile)	565	112371	5.03	1.42 (1.29-1.57)	<0.001	1.41 (1.28-1.56)	<0.001
AGA (10th-90th percentile)	4185	1178585	3.55	1.00		1.00	
LGA (>90th percentile)	474	168568	2.81	0.79 (0.71-0.86)	<0.001	0.78 (0.70-0.87)	<0.001
APGAR 5 score							
< 7 (abnormal)	366	68362	5.35	1.54 (1.37-1.74)	<0.001	1.07 (0.95-1.20)	0.292
≥7 (healthy)	4855	1390800	3.49	1.00		1.00	
Maternal							
Maternal Age							
<20 yrs	367	83285	4.41	1.24 (1.09-1.42)	0.001	1.15 (1.01-1.30)	0.037
20-24 yrs	839	232904	3.60	1.02 (0.93-1.12)	0.688	0.98 (0.89-1.07)	0.636
25-29 yrs	1361	385291	3.53	1.00		1.00	
30-34 yrs	1445	420534	3.44	0.97 (0.90-1.05)	0.498	1.00 (0.92-1.08)	0.903
35+ yrs	1212	337509	3.59	1.02 (0.93-1.11)	0.702	0.98 (0.90-1.07)	0.652
Gravidity							
0	1636	468533	3.49	0.97 (0.89-1.07)	0.609	0.90 (0.82-0.98)	0.013
1	1315	391572	3.36	0.94 (0.87-1.03)	0.193	0.91 (0.84-1.00)	0.048
2	914	255682	3.57	1.00		1.00	
≥3	1359	343737	3.95	1.11 (1.01-1.22)	0.028	1.02 (0.93-1.11)	0.692
Area							
Socio-economic status							
Most disadvantaged 1	463	101208	4.57	1.34 (1.20-1.51)	<0.001	1.09 (0.97-1.24)	0.123
2	784	223630	3.51	1.03 (0.94-1.13)	0.555	0.97 (0.89-1.06)	0.460
3	660	187114	3.53	1.03 (0.94-1.14)	0.497	0.99 (0.90-1.08)	0764
4	1419	394826	3.59	1.05 (0.98-1.14)	0.183	1.03 (0.95-1.10)	0.501
Least disadvantaged 5	1760	515750	3.41	1.00		1.00	
Remoteness							

Major city	2067	623862	3.31	1.00		1.00	
Inner regional	1956	542383	3.61	1.09 (1.02-1.16)	0.014	1.08 (1.01-1.15)	0.019
Outer regional	502	112445	4.46	1.35 (1.21-1.50)	<0.001	1.25 (1.13-1.39)	<0.001
Remote	125	39404	3.17	0.967 (0.79-1.17)	0.664	0.97 (0.80-1.17)	0.736
Very remote	436	104434	4.17	1.26 (1.13-1.42)	<0.001	1.10 (0.97-1.24)	0.130
			All cause emergency department presentations post discharge-11 months				
	Events	**Time at risk**	**(Events/Risk)*1000**	**unadjusted IRR (95% CI)**	***p value***	**multivariable IRR (95% CI)***	***p value***
Infant							
Indigenous status							
Indigenous	1256	147694	8.50	2.55 (2.24-2.91)	<0.001	1.84 (1.60-2.18)	<0.001
Non-Indigenous	4395	1311830	3.35	1.00		1.00	
Prematurity**							
<28wk	295	37324	7.90	2.16 (1.71-2.74)	<0.001	2.12 (1.69-2.66)	<0.001
28<32wk	524	99643	5.26	1.45 (1.23-1.72)	<0.001	1.41 (1.20-1.65)	<0.001
32<37wk	4832	1322556	3.65	1.00		1.00	
Child sex							
Male	3322	802670	4.14	1.17 (1.07-1.28)	0.001	1.21 (1.11-1.32)	<0.001
Female	2329	656854	3.55	1.00		1.00	
Birth weight							
Low birth weight (<2500g)	2818	660523	4.27	1.22 (1.11-1.33)	<0.001	1.19 (1.09-1.30)	<0.001
Normal birth weight (≥2500g)	2833	799001	3.55	1.00		1.00	
Small for gestational age index							
SGA (<10th percentile)	522	112371	4.65	1.23 (1.05-1.45)	0.960	1.20 (1.03-1.41)	0.022
AGA (10th-90th percentile)	4486	1178585	3.81	1.00		1.00	
LGA (>90th percentile)	643	168568	3.81	1.00 (0.86-1.15)	0.013	0.99 (0.86-1.14)	0.906
APGAR 5 score							
< 7 (abnormal)	341	68362	4.99	1.33 (1.08-1.62)	0.006	1.13 (0.93-1.38)	0.214
≥7 (healthy)	5308	1390800	3.82	1.00		1.00	
Maternal							
Maternal Age							
<20 yrs	538	83285	6.46	1.70 (1.40-2.05)	<0.001	1.56 (1.28-1.89)	<0.001
20-24 yrs	1308	232904	5.62	1.48 (1.29-1.69)	<0.001	1.40 (1.22-1.59)	<0.001
25-29 yrs	1460	385291	3.79	1.00		1.00	
30-34 yrs	1357	420534	3.23	0.85 (.75-.996)	0.008	0.90 (0.80-1.01)	0.078
35+ yrs	988	337509	2.93	0.78 (0.68-0.88)	<0.001	0.77 (0.67-0.87)	<0.001
Gravidity							
0	1620	468533	3.46	0.90 (0.78-1.02)	0.112	0.79 (0.70-0.91)	0.001
1	1437	391572	3.67	0.95 (0.83-1.09)	0.476	0.89 (0.78-1.02)	0.093
2	989	255682	3.87	1.00		1.00	
≥3	1605	343737	4.67	1.22 (1.06-1.41)	0.005	1.13 (0.99-1.30)	0.071
Area							
Socio-economic status							
Most disadvantaged 1	809	101208	7.99	2.58 (2.17-3.05)	<0.001	1.62 (1.35-1.93)	<0.001

2	795	223630	3.55	1.15 (1.00-1.32)	0.050	1.02 (0.89-1.17)	0.769
3	838	187114	4.48	1.45 (1.25-1.67)	<0.001	1.27 (1.10-1.46)	0.001
4	1460	394826	3.70	1.19 (1.06-1.34)	0.003	1.09 (0.98-1.22)	0.116
Least disadvantaged 5	1602	515750	3.11	1.00		1.00	
Remoteness							
Major city	1878	623862	3.01	1.00		1.00	
Inner regional	1974	542383	3.64	1.21 (1.09-1.34)	<0.001	1.09 (0.98-1.20)	0.108
Outer regional	624	112445	5.55	1.85 (1.57-2.17)	<0.001	1.51 (1.29-1.77)	<0.001
Remote	201	39404	5.10	1.68 (1.29-2.19)	<0.001	1.44 (1.11-1.86)	0.006
Very remote	827	104434	7.92	2.64 (2.25-3.11)	<0.001	1.81 (1.51-2.15)	<0.001

* Adjusted for Indigenous status, IRSD (Index of Relative Socio-Economic Disadvantage), maternal age, gravidity, gender of child, birth weight
**Prematurity was not adjusted for birth weight due to collinearity

Table 3: Effect of socio-economic quintile and geographic location on hospital utilisation in Indigenous and non-Indigenous preterm infants post discharge from birth hospital to 11 months, 2010-2011

	Indigenous				Non Indigenous			
	Events	Time at risk	(Events/Risk)* 1000	aIRR* (95% CI)	Events	Time at risk	(Events/Risk)* 1000	aIRR* (95% CI)
Hospital admissions								
Socio-economic status								
Most disadvantaged 1	297	55081	5.39	1.20 (0.90-1.60)	166	46128	3.60	1.02 (0.87-1.20)
2	96	19393	4.95	1.03 (0.72-1.48)	688	204238	3.37	0.96 (0.88-1.05)
3	86	18992	4.53	0.91 (0.63-1.31)	574	168122	3.41	1.00 (0.90-1.10)
4	129	26309	4.90	1.05 (0.75-1.47)	1290	368518	3.50	1.02 (0.95-1.10)
Least disadvantaged 5	96	21764	4.41	1.00	1664	493987	3.37	1.00
				P value trend 0.150				P value trend 0.553
Geographic location								
Most remote	326	64023	5.09	1.52 (1.16-1.99)	235	79816	2.94	0.94 (0.82-1.07)
Outer regional	115	19829	5.80	1.57 (1.13-2.18)	387	92617	4.18	1.24 (1.11-1.39)
Inner regional	158	28520	5.54	1.53 (1.14-2.09)	1798	513864	3.50	1.05 (0.99-1.13)
Major city	105	29167	3.60	1.00	1962	594696	3.30	1.00
				P value trend 0.014				P value trend 0.127
Emergency presentations								
Socio-economic status								
Most disadvantaged 1	544	55081	9.88	1.02 (0.74-1.40)	265	46128	5.74	1.80 (1.42-2.29)
2	107	19393	5.52	0.54 (0.36-0.82)	688	204238	3.37	1.08 (0.94-1.24)
3	159	18992	8.37	0.84 (0.56-1.25)	679	168122	4.04	1.30 (1.12-1.51)
4	167	26309	6.35	0.62 (0.42-0.90)	1293	368518	3.51	1.17 (1.01-1.28)
Least disadvantaged 5	207	21764	9.51	1.00	1395	493987	2.82	1.00
				P value trend 0.251				P value trend p<0.001
Geographic location								
Most remote	640	64023	10.00	1.97 (1.46-2.67)	388	79816	4.86	1.61 (1.33-1.95)
Outer regional	178	19829	8.98	1.63 (1.11-2.39)	446	92617	4.82	1.50 (1.26-1.80)
Inner regional	206	28520	7.22	1.35 (0.95-1.93)	1768	513864	3.44	1.06 (0.96-1.18)
Major city	160	29167	5.49	1.00	1718	594696	2.89	1.00
				P value trend p<0.001				P value trend p<0.001

IRR = incidence rate ratio, aIRR = adjusted incidence rate ratio, 95% CI = 95% confidence interval
* Adjusted for maternal age, gravidity, sex of child, birth weight

Table 4 ICD 10 classification of primary cause of hospital admissions in preterm infants post discharge from birth hospital to 11 months by Indigenous status, 2010-2011

Primary cause of hospital admission	Total			Indigenous			Non-Indigenous		
	Events	Time at risk	(Events/Risk)* 1000	Events	Time at risk	(Events/Risk)* 1000	Events	Time at risk	(Events/Risk)* 1000
Respiratory system	619	151299	4.09	178	31803	5.60	441	119496	3.69
Infectious and parasitic diseases	188	54855	3.43	45	11880	3.79	143	42975	3.33
Digestive system	211	61155	3.45	22	6287	3.50	189	54868	3.44
Skin and subcutaneous tissue	36	12232	2.94	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Ear and mastoid process	39	12458	3.13	12	3965	3.03	27	8493	3.18
Nutritional diseases	14	4076	3.43	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Injury and poisoning	56	19132	2.93	44	15160	2.90	12	3971	3.02
Perinatal conditions	3298	951977	3.46	350	91812	3.81	2948	860165	3.43
Congenital malformations, deformations and chromosomal abnormalities	169	47687	3.54	11	2149	5.12	158	44538	3.55
Other	594	152293	3.90	101	22920	4.41	493	129373	3.81
Total admissions	5224	1459524	3.58	736	147694	4.98	4488	1311830	3.42

n.p. = Not publishable due to small numbers and confidentiality restrictions

SUPPORTING INFORMATION
Tables provided – Webappendix A-C

Webappendix A Length of stay in hospital for the birth admission and deaths in the study population, 2010-2011

Characteristics		Total infants n=4127	Length of stay for birth admission Median (IQR) days n=4127	Deaths n=84
Infant				
Indigenous status				
	Indigenous	419 (10.2%)	6 (3-14)	14 (16.7%)
	Non-Indigenous	3708 (89.8%)	6 (4-11)	70 (83.3%)
Prematurity				
	<28wk	135 (3.3%)	93 (64-115)	51 (60.7%)
	28<32wk	301 (7.3%)	33 (22-48)	10 (11.9%)
	32<37wk	3691 (89.4%)	5 (3-9)	23 (27.4%)
	>37	N/A	3 (2-5)	N/A
Child sex				
	Male	2268 (55.0%)	6 (3-11)	48 (57.1%)
	Female	1859 (45.0%)	6 (4-11)	36 (42.9%)
Birth weight				
	Low birth weight (<2500g)	1910 (46.3%)	10 (5-23	73 (86.9%)
	Normal birth weight (≥2500g)	2217 (53.7%)	5 (3-6)	11 (13.1%)
Small for gestational age index				
	SGA (<10th percentile)	324 (7.9%)	10 (5-20)	11 (13.1%)
	AGA (10th-90th percentile)	3,331 (80.7%)	6 (4-11)	55 (65.5%)
	LGA (>90th percentile)	472 (11.4%)	5 (3-7)	11 (13.1%)
	Missing			7 (8.3%)
APGAR 5 score				
	< 7 (abnormal)	205 (5.0%)	13 (5-46)	54 (64.3%)
	≥7 (healthy)	3921 (95.0%)	6 (4-10)	30 (35.7%)
Maternal				
Maternal Age				
	<24 yrs	891 (21.6%)	5 (3-10)	23 (27.4%)
	25+ yrs	3236 (78.4%)	6 (4-11)	61 (72.6%)
Gravidity				
	0	1327 (32.2%)	6 (4-12)	31 (36.9%)
	1	1106 (26.8%)	6 (3-10)	15 (17.9%)
	2	720 (17.5%)	5 (3-10)	16 (19.0%)
	≥3	974 (23.6%)	5 (3-12)	22 (26.2%)
Area				
Socio-economic status				
	Most disadvantaged	407 (11.3%)	6 (3-12)	19 (22.6%)
	Least disadvantaged	3615 (88.7%)	6 (4-11)	64 (76.2%)
	Missing			n.p.
Remoteness				
	Most remote	920 (22.3%)	6 (4-12)	10 (11.9%)
	Least remote	3102 (77.7%)	6 (4-10)	73 (86.6%)
	Missing			n.p.

N/A= not applicable; n.p.= Not publishable due to small numbers and confidentiality restrictions

Webappendix B Hospital utilisation in preterm post discharge from birth hospital to 11 months by socio demographic characteristics, 2010-2011

Characteristics	Number of infant			All cause hospitalisations			All cause emergency department presentations		
	Total n=4127	Indigenous n=419	Non-Indigenous n=3708	Number of infants with at least one hospital admission	Number of Indigenous infants with at least one hospital admission	Number of non-Indigenous infants with at least one hospital admission	Number of infants with at least one emergency department presentation	Number of Indigenous infants with at least one emergency department presentation	Number of non-Indigenous infants with at least one emergency department presentation
				n=3047 (73.8%)	n=316 (75.4%)	n=2731 (73.6%)	n=2214 (53.7%)	n=317 (75.7%)	n=1897 (51.2%)
Infant									
Prematurity									
<28wk	135 (3.3%)	20 (4.8%)	115 (3.1%)	118 (87.4%)	19 (95.0%)	99 (86.1%)	97 (71.9%)	18 (90.0%)	79 (68.7%)
28<32wk	301 (7.3%)	45 (10.7%)	256 (6.9%)	265 (88.0%)	39 (86.7%)	226 (88.3%)	185 (61.5%)	36 (80.0%	149 (58.2%)
32<37wk	3691 (89.4%)	354 (84.5%)	3337 (90.0%)	2664 (72.2%)	258 (72.9%)	2406 (72.1%)	1932 (52.3%)	263 (74.3%)	1669 (50.0%)
Child sex									
Male	2268 (55.0%)	218 (52.0%)	2050 (55.3%)	1696 (74.8%)	163 (74.8%)	1533 (74.8%)	1246 (54.9%)	168 (77.1%)	1078 (52.6%)
Female	1859 (45.0%)	201 (48.0%)	1658 (44.7%)	1351 (72.7%)	153 (76.1%)	1198 (72.3%)	968 (52.1%)	149 (74.1%)	819 (49.4%)
Birth weight									
Low birth weight (<2500g)	1910 (46.3%)	246 (58.7%)	1664 (44.9%)	1677 (87.8%)	220 (89.4%)	1457 (87.6%)	1682 (55.9%)	197 (80.1%)	871 (52.3%)
Normal birth weight (≥2500g)	2217 (53.7%)	173 (41.3%)	2044 (55.1%)	1370 (61.8%)	96 (55.5%)	1274 (62.3%)	1146 (51.7%)	120 (69.4%)	1026 (50.2%)
Small for gestational age index									
SGA (<10th percentile)	324 (7.9%)	46 (11.0%)	278 (7.5%)	289 (89.2)	43 (93.5%)	246 (88.5%)	182 (56.2%)	39 (84.8%)	143 (51.4%)
AGA (10th-90th percentile)	3,331 (80.7%)	331 (79.0%)	3,000 (80.9%)	2459 (73.8%)	244 (73.7%)	2215 (73.8%)	1769 (53.1%)	246 (74.3%)	1523 (50.8%)
LGA (>90th percentile)	472 (11.4%)	42 (10.0%)	430 (11.6%)	299 (63.4%)	29 (69.1%)	270 (62.8%)	263 (55.7%)	32 (76.2%)	231 (53.7%)
APGAR 5 score									
< 7 (abnormal)	205 (5.0%)	25 (6.0%	180 (4.9%)	182 (88.8%)	22 (88.0%)	160 (88.9%)	136 (66.3%)	21 (84.0%)	115 (63.9%)
≥7 (healthy)	3921 (95.0%)	394 (94.0%)	3527 (95.1%)	2864 (73.0%)	294 (74.6%)	2570 (72.9%)	2077 (53.0%)	296 (75.1%)	1781 (50.5%)
Data missing	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Mother									
Maternal Age									
<20 yrs	235 (5.7%)	83 (19.8%)	152 (4.1%)	177 (75.3%)	63 (75.9%)	114 (75.0%)	166 (70.6%)	66 (79.5%)	100 (65.8%)
20-24 yrs	656 (15.9%)	128 (30.6%)	528 (14.2%)	466 (71.0%)	95 (74.2%)	371 (70.3%)	424 (64.6%)	100 (78.1%)	324 (61.4%)
25-29 yrs	1090 (26.4%)	108 (25.8%)	982 (26.5%)	783 (71.8%)	76 (70.4%)	707 (72.0%)	587 (53.8%)	84 (77.8%)	502 (51.1%)
30-34 yrs	1187 (28.8%)	55 (13.1%)	1132 (30.5%)	896 (75.5%)	45 (81.8%)	851 (75.2%)	591 (49.8%)	35 (63.6%)	556 (49.1%)
35+ yrs	959 (23.2%)	45 (10.7%)	914 (24.7%)	725 (75.6%)	37 (82.2%)	688 (75.3%)	447 (46.6%)	32 (71.1%)	415 (45.4%)

Gravidity									
0	1327 (32.2%)	91 (21.7%)	1236 (33.3%)	1005 (75.7%)	75 (82.4%)	930 (75.2%)	677 (51.1%)	77 (84.6%)	601 (48.6%)
1	1106 (26.8%)	87 (20.8%)	1019 (27.5%)	782 (70.7%)	60 (69.0%)	722 (70.8%)	583 (53.0%)	66 (75.9%)	520 (51.0%)
2	720 (17.5%)	63 (15.0%)	657 (17.7%)	536 (74.4%)	42 (66.7%)	494 (75.2%)	388 (53.2%)	49 (77.8%)	334 (50.8%)
≥3	974 (23.6%)	178 (42.5%)	796 (21.5%)	724 (74.3%)	139 (78.1%)	585 (73.5%)	567 (58.2%)	125 (70.2%)	442 (55.5%)
Area									
Socio-economic status									
Most disadvantaged 1	287 (7.0%)	156 (37.2%)	131 (3.5%)	218 (76.0%)	121 (77.6%)	97 (74.1%)	221 (76.7%)	126 (80.8%)	94 (71.8%)
2	633 (15.3%)	55 (13.1%)	578 (15.6%)	462 (73.0%)	44 (80.0%)	418 (72.3%)	333 (52.6%)	37 (67.3%)	296 (51.2%)
3	528 (12.8%)	54 (12.9%)	474 (12.8%)	365 (69.1%)	37 (68.5%)	328 (69.2%)	318 (60.2%)	42 (77.8%)	276 (58.2%)
4	1115 (27.0%)	74 (17.7%)	1041 (28.1%)	813 (72.9%)	54 (73.0 %)	759 (72.3%)	590 (53.0%)	51 (68.9%)	540 (51.9%)
Least disadvantaged 5	1459 (35.4%)	62 (14.8%)	1397 (37.7%)	1109 (76.0%)	47 (75.8%)	1062 (76.0%)	696 (47.7%)	47 (75.8%)	649 (46.5%)
Data missing	105 (2.5%)	18 (4.3%)	87 (2.4%)	80 (76.2%)	13 (72.2%)	67 (77.0%)	56 (53.3%)	14 (77.8%)	42 (48.3%)
Remoteness									
Major city	1767 (42.8%)	82 (19.6%)	1685 (45.4%)	1318 (74.6%)	56 (68.3%)	1262 (74.9%)	854 (48.6%)	54 (65.9%)	804 (47.7%)
Inner regional	1529 (37.1%)	81 (19.3%)	1448 (39.1%)	1117 (73.1%)	67 (82.7%)	1050 (72.5%)	783 (51.1%)	57 (70.4%)	725 (50.1%)
Outer regional	319 (7.7%)	56 (13.4%)	263 (7.1%)	249 (78.1%)	44 (78.6%)	205 (78.0%)	221 (69.9%)	44 (78.6%)	179 (68.1%)
Remote	111 (2.7%)	20 (4.8%)	91 (2.5%)	75 (67.6%)	14 (70.0%)	61 (67.0%)	71 (64.9%)	18 (90.0%)	54 (59.3%)
Very remote	296 (7.2%)	162 (38.7%)	134 (3.6%)	208 (70.2%)	122 (75.3%)	86 (64.2%)	223 (75.3%)	130 (80.3%)	93 (69.4%)
Data missing	105 (2.5%)	18 (4.3%)	87 (2.4%)	80 (76.2%)	13 (72.2%)	67 (77.0%)	56 (53.3%)	14 (77.8%)	42 (48.3%)

n.p. = Not publishable due to small numbers and confidentiality restrictions

Table C. Risk of hospital utilisation in preterm infants during the time period between discharge from the birth hospital to 11 months of age, by length of birth hospital stay, 2010-2011

	Events	Time at risk	(Events/Risk)*1000	Median (IQR)	unadjusted IRR (95% CI)	*p value*	multivariable IRR (95% CI)*	*p value*
				All cause hospitalisations				
Length of stay								
<15 days	3820	1202739	3.18	1 (0-2)	1.00		1.00	
15-28 days	681	142342	4.78	1 (1-2)	1.51 (1.38-1.65)	p<0.001	1.51 (1.38-1.65)	p<0.001
>28 days	723	114443	6.32	1 (1-3)	2.00 (1.83-2.18)	p<0.001	1.99 (1.82-2.18)	p<0.001
				All cause emergency department presentations				
<15 days	4392	1202739	3.65	1 (0-2)	1.00		1.00	
15-28 days	531	142342	3.73	1 (0-2)	1.02 (0.89-1.19)	0.775	1.07 (0.92-1.23)	0.392
>28 days	728	114443	6.36	1 (0-3)	1.77 (1.52-2.05)	p<0.001	1.72 (1.49-1.99)	p<0.001

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Cross-sectional page 5-6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*8-9*
Bias	9	Describe any efforts to address potential sources of bias	7 – multiple births
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	N/A limited missing data
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods	

		taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	N/A
Results			**Page #**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Webappendix A and B
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*N/A*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	*N/A*
		Cross-sectional study—Report numbers of outcome events or summary measures	Table 2; Webappendix B
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Specified under all tables.
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Tabe 3; 4 and webappendix C
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely

available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The effect of socio-economic disadvantage, remoteness, and Indigenous status on hospital utilisation for Western Australian preterm infants under 12 months of age: a population based data linkage study

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The effect of socio-economic disadvantage, remoteness, and Indigenous status on hospital utilisation for Western Australian preterm infants under 12 months of age: a population based data linkage study

Running title: Risk factors for hospital utilisation for preterm infants

Natalie A. Strobel[1], Sue Peter[2], Kimberley E. McAuley[1], Daniel R. McAullay[1,3], Rhonda Marriott[4], Karen M. Edmond[1]

[1]School of Paediatrics and Child Health, University of Western Australia, Perth, Western Australia, Australia

[2]Princess Margaret Hospital for Children, Perth, WA

[3]Kurongkurl Katitjin, Centre for Indigenous Australian Education and Research, Edith Cowan University, Perth, Western Australia, Australia

[4]School of Psychology and Exercise Science, Murdoch University, Perth, Western Australia, Australia

Corresponding author

Natalie A Strobel

School of Paediatrics and Child Health

The University of Western Australia

35 Stirling Highway

Crawley

Western Australia

Australia 6009

E-mail: natalie.strobel@uwa.edu.au

Phone: +61 8 9340 7507

ABSTRACT

Objectives

Our primary objective was to determine the incidence of hospital admission and emergency department presentation in Indigenous and non-Indigenous preterm infants aged post discharge from birth admission to 11 months in Western Australia. Secondary objectives were to assess incidence in the poorest infants from remote areas and to determine the primary causes of hospital utilisation in preterm infants.

Design

Prospective population-based linked dataset.

Setting and participants

All preterm babies born in Western Australia during 2010 and 2011.

Main outcome measures

All-cause hospitalisations and emergency department presentations.

Results

There were 6.9% (4,211/61,254) preterm infants, 13.1% (433/3,311) Indigenous preterm infants and 6.5% (3,778/57,943) non-Indigenous preterm infants born in Western Australia. Indigenous preterm infants had a higher incidence of hospital admission (aIRR 1.24, 95% CI 1.08, 1.42) and emergency department presentation (aIRR 1.71, 95% CI 1.44, 2.02) compared to non-Indigenous preterm infants. The most disadvantaged preterm infants (7.8/1000 person days) had a greater incidence of emergency presentation compared to the most advantaged infants (3.1/1000 person days) (aIRR 1.61, 95%CI 1.30, 2.00). The most remote preterm infants (7.8/1000 person days) had a greater incidence of emergency presentation compared to the least remote preterm infants (3.0/1000 person days) (aIRR 1.82, 95% CI 1.49,2.22).

Conclusions

In Western Australia, preterm infants have high hospital utilisation in their first year of life. Infants living in disadvantaged areas, remote area infants and Indigenous infants are at increased risk. Our data highlights the need for improved post-discharge care for preterm infants.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- To the best of our knowledge, this is the first study to investigate the effect of risk factors on hospital utilisation and the burden of hospital admissions in Indigenous preterm infants under 12 months of age.
- This study uses population based data for all Western Australian preterm infants born 2010-2011 and high quality administrative datasets to determine hospital use for these infants.
- The sample size was sufficient to determine the differences in hospital use between Indigenous preterm infants, socio-economic status and remoteness for preterm infants.
- Environmental factors and maternal education were unable to be assessed.

INTRODUCTION

In 2010, it was estimated globally that 15 million babies, 11.1% of all livebirths worldwide, were born preterm (less than 37 weeks gestation).[1] Preterm infants are at a greater risk of experiencing serious health complications than fullterm infants. Complications include respiratory infections, anaemia, vision and hearing loss, and developmental delay.[1] Infants with complications from prematurity need many more health and social services than full term infants and infants without these complications.[2,3] This places a high economic, health and social burden on families and health systems.[4]

In 2013 8.6% of all babies born in Australia were preterm; most with a gestational age of between 32–36 completed weeks.[5] These data are similar to other developed countries. However, during 2013, 14% of babies born to Australian Aboriginal and Torres Strait Islander (hereafter referred to as Indigenous) mothers were preterm.[5] This high preterm risk has changed little over the last decade.[6] These data are comparable to many of the poorest countries in the world where the most recent data indicate that approximately 12% of babies are born preterm.[7]

Despite the high risks, there has been little focus on understanding hospital utilisation patterns and what follow-up care is needed for high risk preterm Aboriginal infants, especially the poorest infants who live in remote areas. This is particularly important because mothers who carry a higher burden of ill health and social dysfunction have a higher risk of delivering a preterm or low birth weight infant.[8,9] These mothers often have more difficulties accessing the health system and adhering to medication regimens.[8]

Western Australia (WA) has a large de-identified prospective longitudinal population based data system involving the probabilistic systematic record linkage of total population administrative health datasets.[10] Data are available for birth cohorts and include information on maternal and infant characteristics, hospital admission and emergency department presentations including length of stay, cause of hospital admission, Indigenous status and socio-economic status.

Our study was designed to assess differentials in incidence of all-cause hospital admission and emergency department presentation for Indigenous and non-Indigenous preterm infants (born <37 weeks) during their first 12 months of life. Our primary objective was to determine the incidence of hospital admission and emergency department presentation in Indigenous and non-Indigenous infants from time of discharge from birth admission to 11 months (0-11 months). Secondary objectives were to assess incidence in the poorest infants from remote areas and to determine the primary causes of hospital utilisation in preterm infants.

METHODS

Study setting and database access

All live births occurring at <37 weeks gestational age in WA from 1 January 2010 to 31 December 2011 were included in this study. Prospective population based linked data from the WA Midwives' Notification System, Hospital Morbidity Data System, Emergency Department Data Collection, Death Registrations, the Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD)[11] and the Accessibility/ Remoteness Index of Australia (ARIA)[12] were obtained from the Department of Health of Western Australia (DOHWA).

The Midwives' Notification System includes clinical (infant weight, gestational age, Apgar score, multiple birth, gravidity) and socio demographic (baby's gender, mother's age, Indigenous status, socio-economic status, remoteness index) data on all WA live births and stillbirths of more than 20 weeks' gestation or birth weight greater than 400g which are reported by trained midwives within 48 hours of delivery. The Hospital Morbidity Data System and Emergency Department Data Collection include data on all completed hospital admissions and emergency department presentations to all public hospitals in WA. These data are entered by trained medical records staff following the occasion of service. Death Registrations are linked monthly and include date and cause of death. The Australian Bureau of Statistics (ABS) Index of Relative Socio-Economic Disadvantage (IRSD) divides statistical local areas based on the 2006 Australian national census data into quintiles from most deprived (1) to least deprived (5).[11] The Accessibility/ Remoteness Index of Australia (ARIA) was developed by the Department of Health and Aged Care and is maintained by the Australian Institute of Health and Welfare.[12] This index classifies geographic location on the basis of isolation and distance from service centres and health care facilities. ARIA data are split into five categories from least remote (1) (major cities) to most remote (5) (remote area communities).

The databases were systematically linked by DOHWA data linkage staff using probabilistic matching and de-identified. The final database included date of hospital admission, date of emergency department presentation, hospital length of stay, maternal ethnicity, maternal age, gravidity, infant age, infant birth weight, gestational age, infant sex, multiple birth, and infant health status at birth (Apgar score). ISRD quintile, ARIA level and health region from the Midwives Notification System were also included.

Inclusion and exclusion criteria

Infants were classified as Indigenous if the mother was recorded in the Midwives Notification System as Aboriginal and/or Torres Strait Islander.[13] All other infants were classified as non-Indigenous. To avoid clustering within multiple births the population was limited to singleton babies.

Definitions

Specific cut points were used to define preterm; 'extremely preterm' (<28 weeks gestation); 'very preterm' (births between 28 - <32 weeks gestation); and 'moderate preterm' (births between 32 - <37 weeks gestation).[1] The small for gestational age index was calculated as small for gestational age 'SGA' (<10th percentile for weight); appropriate for gestational age 'AGA' (10-90th percentile for weight); large for gestational age 'LGA' (>90th percentile).[14]

We defined the 'person time at risk' as the number of days between discharge from the birth admission to 11 months of chronological age. This excluded the stay in hospital after birth for both well and unwell babies. Hospital admissions were defined as the number of admissions of infants to a WA hospital ward for care during the period between discharge from the birth admission to 11 months. Between hospital transfers were included as one admission. Emergency department presentations were defined as the number of presentations of infants to a WA hospital emergency department (regardless of whether the child was admitted) during the period between discharge from the birth admission to 11 months. The frequency of emergency department presentations was defined as the count of presentations to any emergency department regardless of whether the child was admitted to hospital. 'Low socio-economic status' was defined as the two lowest IRSD quintiles (IRSD 1-2). 'Remote residence' was defined as the two most remote ARIA categories (ARIA 4-5).

Primary cause of hospitalisation and emergency department presentations were classified using the International Classification of Disease Version 10 (ICD-10) classification system by medical record staff. Each admission only received one diagnostic code.[15] All hospital admissions were classified with a primary cause of hospitalisation but secondary diagnoses or comorbidity data were not available. No data on cause of emergency department presentation were available. Causes of hospitalisation were defined according to the AIHW,[16] and adapted for use with infants.[17] Diseases were categorised as the respiratory system, digestive system, skin and subcutaneous tissue, ear and mastoid process, infectious and parasitic diseases, nutritional diseases, and injury and poisoning, perinatal conditions (e.g. prematurity, hypoxic-ischaemic encephalopathy), congenital malformations, chromosomal abnormalities and all other conditions.

Sample size and data analysis

Our primary outcome measure was the incidence of hospital admissions between discharge from the birth admission to 11 months of chronological age in Indigenous and non-Indigenous preterm infants from 2010-2011.

Incidence of hospital utilisation was calculated as the number of events (hospital admissions or emergency presentations) between discharge from birth admission to 11 months of chronological age divided by the total days at risk between discharge from the birth admission to 11 months. All incidence rates were expressed as 1000 person days. We also calculated median and interquartile range (IQR, 25th to 75th percentile) estimates.

Analyses were completed using multi-level generalised estimating equation modelling clustering for geographical location. Crude incident rate ratios (IRR), adjusted incident rate ratios (aIRR) and 95% confidence intervals (95% CI) were calculated using negative

binomial regression analysis with an exchangeable correlation structure to assess the association between hospital admissions and emergency presentations for preterm infants and Indigenous status, socio-economic status and remoteness.[18,19] Potential confounders were included in the models *a priori* to adjust for the effect of important explanatory variables. We identified factors that are known to be associated with both the exposure and the outcome and were not a causal step in the pathway. We only included variables from the Midwives' Notification System: maternal characteristics (maternal age, gravidity), infant factors (gender of child, birth weight), Indigenous status, and socio-economic status (ISRD). Data analyses were conducted using STATA 13.1 (StataCorp, USA).

We calculated that our study population of 4,211 infants would provide 90% power to detect at least a 10% difference in hospital admission incidence between Indigenous and non-Indigenous infants. We assumed a 5% significance level, a hospital admission incidence of 5.0 per 1000 person days and that the ratio between Indigenous to non-Indigenous infants would be approximately 1:9.

Ethics

Approvals were obtained from the WA Department of Health Human Research Ethics Committee, the University of Western Australia Human Research Ethics Committee, and the Western Australian Aboriginal Health Ethics Committee (WAAHEC).

RESULTS

During 2010-2011 in WA there were 62,965 live births, 98.3% (61,254) were singletons and 6.9% (4,211) of these infants were preterm. Of these, 2.0% (84/4211) preterm infants died in

the first year of life (Webappendix A). 13.1% (433/3,311) of the preterm infants were classified as Indigenous and 6.5% (3,778/57,943) were classified as non-Indigenous (Table 1). 37.2% (161) of preterm Indigenous infants were classified in the most disadvantaged quintile compared to 3.5% (132) non-Indigenous infants. 38.6% (167) of preterm Indigenous infants lived in the most remote area (ARIA 5) compared to 3.6% (134) of non-Indigenous infants (Table 1).

The median (IQR) length of stay during the birth admission was 75 days (IQR 4-107) for infants with gestational age < 28 weeks; 33 days (IQR 21-48) for infants with gestational age 28 to <32 weeks and 5 days (IQR 3-8) for infants with gestational age 32 to <37 weeks. Webappendix A provides further detail of the length of hospital stay in birth hospital.

Overall, there were a total 5,284 hospital admissions in 3,102 preterm infants and 5,657 emergency presentations in 2,220 preterm infants during the period between discharge from birth admission to 11 months of chronological age. Of hospital admissions 2,233 (42.3%) were elective admissions, 3,007 (56.9%) were emergency related admissions and the remaining 44 (0.8%) were unknown. 73.7% (3,102) of preterm infants had at least one hospital admission and 52.7% (2,220) of infants had at least one emergency department presentation between discharge from birth admission to 11 months (Webappendix B).

Indigenous preterm infants had a higher incidence of emergency department presentation (aIRR 1.71, 95% CI 1.44, 2.02) and hospital admission (aIRR 1.24, 95% CI 1.08, 1.42) compared to non-Indigenous preterm infants even after adjusting for confounding factors (Table 2). Preterm infants with gestational age under 32 weeks had a greater incidence of hospital admission (5.9/1000 person days) compared to infants with a gestational age 32-37

weeks (3.3/1000 person days) (aIRR 1.79, 95% CI 1.67, 1.93) (Table 2). There was also an increased incidence of emergency department presentations for infants with a gestational age under 32 weeks (aIRR 1.40, 95% CI 1.27, 1.54). Length of stay for birth admissions over 28 days were significantly associated with subsequent hospital admissions (aIRR 1.98, 95% CI 1.81, 2.17) and emergency department presentations (aIRR 1.66, 95% CI 1.48-1.86) compared to stays less than 14 days (Webappendix C). There were no marked effects of other socio demographic characteristics on hospital utilisation in preterm infants (Table 2).

Preterm infants living in the most disadvantaged areas had an increased incidence of presenting to emergency department (7.8/1000 person days) compared to the most advantaged (ISRD 5) preterm infants (3.1/1000 person days) (aIRR 1.61, 95%CI 1.30, 2.00) (Table 2). There also appeared to be some evidence of a dose response with increased incidence of emergency department presentation with increased levels of disadvantage for Indigenous infants (p value for trend = 0.004) (Table 3) but not for infants overall (p value for trend = 0.615) and for non-Indigenous preterm infants (p value for trend = 0.178 (Table 2 and 3). Preterm infants living in the most disadvantaged areas had higher but not significant incidence of hospital admissions (4.5/1000 person days) compared to the most advantaged infants (3.4/1000 person days) (aIRR 1.11, 95%CI 0.95, 1.30). There was no obvious trend (p value for trend = 0.800) (Table 2 and 3).

There was an increased incidence of emergency department presentation for the most remote preterm infants (7.8/1000 person days) compared to non-remote preterm infants (3.0/1000 person days) (aIRR 1.82, 95% CI 1.49, 2.22) (Table 2). There was also some evidence of a dose response for increased incidence of emergency department presentation with increased levels of remoteness overall (p value for trend = <0.001) (Table 2) and for

Indigenous (p value for trend = <0.001) and non-Indigenous (p value for trend = <0.001) preterm infants (Table 3). Remote area preterm infants had a higher but not significant incidence of hospitalisation (4.1/1000 person days) compared to the least remote preterm infants (3.3/1000 person days) (aIRR 1.09, 95% CI 0.92, 1.29) (Table 2). There was also some evidence of a dose response with increased risk of hospital admission with increased levels of remoteness for Indigenous preterm infants (p value for trend = 0.043), however there was no trend for non-Indigenous preterm infants (p value for trend = 0.252) and overall (p value for trend = 0.058) preterm infants (Table 2 and 3).

Overall, the distribution of causes were similar in Indigenous and non-Indigenous infants (Table 4). Indigenous infants appeared more likely to be hospitalised for respiratory disease (1.6/1000 person days) than non-Indigenous infants (0.5/1000 person days) (Table 4). Indigenous infants appeared more likely to be hospitalised for infectious and parasitic diseases (0.4/1000 person days) than non-Indigenous infants (0.2/1000 person days) (Table 4). However, numbers were too small to perform statistical tests.

COMMENTS

In our WA population based study, 53% of preterm infants presented to a hospital emergency department and 74% were admitted in the time between discharge from birth admission to11 months of chronological age. Incidence of hospital admission and emergency department presentation was 1.2-1.7 fold greater in Indigenous compared to non-Indigenous infants. Preterm infants located in the poorest and most remote areas of WA had significantly greater hospital utilisation compared to preterm infants living in less poor and urban areas.

In the past 10 years there have been a number of studies showing that preterm infants are at greater risk of hospital admissions and emergency presentations than term infants.[2,20] Despite this, few have investigated whether preterm infants from vulnerable families have an increased risk of hospital utilisation compared to the general population. Hispanic and African American preterm infants have been reported to have a greater risk of hospital admission and emergency presentation compared to white preterm infants.[20] Bar-Zeev et al reported that 60% of Indigenous preterm infants were readmitted to hospital in the Top End of the Northern Territory of Australia in the first year of life compared to only 44% of Indigenous term infants.[21] However, there have been no published reports of the differences in hospital utilisation between Australian Indigenous and non-Indigenous preterm infants in the last 10 years.

Population based studies in infants of all gestational ages have shown increased risk of hospital admissions,[22,23] length of stay,[23] and emergency presentations[24] in socially disadvantaged infants compared to the least disadvantaged. We reported that the most disadvantaged preterm infants had a 60% greater incidence of emergency department presentations compared to infants from the most advantaged areas. Although preterm infants are more likely to be born to families who are socially disadvantaged,[8] we located no other studies that examined how socio-economic status may influence subsequent hospital use in preterm infants. Preterm infants living in remote areas in our study had a 1.1-1.8 fold greater risk of presenting to the emergency department and hospital admission compared to the least remote infants. Population based studies have reported that infants located in remote areas have an increased risk of readmission [22] and emergency department presentation[24] in the first six weeks after birth. However, we were unable to locate other studies that examined the effect of geographic location on hospital use in preterm infants.

We also showed that length of stay for the birth admission was significantly associated with subsequent hospital admissions and emergency department presentations. Length of hospital stay can be seen as a proxy for the health status and 'unwellness' of the child during the hospital admission. It has been shown in many studies to have a clear influence on subsequent hospital utilisation.[25,26]

Over the last 10 years there has been significant Australian Federal Government funding to improve access to urban, rural and remote paediatric services including building hospitals, clinics and Aboriginal Community Controlled Health Services (ACCHS).[27,28] There has also been an increase in staffing levels of all health care providers in rural and remote areas and major investments in specialist outreach services and care coordination. In WA, there is free antenatal care and culturally appropriate midwifery and post-discharge care for disadvantaged mothers and infants, home visits within 72 hours of discharge,[29] regular medical and developmental follow-up of all preterm infants,[30] and universal and targeted surveillance and screening programs.[29,31] It is highly likely that these initiatives have improved health status and subsequent morbidity and mortality risks. However our study shows that important inequities remain in service use in remote areas, in poor families and in Indigenous families.

The most common causes of hospitalisation were respiratory, and infectious and parasitic diseases in Indigenous and non-Indigenous preterm infants. Respiratory disease has previously been cited as the most common cause for hospital admissions for Indigenous infants up 12 months in the Northern Territory[21] and WA.[24] For all preterm infants under 12 months of age, respiratory and infectious conditions have repeatedly been shown to be the main cause of admission.[26,32] Many of these conditions are preventable by improving

coverage of routine childhood vaccines such as pneumococcal and rotavirus vaccines and also through improving housing and education levels in families. Cause of emergency presentations was not assessed in this study due to no data being available, however existing evidence suggests that many emergency presentations may also be the result of potentially avoidable conditions.[17,33] Our data indicate that more can be done to improve health services and reduce hospital use in preterm infants in WA. We are also aware that the underlying socio-economic determinants of health such as education and employment are also important determinants of health service use and many improvements are needed in these areas.

Our study had some limitations. Our study was observational and could only report associations and did not provide proof of causality. Indigenous status can be missing or misclassified which may result in an under-estimation of risk.[34,35] Despite this, our results show a highly significant effect of Indigenous status on hospital utilisation and it is unlikely that any misclassification would have biased the results. Where available we adjusted for all potential confounding factors. However, we were unable to adjust for measures of maternal illness or education or any underlying social conditions (e.g. housing and infrastructure) that may have played a role in hospital utilisation, particularly preventable causes of hospital use.[36] Within Australia socio-economic data are primarily based on AIHW IRSD quintiles which can cause misclassification when applied at an individual level.[11] However, we did show strong associations between hospital utilisation and socioeconomic status and any differential misclassification would have biased towards the null. Small sample size for Indigenous pre-term infants in some of the sub-analyses could have resulted in a type II error as a result of reduced power to detect true differences. We did not have the mode of separation variable in our data therefore we are unable to determine whether a baby was discharged home or transferred to another hospital following the length of stay at the birth

hospital. However, our length of stay data are similar to previously reported data from New South Wales (Australia) which were published earlier in 2016 (Median length of stay for infants < 28 weeks gestation 87 (IQR 31) and median length of stay for infants 28-23 weeks gestation 47 (IQR 23).[26]

There are strengths related to the data collections we used. The cause specific hospitalisation data were limited to primary cause of hospitalisation. These data are considered to be highly accurate,[10,37] because the Hospital Morbidity Data System uses the World Health Organisation ICD 10 coding system[15] and highly trained coders. The Midwives' Notification System uses clear definitions that are based on Australian standard definitions[5] and is reported to have a very high level of completion and clinical certainty. [38,39] Our emergency department presentations were also recorded in a clearly defined patient administration system ('EDIS').[40,41] This system is considered by Emergency Department staff to be highly reliable though formal documentation of its accuracy is not available. In contrast, the accuracy of cause specific emergency department data has been questioned,[33] which is why we did not include cause specific emergency department data in this study. Lastly, we controlled for confounding effects of multiple births by restricting the analysis to singleton births.

Our study has implications for policy and program development. Despite investments in maternal and child health services we reported that preterm infants had high hospital utilisation rates and that important risk groups were infants living in disadvantaged areas, remote area infants and Indigenous infants. Our data highlight the need for improved post-discharge care of preterm infants, particularly in remote regions and for poor, Indigenous infants. This includes preventive programs focused on improving skills of families and

service providers in caring for small infants and care coordination programs. The WA government has provided recent funding to improve post-discharge care and care coordination for Indigenous children across WA. These interventions have the potential to improve hospital utilisation and long term health outcomes of these vulnerable infants and reduce long term burden on families. We will continue to monitor impacts and will report trends in subsequent papers.

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Contributorship statement

Conceived and designed the experiments: SP KE DM RM. Performed the experiments: NS KM. Analysed the data: NS KM KE. Contributed reagents/materials/analysis tools: NS. Wrote the paper: NS SP KM DM RM KE.

Competing interests

The authors have no competing interests to declare.

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Data sharing statement

Data are available from the Western Australia Department of Health Data Linkage Branch with ethical approval through the Western Australia Department of Health Human Research Ethics Committee (Ref 2013/33). To maintain confidentiality and security, interested individuals may apply for access to linked data by contacting the Western Australian Data

Linkage Branch. Contact details are DataServices@health.wa.gov.au; +61-8-9222 2370.

The computing code is available on request from the corresponding author.

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Table 1 Socio demographic characteristics in the study population, 2010-2011

Characteristics	Total number of infants	Number of Indigenous infants	Number of non-Indigenous infants	OR 95% CI	P value
	n = 4211	n = 433	n = 3778		
Infant					
Prematurity					
<28wk	186 (4.4%)	28 (6.5%)	158 (4.2%)	1.58 (1.05-2.40)	0.030
28<32wk	311 (7.4%)	45 (10.4%)	266 (7.0%)	1.53 (1.10-2.14)	0.012
32<37wk	3714 (88.2%)	360 (83.1%)	3354 (88.8%)	0.62 (0.48-0.82)	0.001
Child sex					
Male	2316 (55.0%)	226 (52.2%)	2090 (55.3%)	0.88 (0.72-1.08)	0.216
Female	1895 (45.0%)	207 (47.8%)	1688 (44.7%)	1.13 (0.93-1.38)	0.216
Birth weight					
Low birth weight (<2500g)	1983 (47.1%)	258 (59.6%)	1725 (45.7%)	0.57 (0.47-0.70)	<0.001
Normal birth weight (≥2500g)	2228 (52.9%)	175 (40.4%)	2053 (54.3%)	1.75 (1.43-2.15)	<0.001
Small for gestational age index					
SGA (<10th percentile)	335 (8.0%)	48 (11.1%)	287 (7.6%)	1.52 (1.10-2.10)	0.011
AGA (10th-90th percentile)	3386 (80.4%)	341 (78.8%)	3045 (80.6%)	0.91 (0.71-1.16)	0.431
LGA (>90th percentile)	483 (11.5%)	42 (9.7%)	441 (11.7%)	0.82 (0.58-1.14)	0.231
Data missing	n.p.	n.p.	n.p.		
APGAR 5 score					
< 7 (abnormal)	259 (6.2%)	31 (5.1%)	228 (6.0%)	1.20 (0.81-1.76)	0.369
≥7 (healthy)	3951 (93.8%)	402 (94.9%)	3549 (93.9%)	0.83 (0.56-1.23)	0.357
Data missing	n.p.	n.p.	n.p.		
Maternal					
Maternal Age					
<20 yrs	243 (5.8%)	87 (18.4%)	156 (4.1%)	5.84 (4.39-7.76)	<0.001
20-24 yrs	671 (15.9%)	135 (31.6%)	536 (14.2%)	2.74 (2.19-3.42)	<0.001
25-29 yrs	1115 (26.5%)	109 (27.3%)	1006 (26.6%)	0.93 (0.74-1.17)	0.516
30-34 yrs	1207 (28.7%)	57 (12.9%)	1150 (30.4%)	0.35 (0.26-0.46)	<0.001
35+ yrs	975 (23.2%)	45 (9.8%)	930 (24.6%)	0.36 (0.26-0.49)	<0.001
Gravidity					
0	1358 (32.2%)	95 (21.9%)	1263 (33.4%)	0.56 (0.44-0.71)	<0.001
1	1121 (26.6%)	90 (20.8%)	1031 (27.3%)	0.70 (0.55-0.89)	<0.001
2	736 (17.5%)	65 (15.0%)	671 (17.8%)	0.82 (0.62-1.08)	0.154
≥3	996 (23.7%)	183 (42.3%)	813 (21.5%)	2.67 (2.17-3.28)	<0.001
Area					
Socio-economic status					
Most disadvantaged 1	293 (7.0%)	161 (37.2%)	132 (3.5%)	17.09 (13.13-22.22)	<0.001
2	646 (15.3%)	58 (13.4%)	588 (15.6%)	0.86 (0.64-1.15)	0.299
3	537 (12.8%)	56 (12.9%)	481 (12.7%)	1.04 (0.77-1.40)	0.793
4	1143 (27.1%)	75 (17.3%)	1068 (28.3%)	0.54 (0.42 -0.70)	<0.001
Least disadvantaged 5	1486 (35.3%)	65 (15.0%)	1421 (37.6%)	0.30 (0.23-0.39)	<0.001
Data missing	106 (2.5%)	18 (4.2%)	88 (2.3%)		
Geographic location (ARIA)					
Major city	1802 (42.8%)	84 (19.4%)	1718 (45.5%)	0.29 (0.23-0.37)	<0.001
Inner regional	1559 (37.0%)	82 (18.9%)	1477 (39.1%)	0.37 (0.29-0.47)	<0.001
Outer regional	327 (7.8%)	58 (13.4%)	269 (7.1%)	2.07 (1.52-2.80)	<0.001
Remote	116 (2.8%)	24 (5.5%)	92 (2.4%)	2.40 (1.51-3.81)	<0.001
Very remote	301 (7.1%)	167 (38.6%)	134 (3.6%)	17.87 (13.76-23.20)	<0.001
Data missing	106 (2.5%)	18 (4.2%)	88 (2.3%)		

n.p. – Not publishable due to small numbers and confidentiality restrictions

Table 2: Rate of hospital utilisation in preterm infants post discharge from birth admission to 11 months by socio demographic characteristics, 2010-2011

Characteristics	Events	Time at risk	All cause hospitalisations post discharge from birth admission to 11 months (Events/Risk)*1000	unadjusted IRR (95% CI)	*p value*	multivariable IRR (95% CI)*	*p value*
Infant							
Indigenous status							
Indigenous	745	152285	4.89	1.44 (1.28-1.62)	<0.001	1.24 (1.08-1.42)	0.002
Non-Indigenous	4539	1335534	3.40	1.00		1.00	
Prematurity**							
<28wk	340	54951	6.19	1.95 (1.74-2.19)	<0.001	1.91 (1.70-2.13)	<0.001
28<32wk	598	103070	5.80	1.76 (1.61-1.93)	<0.001	1.73 (1.59-1.88)	<0.001
32<37wk	4346	1329798	3.27	1.00		1.00	
Child sex							
Male	3036	818577	3.71	1.10 (1.04-1.17)	0.002	1.16 (1.09-1.24)	<0.001
Female	2248	669242	3.36	1.00		1.00	
Birth weight							
Low birth weight (<2500g)	3212	685424	4.69	1.84 (1.72-1.96)	<0.001	1.83 (1.72-1.96)	<0.001
Normal birth weight (≥2500g)	2072	802395	2.58	1.00		1.00	
SGA index							
SGA (<10th percentile)	576	116067	4.96	1.42 (1.26-1.59)	<0.001	1.41 (1.26-1.58)	<0.001
AGA (10th-90th percentile)	4226	1196920	3.53	1.00		1.00	
LGA (>90th percentile)	482	172420	2.80	0.79 (0.72-0.86)	<0.001	0.78 (1.26-1.58)	<0.001
APGAR 5 score							
< 7 (abnormal)	396	87068	4.55	1.33 (1.18-1.50)	<0.001	0.94 (0.83-1.06)	0.322
≥7 (healthy)	4885	1400390	3.49	1.00		1.00	
Maternal							
Maternal Age							
<20 yrs	372	86080	4.32	1.22(1.06-1.42)	0.007	1.15 (0.99-1.34)	0.060
20-24 yrs	853	237825	3.59	1.02 (0.93-1.13)	0.664	0.98 (0.88-1.08)	0.633
25-29 yrs	1378	393858	3.50	1.00		1.00	
30-34 yrs	1459	427127	3.42	0.98 (0.90-1.07)	0.704	1.00 (0.92-1.09)	0.987
35+ yrs	1222	342931	3.56	1.03 (0.95-1.12)	0.444	0.99(0.91-1.08)	0.865
Gravidity							
0	1658	479189	3.46	0.98 (0.90-1.06)	0.572	0.89 (0.82-0.97)	0.009
1	1323	396837	3.33	0.94 (0.86-1.03)	0.186	0.91 (0.83-0.99)	0.039
2	924	261034	3.54	1.00		1.00	
≥3	1379	350759	3.93	1.12 (1.01-1.24)	0.033	1.02 (0.92-1.12)	0.770
Area							
Socio-economic status							
Most disadvantaged 1	467	103279	4.52	1.34 (1.12-1.59)	0.001	1.11 (0.95-1.30)	0.183
2	793	227854	3.48	1.04 (0.92-1.16)	0.553	0.98 (0.86-1.11)	0.742
3	665	190211	3.50	1.03 (0.91-1.17)	0.597	0.98 (0.89-1.08)	0.679
4	1444	404092	3.57	1.06 (0.95-1.17)	0.287	1.02 (0.93-1.13)	0.619
Least disadvantaged 5	1776	525038	3.38	1.00		1.00	
Remoteness							
Major city	2089	635695	3.29	1.00		1.00	

Inner regional	1982	552517	3.59	1.09 (1.02-1.17)	0.012	1.07 (1.01-1.14)	0.017
Outer regional	507	115243	4.40	1.34 (1.18-1.52)	<0.001	1.24 (1.09-1.41)	0.001
Remote	128	40877	3.13	0.95 (0.80-1.13)	0.569	0.95 (0.81-1.13)	0.574
Very remote	439	106142	4.14	1.27 (1.05-1.54)	0.014	1.09 (0.92-1.29)	0.330
	All cause emergency department presentations post discharge from birth admission to 11 months						
	Events	**Time at risk**	**(Events/Risk)*1000**	**unadjusted IRR (95% CI)**	***p value***	**multivariable IRR (95% CI)***	***p value***
Infant							
Indigenous status							
Indigenous	1257	152285	8.25	2.20 (1.94-2.49)	<0.001	1.71 (1.44-2.02)	<0.001
Non-Indigenous	4400	1335534	3.29	1.00		1.00	
Prematurity**							
<28wk	295	54951	5.37	1.47 (1.23-1.76)	<0.001	1.48 (1.25-1.76)	<0.001
28<32wk	526	103070	5.10	1.36 (1.21-1.52)	<0.001	1.36 (.21-1.53)	<0.001
32<37wk	4836	1329798	3.64	1.00		1.00	
Child sex							
Male	3327	818577	4.06	1.16 (1.09-1.25)	<0.001	1.20 (1.11-1.29)	<0.001
Female	2330	669242	3.48	1.00		1.00	
Birth weight							
Low birth weight (<2500g)	2821	685423	4.12	1.18 (1.09-1.27)	<0.001	1.16 (1.06-1.26)	0.001
Normal birth weight (≥2500g)	2836	802395	3.53	1.00		1.00	
SGA index							
SGA (<10th percentile)	523	116067	4.51	1.19 (1.03-1.39)	0.020	1.19 (1.02-1.38)	0.024
AGA (10th-90th percentile)	4491	1196920	3.75	1.00		1.00	
LGA (>90th percentile)	643	172419	3.73	0.95 (0.82-1.09)	0.426	0.97 (0.84-1.12)	0.698
APGAR 5 score							
< 7 (abnormal)	343	87067	3.94	1.05 (0.90-1.23)	0.541	0.92 (0.78-1.08)	0.295
≥7 (healthy)	5312	1400390	3.79	1.00		1.00	
Maternal							
Maternal Age							
<20 yrs	538	86080	6.25	1.53 (1.29-1.81)	<0.001	1.51 (1.22-1.87)	<0.001
20-24 yrs	1309	237825	5.50	1.39 (1.23-1.56)	<0.001	1.37 (1.20-1.56)	<0.001
25-29 yrs	1462	393858	3.71	1.00		1.00	
30-34 yrs	1360	427127	3.18	0.90 (0.81-1.00)	0.060	0.92 (0.81-1.05)	0.231
35+ yrs	988	342931	2.88	0.82 (0.73-0.92)	0.001	0.80 (0.70-0.91)	0.001
Gravidity							
0	1620	479189	3.38	0.91 (0.79-1.04)	0.153	0.82 (0.70-0.95)	0.010
1	1437	396836	3.62	0.97 (0.84-1.11)	0.642	0.92 (0.78-1.07)	0.278
2	990	261034	3.79	1.00		1.00	
≥3	1610	350759	4.59	1.16 (1.00-1.35)	0.047	1.14 (0.98-1.33)	0.089
Area							
Socio-economic status							
Most disadvantaged 1	809	103279	7.83	2.46 (1.93-3.14)	<0.001	1.61 (1.30-2.00)	<0.001
2	796	227854	3.49	1.17 (0.92-1.49)	0.199	1.04 (0.86-1.25)	0.679

3	838	190211	4.41	1.39 (1.06-1.80)	0.016	1.25 (1.03-1.51)	0.023
4	1464	404092	3.62	1.14 (0.89-1.47)	0.302	1.09 (-0.89-1.34)	0.402
Least disadvantaged 5	1603	525038	3.05	1.00		1.00	
Remoteness							
Major city	1881	635695	2.96	1.00		1.00	
Inner regional	1976	552517	3.58	1.26 (1.06-1.49)	0.008	1.11 (0.97-1.27)	0.137
Outer regional	624	115243	5.41	1.82 (1.48-2.24)	<0.001	1.48 (1.26-1.75)	<0.001
Remote	202	40877	4.94	1.70 (1.27-2.26)	<0.001	1.39 (1.06-1.84)	0.018
Very remote	827	106142	7.79	2.72 (2.20-3.37)	<0.001	1.82 (1.49-2.22)	<0.001

** Adjusted for Indigenous status, IRSD (Index of Relative Socio-Economic Disadvantage), maternal age, gravidity, gender of child, birth weight
**Prematurity was not adjusted for birth weight due to collinearity

Table 3: Effect of socio-economic quintile and geographic location on hospital utilisation in Indigenous and non-Indigenous preterm infants post discharge from birth admission to 11 months, 2010-2011

	Indigenous				Non Indigenous			
	Events	Time at risk	(Events/Risk)* 1000	aIRR* (95% CI)	Events	Time at risk	(Events/Risk)* 1000	aIRR* (95% CI)
Hospital admissions								
Socio-economic status								
Most disadvantaged 1	300	56795	5.28	1.29 (0.93-1.80)	167	46484	3.59	1.04 (0.85-1.28)
2	98	20178	4.86	1.08 (0.74-1.58)	695	207676	3.35	0.97 (0.84-1.12)
3	88	19685	4.47	0.92 (0.61-1.38)	577	170526	3.38	0.99 (0.91-1.09)
4	130	26672	4.87	1.12 (0.68-1.84)	1314	377420	3.48	1.01 (0.94-1.09)
Least disadvantaged 5	97	22800	4.25	1.00	1679	502239	3.34	1.00
				P value trend 0.654				P value trend 0.835
Geographic location								
Most remote	331	66865	4.95	1.51 (1.10-2.06)	236	80154	2.94	0.95 (0.82-.10)
Outer regional	117	20521	5.70	1.56 (1.02-2.39)	390	94722	4.12	1.23 (1.10-1.37)
Inner regional	159	28882	5.51	1.58 (1.14-2.21)	1823	523635	3.48	1.05 (0.98-1.12)
Major city	106	29861	3.55	1.00	1983	605834	3.27	1.00
				P value trend 0.043				P value trend 0.252
Emergency presentations								
Socio-economic status								
Most disadvantaged 1	544	56795	9.58	1.03 (0.74-1.41)	265	46484	5.70	1.79 (1.51-2.12)
2	108	20178	5.35	0.57 (0.40-0.81)	688	207676	3.31	1.12 (0.94-1.33)
3	159	19685	8.08	0.87 (0.62-1.22)	679	170526	3.98	1.30 (1.10-1.55)
4	167	26672	6.26	0.63 (0.43-0.94)	1297	377420	3.44	1.14 (0.95-1.38)
Least disadvantaged 5	207	22800	9.08	1.00	1396	502239	2.78	1.00
				P value trend 0.004				P value trend 0.178
Geographic location								
Most remote	641	66865	9.59	1.92 (1.53-2.40)	388	80154	4.84	1.61 (1.31-1.99)
Outer regional	178	20521	8.67	1.65 (1.31-2.09)	446	94722	4.71	1.48 (1.23-1.78)
Inner regional	206	28882	7.13	1.38 (1.02-1.86)	1770	523635	3.38	1.08 (0.94-1.23)
Major city	160	29861	5.36	1.00	1721	605834	2.84	1.00
				P value trend <0.001				P value trend <0.001

IRR = incidence rate ratio, aIRR = adjusted incidence rate ratio, 95% CI = 95% confidence interval
* Adjusted for maternal age, gravidity, sex of child, birth weight

Table 4 ICD 10 classification of primary cause of hospital admissions in preterm infants post discharge from birth admission to 11 months by Indigenous status, 2010-2011

Primary cause of hospital admission	Total			Indigenous			Non-Indigenous		
	Events	Time at risk	(Events/Risk)*1000 (95% CI)	Events	Time at risk	(Events/Risk)*1000 (95% CI)	Events	Time at risk	(Events/Risk)*1000 (95% CI)
Respiratory system	620	1091028	0.57 (0.53-0.65)	178	113466	1.57 (1.27-2.00)	442	977562	0.45 (0.42-0.52)
Infectious and parasitic diseases	188	1091028	0.17 (0.14-0.20)	45	113466	0.40 (0.26-0.56)	143	977562	0.15 (0.12-0.17)
Digestive system	212	1091028	0.19 (0.17-0.24)	23	113466	0.20 (0.13-0.33)	189	977562	0.19 (0.17-0.24)
Skin and subcutaneous tissue	36	1091028	0.03 (0.02-0.05)	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Ear and mastoid process	39	1091028	0.04 (0.03-0.05)	12	113466	0.11 (0.05-0.18)	27	977562	0.03 (0.02-0.04)
Nutritional diseases	15	1091028	0.01 (0.01-0.02)	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Injury and poisoning	57	1091028	0.05 (0.04-0.07)	12	113466	0.11 (0.04-0.16)	45	977562	0.05 (0.03-0.06)
Perinatal conditions	3354	1091028	3.07 (3.02-3.14)	358	113466	3.16 (2.95-3.40)	2996	977562	3.06 (3.01-3.14)
Congenital malformations, deformations and chromosomal abnormalities	169	1091028	0.15 (0.13-0.18)	11	113466	0.10 (0.03-0.16)	158	977562	0.16 (0.13-0.19)
Other	594	1091028	0.54 (0.49-0.62)	101	113466	0.89 (0.53-1.26)	493	977562	0.50 (0.46-0.58)
Total admissions	5284	1091028	4.84 (4.78-5.04)	745	113466	6.57 (6.05-7.36)	4539	977562	4.64 (4.58-4.82)

n.p. = Not publishable due to small numbers and confidentiality restrictions

SUPPORTING INFORMATION

Tables provided – Webappendix A-C

Webappendix A Length of stay in hospital for the birth admission and deaths in the study population, 2010-2011

Characteristics		Total infants n=4211	Length of stay for birth admission Median (IQR) days n=4211	Deaths n=84
Infant				
Indigenous status				
	Indigenous	433 (10.3%)	6 (3-13)	14 (3.2%)
	Non-Indigenous	3778 (89.7%)	6 (4-10)	70 (1.9%)
Prematurity				
	<28wk	186 (4.4%)	75 (4-107)	51 (27.4%)
	28<32wk	311 (7.4%)	33 (21-48)	10 (3.2%)
	32<37wk	3714 (88.2%)	5 (3-8)	23 (0.6%)
	>37	N/A	3 (2-5)	N/A
Child sex				
	Male	2316 (55.0%)	6 (3-11)	48 (2.1%)
	Female	1895 (45.0%)	6 (4-11)	36 (1.9%)
Birth weight				
	Low birth weight (<2500g)	1983 (47.1%)	10 (5-22)	73 (3.7%)
	Normal birth weight (≥2500g)	2228 (52.9%)	5 (3-6)	11 (0.5%)
Small for gestational age index				
	SGA (<10th percentile)	335 (8.0%)	10 (5-20)	11 (3.3%)
	AGA (10th-90th percentile)	3386 (80.4%)	6 (4-11)	55 (1.6%)
	LGA (>90th percentile)	483 (11.5%)	5 (3-7)	11 (2.3%)
	Missing	n.p.		n.p.
APGAR 5 score				
	< 7 (abnormal)	259 (6.2%)	8 (1-34)	54 (64.3%)
	≥7 (healthy)	3951 (93.8%)	6 (4-10)	30 (35.7%)
Maternal				
Maternal Age				
	<24 yrs	914 (21.7%)	5 (3-10)	23 (2.5%)
	25+ yrs	3297 (78.3%)	6 (4-11)	61 (1.9%)
Gravidity				
	0	1358 (32.2%)	6 (4-12)	31 (2.3%)
	1	1121 (26.6%)	6 (3-10)	15 (1.3%)
	2	736 (17.5%)	5 (3-10)	16 (2.2%)
	≥3	996 (23.7%)	5 (3-12)	22 (2.2%)
Area				
Socio-economic status				
	Most disadvantaged	939 (22.3%)	6 (4-12)	19 (2.0%)
	Least disadvantaged	3166 (75.2%)	6 (3-10)	64 (2.0%)
	Missing	106 (2.5%)		n.p.
Remoteness				
	Most remote	417 (9.9%)	6 (3-12)	10 (2.4%)
	Least remote	3688 (87.6%)	6 (4-11)	73 (2.0%)
	Missing	106 (2.5%)		n.p.

N/A= not applicable; n.p.= Not publishable due to small numbers and confidentiality restrictions

Webappendix B Hospital utilisation in preterm post discharge from birth admission to 11 months by socio demographic characteristics, 2010-2011

Characteristics	Number of infant			All cause hospitalisations			All cause emergency department presentations		
	Total n=4211	Indigenous n=433	Non-Indigenous n=3778	Number of infants with at least one hospital admission	Number of Indigenous infants with at least one hospital admission	Number of non-Indigenous infants with at least one hospital admission	Number of infants with at least one emergency department presentation	Number of Indigenous infants with at least one emergency department presentation	Number of non-Indigenous infants with at least one emergency department presentation
				n=3102 (73.7%)	n=324 (74.8%)	n=2778 (73.5%)	n=2220 (52.7%)	n=318 (73.4%)	n=1902 (50.3%)
Infant									
Prematurity									
<28wk	186 (4.4%)	28 (6.5%)	158 (4.2%)	148 (79.6%)	24 (85.7%)	124 (78.5%)	96 (52.5%)	18 9 (64.3%)	79 (50.0%)
28<32wk	311 (7.4%)	45 (10.4%)	266 (7.0%)	272 (87.5%)	39 (86.7%)	233 (87.6%)	187 (60.1%)	36 (80.0%)	151 (56.8%)
32<37wk	3714 (88.2%)	360 (83.1%)	3354 (88.8%)	2682 (72.2%)	261 (72.5%)	2421 (72.2%)	1936 (52.1%)	264 (73.3%)	1672 (49.9%)
Child sex									
Male	2316 (55.0%)	226 (52.2%)	2090 (55.3%)	1727 (74.6%)	169 (74.8%)	1558 (74.6%)	1251 (54.0%)	169 (74.8%)	1082 (51.2%)
Female	1895 (45.0%)	207 (47.8%)	1688 (44.7%)	1375 (72.6%)	155 (74.9%)	1220 (72.3%)	969 (51.1%)	149 (72.0%)	820 (48.6%)
Birth weight									
Low birth weight (<2500g)	1983 (47.1%)	258 (59.6%)	1725 (45.7%)	1725 (87.0%)	228 (88.4%)	1497 (86.8%)	1071 (54.0%)	197 (69.1%)	874 (50.7%)
Normal birth weight (≥2500g)	2228 (52.9%)	175 (40.4%)	2053 (54.3%)	1377 (61.8%)	96 (54.9%)	1281 (62.4%)	1149 (51.6%)	121 (69.1%)	1028 (50.1%)
Small for gestational age index									
SGA (<10th percentile)	335 (8.0%)	48 (11.1%)	287 (7.6%)	229 (89.3%)	45 (93.8%)	254 (88.5%)	183 (54.6%)	39 (81.3%)	144 (50.2%)
AGA (10th-90th percentile)	3386 (80.4%)	341 (78.8%)	3045 (80.6%)	2496 (73.7%)	250 (73.3%)	2246 (73.8%)	1774 (52.4%)	247 (72.4%)	1527 (50.2%)
LGA (>90th percentile)	483 (11.5%)	42 (9.7%)	441 (11.7%)	307 (63.6%)	29 (69.1%)	278 (63.0%)	263 (54.5%)	32 (76.2%)	231 (52.4%)
Data missing	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
APGAR 5 score									
< 7 (abnormal)	259 (6.2%)	31 (5.1%)	228 (6.0%)	211 (81.5%)	24 (77.4%)	187 (82.0%)	138 (53.3%)	21 (67.7%)	117 (51.3%)
≥7 (healthy)	3951 (93.8%)	402 (94.9%)	3549 (93.9%)	2890 (73.2%)	300 (74.6%)	2590 (73.0%)	2081 (52.7%)	297 (73.9%)	1784 (50.3%)
Data missing	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
Mother									
Maternal Age									
<20 yrs	243 (5.8%)	87 (18.4%)	156 (4.1%)	182 (74.9%)	66 (75.9%)	116 (74.4%)	166 (68.3%)	66 (75.9%)	100 (64.1%)
20-24 yrs	671 (15.9%)	135 (31.6%)	536 (14.2%)	478 (71.2%)	100 (74.1%)	378 (70.5%)	425 (63.3%)	100 (74.1%)	325 (60.6%)
25-29 yrs	1115 (26.5%)	109 (27.3%)	1006 (26.6%)	799 (71.7%)	76 (69.7%)	723 (71.9%)	588 (52.7%)	84 (77.1%)	504 (50.1%)
30-34 yrs	1207 (28.7%)	57 (12.9%)	1150 (30.4%)	909 (75.3%)	45 (79.0%)	864 (75.1%)	594 (49.2%)	36 (63.2%)	558 (48.5%)
35+ yrs	975 (23.2%)	45 (9.8%)	930 (24.6%)	734 (75.3%)	37 (82.2%)	697 (75.0%)	447 (45.9%)	32 (71.1%)	415 (44.6%)

Gravidity									
0	1358 (32.2%)	95 (21.9%)	1263 (33.4%)	1026 (75.6%)	78 (82.1%)	948 (75.1%)	677 (49.9%)	77 (81.1%)	601 (47.6%)
1	1121 (26.6%)	90 (20.8%)	1031 (27.3%)	790 (70.5%)	62 (68.9%)	728 (70.6%)	586 (52.3%)	66 (73.3%)	520 (50.4%)
2	736 (17.5%)	65 (15.0%)	671 (17.8%)	546 (74.2%)	44 (67.7%)	502 (74.8%)	384 (52.2%)	49 (75.4%)	335 (49.9%)
≥3	996 (23.7%)	183 (42.3%)	813 (21.5%)	740 (74.3%)	140 (76.5%)	600 (73.8%)	572 (57.4%)	126 (68.9%)	446 (54.9%)
Area									
Socio-economic status									
Most disadvantaged 1	293 (7.0%)	161 (37.2%)	132 (3.5%)	222 (75.8%)	124 (77.0%)	98 (74.2%)	221 (75.1%)	126 (78.3%)	94 (71.2%)
2	646 (15.3%)	58 (13.4%)	588 (15.6%)	470 (72.8%)	45 (77.6%)	425 (72.3%)	334 (51.7%)	38 (65.5%)	296 (50.3%)
3	537 (12.8%)	56 (12.9%)	481 (12.7%)	370 (68.9%)	39 (69.6%)	331 (68.8%)	318 (59.2%)	42 (75.0%)	276 (57.4%0
4	1143 (27.1%)	75 (17.3%)	1068 (28.3%)	835 (73.1%)	55 (73.3%)	780 (73.0%)	595 (52.1%)	51 (68.0%)	544 (50.9%)
Least disadvantaged 5	1486 (35.3%)	65 (15.0%)	1421 (37.6%)	1124 (75.6%)	48 (73.9%)	1076 (75.7%)	697 (46.9%)	47 (72.3%)	650 (45.7%)
Data missing	106 (2.5%)	18 (4.2%)	88 (2.3%)	81 (76.4%)	13 (72.2%)	68 (77.3%)	56 (52.8%)	14 (77.8%)	42 (47.7%)
Remoteness									
Major city	1802 (42.8%)	84 (19.4%)	1718 (45.5%)	1337 (74.2%)	57 (67.9%)	1280 (74.5%)	863 (47.8%)	54 (64.3%)	807 (47.0%)
Inner regional	1559 (37.0%)	82 (18.9%)	1477 (39.1%)	1142 (73.3%)	68 (82.9%)	1074 (72.7%)	784 (50.3%)	57 (69.5%)	727 (49.2%)
Outer regional	327 (7.8%)	58 (13.4%)	269 (7.1%)	254 (77.7%)	46 (79.3%)	208 (77.3%)	222 (68.2%)	44 (75.9%)	179 (66.5%)
Remote	116 (2.8%)	24 (5.5%)	92 (2.4%)	77 (66.4%)	15 (62.5%)	62 (67.4%)	73 (62.9%)	19 (79.2%)	54 (58.7%)
Very remote	301 (7.1%)	167 (38.6%)	134 (3.6%)	211 (70.1%)	125 (74.9%)	86 (64.2%)	223 (74.1%)	130 (77.8%)	93 (6.4%)
Data missing	106 (2.5%)	18 (4.2%)	88 (2.3%)	81 (76.4%)	13 (72.2%)	68 (77.3%)	56 (52.8%)	14 (77.8%)	42 (47.7%)

n.p. = Not publishable due to small numbers and confidentiality restrictions

Table C. Risk of hospital utilisation in preterm infants during the time period between discharge from the birth admission to 11 months of age, by length of birth hospital stay, 2010-2011

	Events	Time at risk	(Events/Risk)*1000	Median (IQR)	unadjusted IRR (95% CI)	*p value*	multivariable IRR (95% CI)*	*p value*
				All cause hospitalisations				
Length of stay								
<15 days	3839	1213826	3.16	1 (0-2)	1.00		1.00	
15-28 days	706	155425	4.54	1 (1-2)	1.44 (1.34-1.54)	<0.001	1.44 (1.34-1.55)	<0.001
>28 days	739	118568	6.23	1 (1-3)	2.01 (1.84-2.20)	<0.001	1.98 (1.81-2.17)	<0.001
				All cause emergency department presentations				
<15 days	4393	1213826	3.62	1 (0-2)	1.00		1.00	
15-28 days	532	155425	3.42	1 (0-2)	0.96 (0.86-1.08)	0.537	0.98 (0.87-1.11)	0.804
>28 days	732	118567	6.17	1 (0-3)	1.66 (1.48-1.85)	<0.001	1.66 (1.48-1.86)	<0.001

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Cross-sectional page 5-6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*8-9*
Bias	9	Describe any efforts to address potential sources of bias	7 – multiple births
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	N/A limited missing data
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods	

		taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	N/A
Results			**Page #**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Webappendix A and B
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*N/A*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	*N/A*
		Cross-sectional study—Report numbers of outcome events or summary measures	Table 2; Webappendix B
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Specified under all tables.
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Table 3; 4 and Webappendix C
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.