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Perinatal risk factors associated with skin infection hospitalisation in Western Australian Aboriginal and Non-Aboriginal children

Short running title: Risk factors for skin infections

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Social media quote:

Researchers from @WCVID @telethonkids have found that 23% of #skin infection hospitalisations among #Aboriginal children are linked to socioeconomic disparity and very remote location at birth - pin-pointing the importance of minimising these barriers: journal link here

Handles to tag with image: @HannahMooreWA @AshaBowen @jcarapetis @ChrisBlyth74 @RozWalker1 @pfathima1 @YueYw1

SYNOPSIS

Study question

What are the perinatal risk factors associated with skin infection hospitalisation in Western Australian Aboriginal and non-Aboriginal children?

What's already known

Indigenous status and younger age are well-documented risk factors for skin infection hospitalisation in children. Other risk factors previously reported in the literature include male sex, vaginal birth, low birthweight, socioeconomic disparity, remote location, seasonality and households with residents who smoked.

What this study adds

Our individual-level population-based study, with linked perinatal and hospitalisation data, indicated that for Western Australian Aboriginal children aged <17 years socioeconomic disparity and very remote location at birth account for 24% and 23% of skin infection hospitalisations respectively. Further, we have identified previously unknown maternal factors of maternal age <20 years, pre-existing maternal diabetes and maternal smoking during pregnancy which can inform prevention strategies.

ABSTRACT

Background: Hospitalisation with skin infection in Western Australian (WA) Aboriginal children is common, with the highest rates in infants and children from remote WA.

Objective: We aimed to quantify infant, maternal, and sociodemographic risk factors for skin infection hospitalisation in WA children, focussing on Aboriginal children aged <17 years.

Methods: We conducted a retrospective population-based cohort study with linked perinatal and hospitalisation data on WA-born children (1996-2012), of whom 31,348 (6.7%) were Aboriginal. We used Cox regression to calculate adjusted hazard ratios and associated population attributable fractions (PAFs) for perinatal factors attributed to first hospitalisation with skin infection. To identify specific risk factors for early onset infection, we further restricted the cohort to infants aged <1 year.

Results: Overall, 5,439 (17.4%) Aboriginal and 6,750 (1.5%) non-Aboriginal children were hospitalised at least once with a skin infection. Aboriginal infants aged <1 year had the

highest skin infection hospitalisation rate (63.2/1,000 child-years). The strongest risk factors in Aboriginal children aged <17 years were socio-economic disadvantage, very remote location at birth and multi-parity (≥ 3 previous pregnancies) accounting for 24%, 23% and 15% of skin infection hospitalisations respectively. Other risk factors included maternal age <20 years, maternal smoking during pregnancy and low birthweight.

Conclusions: We have quantified the relative influence of perinatal risk factors associated with skin infection hospitalisations in WA children, providing measures indicating which factors have the potential to reduce the most hospitalisations. Our evidence supports existing calls for substantial government investment in addressing underlying social and environmental barriers to healthy skin in WA Aboriginal children but also identifies potential areas to target health promotion messaging at individuals/families on maternal smoking during pregnancy and skin hygiene for families.

Keywords: skin infection; hospitalisations; children; record linkage

BACKGROUND

Australian Aboriginal and Torres Strait Islander (herein respectfully referred to as Aboriginal) children experience substantial barriers to healthy skin, resulting in high numbers presenting to hospital with skin infections.[1] Infants aged below one year and children from remote parts of Western Australia (WA), particularly the sub-tropical Kimberley and Pilbara regions are the most affected.[1] The burden of impetigo, and scabies[2, 3] have led to high rates of long-term sequelae of skin infections in Australian Aboriginal people. Among remote Australian Aboriginal children the median impetigo prevalence is 45% affected at any one time, surpassing median prevalence in Africa (7%), Asia (7%), and overall Oceania (30%).[2] The point prevalence of scabies has been reported to range from 5-35% in remote Australian contexts,[2, 3] with Aboriginal children also having one of the highest reported prevalence's in the world, a burden only surpassed by Panama (78%) and Fiji (44%).[3] While skin infections are generally viewed as a primary care issue, we have previously identified in WA that 14.8% of Aboriginal children and 1.5% of non-Aboriginal children are hospitalised at least once for skin infections (1996-2012) during childhood, with rates in Aboriginal infants

20 times that of their non-Aboriginal counterparts.[1] We have also confirmed that skin infections are under-reported in hospitalised patients due to under-recognition and normalisation, suggesting that the burden of skin infection hospitalisations might be substantially higher.[4]

Social and environmental risk factors for skin infections include household crowding, hot weather and humidity, and access to functional health hygiene equipment.[4] To further investigate this high burden, we aimed to utilise our available dataset with linked information on perinatal characteristics for both Aboriginal and non-Aboriginal children to identify additional infant and maternal risk factors that may predispose children to hospitalisation with skin infection. In addition, we aimed to estimate the population attributable fractions (PAFs) of the perinatal risk factors to guide future prevention measures.

METHODS

Study population, design and setting

WA has a population of 2.6 million, 79% of whom reside in the capital city, Perth, and 6.4% of whom are Aboriginal.[5] Over 60% of Aboriginal people reside in rural and remote regions compared with approximately 27% of non-Aboriginal people.[6] The climate varies across WA from a temperate climate in metropolitan WA (Perth and its surrounds) and the south of the State, to a subtropical climate in the northern regions and a dry, desert climate in the central regions. We conducted a population-based retrospective cohort study of WA births between 1996 and 2012 (n=469,589, of which 31,348, 6.7% were Aboriginal). Further details on the cohort are provided elsewhere.[1] Ethical approval was obtained from the Western Australian Department of Health Human Research Ethics Committee and the WA Aboriginal Health Ethics Committee.

Data sources

Our assembled linked birth cohort dataset (1996 – 2012) contained information from across the state of WA on births, and deaths and hospitalisations from birth up to age 17 years. Hospitalisation records were sourced from the Hospital Morbidity Database Collection (HMDC) which contains information on all public, private and same day hospitalisations. Perinatal risk factors were sourced from the Midwives' Notification System which records information on pregnancy, labour and birth, and infant and maternal factors and contains data for over 99% of WA births.[7] Aboriginal status is identified using a validated algorithm across all available records.[8] Data from the Birth and Death Registers, Midwives Notification System and HMDC were probabilistically linked through the Western Australian Data Linkage Branch, using best practice protocols.[9]

Hospitalisations with skin infections were identified from International Classification of Diseases (ICD) codes for any diagnosis (principal or additional diagnosis) for cellulitis, abscess, impetigo, pyoderma, scabies, head lice and fungal infections and other infestations. A full list of ICD codes included is available elsewhere.[1]

Exposure variables

The following risk factors were identified *a priori* for their association with hospitalisations with respiratory infections[10]: sex, plurality, mode of delivery, gestational age, percent optimal birth weight (POBW), visit to special care unit, maternal smoking during pregnancy, maternal age, number of previous pregnancies, season of birth, Socio-Economic Index for Area (SEIFA) and Remoteness Area (Accessibility/Remoteness Index of Australia). Pre-existing maternal morbidity including diabetes and gestational diabetes were considered, as hyperglycaemia in pregnancy may be a risk factor for skin infections in the mother and offspring.[11] The POBW measure was used as an appropriate measure of foetal growth as it takes into account the gestational duration, foetal gender, maternal age, maternal height and parity.[12] The seasons were based on a temperate climate and defined as spring (September to November), summer (December to February), autumn (March to May) and winter (June to August). When examining risk factors in children from the northern tropical/sub-tropical regions (the Kimberley and Pilbara) we used the dry season (May to

October) and wet season (November to April) to define season of birth. As the hospital location was not available in the data, residential postcode at birth was used to measure geographical variables and examine risk factors in children from the Kimberley and Pilbara, where the highest burden of skin infection is observed.[1] The SEIFA index used for this study was the Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD) which indicates relative access to resources and ability to participate in society for households within the same collection district (approximately 200 dwellings) using information from the latest census.[13] The SEIFA was measured at the time of the child's birth and grouped into quintiles. The Accessibility/Remoteness Index of Australia classifies the population into five categories based on their geographical area of residence at birth and relative access to services.[14]

Statistical analysis

Our analysis included several hospitalisation endpoints (Figure 1). Using survival analysis in Stata (Stata 14, College Station, TX, USA) we calculated the age-specific rates per 1,000 child years with 95% confidence intervals, for first hospitalisation with skin infection. The censor date was set to the date of first skin infection hospitalisation, date of death, or the study end date (31 December 2012), whichever occurred first. We compared rates between Aboriginal and non-Aboriginal children using incidence rate ratios (IRRs). We used Cox proportional hazards models to calculate hazard ratios with 95% confidence intervals (CIs) for the associations between perinatal factors and time to first hospitalisation for skin infection. To select factors for the final model we first examined univariate associations between hospitalisation with skin infection and each factor and included potential risk factors (selected if $p<0.10$) in the multivariable models. We tested the proportionality assumption in the final models by visually assessing log–log plots as to whether the curves were parallel and formally tested using Schoenfeld residuals. Using the *punafcc* command in Stata,[15] we calculated the proportion of disease in the population attributable to a particular factor (PAFs) with 95% CIs for each variable, accounting for both the prevalence of the factor in the population and the strength of the association with disease. The focus of this study was to identify risk factors in Aboriginal children in whom the highest burden is observed however models were examined in both Aboriginal and non-Aboriginal children,

to identify any key differences. A secondary analysis restricted the cohort to infants aged less than one year to identify specific risk factors for early onset infection during the period of highest described burden[1], to identify potentially modifiable factors. The follow up time was to first hospitalisation by age one year, death, or first birthday, whichever occurred first. Further, we restricted our cohort to children (aged <17 years) from the Kimberley and Pilbara regions using postal code at birth to examine risk factors in Aboriginal children from these remote areas of WA, removing only the remoteness index variable from the multivariable model as the values for those living in these areas were the same.

RESULTS

From the birth cohort of 31,348 Aboriginal and 438,241 non-Aboriginal children, 17.4% (n=5,439) of Aboriginal and 1.5% (n=6,750) of non-Aboriginal children were hospitalised at least once with a skin infection before age 17 years. The median age at first admission for Aboriginal children hospitalised with a skin infection was 22.0 months (Q1-Q3=8.6-57.0), almost a year younger on average than their non-Aboriginal peers (33.8 months; Q1-Q3=13.9-72.4). Skin infection hospitalisation rates in Aboriginal children aged below one year were 18 times that of their non-Aboriginal peers (Table 1). In both Aboriginal and non-Aboriginal children, the highest rates were in infants aged less than one year (63.2/1,000 child-years in Aboriginal and 3.5/1,000 child-years in non-Aboriginal children).

Aboriginal children

A number of perinatal risk factors were associated with skin infection hospitalisation in Aboriginal children <17 years: male sex, low birthweight, special care unit contact, pre-existing maternal diabetes, maternal smoking during pregnancy, maternal age <20 years, multi-parity (≥3 previous pregnancies), socioeconomic disadvantage and remote or major city location at birth (Table 2). Those factors with the strongest association were very remote location at birth (aHR=4.10; 95% CI=3.39, 4.95), socioeconomic disadvantage (aHR=2.41; 95% CI=1.25, 4.65), and multi-parity (≥ 3 previous pregnancies) (aHR=1.52; 95% CI=1.34, 1.73). Associated PAFs for these factors were 23% (95% CI=21.55, 24.36), 24% (95% CI=11.81, 33.88) and 15% (95%CI=11.13, 18.34), respectively. Assessment of the Schoenfeld

residuals test results and log–log plots confirmed our data met the proportional hazards assumption.

When restricted to infants aged less than one year, the factors which remained important were low birthweight, special care unit contact, maternal age <20 years, multi-parity (≥3 previous pregnancies), socioeconomic disadvantage and remote or major city location at birth (Table 3). Being born in a very remote location had the highest PAF of all sub-analyses, accounting for 29% (95% CI=26.92, 31.92) of first hospitalisations with skin infection in Aboriginal infants aged <1 year.

Nearly half (46%) of hospitalisations in Aboriginal children were in those born in the Kimberley and Pilbara regions (33% of Aboriginal births) (Figure 1). When we restricted the data to this population only (with hospitalisations aged <17 years) all factors remained important, with the exception of pre-existing maternal diabetes (Supplementary Table 1). The low number of children born to mothers with pre-existing diabetes may have reduced the statistical power for this association. The PAFs for male sex and low birthweight increased slightly for children born in the Kimberley and Pilbara to 7% (95% CI=1.72, 12.17) and 9% (95% CI=3.32, 14.68), respectively.

Non-Aboriginal children

Risk factors associated with skin infection hospitalisation in non-Aboriginal children differed from those in Aboriginal children (Supplementary Table 2). Low birthweight and pre-existing maternal diabetes were not risk factors for non-Aboriginal children and the association with remote location at birth was substantially lower than for Aboriginal children, in both age groups (children <17 years and infants <1 year). Risk factors which were stronger in non-Aboriginal children were male sex and being born in a major city. In non-Aboriginal children aged <17 years, the PAF's for maternal smoking and maternal age <20 years were approximately half that for Aboriginal children, and in infants aged less than one year the PAF for maternal age <20 years in non-Aboriginal children was one-third of that for

Aboriginal children (Supplementary Table 3). Preterm birth was an additional risk factor for non-Aboriginal children aged <17 years and in infants.

COMMENT

Principal findings

Our study confirms substantial health disparities with Aboriginal infants 18 times more likely to be hospitalised with a skin infection than non-Aboriginal infants. In addition, we have identified for the first time several infant and maternal risk factors for the high burden and confirmed that after adjustment for all the factors, socio-economic disadvantage, very remote location at birth, multi-parity, maternal age <20 years, maternal smoking during pregnancy, low birthweight and special care unit contact were key risk factors in Aboriginal children hospitalised with a skin infection before age 17 years. With the exception of maternal smoking during pregnancy, the same risk factors were also associated with hospitalisation with skin infection in Aboriginal infants in their first year of life and the hazard ratios for these factors were higher than in those aged <17 years suggesting these factors may be particularly important for early onset of infection in the first year of life. These findings identify potential areas to target prevention strategies for skin infections.

Strengths of the study

We have quantified perinatal factors associated with skin infection hospitalisation in Western Australian Aboriginal and non-Aboriginal children at a population level, providing additional insights into important risk factors coupled with PAFs for understanding the high burden in Aboriginal children. To our knowledge, no other study has examined this level of perinatal data to identify potential predisposing factors for hospitalisation with skin infection in children. Hospitalisation is at the severe end of the clinical spectrum for skin infection, and thus we have examined factors associated with severe experiences of

infection posing the largest risks to children's health. These are rich data to use in the planning of effective prevention strategies to reduce the burden of hospitalisation with skin infection among Australian Aboriginal children, which may inform policy or programs in other developing and developed countries with high burdens of skin infections.

Limitations of the data

There are some limitations to our study. Although we were interested in examining birth factors, unmeasured attributes of children at the time of hospitalisation have not been accounted for and location-based variables also do not take into account population mobility. In addition, the index measure used for socioeconomic disadvantage is a community-level measure of disadvantage which we assume is applicable to the individual but we cannot confirm this.

Interpretation

The strongest risk factors of socioeconomic disparity and remoteness are consistent with previous studies.[3, 16-18] In particular, very remote location at birth was the largest independent risk factor for infants in our study accounting for 29% of skin infection hospitalisations. Whilst remote location at birth cannot be modified, our study findings support existing calls for government investment in addressing underlying social and environmental issues leading to poor living conditions in remote Aboriginal communities where there is a high burden of infections.[18] If diagnosed early, most skin infections could be treated in the community, reducing the need for hospitalisation. A key social determinant to be addressed in remote communities is access to health clinics but potentially the more fundamental issues are the under-recognition of skin infections and hence under-treatment by health care workers.[4] Strategies to encourage improved diagnosis and hence treatment have been outlined in the recently released National Healthy Skin Guideline with accompanying pictorial training algorithms for health care workers (https://infectiousdiseases.telethonkids.org.au/our-research/skin-guidelines, accessed 19

Feb, 2019). Research to change the culture of care provision for skin infections is underway in the Kimberley (https://www.telethonkids.org.au/our-research/early-environment/infection-and-vaccines/skin-health/stop-see-treat-prevent-skin-sores-scabies-trial/, accessed 19 Feb, 2019) and Western Desert in the Pilbara however evaluation reports for these are not yet available. Effective prevention strategies could also help reduce the overall community burden of skin infections. These could include tailoring prevention strategies around hand hygiene,[19, 20] infant skin care, and education on how to recognise and seek treatment for skin infections. In addition, specifically alerting health care providers and new parents to the high risk of skin infection in infants may be an effective strategy that can be implemented in the early post-partum period as part of well-health checks of the infant.

We found that socioeconomic disparity was a risk factor after adjusting for remote geographical location, consistent with previous findings.[18] It is not clear exactly which factors may be driving the high burden in socioeconomically disadvantaged Aboriginal children however housing which lacks functioning facilities for removing faeces, concrete floor and crowding, younger children living in older houses, age of carer, family income and high child mobility have been independently associated with skin infection (from carers' reports).[21] Improvements in the quality and quantity of housing and access to functional health hardware in the household are modifiable factors that may have some impact on reducing skin infections in children.[22, 23] A substantial investment in improving housing and living conditions is needed in remote Aboriginal communities in Australia, with studies to document how to translate investment in housing stock into effective change. Community engagement and leadership of these approaches is essential.

The higher risk of hospitalisation for children born into already large families (3 or more children) is logically consistent with studies that have identified household crowding, particularly with siblings, as a key driver of infection transmission,[18] although we had no measure of crowding for inclusion in this analysis. The effects of crowding on transmission are further amplified by inadequate housing infrastructure described above.[18, 23] To address

the additional skin infection burden in large families, education awareness campaigns for skin hygiene for larger families as well as improvements in housing and healthy living, especially for remote Aboriginal communities are needed. There are few evaluation reports from healthy skin promotion campaigns in remote Australia, however there is evidence that providing health and hygiene education to primary caregivers on a one-to-one basis or in small group sessions is the main method for promoting child health in these communities.[23] The evidence associating multi-parity and skin infection could form part of a strategy targeting health promotion messages at larger households.

Some factors in our study are potentially modifiable through ongoing public health awareness campaigns such as teenage pregnancy and maternal smoking during pregnancy, which if addressed could reduce hospitalisation with skin infection by 11.6% and 9.6% respectively. Maternal smoking during pregnancy has previously been linked with weakened immunity and infections in the child.[24] Encouraging smoke-free pregnancies is an important public health goal, for both maternal and infant health benefits. Other evidence has highlighted higher hospitalisation rates in children born to teenage mothers including higher rates of hospitalisation for respiratory infections[10] and gastroenteritis.[25] Further research is needed to understand the reason for this association, whether biological or a result of social or economic circumstances which were not measured in this study. Nevertheless, given our finding of this risk factor there might be a benefit in educating health care workers about the need for additional health care assessments for infants of young mothers, to detect and treat skin infections early. Young mothers may also be responsive to social media messages that alert them to the risks of skin infections in their new babies and how to seek care.[26]

Higher rates of hospitalisation with skin infection in boys compared with girls are consistent with findings from New Zealand.[16, 17] Studies of primary care settings on the other hand have found no significant gender difference[27] and studies specifically on head lice have identified higher rates in girls than in boys in the school setting, independent of hair length.[28] Male sex may be a risk factor only for severe skin infections requiring hospitalisation. Complications of skin infections including *Staphylococcus aureus*

bacteraemia are more common in boys,[29] which has been hypothesised to be due to increased rates of minor trauma resulting in bacterial skin infections.

Several of the identified risk factors in Aboriginal children (aged <17 years) were consistent with risk factors for hospitalisation for lower respiratory infections in Aboriginal children including male sex, multi-parity, maternal age <20 years, maternal smoking during pregnancy and socioeconomic disadvantage.[10] Given the overlap with other infections, effective multi-modal health promotion strategies directed at groups with higher risk of hospitalisation are needed. This could include education about strategies to prevent skin infections, immunisation uptake, and smoking cessation and/or smoke free homes. Future studies should aim to assess if these factors increase the risk of hospitalisation or the risk of infections themselves.

Although rates of skin infection hospitalisation in non-Aboriginal children are much lower than in Aboriginal children, most risk factors were consistent with those for Aboriginal children. In contrast to Aboriginal children, for non-Aboriginal children born preterm the risk of hospitalisation with skin infection was 67% higher than that for full term non-Aboriginal children. Potentially due to the low numbers of preterm children this resulted in a PAF estimating a reduction in skin infection hospitalisation of only 1%. Awareness raising about the importance of skin integrity, seeking health care support early for skin infections and protecting ex-premature infants from exposure to bacterial and parasitic pathogens is needed and needs to be conveyed to families as well as health practitioners.

CONCLUSIONS

Our study suggests there are barriers to healthy skin at environmental, social and individual/family levels. To increase the likelihood of success, interventions may need to take an ecological approach to target each of these levels. Our findings indicate that removing social and environmental barriers will be fundamental in making a substantial reduction in skin infection hospitalisations. In addition, tailored education and health

promotion strategies targeted at families and communities could aid in changing social norms around skin hygiene and improve healthy behaviour.

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Figure 1. Study cohort and hospitalisation endpoints examined

Table 1. Number and rate per 1,000 child years of first hospitalisation with a skin infection

Age group	Aboriginal N=31,348		Non-Aboriginal N=438,241		IRR (95% CI)
	n	Rate (95% CI)	n	Rate (95% CI)	
<1 year	1,842	63.2 (60.4, 66.1)	1,462	3.5 (3.3, 3.7)	18.2 (17.0, 19.5)
1-4 years	2,318	26.1 (25.0, 27.4)	3,166	2.3 (2.2, 2.4)	11.3 (10.7, 11.9)
5-9 years	992	14.9 (14.0, 15.8)	1,422	1.3 (1.2, 1.4)	11.5 (10.6, 12.5)
10-17 years	287	9.3 (8.3, 10.5)	700	1.2 (1.2, 1.3)	7.5 (6.5, 8.7)
Total	5,439	25.2 (24.6, 25.9)	6,750	2.0 (1.9, 2.0)	12.9 (12.5, 13.4)

CI=Confidence interval. IRR=Incidence Rate Ratio.

Table 2. Risk factors associated with hospitalisation with any skin infection in Aboriginal children aged <17 years

Risk factor	Number of hospitalisations	Unadjusted HR (95% CI)	Adjusted HR (95% CI)	Adjusted PAF (95% CI)
Sex				
Female	2,550	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Male	2,889	1.10 (1.05, 1.17)	1.11 (1.03, 1.19)	5.10 (1.73, 8.35)
Plurality				
Single birth	5,294	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Multiple birth	145	1.22 (1.04, 1.44)	1.09 (0.88, 1.35)	0.24 (-0.35, 0.83)
Mode of delivery				
Vaginal	3,956	1.16 (1.04, 1.30)	1.05 (0.90, 1.23)	3.57 (-7.88, 13.81)
Instrumental	320	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Elective caesarean	399	0.93 (0.84, 1.03)	1.12 (0.92, 1.36)	0.86 (-0.57, 2.27)
Emergency caesarean	747	1.09 (1.01, 1.18)	1.12 (0.93, 1.33	1.42 (-0.81, 3.60)
Percent Optimal Body Weight				
Low (<85%)	1,410	1.46 (1.29, 1.65)	1.27 (1.08, 1.48)	5.79 (2.30, 9.15)
Normal (85-114%)	3,320	1.16 (1.03, 1.30)	1.12 (0.97, 1.30)	7.08 (-2.01, 15.36)
High (≥115%)	297	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Gestational age				
≥37 weeks	4,492	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
33-36 weeks	727	1.31 (1.21, 1.41)	1.10 (0.98, 1.23)	1.22 (-0.17, 2.57)
<33 weeks	203	1.24 (0.96, 1.60)	1.11 (0.91, 1.36)	0.41 (-0.33, 1.15)

Risk factor	Number of hospitalisations	Unadjusted HR (95% CI)	Adjusted HR (95% CI)	Adjusted PAF (95% CI)
Special care unit visit				
No	4,670	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Yes	769	1.28 (1.19, 1.39)	1.31 (1.16, 1.47)	3.85 (2.38, 5.29)
Pre-existing maternal diabetes				
No	5,301	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Yes	121	1.71 (1.43, 2.05)	1.47 (1.16, 1.86)	0.77 (0.38, 1.15)
Maternal smoking during pregnancy				
No	2,029	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Yes	2,547	1.32 (1.24, 1.40)	1.21 (1.13-1.30)	9.57 (6.24, 12.78)
Maternal age				
≥35 years	313	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
30-34 years	660	0.98 (0.85, 1.12)	1.03 (0.87, 1.23)	0.43 (-1.73, 2.54)
25-29 years	1,254	1.03 (0.91, 1.17)	1.12 (0.95, 1.31)	2.55 (-0.92, 5.89)
20-24 years	1,735	1.07 (0.95, 1.20)	1.25 (1.06, 1.47)	6.16 (2.06, 10.09)
<20 years	1,460	1.26 (1.11, 1.42)	1.81 (1.51, 2.17)	11.60 (8.95, 14.17)
Number of previous pregnancies				
0	1,218	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
1	1,100	0.99 (0.91, 1.08)	1.09 (0.97, 1.22)	1.64 (-0.46, 3.69)
2	900	1.02 (0.94, 1.11)	1.26 (1.11, 1.44)	3.59 (1.83, 5.32)
≥3	2,204	1.08 (1.01, 1.16)	1.52 (1.34, 1.73)	14.81 (11.13, 18.34)

Risk factor	Number of hospitalisations	Unadjusted HR (95% CI)	Adjusted HR (95% CI)	Adjusted PAF (95% CI)
Season of birth				
Spring	1,239	1.00 (0.93, 1.08)	1.08 (0.97, 1.19)	1.76 (-0.52, 3.98)
Summer	1,329	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Autumn	1,491	1.06 (0.98, 1.14)	1.06 (0.96, 1.17)	1.53 (-0.95, 3.95)
Winter	1,380	1.06 (0.98, 1.14)	1.12 (1.01, 1.23)	2.64 (0.36, 4.87)
Socio-economic index[a]				
91-100% (least disadvantaged)	12	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
76-90%	95	1.33 (0.73, 2.43)	1.44 (0.72, 2.88)	0.71 (-0.40, 1.81)
26-75%	1,416	1.83 (1.04, 3.23)	1.83 (0.95, 3.53)	15.60 (2.29, 27.10)
11-25%	922	1.80 (1.02, 3.19)	1.91 (0.99, 3.70)	10.78 (2.67, 18.22)
0-10% (most disadvantaged)	1,686	2.49 (1.41, 4.39)	2.41 (1.25, 4.65)	23.64 (11.81, 33.88)
Remoteness Area				
Major city	1,273	1.60 (1.36, 1.88)	1.83 (1.52, 2.22)	14.63 (11.24, 17.89)
Inner regional	167	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Outer regional	696	1.15 (1.04, 1.26)	2.01 (1.65, 2.46)	7.92 (6.35, 9.46)
Remote	899	1.37 (1.26, 1.50)	2.61 (2.14, 3.18)	11.05 (9.68, 12.41)
Very remote	1,639	2.45 (2.28, 2.64)	4.10 (3.39, 4.95)	22.97 (21.55, 24.36)

[a]91-100% represents the least disadvantaged and 0-10% represents the most disadvantaged. HR=Hazard ratio; CI=Confidence interval. PAF=population attributable fraction.

Table 3. Risk factors associated with hospitalisation with any skin infection in Aboriginal children aged <1 year

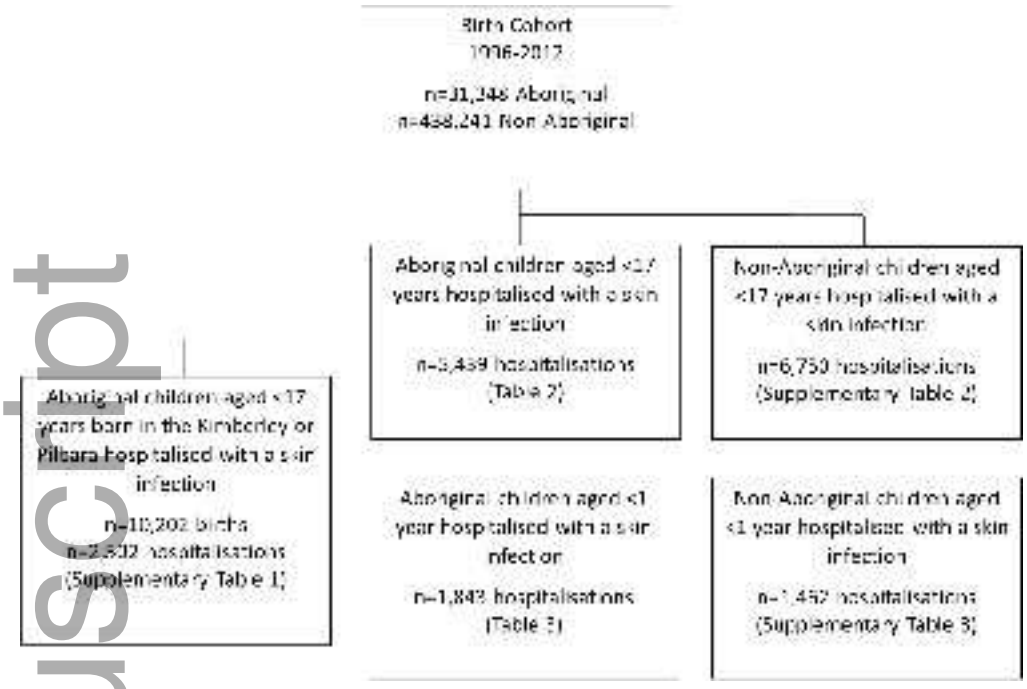
Risk factor	Number of	Unadjusted	Adjusted	Adjusted

	hospitalisations	HR (95% CI)	HR (95% CI)	PAF% (95% CI)
Sex				
Female	887	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Male	956	1.04 (0.95, 1.14)	1.07 (0.94, 1.21)	3.27 (-2.90, 9.06)
Plurality				
Single birth	1,782	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Multiple birth	61	1.48 (1.15, 1.91)	1.38 (1.00, 1.90)	1.16 (0.16, 2.14)
Mode of delivery				
Vaginal	1,316	1.24 (1.01, 1.52)	1.07 (0.81, 1.42)	4.65 (-15.70, 21.43)
Instrumental	101	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Elective caesarean	144	1.21 (0.94, 1.56)	1.20 (0.85, 1.71)	1.43 (-1.06, 3.86)
Emergency caesarean	277	1.40 (1.11, 1.76)	1.30 (0.95, 1.78)	3.83 (-0.27, 7.76)
Percent Optimal Body Weight				
Low (<85%)	551	1.82 (1.46, 2.27)	1.36 (1.03, 1.78)	8.19 (1.74, 14.21)
Normal (85-114%)	1,045	1.19 (0.96, 1.48)	1.05 (0.81, 1.36)	3.20 (-13.35, 17.33)
High (≥115%)	90	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Gestational age				
≥37 weeks	1,470	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
33-36 weeks	276	1.47 (1.29, 1.67)	1.02 (0.84, 1.24)	0.29 (-2.45, 2.96)
<33 weeks	92	1.81 (1.47, 2.24)	1.16 (0.84, 1.61)	0.72 (-0.72, 2.13)
Special care unit visit				
No	1,558	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)

Yes	285	1.35 (1.19, 1.53)	1.40 (1.15, 1.70)	5.43 (2.75, 8.04)
Pre-existing maternal diabetes				
No	1,794	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Yes	43	1.58 (1.16, 2.13)	1.21 (0.80, 1.82)	0.43 (-0.43, 1.28)
Maternal smoking during pregnancy				
No	683	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Yes	827	1.26 (1.13, 1.39)	1.11 (0.98, 1.26)	5.52 (-0.87, 11.50)
Maternal age				
≥35 years	109	1.01 (0.81, 1.28)	1.04 (0.78, 1.38)	0.25 (-1.70, 2.16)
30-34 years	220	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
25-29 years	412	1.05 (0.89, 1.24)	1.12 (0.91, 1.39)	2.61 (-2.01, 7.02)
20-24 years	583	1.10 (0.94, 1.28)	1.29 (1.04, 1.61)	6.72 (1.49, 11.67)
<20 years	514	1.36 (1.16, 1.60)	2.19 (1.69, 2.84)	14.59 (11.35, 17.71)
Number of previous pregnancies				
0	412	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
1	367	0.98 (0.85, 1.12)	1.34 (1.10, 1.64)	5.40 (2.16, 8.53)
2	297	1.01 (0.87, 1.18)	1.47 (1.17, 1.86)	5.22 (2.60, 7.78)
≥3	762	1.12 (0.99, 1.26)	1.93 (1.54, 2.43)	21.24 (15.85, 26.28)
Season of birth				
Spring	375	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Summer	442	1.09 (0.95, 1.25)	1.04 (0.86, 1.24)	0.82 (-3.41, 4.87)
Autumn	528	1.24 (1.09, 1.41)	1.17 (0.98, 1.39)	4.01 (-0.29, 8.14)

Winter	498	1.26 (1.10, 1.44)	1.29 (1.08, 1.53)	6.20 (2.31, 9.93)
Socio-economic index[a]				
91-100% (least disadvantaged)	6	1.18 (0.49, 2.83)	1.14 (0.43, 2.98)	0.06 (-0.35, 0.47)
76-90%	31	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
26-75%	442	1.41 (0.98, 2.03)	1.25 (0.82, 1.89)	6.47 (-5.14, 16.81)
11-25%	294	1.35 (0.93, 1.95)	1.23 (0.81, 1.88)	4.10 (-3.64, 11.26)
0-10% (most disadvantaged)	594	2.07 (1.44, 2.98)	1.63 (1.08, 2.48)	16.57 (4.90, 26.81)
Remoteness Area				
Major city	372	1.55 (1.15, 2.08)	1.77 (1.25, 2.52)	12.65 (6.68, 18.24)
Inner regional	50	1.00 (Reference)	1.00 (Reference)	0.00 (Reference)
Outer regional	212	1.82 (1.34, 2.48)	2.03 (1.40, 2.94)	7.08 (4.51, 9.59)
Remote	287	2.26 (1.68, 3.05)	2.63 (1.83, 3.80)	10.51 (8.12, 12.83)
Very remote	637	4.79 (3.59, 6.38)	5.09 (3.60, 7.20)	29.46 (26.92, 31.92)

[a]91-100% represents the least disadvantaged and 0-10% represents the most disadvantaged. HR=Hazard ratio; CI=Confidence interval. PAF=population attributable fraction.



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