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Burn Injuries in Hospitalized Australian Children—An Epidemiological Profile

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Globally, First Nations children sustain burns at a higher rate than other children. Little is understood about how health inequities contribute, especially from an Indigenous viewpoint. We analyzed data from the Burns Registry of Australian and New Zealand (BRANZ) for acute burns in children (<16 years) admitted to hospital between October 2009 and July 2018. Descriptive statistics examined equity variables in patient and injury characteristics. Poisson regression was used to describe factors associated with bacterial infection. Indigenous research methods were used throughout. Aboriginal and Torres Strait Islander children represented 10.4% of the study population. Health inequities were present for Aboriginal and Torres Strait Islander children with longer hospital length of stay (9.5 vs 4.6 days), rural residency (61.3% vs 13.9%), lower socioeconomic status (72.2% vs 34.9%), and more flame burns (19.5% vs 10.6%) compared to other Australian children. *Streptococcus* sp. infection risk was four times greater in Aboriginal and Torres Strait Islander children compared to other Australian children. Flame burns and high percentage total body surface area burns were a risk for *Staphylococcus* sp. and *Streptococcus* sp. infection in all children. The epidemiological profile for burn injuries managed in Australian burns centers differs between Aboriginal and Torres Strait Islander children and other children, indicating persistent health inequities. These differences should be considered in the development of injury prevention strategies and the clinical management of burn injuries for Aboriginal and Torres Strait Islander children and their families.

Globally, burns are a leading cause of mortality and morbidity in children.[1–4] In high income countries, such as America, Australia, and Canada, burns are one of the leading causes of mortality for unintentional injury in children with similar profiles: male, less than 5 years of age, and a predominance of scald burns.[1,2,5–7] Health inequities, including the presence of avoidable or discriminatory health disparities, remain prevalent.[8–10] Inequity indicators, such as low socioeconomic status (SES) and residential remoteness, influence both burn incidence and severity. Furthermore, these inequities are greatest in children from minority backgrounds.[4,5,11–13] Recent international research in adults and children has reported a decline in burn incidence.[2,5,14,15] Although this may be true in the dominant population, studies have often neglected reporting on First Nation children, so trends in these populations are unclear.[2,5,12,16]

In Australia, Aboriginal and Torres Strait Islander burn injury hospital admissions are triple those of other Australians.[1,17] Hospital length of stay (LOS) is proportionally longer for Aboriginal and Torres Strait Islander patients, despite burn severity not differing significantly to other Australian patients.[1,13,17] In America and Canada, the mortality rate from unintentional injury is 2 to 4 times greater for Aboriginal (Native American, Canada—First Nation, Inuit, and Métis peoples) children than other American or Canadian children, with fire-related injuries being a common cause.[18–22] Hospitalization rates from injury are also greater for Native American children.[23] High burn injury rates, longer LOS, and increased morbidity in First Nations children are indicative of health inequities, with people from low SES, minority groups, and regional areas at higher risk.[1,12,13,17–19,24,25]

Research published on burns in Australia has generally focused on Western biomedical models of health, with limited examination of health inequities.[13,16,26–34] Although First Nation children are over-represented in burns, to date, no enquiry has used Indigenous research methodologies or methods, which inhibits an authentic understanding of

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the issues, or development of appropriately contextualized approaches for prevention.[35–40] In contrast, this study uses Knowledge Interface Methodology (Appendix 1) to analyze data from the Burns Registry of Australia and New Zealand (BRANZ). This paper aims to examine the burns epidemiological profile and risk of bacterial infection using an equity lens, underpinned by decolonization processes.

METHODS

Design

This research is underpinned by Indigenous methodologies—knowledge interface and decolonization (Appendix 1).[41–45] Decolonization as a research process acts to counteract and redefine unacknowledged processes of power, information, and truth generated through the colonization and imperialism of First Nations communities.[46] The shifting of power dynamics in the research process, by having an Aboriginal research lead the study with support of senior Aboriginal researchers, is an example of this.[39,46] Indigenous knowledge (knowing, being, and doing) and Western quantitative knowledge were woven together for this study's knowledge interface, across variable selection, strength-based approach, outcome contextualization, interpretation, and in resetting dominant research norms (Appendix 1).[35,38,42–44,47] A weaving approach, published by the First Author,[44] was used to ensure the primacy of Indigenous knowledge and experience was privileged. For example, in interpretation naryi kati processes were employed to privilege First Nations voices. Naryi kati repositions quantitative research with an Indigenous lens, and in this process other Australian children are not treated or considered as the unacknowledged norm.[38,44] This resetting occurred with an equity focus (as defined by PROGRESS-Plus [PROGRESS-Plus: Place (residence), Race (ethnicity), Occupation, Gender, Religion, Education, Social-capital, Socioeconomic position, Age, Disability, Sexual Orientation, Other Vulnerable Groups.[52]]), to define variables and contextulize outcomes.[44] These processes were limited by the Burns Registry of Australian and New Zealand (BRANZ), which is constructed from a Western biomedical knowledge system, and which does not conform to Indigenous data sovereignty principles (ie, data management, interpretation, and dissemination).[38,39,44] The BRANZ is a clinical quality and epidemiological data repository, with 17 participating hospitals/burns centers in Australia and New Zealand.[1,28,48]

Data Source

The BRANZ includes hospital transfers and patients managed by dedicated burns units over three set criteria: 1) Admissions ≥ 24 hours, 2) Admissions ≤ 24 hours requiring surgery, and 3) In hospital death.[1,28,48] Initial admission must occur within 28 days of injury for registry inclusion.[1,28,48] The BRANZ Admission data from 1 October 2009 to 31 July 2018 were analyzed, and participant inclusion criteria required Australian ethnicity, <16 years of age, with an acute burns admission (Appendix 2). Data were extracted under three categories:

1) Demographics (surrounding PROGRESS-Plus) were populated from BRANZ data. A measure of remoteness (Accessibility/Remoteness Index of Australia—ARIA) and SES (Socioeconomic Indexes for Area—SEIFA) were derived from residential postcode.[8,49–52]
2) Injury Characteristics: anatomical location, primary, and secondary burn cause as recorded by BRANZ.[48]
3) Injury Severity: BRANZ recorded Hospital LOS, Percentage Total Body Surface Area (%TBSA) range, and burn depth variables, and Bacterial Infection derived from International Statistical Classification of Diseases and Related Problems, tenth revision (ICD10-AM) codes (*Staphylococcus* sp. and *Streptococcus* sp. B95).[48,53]

Analysis

Descriptive statistics (binomial confidence interval) described patient demographics and injury clinical characteristics, where χ^2 tests (categorical) and *t* tests (continuous) assessed significance. Univariate and multivariate Poisson regression with robust error variance assessed the risk ratio (95% CI) of bacterial infection (*Staphylococcus* sp. and *Streptococcus* sp.) to covariates (sex, age, ARIA, burn cause, depth, and %TBSA). In keeping with knowledge interface methodology, data were stratified by Aboriginal and Torres Strait Islander status. To account for missing data, we used multiple imputation with chained equations with predictive mean matching with 40 imputations (profile—Appendix 3)[54]. Data were prepared, analyzed, and plotted with Stata 15.1 (StataCorp), SAS/Stat 14.2 (SAS Institute, Cary, NC), and ggplot2 in [R].[55]

Ethics

Ethics approval was acquired from Human Research Ethics Committee at the University of New South Wales Sydney (HC17712) and the Aboriginal Health and Medical Research Council of New South Wales (1032/14).

RESULTS

Patient and Injury Characteristics

Of the 6980 children admitted to a BRANZ hospital for an acute burns injury, 723 (10.4%) were recorded as Aboriginal and/or Torres Strait Islander children (Table 1). Although the sex distribution was similar, there were slight variations for age between groups (Table 1). "Very low" to "low" SES was common in all children, but the proportion was higher in Aboriginal and Torres Strait Islander children (72.2% vs 43.9%; Table 1). A greater percentage of Aboriginal and Torres Strait Islander children resided in outer regional to very remote regions compared to other Australian children (61.3% vs 13.9%).

Anatomic locations differed between groups. In Aboriginal and Torres Strait Islander children, hip and lower limb burns were greater, compared to trunk burns in other Australian children (Table 2). Scalds were the most common burn cause in all children, with secondary causes differing (Table 2). For example, other Australian children had greater percentages of friction burns by treadmill (1.0% vs 4.9%). Flame burns in Aboriginal and Torres Strait Islander children were higher (19.5% vs 10.6%) across all residential locations (Table 3). Primary cause of burn differed based on residency for Aboriginal and Torres Strait Islander children; the percentage

Table 1. Demographic profile of Australian children admitted to a BRANZ reporting hospital (2009–2018)

	Aboriginal and Torres Strait Islander		Other Australian		Total		
Variable	**Count**	**Proportion (CI)**	**Count**	**Proportion (CI)**	**Count**	**Proportion (CI)**	***P***
Total	723	10.4 (9.7–11.1)	6257	89.6 (88.9–90.3)	6980		
Sex*							.60
Female	276	38.2 (34.7–41.8)	2443	39.0 (37.8–40.3)	2719	39.0 (37.8–40.1)	
Male	447	61.8 (58.2–65.3)	3812	60.9 (59.7–62.1)	4259	61.0 (59.9–62.2)	
Age (y)							
Mean		4.9 (4.5–5.2)		4.4 (4.3–4.5)		4.4 (4.3–4.5)	.01
< 1	50	6.9 (5.3–9.0)	744	11.9 (11.1–12.7)	794	11.9 (10.7–12.1)	
1–4	384	53.1 (49.5–56.7)	3310	52.9 (52.7–54.1)	3694	52.9 (51.8–54.1)	
5–9	154	21.3 (18.5–24.4)	1072	17.1 (16.2–18.1)	1226	17.6 (16.7–18.5)	
10–15	135	18.7 (16.0–21.7)	1131	18.1 (17.1–19.1)	1266	18.4 (17.3–19.1)	
Regional area index							< .001
Metropolitan (RA1)	173	23.9 (21.0–27.2)	3819	61.0 (59.8–62.2)	3992	57.2 (56.0–58.4)	
Inner Regional (RA2)	108	14.9 (12.5–17.7)	1571	25.1 (24.1–26.2)	1678	24.0 (23.1–25.1)	
Outer Regional (RA3)	209	28.9 (25.7–32.3)	677	10.8 (10.1–11.6)	886	12.7 (11.9–13.5)	
Remote (RA4)	121	16.7 (14.2–19.6)	132	2.1 (1.8–2.5)	252	3.6 (3.2–4.1)	
Very Remote (RA5)	113	15.6 (13.2–18.5)	58	0.9 (0.7–1.2)	171	2.5 (2.1–2.8)	
Index of relative socioeconomic advantage and disadvantage							
Mean		2.0 (1.9–2.1)		2.83 (2.8–2.9)		2.73 (2.7–2.8)	< .001
Very low: 1–2	370	51.2 (47.5–54.8)	1571	25.1 (24.1–26.2)	1942	27.8 (26.8–28.9)	
Low: 3–4	152	21.0 (18.2–24.1)	1175	18.8 (17.8–19.8)	1327	19.0 (18.1–20.0)	
Medium: 5–6	91	12.6 (10.4–15.2)	1410	22.5 (21.5–23.6)	1501	21.5 (20.6–22.5)	
High 7–8	66	9.1 (7.2–11.5)	975	15.6 (14.7–16.5)	1041	14.9 (14.2–15.8)	
Very high: 9–10	44	6.1 (4.6–8.1)	1125	18.0 (17.1–19.0)	1170	16.8 (15.9–17.7)	

*Sex X—Intersex/indeterminate < 0.00%. *CI*, Confidence interval.

of contact burns increased proportionally with remoteness whilst the inverse was evident in scald burns (Table 3). The proportion of children who had flame burns increased from urban to rural locations (Table 3). Bacterial infection was greater in Aboriginal and Torres Strait Islander children (Table 4). Percentage TBSA was similar between groups (Table 4); however, a greater proportion of Aboriginal and Torres Strait Islander children (15.6%) had a full thickness burn compared to other Australian children (11.6%; $P < .001$). Aboriginal and Torres Strait Islander children had longer LOS 9.5 days (CI: 8.3–10.7), when compared with other Australian children, 4.6 days (CI: 4.1–5.0; Table 4).

Characteristics Associated With Infection After Burns

In Aboriginal and Torres Strait Islander children, the risk ratio of *Streptococcus* sp. infection was 4.3 times greater (9.0 [CI 7.1–11.3]) than other Australian children (2.1 [CI 1.8–2.5]). The risk ratio of *Staphylococcus* sp. infection was even greater in Aboriginal and Torres Strait Islander children (14.4 [CI 12.0–17.2]), compared to other Australian children (8.0 [CI 7.3–8.6]).

In univariate analyses stratified by Aboriginal and Torres Strait Islander status, several factors were significantly associated with *Staphylococcus* sp. infection in Aboriginal and Torres Strait Islander children including flame burns, and TBSA >10% (Appendix 4). The same was evident for *Streptococcus* sp. infection, but for a TBSA > 19% and rural residency. In other Australian children, flame and %TBSA were also significant risks for infection, with *Streptococcus* sp. infection risk in burns above 19% double that of Aboriginal and Torres Strait Islander children. Additional risks for other Australian children, included age (1 to 4 years), partial or full thickness burns for Staphylococcus sp. infection, and partial thickness burns and burns greater than 10% TBSA for *Streptococcus* sp. infection.

In the multivariable model, flame burns, burns above 19% TBSA, and rural residency remained risks for *Streptococcus* sp. infection, with female sex emerging as a risk in Aboriginal and Torres Strait Islander children (Table 5, Figure 1). Burns above 10% TBSA remained as a risk for *Staphylococcus* sp. infection in Aboriginal and Torres Strait Islander children. Full and partial thickness burns, age 1 to 4 years remained a risk for *Staphylococcus* sp. infection, burns above 10% remained as a risk of infection for either species in other Australian children (Table 5, Figure 1).

DISCUSSION

Health inequities for First Nations children hospitalized for a burns injury clearly remain an important social and healthcare issue. Aboriginal and Torres Strait Islander children are overrepresented for burn injury admissions, 10.8% of this registry, while representing approximately 5.3% of the Australian population from 0 to 15 years.[56] In Australia, 44% of Aboriginal and Torres Strait Islander people reside in outer regional to

Table 2. Burn injury characteristics of Australian children admitted to a BRANZ reporting hospital (2009–2018)

	Aboriginal and Torres Strait Islander (n = 723)		Other Australian (n = 6257)		Total (n = 6980)		
Variable	**Count**	**Proportions (CI)**	**Count**	**Proportions (CI)**	**Count**	**Proportions (CI)**	***P***
Primary burn cause							.002
Scald	285	39.4 (35.9–43.0)	3192	51.0 (50.0–52.3)	3477	49.8 (48.6–51.0)	
Food/beverage	115	15.9 (13.4–18.8)	1691	27.0 (25.9–28.1)	1806	25.9 (24.9–26.9)	
Hot water	132	18.3 (15.6–21.2)	1031	16.5 (15.6–17.4)	1163	16.7 (15.8–17.6)	
Other	38	5.3 (3.9–7.1)	469	7.5 (6.9–8.2)	507	7.3 (6.7–7.9)	
Contact	229	31.7 (28.4–35.2)	1587	25.4 (24.3–26.5)	1816	26.0 (25.0–27.1)	
Coal/Ashes	102	14.1 (11.8–16.8)	366	5.9 (5.3–6.5)	468	6.7 (6.1–7.3)	
Vehicle Exhaust	47	6.5 (4.9–8.5)	305	4.9 (4.4–5.4)	352	5.0 (4.6–5.6)	
Household Surface	18	2.5 (1.6–3.9)	312	5.0 (4.5–5.6)	330	4.7 (4.3–5.3)	
Other	62	8.6 (6.8–10.8)	602	9.6 (8.9–10.4)	664	9.5 (8.9–10.2)	
Flame	141	19.5 (16.8–22.6)	662	10.6 (9.8–11.4)	803	11.5 (10.8–12.3)	
Campfire/bonfire	53	7.3 (5.7–9.5)	236	3.8 (3.3–4.3)	739	10.6 (9.9–11.3)	
Lighter/matches	48	6.6 (5.0–8.7)	153	2.5 (2.1–2.9)	289	4.1 (3.7–4.6)	
Other	40	5.5 (4.1–7.5)	272	4.4 (3.9–4.9)	201	2.9 (2.5–3.3)	
Friction	29	4.0 (2.8–5.7)	519	8.3 (7.6–9.0)	312	4.5 (4.0–5.0)	
Treadmill	7	1.0 (0.5–2.0)	308	4.9 (4.4–5.5)	315	4.5 (4.1–5.0)	
Vehicle/Motorbike	20	2.8 (1.8–4.2)	155	2.5 (2.1–3.0)	175	2.5 (2.2–2.9)	
Other	2	0.3 (0.0–0.0)	56	0.9 (0.7–1.2)	58	0.8 (0.6–1.1)	
Other	39	5.4 (4.0–7.3)	296	4.7 (4.2–5.3)	335	4.8 (4.3–5.3)	
Chemical	17	2.4 (1.5–3.7)	101	1.6 (1.3–2.0)	118	1.7 (1.4–2.0)	
Electrical	11	1.5 (0.9–2.7)	49	0.8 (0.6–1.0)	60	0.9 (0.7–1.1)	
Other	5	0.7 (0.3–1.6)	122	2.0 (1.6–2.3)	127	1.8 (1.5–2.2)	
No Cause	6	0.8 (0.4–1.8)	29	0.5 (0.3–0.7)	35	0.5 (0.4–0.7)	
Anatomical location							
Head and Neck (T20X)	120	16.6 (14.1–19.5)	1100	17.6 (16.7–18.5)	1220	17.5 (16.6–18.4)	
Trunk (T21X)	155	21.4 (18.6–24.6)	1526	24.4 (23.3–25.5)	1681	24.1 (23.1–25.1)	
Shoulder and Upper Limb (T22X)	138	19.1 (16.4–22.1)	1360	21.7 (20.7–22.8)	1498	21.5 (20.5–22.4)	
Wrist and Hand (T23X)	123	17.0 (14.5–19.9)	1306	20.9 (19.9–21.9)	1429	20.5 (19.5–21.4)	
Hip and Lower Limp (T24X)	156	21.6 (18.7–24.7)	1260	20.1 (19.2–21.2)	1416	20.3 (19.4–21.3)	
Ankle and Foot (T25X)	87	12.0 (9.9–14.6)	656	10.5 (9.8–11.3)	743	10.6 (9.9–11.4)	

CI, Confidence interval.

Table 3. Burn cause by residential location (ARIA) for Australian children admitted to a BRANZ reporting hospital (2009–2018)

	Scald		Contact		Flame	
ARIA	**Count**	**Proportions (CI)**	**Count**	**Proportions (CI)**	**Count**	**Proportions (CI)**
Aboriginal and Torres Strait Islander Children (n = 723)						
Metropolitan (RA1)	86	50.0 (42.6–57.4)	40	23.3 (17.6–30.1)	27	15.7 (11.0–21.9)
Inner Regional (RA2)	49	45.8 (36.7–55.2)	26	24.3 (17.2–33.2)	20	18.7 (12.4–27.1)
Outer Regional (RA3)	80	38.5 (32.1–45.2)	70	33.7 (27.6–40.3)	45	21.6 (16.6–27.7)
Remote (RA4)	37	30.8 (23.3–39.9)	44	36.7 (28.6–45.9)	26	21.7 (15.2–29.9)
Very Remote (RA5)	32	28.6 (21.0–37.5)	48	42.9 (34.1–52.1)	22	19.6 (13.3–28.0)
Other Australian Children (n = 6257)						
Metropolitan (RA1)	2192	57.7 (56.1–59.2)	708	18.6 (17.4–19.9)	361	9.5 (8.6–10.5)
Inner Regional (RA2)	661	42.3 (39.7–44.8)	536	34.3 (32.0–36.9)	187	12.0 (10.5–13.7)
Outer Regional (RA3)	276	41.0 (37.3–44.7)	244	36.2 (32.7–39.9)	87	12.9 (10.6–15.7)
Remote (RA4)	34	26.0 (19.2–34.1)	60	45.8 (37.5–54.3)	19	14.5 (9.5–21.5)
Very Remote (RA5)	19	32.8 (22.1–45.6)	30	51.7 (39.2–64.1)	4	6.9 (2.7–16.4)

Burn by friction or other not included. *CI*, Confidence interval.

Table 4. Severity of burn injury, bacterial infection, and length of hospital stay for Australian children admitted to a BRANZ reporting hospital (2009–2018)

	Aboriginal and Torres Strait Islander (n = 723)		Other Australian (n = 6257)		Total (n = 6980)		
Variable	**Count**	**Proportions (CI)**	**Count**	**Proportions (CI)**	**Count**	**Proportions (CI)**	***P***
Bacterial infection							
Streptococcus	65	9.0 (7.1–11.3)	131	2.1 (1.8–2.5)	196	2.8 (2.5–3.2)	<.001
Staphylococcus	104	14.4 (12.0–17.1)	497	7.9 (7.3–8.6)	601	8.6 (8.0–9.3)	<.001
Total body surface area %							
Mean		4.4 (3.9–4.8)		4.0 (3.8–4.1)		4.0 (3.9–4.2)	.07
Unknown	26	3.6 (2.5–5.2)	203	3.3 (2.8–3.7)	228	3.3 (2.9–3.7)	
< 10%	612	84.7 (81.8–87.1)	5450	87.1 (86.3–87.9)	6059	86.8 (86.0–87.6)	
10–19%	61	8.4 (6.6–10.7)	461	7.4 (6.8–8.0)	522	7.5 (6.9–8.1)	
> 19%	24	3.3 (2.2–4.9)	147	2.4 (2.0–2.8)	171	2.5 (2.1–2.8)	
Depth of injury							<.001
Superficial thickness	63	8.7 (6.9–11.0)	695	11.1 (10.4–11.9)	758	10.9 (10.2–11.6)	
Partial thickness	547	75.7 (72.4–78.6)	4839	77.3 (76.3–78.4)	5386	77.2 (76.2–78.1)	
Full thickness	113	15.6 (13.2–18.5)	723	11.6 (10.8–12.4)	837	12.0 (11.3–12.8)	
Length of stay (d)							
Mean		9.5 (8.3–10.7)		4.6 (4.1 – 5.0)		5.1 (4.7–5.5)	<.001
< 1	81	11.2 (9.1–13.7)	2103	33.6 (32.5–34.8)	2168	31.1 (30.0–32.2)	
1	86	11.9 (9.7–14.5)	1199	19.2 (18.2–20.2)	1280	18.3 (17.5–19.3)	
2–7	276	38.2 (34.7–41.8)	1888	30.2 (29.1–31.3)	2169	31.1 (30.0–32.2)	
8–28	242	33.5 (30.1–37.0)	918	14.7 (13.8–15.6)	1173	16.8 (16.0–17.7)	
> 28	39	5.4 (4.0–7.3)	148	2.4 (2.0–2.8)	189	2.7 (2.4–3.1)	

CI, Confidence interval.

remote areas, as opposed to 10% of other Australian children.[57] Over 60% of Aboriginal and Torres Strait Islander children in this study resided in these regions, compared to 14% of other Australian children, highlighting the importance of rural residency as a health inequity for these children. Although very low SES was common in any Australian child hospitalized with a burn injury, this proportion was more pronounced in Aboriginal and Torres Strait Islander children, where over 70% of Aboriginal and Torres Strait Islander children came from low to very low SES backgrounds. Greater proportions of low SES have been reported in Native American children and Māori patients admitted for burn injury.[58,59] These results are indicative of impacts from economic marginalization and social exclusion that First Nations communities experience from continued colonization in the form of colonialism (political exclusion, racism, transgenerational trauma).[43,60,61] Australia, like most colonized countries, exists in a state of neocolonialism where colonization continues to affect Aboriginal and Torres Strait Islander communities through structural oppressions; be that land dispossession, racism, transgenerational trauma, health inequities, or political control and assimilation (ie, cashless welfare cards [Cashless welfare cards are an Australian Government income management strategy program. The program uses behavioral control, restricting 80% of an individual's state benefit payment (eg, Centerlink), only allowing this money to be spent on certain items at specific shops[61].]).[43,60,61]

We found LOS for Aboriginal and Torres Strait Islander children to be double that of other Australian children. In this study, our mean of 9.4 days was greater than previous reporting of 6.1 days,[13] perhaps reflecting the use of national data over a 9 year period. The longer LOS for Aboriginal and Torres Strait Islander children could be explained by cause of burn, severity, and patient place of residence. Similarly longer hospital LOS has been reported in Native American communities.[62] Scalds were the most common cause of burns in Australian children,[1,13,27,28] but they decreased as the cause of a burn with increasing remoteness, which is consistent with prior reporting.[24,63] In contrast, the proportion of cases with contact burns increased with remoteness in both child groups, unlike some past reports.[63] These differences may be due to specific amenities being more common rurally, such as the "pot belly" stoves, open fire places, convection ovens or cooktops, and outdoor kitchen facilities.[24,64,65] Flame burn incidence was greater in Aboriginal and Torres Strait Islander children across all areas of remoteness, which is consistent with previous Australian research and comparable to both Canadian Aboriginal children and Native American communities.[13,59,62,66,67] Greater exposure to outdoor-related activities, such as camping, bonfires, and motorbikes, is more common in rural areas and may contribute to these contact and scald results.[64–66]

In Aboriginal and Torres Strait Islander children, flame burns and high %TBSA (>19%) was a risk for infection for both bacteria species. After adjusting for patient and injury characteristics, %TBSA remained as a risk factor. Flame burns remained as a risk for *Staphylococcus* sp. infection and rural residency remained for *Streptococcus* sp. infection. Delayed access to specialized burn centers located in major Australian cities, due to distance and transport availability, may contribute to

Table 5. Multivariate risk ratio (RR) is infection by bacterial species (relative to no infection), in Australian children admitted to a BRANZ reporting hospital (2009–2018)

	Staphylococcus sp.		*Streptococcus* sp.	
Variable	**Aboriginal & Strait Islander RR**	**Other Australian RR**	**Aboriginal & Torres Strait Islander RR**	**Other Australian RR**
Sex (Reference: Male)				
Female	1.1 (0.8–1.6)	1.0 (0.9–1.2)	**1.7 (1.0–2.7)**	1.2 (0.8–1.6)
Age (Reference: <1 y)				
1 to 4 y	1.0 (0.5–1.9)	1.3 (1.0–1.8)	0.6 (0.2–1.4)	0.9 (0.5–1.4)
5 to 9 y	1.2 (0.5–2.5)	1.1 (0.8–1.6)	0.9 (0.3–2.4)	0.7 (0.4–1.3)
10 to 15 y	1.1 (0.5–2.4)	1.0 (0.7–1.4)	1.2 (0.5 – 3.0)	0.6 (0.3–1.1)
Depth of Injury (Reference: Superficial Depth)				
Partial Thickness	1.7 (0.7–4.3)	**3.5 (2.09–5.90)**	2.1 (0.6–8.2)	1.9 (0.8–4.4)
Full Thickness	1.2 (0.4–3.3)	**1.8 (1.0–3.3)**	1.5 (0.4–6.7)	1.2 (0.4–3.3)
Primary Burn Cause (Reference: Scald)				
Contact	1.4 (0.9–2.3)	1.1 (0.9–1.4)	0.9 (0.5–1.9)	0.8 (0.5–1.4)
Flame	**1.6 (1.0–2.5)**	1.2 (0.9–1.5)	1.6 (0.8 – 3.0)	1.3 (0.8–2.2)
Other*	1.2 (0.6–2.6)	1.0 (0.8–1.4)	1.1 (0.5–2.8)	1.0 (0.5–1.8)
Regional Area Index (Reference: Metropolitan to Inner Regional RA1-RA2)				
Outer Regional to Very Remote (RA3–RA5)	1.2 (0.8–1.7)	1.0 (0.8–1.2)	**1.8 (1.0 – 3.0)**	0.8 (0.5–1.5)
% Total Body Surface Area (Reference: Less than 10%)				
10% to 19%	**1.9 (1.1–3.3)**	**2.6 (2.1–3.3)**	1.6 (0.7–3.4)	**3.4 (2.2–5.3)**
Greater than 19%	**4.2 (2.5–7.1)**	**5.1 (3.9–6.8)**	**4.2 (2.1–8.1)**	**9.7 (6.0–15.9)**

*Other—chemical, electrical, friction, and other burns (Table 2). Multivariate risk ratio—RR. Statistically significant results for RR are marked in bold.

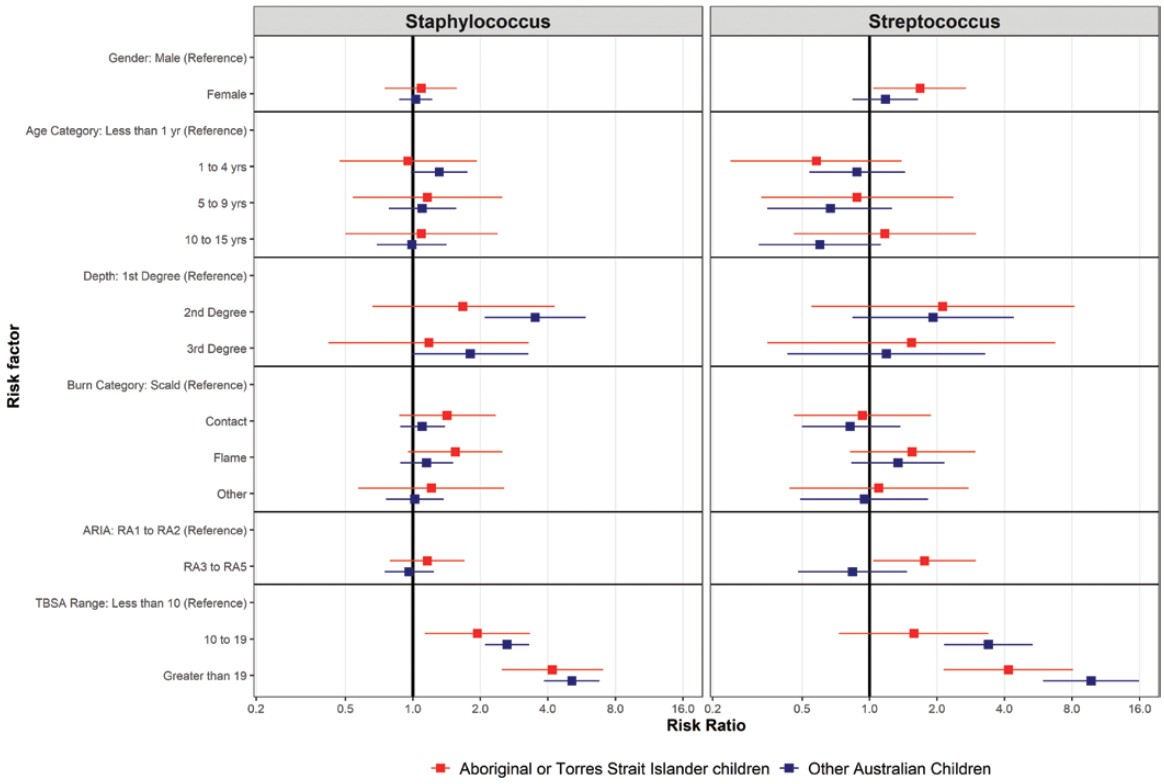

Figure 1. Risk ratio of *Staphylococcus* sp. and *Streptococcus* sp. infection for Aboriginal and Torres Strait Islander children and other Australian children.

this finding. Infection with *Streptococcus* sp. is of particular concern in burns, as unless this infection is cleared before any skin grafting procedure, loss of the graft would likely occur, increasing LOS and the potential for additional operative interventions. The risk of infection with this species was four times greater in Aboriginal and Torres Strait Islander children than other Australian children. Reoccurring *Streptococcus* sp. skin infections can cause acute poststreptococcal glomerulonephritis (APSGN) in children, and in Aboriginal and Torres Strait Islander communities this is an identified risk factor for renal disease later in life.[68–71] Incidence of APSGN in Aboriginal children in the Northern Territory is reported at 124 cases per 100, 000 person-years when compared with 17 cases per 100, 000 person-years for other Australian children; however, recent research has suggested this could be as high as 228 cases per 100,00 person-years for Aboriginal children in Central Australia.[69,72] This health inequity may be minimized in these cases through careful education, ongoing monitoring, and early treatment of Aboriginal and Torres Strait Islander burn injury survivors and their family, to help prevent further manifestation of *Streptococcus* sp. or significant comorbidities later in life.

The burns profile for Aboriginal and Torres Strait Islander children is different from other Australian children. In this profile, persistent health inequities are present, through higher proportions of remote residency, lower SES (a manifestation of ongoing colonization), longer LOS, and increased burn severity (full thickness depth and bacterial infection). Clinical teams need to carefully consider the broader impact of the burn injury on Aboriginal and Torres Strait Islander children and their families. Limited access to local tertiary health and specialized outpatient services in Australia results in rural and remote children having longer hospital LOS.[66,73] The need to access specialized health services becomes an extra burden on families (ie, financial, community responsibilities, or sibling impacts).[13] Furthermore, all burn survivors can expect to face months, or even years of ongoing treatment including further surgery and ongoing therapies. Prevention programs, clinical guidelines, injury rehabilitation programs, education programs, and government policy, looking to target inequities in burns injury, must first target overall health inequities, with a strong focus on the multiple determinants of First Nations' health and concepts of health and well-being.[8,66,74,75] Central to this is a focus on cultural safety, so that initiatives or programs can be designed and tailored to meet the needs of First Nations children and their families.[74]

Strengths and Limitations

At the time of this study, the BRANZ covered 14 hospitals in Australia. This included all Paediatric Burn Centres in Australia; however, children with minor burns may have been treated elsewhere. Not all BRANZ hospitals have been reporting for the same amount of time. Postcode were used to create SES and may not be a true indication for individual patients. Our results are likely to demonstrate an underrepresentation of Aboriginal and Torres Strait Islander children, due to underreporting in routinely collected data.[13,76] Strengths of this paper include a principled approach to account for missing data, engagement with a health equity enquiry, and application of knowledge interface and decolonization methodologies led by the Aboriginal first author.

CONCLUSION

Noticeable health inequities exist in the epidemiological profile of acute burns in Australian children. Aboriginal and Torres Strait Islander children have longer hospital LOS for their injuries, which places an additional burden on families, especially those residing in rural locations and from lower SES backgrounds. Higher risks of bacterial infection are present in Aboriginal and Torres Strait Islander children, adding further challenges and potential for progression of other diseases later in life. For meaningful change programs, policies, and clinical guidelines, targeting burns prevention and treatment must engage with health inequities present in the burns profile of Australian children, especially for Aboriginal and Torres Strait Islander communities.

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APPENDIX 1: KNOWLEDGE INTERFACE FOR RESEARCH IN THIS MANUSCRIPT

(a) A process of deep listening, of engaging with the narrative to numbers, in a way to respect and understand.[44]

APPENDIX 2: PATIENT INCLUSION PROCESS FOR BRANZ DATA

*Oceanian variable in BRANZ is a patient's cultural affiliation, defined as where a patient feels that they belong.[19]

APPENDIX 3: MISSING DATA PROFILE

Table 1. Profile of missing data

Variable	Number missing	%
Length of Stay	751	*10.76*
Burn Depth	539	*7.72*
Socioeconomic Status	49	*0.70*
Regional Area Index	34	*0.49*
Primary Burn Cause	1	*0.01*

All missing data were imputed.

APPENDIX 4. STRATIFIED UNIVARIATE ANALYSIS FOR *STAPHYLOCOCCUS* SP. AND *STREPTOCOCCUS* SP. INFECTION (RELATIVE TO NO INFECTION)

		Staphylococcus sp.		*Streptococcus* sp.	
Variable	**Level**	**Aboriginal and Torres Strait Islander OR**	**Other Australian OR**	**Aboriginal and Torres Strait Islander OR**	**Other Australian OR**
Sex	Male	Reference	Reference	Reference	Reference
	Female	1.02 (0.67–1.56)	1.01 (0.84–1.22)	1.54 (0.92–2.56)	1.17 (0.83–1.66)
Age Category	Less than 1 year	Reference	Reference	Reference	Reference
	1 to 4 years	0.86 (0.37–1.98)	1.38 (1.01–1.89)	0.59 (0.22 – 1.56)	0.89 (0.53–1.49)
	5 to 9 years	1.03 (0.41–2.57)	1.07 (0.74–1.55)	1.12 (0.41–3.10)	0.72 (0.38–1.37)
	10 to 15 years	1.31 (0.54–3.16)	1.18 (0.82–1.71)	1.22 (0.44–3.41)	0.76 (0.40–1.44)
Depth	Superficial thickness	Reference	Reference	Reference	Reference
	Partial thickness	1.93 (0.72–5.16)	4.22 (2.51–7.10)	2.02 (0.54–7.52)	2.37 (1.07–5.24)
	Full thickness	1.77 (0.59–5.29)	2.41 (1.31–4.41)	2.10 (0.50–8.83)	1.92 (0.74–4.95)
Burn Category	Scald	Reference	Reference	Reference	Reference
	Contact	1.20 (0.72–2.01)	0.76 (0.60–0.96)	0.85 (0.43–1.66)	0.51 (0.31–0.85)
	Flame	1.99 (1.17–3.41)	1.33 (1.01–1.74)	2.20 (1.18–4.12)	1.65 (1.04–2.61)
	Other	1.02 (0.46–2.29)	0.73 (0.53–0.99)	1.22 (0.48–3.06)	0.64 (0.35–1.17)
ARIA	Metropolitan (RA1)	Reference	Reference	Reference	Reference
	Inner Regional (RA2)	0.57 (0.27–1.22)	0.81 (0.64–1.01)	0.22 (0.06–0.88)	0.73 (0.48–1.13)
	Outer Regional (RA3)	0.45 (0.24–0.87)	0.87 (0.64–1.18)	0.45 (0.20–1.03)	0.77 (0.43–1.40)
	Remote (RA4)	1.48 (0.82–2.69)	0.93 (0.49–1.76)	1.71 (0.84–3.49)	0.79 (0.22–2.83)
	Very Remote (RA5)	1.54 (0.84–2.82)	0.68 (0.23–2.05)	2.10 (1.04–4.23)	0.36 (0.02–5.93)
%TBSA Range	Less than 10%	Reference	Reference	Reference	Reference
	10% to 19%	2.09 (1.10–3.94)	3.32 (2.57–4.29)	1.58 (0.69–3.58)	4.20 (2.70–6.54)
	Greater than 19%	7.04 (3.06–16.2)	6.55 (4.55–9.42)	7.22 (3.01–17.3)	12.0 (7.25–19.7)