Incidence and Characteristics of Low-Speed Vehicle Run-Over Events in Australian Aboriginal and/or Torres Strait Islander Children and Other Australian Children Aged 0 to 14 Years in Queensland: An 11-Year (1999–2009) Retrospective Analysis

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KEYWORDS
Paediatric; pedestrian; pediatric; low-speed; roll- over; run-over; trauma

ABSTRACT

The main objective of this study is to describe incidence rates (IRs) of low-speed vehicle run-over events among children aged 0 to 14 years in Queensland, Australia, from 1999 to 2009, by Indigenous Australian status. Data on low-speed vehicle run-over events among children aged 0 to 14 years in Queensland were obtained for 11 calendar years (1999–2009) from all relevant data sources using *International Classification of Diseases* (ICD) codes, text description, word searches, and medical notes and were manually linked. Crude fatal and non- fatal IRs were calculated for Indigenous and non-Indigenous children; trends over time were analyzed by chi-square test for trend. Relative risks (RRs) were also calculated. Data on demo- graphics, health service usage/outcomes, incident characteris- tics, and injury characteristics were obtained. Descriptive and multivariate analyses were performed in order to investigate whether these characteristics varied with Indigenous status. IRs were higher among Indigenous Australian children aged 0 to 14 years (21.76/100,000/annum) than other Australian children (14.09), for every year of the 11-year study. The age group most at risk for low-speed vehicle run-over events were young children aged 0 to 4 years, where incidence was 2.13 times greater among Indigenous Australian children (95% con- fidence interval [CI] = 1.67–2.71). There were no significant changes in incidence of low-speed vehicle run-overs among Indigenous Australian children for 0 to 4, 5 to 9, and 10 to 14 years or overall (0–14 years), during the 11-year study period. Over three quarters (*n* = 107) of low-speed vehicle run-over events involving Indigenous Australian children occurred outside of major cities (43.7% in other Australian children). These data indicate that Indigenous Australian chil- dren are at increased risk of low-speed vehicle run-over events and that characteristics of these events may vary as a function of Indigenous status. These results highlight that culturally specific interventions to reduce low-speed vehicle run-over events are required.

Introduction

Injury and poisoning have been identified as the main cause of hospitalization for Australians of Aboriginal and Torres Straight Island[1] descent (Australian Health Ministers Advisory Council, 2011), and the overall burden of disease is greater among this population for almost all diseases, at all ages, in males and females and in remote and nonremote areas (Australian Institute of Health and Welfare, 2016). Indigenous people are 2.9 times more likely to die from a road crash than non-Indigenous persons and up to 6 times more likely to be involved in a road crash (Thomson, Krom, & Ride, 2009). This gap is also apparent in the 0- to 4-year age group, where external causes are the second leading cause of death (nearly 3 times higher than non-Indigenous children), and for children aged 5 to 14 years, the leading cause of death is external causes (Australian Health Ministers Advisory Council, 2011). The Council of Australian Governments (COAG) made a commitment to halving the gap in mortality rates for Indigenous children under 5 within a decade (Australian Health Ministers Advisory Council, 2011). Preventable injuries to children are a significant burden on society and incur considerable cost to the health-care system (Mitchell et al. (2013).

Impact of low-speed vehicle run-over incidents

Low-speed vehicle run-over (LSVRO) is a term used to describe incidents where a pedestrian—usually a child—is injured or killed by a slow-moving vehicle (up to 30 km/hr) in either a traffic or a nontraffic area (Commission for Children and Young People and Child Guardian, 2005). LSVROs have been identified as an area of concern since the mid-1960s (Kravitz & Korach, 1964), and since then, studies have been conducted in various countries, including the United States (Bell, Ternberg, & Bower, 1980; Brison, Wicklund, & Mueller, 1988; Nadler, Courcoulas, Gardner, & Ford, 2001; Silen et al., 1999), the United Kingdom (Campbell-Hewson, Egleston, & Cope, 1997), Austria (Mayr et al., 2001), Canada (Nhan, Rothman, Slater, & Howard, 2009), Brazil (Cavalcanti & Barros De Alencar, 2010), and New Zealand (Hsun-Hsiao et al., 2009; Murphy, White, & Morreau, 2002; Roberts, Kolbe, & White, 1993; Shepherd, Austin, & Chambers, 2010). A collection of

recent finding from this study has indicated that LSVRO incidence in Queensland is highest in the 0- to 4-year age group, in males, and is on the increase for children aged 0 to 15 years (Griffin, Watt, Wallis, Shields, & Kimble, 2014). Additionally, Queensland had the highest incidence of non-fatal events published to date.

We have recently reported that there is some evidence to suggest that Indigenous children may be at greater risk for LSVRO events than non-Indigenous children (Griffin, Watt, Shields, & Kimble, 2014). Some literature from New Zealand indicates that Maori and Pacific Islanders are more frequently involved in driveway run-over events than non-Maori and Pacific Islanders (Hsiao et al., 2009; Murphy et al., 2002; Roberts, Norton, & Jackson, 1995). These authors suggested that possible contributing factors may include inherent cultural practices, housing, and environmental issues. To date, research has focused on driveway injuries only (not other environments), nor have there been studies conducted in Australia regarding the incidence of LSVRO events among the Indigenous population.

The purpose of this study is to describe the incidence of LSVRO events among Indigenous and non-Indigenous children aged 0 to 14 years in Queensland, from 1999 to 2009, and to describe the associated patterns of injury, in order to determine whether there are any differences in patterns of injury as a function of Indigenous status, to inform the development of culturally specific interventions. To the best of our current knowledge, there have been no advances in LSVRO injury prevention interventions in Australian populations, making this the most current data. This is one of a collection of manuscripts from this work, and because it is an important story to be told, publications from the data will continue. Challenges in methodology of linking and identifying the data slowed down the progress of the project.

Methodology

This was a retrospective, population-based cohort study of all fatal and nonfatal LSVRO events that occurred in Queensland among Indigenous and non-Indigenous children aged 0 to 14 years between January 1999 and December 2009. For the purposes of this study, the definition of LSVRO suggested by the Commission for Children Young People and Child Guardian (CCYPCG) and Queensland Injury Surveillance Unit (QISU) has been used: "LSVRO incidents as those where a pedestrian, usually a child, is injured or killed by a slow moving vehicle (<30 kilometres/hour) in both traffic and non-traffic areas." Data were extracted from multiple databases including (a) Queensland admitted patient data collection (QHAPDC), (b) statewide ambulance data (QAS), (c) statewide emergency department data (EDIS), (d) injury surveillance data (QISU), and (e) child death review (CCYPCG) and manually linked. More detailed information

regarding the methodology used in this study has been published elsewhere (Griffin, Watt, Shields, Wallis, & Kimble, 2013; Griffin et al., 2014, 2014).

Data collection

Any child identified as Australian Aboriginal and/or Torres Strait Islander in the relevant database was classified as "Indigenous" for the purposes of this article. We attempted to be as culturally safe with the use of these data as possible, avoiding any low counts of data.

Data analysis

Data were analyzed to identify the risk factors associated with LSVRO events among Indigenous and non-Indigenous children. Crude incidence rates (IRs) were calculated separately for Indigenous and non-Indigenous LSVRO events. The Australian Bureau of Statistics provides population data for Indigenous and non-Indigenous populations for each age year, from 1901 until 2006. After this date, the bureau does provide estimated summary population data for Indigenous and non-Indigenous children, by age group (0–4, 5–9, and 10–14 years), for the Year 2006. The summary data from 2006 were compared with the population data provided per age year, for years up until 2006. There were no marked differences for the age group of interest in this study (0- to 14-year-olds). Hence, IRs were calculated for age group, using the population data by age group provided for 2006 for every calendar year from 1999 to 2009. IRs were calculated separately for males and females and for the total population. Due to the small number of fatalities from LSVRO events among the Indigenous population, IRs were calculated for fatal and nonfatal events combined. Trends over time were analyzed by chi-square test for trend using Epi Info (7.0). Relative risks (RRs) and 95% confidence intervals (CIs) were calculated using SPSS 21.

Descriptive analyses were used to examine the injury characteristics of Indigenous and non-Indigenous children. Where variables were categorical, chi-square analysis was used. Where expected cell counts were less than five, Fisher's exact test was used. For continuous variables, *t* tests or analysis of variance (ANOVA) were used. When assumptions of homogeneity of variance were violated, Kruskal–Wallis tests were used.

Nature of injury, region of body injured, and specific injury were obtained using *International Classification of Diseases–Australian Modification* (ICD-AM) codes documented in QHAPDC, QISU, or EDIS.

Ethics approval

This study was approved by the University of Queensland (2009001464), Children's Health Service District–Human Research Ethics Committee

(HREC/09/QRCH/79), and the Office of Health and Medical Research–Queensland Health (RD002327). Data analyzed were de-identified and reporting deliberately omitted low counts to incorporate cultural safety by avoiding coincidental identification.

Results

IRs for LSVRO events

Over the 11 years from January 1999 to December 2009, a total of 143 children identified as Indigenous were involved in an LSVRO event, yielding an IR of 21.76/100,000/annum. The overall incidence of LSVRO events (0–14 years) was 1.5 times greater among Indigenous children than among non-Indigenous children (95% CI = 1.29–1.85). For non-Indigenous children, the IR was 14.09/100,000/annum (n = 1310). Figure 1 shows the overall IRs for 0- to 14-year-old children for the 11 years of the study, by Indigenous status. In 1999, the incidence of fatal and nonfatal LSVRO events among 0- to 14-year-olds identified as Indigenous in Queensland was 21.78/100,000 population, and there was no significant change in incidence over the 11-year study period ($p > .05$). IRs were higher among Indigenous children than for non-Indigenous children for every year between 1999 and 2009.

Incidence of LSVRO events varied significantly as a function of age group and Indigenous status ($\chi^2 = 26.702$, $df = 2$, $p < .001$). Young children aged 0 to 4 years were most at risk; the incidence (IR = 36.88/100,000/annum) of

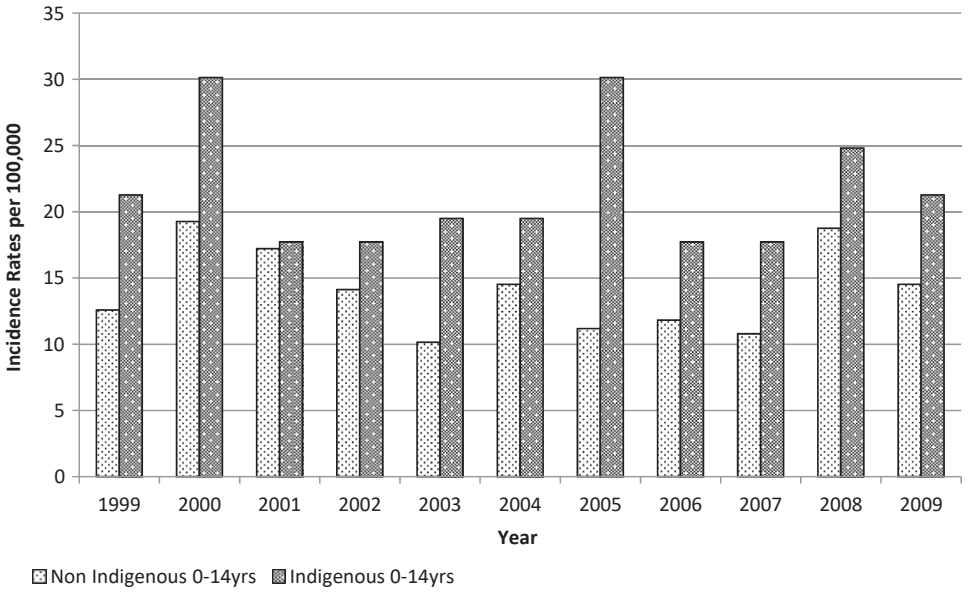

Figure 1. Crude LSVRO incidence by Indigenous status 1999 to 2009. Indigenous total $p > .05$, female $p > .05$, and male $p > .05$. Non-Indigenous total $p > .05$, female $p > .05$, and male $p > .05$.

LSVRO events was 2.13 times greater among Indigenous Australian children than other Australian children (95% CI = 1.67−2.71). Over one half of LSVRO events among Indigenous Australian children occurred in the 0- to 4-year age group, whereas approximately one third of events occurred in this age group in other children (Table 1). The incidence of LSVRO events among Indigenous Australian children in this age group decreased during the study period but not significantly ($p > .05$), whereas a significant reduction was observed among other Australian children ($\chi^2 = 51.49$, $p < .001$). The RR is displayed in Figure 2.

Incidence of LSVROs among 5- to 9-year-old Indigenous Australian children (19.83/100,000/annum) was 1.45 times greater (95% CI = 1.05−2.05) than among other Australian children (IR = 13.64/100,000/annum). Incidence did not change significantly for Indigenous or other Australian children over the 11-year study period ($p > .05$).

Among older children aged 10 to 14 years, lower incidence was observed for Indigenous Australian children (IR = 8.3/100,000/annum) than other Australian children (11.55/100,000/annum), though this difference was not significant (RR = 0.72; 95% CI = 0.44−1.17). Over the 11 years of the study, incidence increased among Indigenous Australian children in this age group (though not significantly; $p > .05$) and significantly among other Australian children ($\chi^2 = 59.08$, $p < .001$).

For every age group, incidence was higher among males than females for Indigenous Australian children and for other Australian children (results not shown). Of the total number of LSVRO events among 0 to 14 years, 82 were Indigenous Australian male children (IR = 25.94/100,000/annum vs. 17.66/100,000/annum for other Australian male children). Incidence was higher among Indigenous Australian girls than other Australian girls (17.42/100,000/annum vs. 10.32/100,000/annum).

Characteristics

Human factors

Socioeconomic status as measured by Socio-Economic Indexes for Areas (SEIFA; Australian Bureau of Statistics, 2018) was used to estimate socioeconomic status in this study. Higher deciles reflect higher relative advantage, and lower deciles reflect lower relative advantage. This varied significantly as a function of Indigenous status. Almost a quarter of LSVRO incidents among Indigenous children occurred in children whose geographical residence reflected a low level of relative advantage ($n = 37$, $\chi^2 = 51.87$, $df = 4$, $p < .001$), compared with 10.5% ($n = 135$) of events among non-Indigenous children. In contrast, one fifth of all events involving non-Indigenous children occurred among those whose geographical residence reflected a high level of relative advantage, where 3.6% ($n = 5$) of Indigenous children were categorized in the same

Table 1. Sample characteristics of Indigenous and non-Indigenous children involved in LSVRO incidents, Queensland, 1999 to 2009.

Sample characteristics		Indigenous (n = 143) n (%)	Non-Indigenous (n = 1310) n (%)
Age (n = 1453, χ^2 = 26.702, df = 2, p < 0.001)	0–4	80 (55.9)	490 (37.4)
	5–9	44 (30.8)	396 (30.2)
	10–14	19 (13.3)	424 (32.4)
Gender (n = 1453, p < .05)	Male	88 (61.5)	848 (64.7)
	Female	55 (38.5)	462 (35.3)
ARIA[a] (n = 1423, χ^2 = 56.340, df = 1, p < 0.001)	Major city	32 (23.0)	725 (56.5)
	Nonmajor city	107 (77.0)	559 (43.5)
SEIFA 1[b] (n = 1426, χ^2 = 51.87, df = 4, p < 0.001)	Deciles 1 and 2	37 (26.61)	135 (10.5)
	Deciles 3 and 4	25 (18.0)	202 (15.7)
	Deciles 5 and 6	37 (25.2)	254 (19.7)
	Deciles 7 and 8	35 (25.2)	436 (33.9)
	Deciles 9 and 10	5 (3.6)	260 (20.2)
Admission type (n = 1453, χ^2 = 10, df = 1, p < 0.001)	ED only	35 (24.6)	501 (38.8)
	Admission	107 (75.4)	791 (61.2)
Day of week (n = 1453, χ^2 = 4.850, df = 1, p < 0.05)	Weekday	110 (76.9)	890 (67.9)
	Weekend day	33 (23.1	420 (32.1)
Location (n = 950, χ^2 = 16.256, df = 3, p < 0.001)	Home or driveway	31 (30.1)	389 (45.9)
	Street or highway	60 (58.3)	322 (38)
	Parking lot	7 (6.8)	62 (7.3)
	Unspecified or other[c]	5 (4.9)	74 (8.7)
Time of incident (n = 474, p < 0.05)	6 a.m.–9 a.m.	5 (8.5)	68 (16.4)
	9 a.m.–midday	6 (10.2)	38 (9.2)
	Midday–3 p.m.	13 (22)	60 (14.5)
	3 p.m.–6 p.m.	26 (44.1)	170 (41)
	6 p.m.–9 p.m.	7 (11.9)	60 (14.5)
	9 p.m.–6 a.m.	<5 (<4)	19 (4.6)
Vehicle type (n = 385)	Four-wheel drive, ute, truck, tractor	4 (12.1)	46 (13.1)
	Car	29 (87.9)	306 (86.9)

[a]Location of usual residence was categorized using Accessibility/Remoteness Index of Australia (ARIA), which was developed by the National Centre for the Social Applications of Geographic Information Systems (GISCA). Each geographical area was allocated a score between 0 and 15, based on the (road) distance to nearby towns that provide services. Scores were then allocated to the following categories: major city: 0.0–0.2, inner regional: 0.2–2.4, outer regional: 2.4–5.92, remote: 5.92–10.53, and very remote: 10.53+).

[b]Socioeconomic Index For Areas (SEIFA) was used to estimate socioeconomic status in this study (Australian Bureau of Statistics, 2018). The first measure was the Index of Relative Socioeconomic Advantage and Disadvantage. Higher deciles reflect higher relative advantage, and lower deciles reflect lower relative advantage.

[c]Farm, bush, park, footpath, or other.

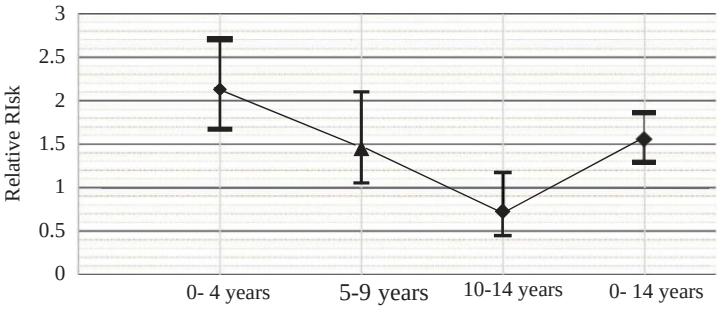

Figure 2. Relative risk of LSVRO by Indigenous status and age (95% CI).

group. The Area of Remoteness Index (ARIA; see Table 1) was scored based on the residential address of the children who were involved in an LSVRO event. Three quarters of LSVRO events involving Indigenous children (77%; $n = 107$) occurred in families residing outside of the state's major cities, compared with 43.5% ($n = 559$) of events in non-Indigenous children ($\chi^2 = 56.3$, $df = 1$, $p < .001$).

Environmental factors

The location of LSVRO events differed between Indigenous and non-Indigenous children ($\chi^2 = 16.256$, $df = 3$, $p < .001$). A total of 3 of every 10 injured Indigenous children and 5 of every 10 non-Indigenous children were run over in the driveway of a private residence, and this was significantly different. More Indigenous (58.3%) than non-Indigenous children (38%, $\chi^2 = 16.256$, $p < .001$) were reported as being run over in a street/highway compared to driveway and other locations. Among events occurring in Indigenous children, location of the incident did not vary as a function of age ($df = 3$, $F = 0.25$, $p > .05$), whereas it did for non-Indigenous children ($df = 3$, $F = 22.54$, $p < .001$). Specifically, for 0 to 4 years, the home/driveway was the most frequent location of incident ($n = 222$, 59%); for 5 to 9 years, street/highway was the most common place of incident ($n = 118$, 43.2%); and for 10 to 14 years, street/highway was also the most common place of incident ($n = 28$, 46.9%). Time of day of incident was not significantly different for Indigenous and non-Indigenous children ($p > .05$). Events most frequently occurred between 3 and 6 p.m. ($n = 196$; 41.4%); a fifth of all incidents occurred between midday and 3 p.m. Day of week of incident did not vary with Indigenous status ($p > .05$), but LSVRO events were significantly less likely to occur on a weekend for Indigenous children than for non-Indigenous children ($\chi^2 = 4.85$, $df = 1$, $p < .05$). Month of year of incident was not significantly different for Indigenous and non-Indigenous children ($p > .05$).

Vehicle factors

Information on vehicle type involved in LSVRO incidents was present in the QISU database and in data on fatal incidents provided by the CCYPCG (Table 1). All patients who were present in the QISU database, and for whom Indigenous status was recorded, were included in the analyses on vehicle type. This includes children who presented for treatment to an emergency department (ED) only (n = 260) and children who were admitted as a consequence of their injuries (n = 178), as well as 22 children who succumbed to their injury.

Among Indigenous children, no LSVRO events in the database involved motorbikes, tractors, or other vehicles, though these vehicle types were involved in LSVRO incidents in non-Indigenous children (motorbikes: n = 10, 2.6%; tractors: n = 7, 1.8%; other: n = 17, 4.5%). For the purposes of analyses, these were combined into one category (see Table 1). The type of vehicle involved in LSVRO events did not vary significantly between Indigenous and non-Indigenous children (p > .05). Cars were the most frequently reported vehicle type associated with incidents among both Indigenous and non-Indigenous children.

Injury characteristics

The mean number of patient days in hospital among Indigenous children who were involved in an LSVRO was 4.3 days (standard deviation [SD] = ±10.63, standard error of the mean [SEM] = ±1.140), compared with 3.25 days among non-Indigenous children (SD = 8.683, M = 0.354); however this difference was not significant (t = 1.043, df = 688, p > .05).

The body region injured did not differ by Indigenous status (p > .05). The most frequently reported primary injury in incidents among Indigenous children was "intracranial injury" (n = 16, 11%), followed by "fracture of lower leg" (n = 15, 11%). By comparison, in the non-Indigenous children, the most frequently reported primary injury was "fracture of lower leg" (n = 108, 8.6%) followed by "superficial head injury" (n = 95, 7.6%).

The nature of the injury did not vary significantly by Indigenous status (p > .05). "Fracture" was the most frequently reported nature of injury for both Indigenous (28%) and non-Indigenous children's incidents (26.5%).

The 10 most frequent specific injury types are listed in Table 2 and ranked in order for Indigenous children. The most frequently reported primary injury in the children identified as Indigenous was "intracranial injury" (n = 16, 11.8%); this injury was ranked third highest among non-Indigenous children involved in LSVRO events (n = 71, 5.7%). The second most frequently reported injury among Indigenous children was "fracture of lower leg, including ankle" (n = 15, 11%), whereas this was the most frequently reported injury for non-Indigenous children (n = 108, 8.6%).

Table 2. Most frequent injury types, stratified by Indigenous status.

	Indigenous incidents		Non-Indigenous incidents	
ICD code, type of injury	Ranking	*n* (%)	Ranking	*n* (%)
s06, intracranial injury	1	16 (11.8)	3	71 (5.7)
s82, fracture of lower leg including ankle	2	15 (11)	1	108 (8.6)
s09, other and unspecified injuries of head	3	11 (8.1)	4	61 (4.9)
S00, superficial Injury to Head	4	8 (5.9)	2	95 (7.6)
s72, fracture of femur	5	7 (5.1)	9	48 (3.8)
s92, fracture of foot, except ankle	6	6 (4.4)	18	24 (1.9)
s93, dislocation sprain strain of joints and ligaments at ankle foot	7	6 (4.4)	12	37 (3)
s01, open wound of head	8	5 (3.7)	5	57 (4.6)
s02, fracture of skull and facial bone	9	5 (3.7)	6	52 (4.2)
T00, superficial injuries involving multiple body regions	10	5 (3.7)	8	49 (3.9)
s90, superficial injury of ankle and foot	13	4 (2.9)	7	50 (4)
s52, fracture of forearm	28	<5 (<1%)	10	47 (3.8)

Discussion

This is the first study in which statewide data across the continuum of care (prehospital to fatality) have been linked to estimate the magnitude and nature of LSVRO events specifically among Indigenous Australian children. IRs were higher among Indigenous Australian children than other Australian children for every year of the 11-year study. The consistently higher IRs in LSVRO events among Indigenous Australian children reflect disparities and health gaps between the Indigenous Australian and mainstream populations (Australian Institute of Health and Welfare, 2016). Given that Indigenous children are at higher risk for sequelae because of poor access to fewer resources, we hypothesize that the consequences for Indigenous children will be worse.

These findings are consistent with the only other published literature on cultural variations in relation to LSVRO events (Hsiao et al., 2009; Murphy et al., 2002; Roberts et al., 1995; Shepherd et al., 2010). Maori and Pacific Islander children were found to be more frequently involved in LSVRO incidents; however "Indigenous-specific" IRs were not calculated in these articles and, therefore, not directly comparable to IRs results discussed in this article. Indigenous children in this study were found to be overrepresented in the socioeconomically disadvantaged scoring which is relative to actual socio-economic distribution. However, this disadvantage could be catastrophic when rehabilitating posttraumatic injury.

Over the 11 years of the study, IRs did not decrease significantly in the Indigenous group when compared to the other Australian children. There were few to no deliberate interventions during this time period; however, there were two famous rugby union players who had unintentionally run over their very young children in this period, and they received a deal of media attention This generated interest in newspapers, blogs, and women's

magazines, but it could be suggested that the reach of this news was not culturally appealing or available to Indigenous Australians.

Although IRs were greater in Indigenous children aged 5 to 9 years compared to other Australian children, rates did not go down significantly for either group. This may have been related to the fact that any media did focus on LSVROs did not highlight any danger to older children. The same trend was not seen in the 10- to 14-year-old groups who both experienced an upward trend. This finding surprised the authors who are yet to hypothesize a reason for the trend.

Interestingly, the time of day of LSVRO events did not differ between Indigenous Australian and other Australian children. However, a recent survey completed in several Indigenous communities indicates that the most dangerous time period for LSVRO events was perceived by the community to be 6 p.m. to 6 a.m. (Willis, 2010). The fact that more LSVRO events involving Indigenous children occurred during midweek may be associated with higher reported rates of nonattendance at school among the Indigenous populations of school age (4 years). Location of the injury incident did not change for Indigenous children, whereas it did for non-Indigenous Australians (more driveway run-overs). Hence, it is also acceptable to raise the question of the level of supervision.

Greater proportions of incidents of LSVROs were occurring outside the metropolitan area for Indigenous children (77%), and this exceeds the 66% of Indigenous children who, according to the Australian Bureau of Statistics, lived outside the metropolitan area in this time period. Although numbers are too low to make definitive statements, the authors are curious as to the potential increased risk of injury for Indigenous children living in rural and remote areas. The increased incidence of events in the Indigenous population sug- gests that Indigenous children are at an even greater risk than what has been reported because fewer Indigenous Australian households have cars when compared with other families. A more accurate exposure of vehicles and vehicle characteristics in events involving Indigenous families with young children is needed (Centers for Disease Control and Prevention, 2015).

The difference in primary injury types is likely attributable to the fact that incidents involving Indigenous children most frequently occurring in 0- to 4-year-olds, who have a much shorter stature, and are, therefore, more likely to have their head come in contact with the vehicle than in the older age groups. Indigenous children were noted to have a higher proportion of fractured femurs, possibly related to the younger age group.

Prevention

It is vital to take into account the contrasting demographic characteristics of the Indigenous population in order to optimize prevention planning. Because of the particular vulnerability of the 0- to 4-year age group, who are unable to reliably respond to instruction even while being supervised, the responsibility of safety around vehicles shifts to adults. Very little is known in terms of the role of supervision in LSVRO events, but increasingly, it is emphasized that effective supervision is complex and resource intensive. Disadvantaged families may be unable to provide these resources, not because of lack of recognition, but the lack of access to resources (Scott, Higgins, & Franklin, 2012). In addition, an Australia-wide survey of Indigenous service stakeholders highlighted that 90% of respondents identified overcrowded homes as a serious or very serious problem. A study in New Zealand found that households with more than three children under 5 years were at greater risk of a driveway incident. Overcrowding should, therefore, be a consideration whenever considering LSVRO prevention in the Indigenous community.

Vehicle safety technologies involving audible sensors and reversing cameras have frequently been suggested to assist in LSVRO prevention (Holland et al., 2000; Hurwitz et al., 2010; Paine & Henderson, 2001); however, the costs of these technologies are beyond the means of the majority of Indigenous families. It has been suggested that most Australians would consider the utilization of these technologies if government reimbursement was available (Jones & Telenta, 2010).

Most research on LSVRO incidents focusses on driveways. Although a significant threat to young children, other areas need to be considered, especially in relation to Indigenous children. Regardless of Indigenous status, in Queensland, the environment outside the driveway needs to be investigated, and research about movement of children through households would provide particularly valuable information for prevention. This is important in large Indigenous households, taking into consideration the specific patterns of flow of children and/or behaviors in Indigenous populations (Willis, 2010).

Limitations

Analyses were limited by availability of data, particularly for nonfatal LSVRO incidents. Data on patients who presented for treatment at an ED only (i.e., were not admitted to hospital or did not succumb to their injury) are incomplete, as not all EDs contributed data to EDIS for the 11-year study period; however, the major EDs are captured in EDIS, and therefore, we are confident that the majority of ED presentations in Queensland are represented. Similarly, not all Queensland hospitals contribute data to QISU. This does not affect ascertainment of LSVRO events but does affect the number of

cases for which additional information such as time of injury, injury circumstance, location of injury, vehicle type, and so on are available. Importantly, identification of Indigenous status is not routinely or consistently collected in all datasets. Hence, it is likely that these results are an underestimate of Indigenous involvement in LSVRO events. This information is not collected at all in prehospital data (i.e., Queensland Ambulance), so LSVRO events resulting in prehospital attendance (and no further treatment) were not included in this study.

In relation to injuries sustained as a consequence of LSVROs, only data on primary injury sustained have been presented here, which is a limitation because LSVRO events often involve more than one injury. Injury severity scores would have been useful to include; however, these were not available.

Conclusion/implications for future research

These data show for the first time that Indigenous Australian children are at greater risk of LSVRO events than other Australian children; young children aged 0 to 4 years are at greatest risk. More research is required to fully comprehend the specific risk factors associated with LSVRO events in Indigenous families and to inform culturally appropriate intervention strategies (e.g., culture, location of incident, remoteness, dwelling design, vehicle design, and patterns of movement). A prospective data collection system is the only possible way to capture this information. Utilizing additional injury and trauma databases (e.g., for injury severity score information), to supplement data on admitted patients and fatal pedestrian, data would assist with the classification of patients. In addition, it is essential to include information of the long-term outcomes of LSVRO events occurring in Indigenous children to inform multidisciplinary opportunities to improve recovery. This depth of research will deliver a context in which to best develop and deliver interventions. Prospective data collection is essential to compare the impact of any interventions implemented over a period of time. These data highlight the need for culturally and age-specific strategies to prevent LSVRO events.

What was already known on the subject?

- Queensland has the highest LSVRO fatality rate in Australia.
- The 0- to 4-year-old age group has been previously described as most at risk.
- Indigenous Australian children are more at risk of injury than non-Indigenous children.
- New Zealand Maori and Pacific Islander population have higher incident counts of driveway run-over incidents compared to New Zealand Europeans.

What this study added

- From 1999 to 2009, Australian Indigenous children aged 0 to 14 years had a higher incidence of LSVROs than non-Indigenous children.
- Indigenous children are less likely to be run over in the driveway than non-Indigenous children.
- LSVRO events in Indigenous children aged 0 to 4 years have the highest incidence.

Note

1. For the purposes of ease of reading, in this article, the authors will, at times, refer to all Aboriginal and Torres Strait Islander people as "Indigenous Australians."

Acknowledgments

We thank Queensland Children's Medical Research Institute for providing a safe and motivating research environment and our data custodians, QHAPDC, QAS, EDIS, QISU, and CCYPCG, for their data extraction assistance. We also thank Dr. Lynore Geia for help with correct wording when referring to Aboriginal and/or Torres Strait Islander people.

Declaration of interest

The authors report no conflict of interest.

Funding

This study was funded under the Queensland Injury Prevention Council.

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