

# Road transport injury in Aboriginal and Torres Strait Islander people in New South Wales, Australia

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Submitted: 7 March 2025; Revision requested: 8 July 2025; Accepted: 5 August 2025

## Abstract

**Objective:** To examine the burden of serious road transport injuries and fatalities among Aboriginal and Torres Strait Islander people in New South Wales (NSW) and identify protective factors to inform targeted road safety initiatives.

**Methods:** This study utilised the NSW Centre for Road Safety linked crash-and-health data from 2005-2023 including police-reported crash, hospital, emergency department, and mortality data. Statistical analysis focused on the burden of serious injury and factors protective of serious injury.

**Results:** Between 2005 and 2023, 7,587 Aboriginal and Torres Strait Islander people aged 17 or older were seriously injured, and 320 were killed in a road transport crash in NSW. Car occupants (53%) and young adults aged 17-29 (48%) were most affected. Fractures (41%) and head injuries (19%) were the most common injuries. Pedestrians experienced the highest proportion of maximum severity injuries (15%). Protective factors for serious injury included wearing seatbelts, holding a standard licence, and crashing in urban areas.

**Conclusions:** The study highlights the significant burden of road transport injuries on communities and identifies key protective factors.

**Implications for Public Health:** Findings emphasise the need for culturally appropriate, community-led road safety initiatives to reduce transport injuries and deaths in Aboriginal and Torres Strait Islander people.

**Key words:** Aboriginal and Torres Strait Islander, Australia, Crash protective factors, Road transport injury

## Background

Despite having been a policy priority for decades and billions of dollars being spent on road safety each year, road transport crashes remain a leading cause of injury and death in Australia, attributing to 1,100 deaths and almost 40,000 hospital admissions each year.<sup>1,2</sup> More than half (53%) of all road transport deaths are car occupants, followed by motorcyclists (18%) and pedestrians (12%).<sup>3</sup> The long-term impacts of injury from transport crashes on the individual and family are often profound, with social and economic costs in excess of \$30 billion per year.<sup>4</sup> Aboriginal and Torres Strait Islander people are disproportionately impacted,<sup>5,6</sup> with

road transport injuries being the second leading cause of death and the fourth leading cause of injury.<sup>7</sup> Of particular concern is a 22% increase in road transport injuries in Aboriginal and Torres Strait Islander people from 2013/14 to 2022/23.<sup>8</sup>

Preventing serious injury and deaths from road transport crashes in Aboriginal and Torres Strait Islander people is a national policy priority.<sup>9</sup> Aboriginal-led road safety programs in Australia have successfully improved driver licencing, child passenger safety, and community road awareness, highlighting the critical role of Aboriginal leadership and ownership,<sup>10,11</sup> but there has only been a small number of studies in Australia investigating transport injuries

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Aust NZ J Public Health. 2025; Online: <https://doi.org/10.1016/j.anzjph.2025.100270>

in Aboriginal and Torres Strait Islander people. Previous studies mainly focussed on crash risk factors such as geography,<sup>12</sup> risky driving,<sup>13,14</sup> behaviour and attitudes,<sup>15</sup> proximal causation,<sup>14</sup> and safer driving programs.<sup>16,17</sup> However, in-depth studies to derive targeted and up-to-date information for prevention are limited. The New South Wales (NSW) statistical profile of the burden of road trauma amongst Aboriginal and Torres Strait Islander people gives a detailed overview, but the last year of data in this report is 2015.<sup>18</sup> More up-to-date information is of particular importance considering the recent increase in people killed in road transport crashes.<sup>19</sup>

This study aims to determine the characteristics of Aboriginal and Torres Strait Islander people seriously injured or killed in a road transport crash and to identify factors protective for serious injury in a crash. Towards these aims, we analysed linked crash and health data to quantify the burden of serious road transport injuries and fatalities and identify protective factors for serious injury or death. The paper presents findings on injury patterns and severity across road user groups, followed by driver and crash characteristics associated with being protective of serious injury or death. The findings are intended to inform road safety initiatives.

## Methods

### Setting

According to the 2021 Census, in NSW 278,000 people (3.4% of the population),<sup>20</sup> identified as Aboriginal and Torres Strait Islander.<sup>21</sup> One-third of Aboriginal and Torres Strait Islander people in NSW live

in the state's capital cities,<sup>20</sup> with the rest living in different levels of rural and remoteness across the state.

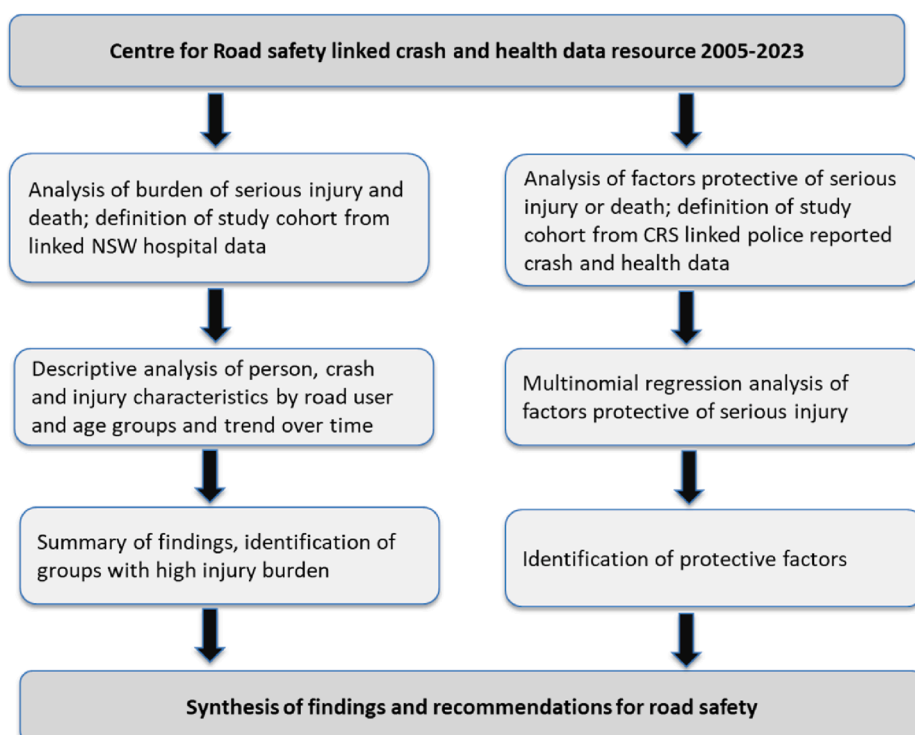
### Data sources

This study used the population-based NSW Centre for Road Safety (CRS) linked crash- and health-data-resource, including police-reported crash, ambulance, emergency department, hospital and mortality data collections from 2005-2023 (Supplement Fig. 1). Data linkage was conducted by the Centre for Health Record Linkage (CheReL). Researchers accessed datasets from which personal identifiers had been removed through a safe remote data connection. The analysis of the burden of serious injury or death from road crashes used the CRS data linked with the NSW Admitted Patient Data Collection (APDC) and mortality data, because it includes all road-users seriously injured or killed (Figure 1, Supplement Fig. 2). The analysis of factors protective of serious injury or death after a crash was restricted to car drivers with a police crash report. This subset was chosen because it enables comparison of crashes resulting in serious injury or death with crashes resulting in no or minor injury, and it records information on factors potentially associated with crash outcomes (Figure 1, Supplement Fig. 3).

### Identification of Aboriginal and Torres Strait Islander people in the linked data

Identification of Aboriginal and Torres Strait Islander people in routinely collected data relies on self-report, and underreporting is a recognised problem.<sup>22</sup> Data linkage offers the opportunity to use more than one data source to identify Aboriginal and Torres Strait Islander people. This study adopted the approach used by the NSW Ministry of Health and the CRS<sup>23</sup> (supplement Box 1).

Figure 1: Research flow chart



## Statistical analysis

The outcome of the study on the burden of serious injury or death from road crashes was hospital admission or death due to a road transport injury. The analysis was stratified by road user groups (car occupants, motorcyclist, pedestrian, pedal-cyclists and other road user). Variables were selected from the linked APDC data including gender, age group, region of hospital admission, reporting year of crash, month of crash, principal injury type, nature of principal injury, injury severity, length of hospital stay, casualty type, crash counterpart, road user group and type of traffic event (Table 1). The injury severity score was derived from the worst injury, grouped into maximum (survival probability (sp) <85.4%), high (sp 85.4%-96.49%), moderate (sp 96.5%-99.19%) and minimum severity ( $\geq 99.2\%$ ). Rates of crashes by year and age groups were calculated using the Australian Bureau of Statistics (ABS) resident population projections.<sup>24</sup>

A strengths-based approach was adopted to investigate factors protective of serious injury or death in a road transport crash.<sup>25</sup> The outcome was severity of injury (no or minor, moderate and serious injury or death) derived from the linked data (supplement box 2), resulting from a road transport crash where the person was the driver of the car. This analysis was restricted to car drivers, because the information in the police crash data are car centred. Variables in the analysis were selected from the police-reported crash data. These were gender, age, licence status, restraint use, number of occupants in the car, status of registration, street alignment, natural lighting, urbanisation, speed limit, type of location group, road surface conditions, first impact type and number of traffic units involved (Table 3). Descriptive statistics were used to tabulate frequencies of the outcome variables by exposure categories, and multinomial logistic regression was used to explore factors associated with crashes resulting in no or minor injury or moderate injury compared with severe injury or death.

## Results

### Burden of serious injury and death from road transport crashes

A total of 7,587 Aboriginal and Torres Strait Islander people aged 17 or above were involved in a crash resulting in serious injury, and 320 were killed in NSW between 2005 and 2023. Most Aboriginal and Torres Strait Islander people who were seriously injured or killed in a road transport crash were car occupants (52.5%), followed by motorcyclists (24.5%), pedestrians (9.7%), pedal cyclists (8.5%) and other road users (4.8%) (Table 1, Figure 1). Most car occupants were aged 17-29 (48.7%) or 30-59 (43.7%), 7.6% were 60 years or older (Supplement Table 2).

A higher percentage of males (67.5%) than females (32.5%) were seriously injured or killed in a road crash. The largest differences between males and females were for motorbike (90.8% male) and pedal-cycle (84.1% male) crashes. Head injuries were the leading type of injury in car occupants (21.1%), pedestrians (23.3%) and pedal cyclists (20.5%) and knee and lower leg injuries (22.4%) in motorcycle riders. Fractures (39.8%) were the leading nature of injury; they contributed to more than half of all motorcycle (52.7%) and 49.1% of pedal-cycle injuries. Most injuries were of moderate (42.8%) or high severity (31.1%). Pedestrians sustained the largest proportion of

maximum severity injuries (14.6%). Car/pick-up/van/ heavy vehicle/ bus were the most common crash counterparts (35.7%) followed by non-collision crashes (28.0%).

Numbers and rates of serious injury or death varied for road user groups over time (Supplement Fig. 4, Table 3-4). For car occupants, rates increased from 2005 to 2016, and declined until 2022, and increased in 2023, with the highest rates in 2016 (210 per 100,000 population). The highest rates of injury and deaths were in those aged 17-29 year olds as car occupants in each year (Supplement Fig. 5). Motorcycle injuries increased over the whole time period.

### Factors protective of serious injury or deaths after road crash

From 2005-2023, 20,402 Aboriginal and Torres Strait Islander people aged 17 or older were involved in 22,393 police-recorded crashes as the driver of a car in NSW. Of these, 2,416 resulted in serious injury or death, 5,465 in moderate injury and 14,512 were minor or no injury crashes (Table 2). Overall, more men ( $n=12,827$ ; 57.3%) than women were involved in a crash and more men sustained serious injuries ( $n=1,444$ , 59.8%). There were differences in crash patterns between males and females, overall and by injury severity (Supplement Table 5). A higher proportion of men ( $n=897$ , 62.1%) than women ( $n=480$ , 49.4%) were involved in single-vehicle crashes resulting in serious injury or deaths, and a higher proportion of women ( $n=297$ , 30.6%) than men ( $n=304$ , 21.1%) were seriously injured in crashes at intersections and in right-angle crashes ( $n=123$ , 12.7% vs.  $n=87$ , 6.0%, respectively).

Drivers in the youngest age group had the highest number of single-vehicle crashes ( $n=3,547$ , 33.2%) followed by those aged 30-59 years ( $n=2,724$ , 26.5%). Most drivers held a standard licence ( $n=11,395$ , 50.9%) and wore a restraint at the time of crash ( $n=20,941$  87.9%). Most drivers were in a registered vehicle at the time of the crash ( $n=19,022$ , 84.9%) and most crashes occurred in metropolitan (Sydney, Wollongong or Newcastle) or in urban country areas ( $n=18,532$ , 82.7%).

In the adjusted regression analysis females had lower odds of minor or no injury after a crash (OR 0.60; 95% CI: 0.54-0.66) than males (Table 3). Each year of increase in age decreased the odds of minor or no injury after a crash by 2%. Drivers holding a standard licence had 70% higher odds of no or minor injury, compared with those driving unauthorised. Drivers wearing a seatbelt (OR 8.54; 95% CI: 6.43-11.33) had higher odds of no or minor injury compared with those not wearing a seatbelt. Compared with those crashing in country non-urban areas, those crashing in Sydney metropolitan area (OR 1.28; 95% CI: 1.04-1.58) had higher odds of no or minor injury after a crash. Each 10 km/h increase in the speed limit decreased the odds of no or minor injury crash by 2%. Those crashing at non-intersections, compared with intersections, had lower odds of no or minor injury (OR 0.81; 95% CI: 0.72-0.92). Drivers crashing in wet conditions had higher odds of no or minor injury (OR 1.51; 95% CI: 1.33-1.72) compared with dry conditions. Compared with head-on crashes, drivers in rear-end crashes (OR 9.50; 95% CI: 7.57-11.91), other angle crashes (OR 5.46; 95% CI: 4.46-6.70) and right-angle crashes (OR 4.44; 95% CI: 3.51-5.61) had higher odds of no or minor injury.

Table 1: Characteristics of Aboriginal and Torres Strait Islander people aged 17 or over seriously injured or killed in a road transport crash, NSW 2005-2023.*							
Variable	Category	Car occupant	Motorcyclist	Pedestrian	Pedal cyclist	Other road user	Total
		Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)
Gender	Male	2362 (55.0)	1824 (90.8)	535 (67.3)	582 (84.1)	216 (55.5)	5519 (67.5)
	Female	1936 (45.0)	184 (9.2)	260 (32.7)	110 (15.9)	173 (44.5)	2663 (32.5)
Age group	17-29	2095 (48.7)	1146 (57.1)	306 (38.5)	232 (33.5)	159 (40.9)	3938 (48.1)
	30-59	1877 (43.7)	804 (40.0)	419 (52.7)	422 (61.0)	186 (47.8)	3708 (45.3)
	60 plus	326 (7.6)	58 (2.9)	70 (8.8)	38 (5.5)	44 (11.3)	536 (6.6)
Region of hospital admission	Greater Sydney	1001 (23.3)	541 (26.9)	298 (37.5)	267 (38.6)	80 (20.6)	2187 (26.7)
	North	1711 (39.8)	749 (37.3)	263 (33.1)	252 (36.4)	147 (37.8)	3122 (38.2)
	South	563 (13.1)	281 (14.0)	87 (10.9)	104 (15.0)	49 (12.6)	1084 (13.2)
	West	611 (14.2)	303 (15.1)	74 (9.3)	55 (7.9)	72 (18.5)	1115 (13.6)
	Unknown	412 (9.6)	134 (6.7)	73 (9.2)	14 (2.0)	41 (10.5)	674 (8.2)
Principal injury type	Head	905 (22.1)	231 (11.8)	185 (24.1)	142 (20.6)	70 (18.0)	1533 (19.4)
	Neck	535 (13.1)	38 (1.9)	22 (2.9)	18 (2.6)	21 (5.4)	634 (8.0)
	Thorax	698 (17.0)	164 (8.4)	52 (6.8)	50 (7.3)	31 (8.0)	995 (12.6)
	Abdomen, lower back, lumbar spine & pelvis	598 (14.6)	162 (8.3)	73 (9.5)	42 (6.1)	37 (9.5)	912 (11.5)
	Shoulder & upper arm	268 (6.5)	195 (9.9)	35 (4.6)	63 (9.1)	40 (10.3)	601 (7.6)
	Elbow & forearm	195 (4.8)	204 (10.4)	50 (6.5)	89 (12.9)	22 (5.7)	560 (7.1)
	Wrist and hand	136 (3.3)	173 (8.8)	22 (2.9)	81 (11.8)	27 (6.9)	439 (5.6)
	Hip & thigh	153 (3.7)	128 (6.5)	48 (6.3)	43 (6.2)	15 (3.9)	387 (4.9)
	Knee, lower leg, ankle, foot	380 (9.3)	579 (29.5)	233 (30.4)	119 (17.3)	59 (15.2)	1370 (17.3)
	Other	230 (5.6)	89 (4.5)	47 (6.1)	42 (6.1)	67 (17.2)	475 (6.0)
Nature of principal injury	Superficial injuries	532 (13.0)	110 (5.6)	59 (7.7)	52 (7.5)	33 (8.5)	786 (9.9)
	Open wound	401 (9.8)	233 (11.9)	90 (11.7)	101 (14.7)	39 (10.0)	864 (10.9)
	Fracture	1364 (33.3)	1059 (53.9)	365 (47.6)	340 (49.3)	130 (33.4)	3258 (41.2)
	Dislocations, sprains & strains	156 (3.8)	94 (4.8)	22 (2.9)	28 (4.1)	21 (5.4)	321 (4.1)
	Injury to internal organs	455 (11.1)	202 (10.3)	100 (13.0)	62 (9.0)	32 (8.2)	851 (10.8)
	Other and unspecified injuries	1016 (24.8)	211 (10.7)	90 (11.7)	68 (9.9)	77 (19.8)	1462 (18.5)
	Unknown	174 (4.2)	54 (2.8)	41 (5.3)	38 (5.5)	57 (14.7)	364 (4.6)
ICISS injury severity indicator - worst injury	Minimum severity	434 (10.1)	338 (16.8)	84 (10.6)	156 (22.5)	89 (22.9)	1101 (13.5)
	Moderate severity	1879 (43.7)	828 (41.2)	307 (38.6)	322 (46.5)	165 (42.4)	3501 (42.8)
	High severity	1395 (32.5)	639 (31.8)	254 (31.9)	170 (24.6)	88 (22.6)	2546 (31.1)
	Maximum severity	378 (8.8)	157 (7.8)	116 (14.6)	41 (5.9)	38 (9.8)	730 (8.9)
	Not recorded	212 (4.9)	46 (2.3)	34 (4.3)	3 (0.4)	9 (2.3)	304 (3.7)
Length of stay group	0-1	1971 (45.9)	789 (39.3)	253 (31.8)	356 (51.4)	181 (46.5)	3550 (43.4)
	2	565 (13.1)	272 (13.5)	91 (11.4)	92 (13.3)	50 (12.9)	1070 (13.1)
	3	314 (7.3)	168 (8.4)	81 (10.2)	70 (10.1)	27 (6.9)	660 (8.1)
	4	202 (4.7)	144 (7.2)	47 (5.9)	28 (4.0)	21 (5.4)	442 (5.4)
	5-7	348 (8.1)	207 (10.3)	61 (7.7)	64 (9.2)	35 (9.0)	715 (8.7)
	8-14	305 (7.1)	210 (10.5)	83 (10.4)	42 (6.1)	31 (8.0)	671 (8.2)
	15-28	200 (4.7)	89 (4.4)	67 (8.4)	18 (2.6)	21 (5.4)	395 (4.8)
	29+	193 (4.5)	84 (4.2)	84 (10.6)	19 (2.7)	23 (5.9)	403 (4.9)
	Not applicable	200 (4.7)	45 (2.2)	28 (3.5)	3 (0.4)	0 (0.0)	276 (3.4)
	Casualty type	Killed	219 (5.1)	53 (2.6)	42 (5.3)	6 (0.9)	0 (0.0)
	Serious injury	4079 (94.9)	1955 (97.4)	753 (94.7)	686 (99.1)	389 (100.0)	7862 (96.1)
Crash counterpart	Car/pick-up/van/ heavy vehicle / bus	1487 (36.3)	445 (22.7)	697 (90.9)	170 (24.7)	23 (5.9)	2822 (35.7)
	Fixed/stationary object	1322 (32.3)	280 (14.3)	0 (0.0)	56 (8.1)	10 (2.6)	1668 (21.1)
	Non-collision	986 (24.1)	818 (41.7)	0 (0.0)	299 (43.4)	113 (29.0)	2216 (28.0)
	Other/unspecified	303 (7.4)	420 (21.4)	70 (9.1)	164 (23.8)	243 (62.5)	1200 (15.2)
Type of traffic event	Non-traffic - off road	261 (6.5)	200 (10.2)	34 (4.5)	94 (13.7)	16 (4.2)	605 (7.8)
	Traffic - public road	3752 (93.1)	1726 (88.1)	630 (83.9)	581 (84.4)	226 (59.9)	6915 (88.6)
	Not specified road type	15 (0.4)	33 (1.7)	87 (11.6)	13 (1.9)	135 (35.8)	283 (3.6)
	Total	4298 (100.0)	2008 (100.0)	795 (100.0)	692 (100.0)	389 (100.0)	8182 (100.0)

\*missing values not shown

**Table 2: Driver and crash characteristics of Aboriginal and Torres Strait Islander people with a police reported crash resulting in serious injury or death, moderate injury or minor or no injury, NSW 2005-2023.**

Variable	Category	Serious injury / death	Moderate injury	Minor / no injury	Total
		Number (%)	Number (%)	Number (%)	Number (%)
Gender	Male	1444 (59.8)	2625 (48.0)	8758 (60.4)	12827 (57.3)
	Female	972 (40.2)	2840 (52.0)	5754 (39.6)	9566 (42.7)
Age group	17-29	1061 (43.9)	2702 (49.4)	6931 (47.8)	10694 (47.8)
	30-59	1142 (47.3)	2461 (45.0)	6691 (46.1)	10294 (46.0)
	60 plus	213 (8.8)	302 (5.5)	890 (6.1)	1405 (6.3)
Licence status	Learner	51 (2.1)	97 (1.8)	287 (2.0)	435 (1.9)
	Provisional	534 (22.1)	1576 (28.8)	3958 (27.3)	6068 (27.1)
	Standard	1100 (45.5)	2549 (46.6)	7746 (53.4)	11395 (50.9)
	Unauthorised	342 (14.2)	557 (10.2)	1131 (7.8)	2030 (9.1)
	Other/ unknown	389 (16.1)	686 (12.6)	1390 (9.6)	2465 (11.0)
Restraint	Belt worn	1845 (76.4)	4777 (87.4)	12400 (85.4)	19022 (84.9)
	Belt not worn	174 (7.2)	99 (1.8)	107 (0.7)	380 (1.7)
	Other / unknown	397 (16.4)	589 (10.8)	2005 (13.8)	2991 (13.4)
Number of occupants	1	1682 (69.8)	3363 (61.7)	8777 (60.7)	13822 (61.9)
	2	459 (19.0)	1254 (23.0)	3378 (23.4)	5091 (22.8)
	3 plus	269 (11.2)	834 (15.3)	2303 (15.9)	3406 (15.3)
Status of registration	Registered	2129 (88.1)	5033 (92.1)	13695 (94.4)	20857 (93.1)
	Not registered	90 (3.7)	118 (2.2)	231 (1.6)	439 (2.0)
	Unknown	197 (8.2)	314 (5.7)	586 (4.0)	1097 (4.9)
Alignment*	Straight	1518 (62.8)	4054 (74.2)	11651 (80.3)	17223 (76.9)
	Curved	898 (37.2)	1411 (25.8)	2860 (19.7)	5169 (23.1)
Natural lighting*	Dawn	88 (3.6)	162 (3.0)	417 (2.9)	667 (3.0)
	Daylight	1279 (52.9)	3439 (63.0)	9562 (66.0)	14280 (63.8)
	Dusk	102 (4.2)	291 (5.3)	886 (6.1)	1279 (5.7)
	Darkness	947 (39.2)	1571 (28.8)	3627 (25.0)	6145 (27.5)
Urbanisation*	Sydney met. Area	421 (17.4)	1182 (21.6)	4828 (33.3)	6431 (28.7)
	Newcastle met. Area	152 (6.3)	416 (7.6)	1199 (8.3)	1767 (7.9)
	Wollongong met. Area	68 (2.8)	154 (2.8)	502 (3.5)	724 (3.2)
	Country urban	866 (35.8)	2565 (47.0)	6179 (42.6)	9610 (42.9)
	Country non-urban	909 (37.6)	1145 (21.0)	1792 (12.4)	3846 (17.2)
Speed limit*	<=50	556 (23.0)	1899 (34.8)	5520 (38.1)	7975 (35.6)
	60	419 (17.3)	1321 (24.2)	4229 (29.2)	5969 (26.7)
	70-80	472 (19.5)	984 (18.0)	2540 (17.5)	3996 (17.9)
	>=90	969 (40.1)	1257 (23.0)	2207 (15.2)	4433 (19.8)
Type of location group*	Intersection	601 (24.9)	2225 (40.7)	6887 (47.5)	9713 (43.4)
	Non-intersection	1815 (75.1)	3239 (59.3)	7623 (52.5)	12677 (56.6)
Surface condition*	Wet	417 (17.3)	1021 (18.8)	2725 (18.8)	4163 (18.6)
	Dry	1981 (82.4)	4417 (81.1)	11742 (81.1)	18140 (81.2)
First impact type	Head-on	279 (11.5)	330 (6.0)	523 (3.6)	1132 (5.1)
	Right angle	210 (8.7)	891 (16.3)	2647 (18.2)	3748 (16.7)
	Rear end	190 (7.9)	1085 (19.9)	4049 (27.9)	5324 (23.8)
	Other angle	315 (13.0)	1033 (18.9)	3616 (24.9)	4964 (22.2)
	Vehicle - Object	1124 (46.5)	1539 (28.2)	2377 (16.4)	5040 (22.5)
	Rollover	271 (11.2)	433 (7.9)	714 (4.9)	1418 (6.3)
	Other/ unknown	27 (1.1)	154 (2.8)	586 (4.0)	767 (3.4)
Number of traffic units involved	1	1377 (57.0)	1995 (36.5)	3173 (21.9)	6545 (29.2)
	2	833 (34.5)	2756 (50.4)	8970 (61.8)	12559 (56.1)
	3 plus	206 (8.5)	714 (13.1)	2369 (16.3)	3289 (14.7)
	Total	2416 (100.0)	5465 (100.0)	14512 (100.0)	22393 (100.0)

\*values for unknown not shown.

## Discussion

Our analysis provides a detailed picture of the epidemiology of road transport injuries and deaths in Aboriginal and Torres Strait Islander

peoples. This paper is also the first to identify factors which are protective of serious injury after a crash using a strength-based analysis.

Car occupants accounted for the highest proportion (53%) of seriously injured road users, followed by motorcyclists, pedal cyclists,

Table 3: Adjusted\* odds ratios of no or minor or moderate injury compared with serious injury or deaths after a vehicle crash as the driver; Aboriginal and Torres Strait Islander people NSW 2005-2023.

Variable	Category	Minor/no injury	p value	Moderate injury	p value
		OR (95% CI)		OR (95% CI)	
Gender	Male	Ref		Ref	
	Female	0.60 (0.54-0.66)	<0.01	1.14 (1.03-1.27)	0.01
Age	Per 1 year increase	0.98 (0.98-0.99)	<0.01	0.98 (0.98-0.99)	<0.01
Licence status	Unauthorised	Ref		Ref	
	Learner	1.27 (0.89-1.81)	0.19	0.87 (0.60-1.28)	0.49
	Provisional	1.42 (1.19-1.69)	<0.01	1.20 (1.00-1.45)	0.05
	Standard	1.70 (1.44-2.01)	<0.01	1.19 (1.00-1.42)	0.05
	Other/unknown	1.05 (0.87-1.27)	0.61	1.00 (0.82-1.22)	0.97
Restraint	Belt not worn	Ref		Ref	
	Belt worn	8.54 (6.43-11.33)	<0.01	3.86 (2.94-5.06)	<0.01
	Unknown	8.59 (6.36-11.59)	<0.01	2.47 (1.84-3.31)	<0.01
Number of occupants	1	Ref		Ref	
	2	1.43 (1.26-1.61)	<0.01	1.29 (1.14-1.47)	<0.01
	3 plus	1.72 (1.49-2.00)	<0.01	1.45 (1.24-1.70)	<0.01
Status of registration	Not registered	Ref		Ref	
	Registered	1.03 (0.77-1.37)	0.86	1.06 (0.78-1.44)	0.71
	Registration status unknown	1.06 (0.76-1.49)	0.72	1.07 (0.76-1.52)	0.69
Alignment	Straight	Ref		Ref	
	Curved	0.92 (0.83-1.03)	0.15	0.91 (0.81-1.02)	0.12
Natural lighting	Darkness	Ref		Ref	
	Daylight	1.27 (0.97-1.66)	0.08	1.23 (0.92-1.63)	0.16
	Dawn	1.43 (1.28-1.60)	<0.01	1.33 (1.19-1.50)	<0.01
	Dusk	1.53 (1.20-1.93)	<0.01	1.31 (1.02-1.68)	0.04
Urbanisation	Country non-urban	Ref		Ref	
	Sydney metro. Area	1.28 (1.04-1.58)	0.02	0.82 (0.65-1.02)	0.08
	Newcastle met. Area	1.06 (0.82-1.36)	0.68	0.92 (0.70-1.20)	0.52
	Wollongong met. Area	1.03 (0.75-1.42)	0.85	0.76 (0.54-1.07)	0.12
	Country urban	1.08 (0.88-1.32)	0.48	1.02 (0.83-1.27)	0.83
Speed limit	Per 10 km increase	0.98 (0.98-0.99)	<0.01	0.99 (0.98-0.99)	<0.01
Type of location group	Intersection	Ref		Ref	
	Non-intersection	0.81 (0.72-0.92)	<0.01	0.83 (0.73-0.95)	0.01
Surface condition	Dry	Ref		Ref	
	Wet	1.51 (1.33-1.72)	<0.01	1.30 (1.14-1.48)	<0.01
	Other/unknown	1.05 (0.40-2.71)	0.93	0.70 (0.24-2.05)	0.51
First impact type	Head-on	Ref		Ref	
	Right angle	4.44 (3.51-5.61)	<0.01	2.36 (1.84-3.03)	<0.01
	Rear end	9.50 (7.57-11.91)	<0.01	4.06 (3.19-5.16)	<0.01
	Other angle	5.46 (4.46-6.70)	<0.01	2.53 (2.04-3.15)	<0.01
	Vehicle - Object	1.89 (1.32-2.72)	<0.01	1.37 (0.93-2.02)	0.12
	Rollover	2.56 (1.73-3.78)	<0.01	1.62 (1.07-2.46)	0.02
	Other/ unknown	19.43 (12.04-31.34)	<0.01	5.99 (3.62-9.88)	<0.01
Number of traffic units involved	1	Ref		Ref	
	2	1.50 (1.07-2.09)	0.02	1.08 (0.75-1.55)	0.67
	3 plus	1.27 (0.88-1.82)	0.21	1.02 (0.69-1.51)	0.92

\*adjusted for all variables in Table and year, months and day of week of crash.

and pedestrians. This pattern is similar to that of the general population in NSW.<sup>26</sup> The number of motorcyclists seriously injured in a crash increased 4.2 fold from 2005-2023 and doubled from 2014-2023. In comparison, numbers changed little in the general population in NSW from 2014-2023<sup>26</sup> but increased in rural and remote areas of Australia over the last decade,<sup>27</sup> where a high proportion of Aboriginal and Torres Strait Islander people live. Poor-quality roads and lack of roadside safety features of regional and remote roads are a major safety issue for motorbike riders.<sup>28</sup> In our

study 42% of motorbike crashes resulting in serious injury were non-collision crashes, suggesting that poor road quality might be a contributing factor. Other contributing factors might be higher off-road motorbike usage in rural and remote areas, and increasing motorbike ownership as it offers a comparatively cheaper form of transport, but the underlying reasons need further investigation, Fractures at 40% were the leading nature of injury, and injuries to the head were the leading injury type, contributing to 19% of all serious injuries overall, and were most common in pedestrians, car occupants

and pedal cyclists. This also has important considerations in access to culturally safe rehabilitation and ongoing support requirements for patients with long-term traumatic brain injuries. The main body regions affected and the nature of injuries were similar to those reported nationally in transport injury data,<sup>6</sup> but the proportion of shoulder and upper limb injuries was lower. This might be explained by differences in road user groups and age as our study only included participants aged 17 years and older.

One third of all road transport injuries were of high severity and 9% of maximum severity. Pedestrians had the highest proportion of deaths among road user groups and at 15%, the highest proportion of maximum severity injuries, which is about double that reported for the general population in NSW.<sup>26</sup> The high proportion of pedestrians with maximum severity injuries may be explained by walking on roads in rural and remote areas with a lack of pedestrian infrastructure, or infrastructure that has not been maintained; similar findings have been previously reported for road fatalities as well as hospitalised injuries.<sup>29</sup>

Car occupants aged 60 years or older had higher rates of fractures and thorax injuries. High rates of thorax injuries in older drivers have also been reported in other studies and have been explained by skeletal fragility due to changes in bone structure and rib cross-sectional geometry.<sup>30,31</sup> In the youngest age group, single-vehicle crashes contributed to one third of all police-reported crashes in which the person was the driver. The relative contribution of these crashes declined in older age groups. This is likely explained by two factors, firstly lack of driving experience resulting in fewer vehicle control skills in younger drivers compared with more experienced older drivers, and secondly, lack of affordability of cars with specialised safety features in younger generations.<sup>32</sup>

Analysis of the police data to identify factors protective of severe injury in drivers showed that, after adjusting for potential confounders and driver and crash characteristics, women had 38% lower odds of sustaining no or minor injury after a crash compared with men. Similar findings have been reported for a cohort of young novice drivers in NSW, which showed that men had a 27% lower rate of crashes that resulted in hospitalisation compared to women.<sup>33</sup> Possible explanations are that women may experience more serious crashes, exhibit a higher likelihood of hospitalisation post-crash, and have higher susceptibility to injuries following crashes compared to men.<sup>34,35</sup> The elevated injury rates in women post-crash have been attributed to biological sex differences in size between males and females, which influence the positioning of drivers within the vehicle concerning safety features like seat belts and airbags, along with other factors such as proximity to the steering wheel.<sup>34,35</sup>

Drivers with a standard licence had higher odds of sustaining no or minor injury after a crash compared with those driving unlicensed. This may be explained by increased driving experience and possibly safer driving as some unlicensed drivers may never have applied for their licence or may have a suspended licence due to penalties, some of which might be related to unsafe driving.<sup>36,37</sup>

Wearing a seatbelt was highly protective against serious injury, with those wearing a seatbelt having 8 times the odds of sustaining no or minor injury in a crash compared with those not wearing a seatbelt. The protective effect of seatbelts in a car crash are well established,<sup>38,39</sup> and wearing a seatbelt has been mandatory in NSW since 1971.<sup>40</sup> Although most drivers wore a seatbelt at the time of crash, which is in line with findings from a survey of road user

behaviour among Aboriginal and Torres Strait Islander people,<sup>15</sup> the highly protective effect shown in this study reiterates the ongoing importance of campaigns encouraging the use of seatbelts at all times.

Travelling in a car with two or three occupants was protective of serious injury in a crash. This is in contrast to findings showing that young novice drivers travelling with peer occupants had higher rates of crashes, in particular fatal crashes, compared with those travelling alone.<sup>41,42</sup> However older drivers have been shown to have lower crash rates when driving with occupants compared with younger drivers, and the rate of crashing with occupants also depends on the occupants—for example, older versus younger passengers.<sup>42</sup>

Crashing in urban areas was protective of serious injury compared with crashes in country areas. Similarly, previous international and Australian whole-of-population studies have also shown a higher proportion of serious injury crashes in rural and remote compared with metropolitan areas.<sup>43,44</sup> This has been explained by higher travelling speeds and less safe roads compared with urban areas. Moreover, delay in access to hospital treatment in remote areas might negatively impact survival and injury severity. This is supported by our finding that higher speed limits and crashing at non-intersection, with higher travelling speeds, decreased the odds of sustaining no or minor injury. Although previous research showed that the overall rate of crash increases in wet conditions,<sup>45</sup> we found that wet road conditions were protective of serious injury. This has also been reported in a previous study from the UK, which showed lower injury severity for crashes in wet compared with dry road conditions.<sup>46</sup> This has been explained by drivers adjusting their driving style to adverse weather conditions travelling at lower speeds, and lower driving exposure as people might delay travel and roads might be closed.

Compared with head-on crashes all other crash types had higher odds of no or minor injury, highlighting the high risk of severe injury in head-on crashes. Similar findings have been reported in Ontario, Canada, with head-on crashes having 13 times the odds of major injury compared to rear-end crash.<sup>47</sup> Divided roads have the potential to reduce cross-median crashes by 97%.<sup>48</sup>

### **Strength and limitations**

The main strength of this study is the large population-based linked data set covering all police-recorded transport injuries and those that resulted in hospital admission or deaths in NSW. Reliance on police data alone can lead to underreporting and misclassification of injuries. Linking police data to hospital and mortality data strengthens the analysis by reducing underreporting (particularly for non-car road user groups) and provides more accurate information on the injury itself.<sup>49</sup> Data linkage also offered the opportunity to identify Aboriginal and Torres Strait Islander people across the different datasets to address underreporting of Aboriginal and Torres Strait Islander status in routinely collected data. Another major strength of this analysis was the leadership provided through an Aboriginal and Torres Strait Islander Governance Group for the overall analyses and interpretation of outcomes.

However, the analysis was restricted by the information collected in the routinely collected data and only covered road transport injuries that were reported to the police or resulted in serious injury requiring hospital admission or deaths. Potential inaccuracies in the external-cause coding in hospital data have been highlighted.<sup>50</sup> A systematic

review reported 85% accuracy in external-cause coding for Australia for broader cause groups based on the ICD-9-CM.<sup>50</sup> Underreporting of crashes with no or minor injuries or those which did not occur on public roads might have impacted on the analysis of factors protective for injury after crash. Moreover, the exposures of interest considered in both analyses were limited to the variables available in the routinely collected data. It would have been desirable to consider other factors such as socioeconomic status, cultural aspects, access to safety resources and driving exposure in the analysis to derive more targeted information for road safety. The information in the police crash data is car centred, and we consequently limited the analysis of factors protective of injury after crash to car drivers.

## Conclusion

We identified characteristics of Aboriginal and Torres Strait Islander people seriously injured in road transport crashes, trends by road user groups, differences by age groups and gender as well as factors protective against serious injury after a crash. Young adults aged 17–29 and males were disproportionately affected, particularly in motorcycle and pedal cycle crashes. Fractures and head injuries were the most common injury types, with pedestrians experiencing the highest proportion of maximum severity injuries. Protective factors associated with reduced injury severity included wearing seatbelts, holding a standard driver's licence and crashing in urban areas. Our findings can help inform road safety initiatives targeted at Aboriginal and Torres Strait Islander communities as well as rural and remote areas. There are currently few road safety initiatives specially targeted at Aboriginal and Torres Strait Islander communities in NSW and Australia. Such programs should be co-designed with community to address community priorities and should be community-led and owned to generate culturally appropriate road safety messaging and education initiatives.

Our study provides comprehensive data to inform injury initiatives for Aboriginal and Torres Strait Islander communities—an identified need in the National Injury Prevention Strategy 2020–2030. Along with findings from the other project studies,<sup>51</sup> it will inform a prevention intervention workshop with the Aboriginal and Torres Strait Islander Governance Group. Workshop findings will be shared with the community, which will be involved in dissemination of the key messages. Policymakers, clinicians, lifetime support authorities and researchers who contributed to the study will be invited to review the findings and discuss the implications for policy development. Moreover, outcomes and initiatives will be translated into policy briefs for key government institutes.

## Ethics approval and project governance

The project “Ongoing Data Linkage of Health Datasets to CrashLink” has ethics approvals from the organisations listed in [Supplement Table 1](#). This project was overseen by an Aboriginal and Torres Strait Islander Governance Group, who provided support for the overall project aims, analyses and interpretations of findings.

## Funding source

This work was supported by the Lifetime Support Authority (Grant Number R2214).

## Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

We acknowledge the traditional lands in which this research was conducted and where outcomes were created and pay respect to their elders, past, present and emerging.

Transport for NSW wishes to thank the following –

- NSW Police Force for supply of road crash data.
- Spinal Cord Injuries Australia for providing coding and data entry service.
- NSW Ministry of Health for providing access to information in the NSW Admitted Patient Data Collection, NSW. Emergency Department Data Collection and the NSW Registry of Births, Deaths and Marriages – Death registrations.
- Centre for Health Record Linkage for conducting the record linkage.
- Aboriginal Health & Medical Research Council for supporting the ongoing data linkage project.
- Independent Hospital Pricing Authority for providing the International Classification of Diseases, 10th Revision, Australian Modification (ICD-10-AM) electronic code lists.
- The State Insurance Regulatory Authority (SIRA) for providing data on Compulsory Third Party insurance and Workers.

Compensation claims.

- The Lifetime Care and Support Authority for data on Lifetime Care participants.
- ACT Health Directorate for providing access to information in the ACT Admitted Patient Care and ACT.

Emergency Department Information System data collections.

- The Cause of Death Unit Record File (COD URF) provided by the Australian Coordinating Registry for the COD URF on behalf of the NSW Registry of Births, Deaths and Marriages, NSW Coroner and the National Coronial Information System.
- The Ambulance Service of NSW for providing data from the Computer-Aided Dispatch, electronic Medical Record and Patient Health Care Record systems.
- Forensic and Analytical Science Service, NSW Health for providing alcohol and drug test results.
- Department of Justice and Community Safety for and on behalf of the State of Victoria, is the source organisation of the coronial information; and the National Coronial Information System (NCIS) is the database source, used for verification of NSW road fatality information.
- NSW Institute of Trauma and Injury Management for access to information on injury outcomes for road crash related casualties that are considered seriously injured by Health.

This reporting of serious injury information forms part of the routine monitoring activity undertaken by Transport for NSW to improve road safety for the community. It was approved by the following ethics committees –

- Approved by the NSW Population & Health Services Research Ethics Committee on 19th December 2013.
- Approved by the Aboriginal Health & Medical Research Council Ethics Committee on 24th January 2014.
- Approved by the ACT Health Human Research Ethics Committee on 13th November 2013.
- Approved by the Calvary Public Hospital Bruce Human Research Ethics Committee on 20th September 2017.

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## **Appendix A Supplementary data**

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.anzjph.2025.100270>.