Inquiry into e-mobility safety and use in Queensland

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Queensland Government

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The Secretariat
State Development, Infrastructure and Works Committee
Queensland Parliament House
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BRISBANE QLD 4000

Email: SDIWC@parliament.qld.gov.au

Re: Queensland Parliamentary Inquiry into e-mobility safety and use in Queensland

To whom it may concern,

The Queensland Trauma, Emergency and Rehabilitation Clinical Networks are multidisciplinary groups of expert clinicians from across Queensland. The following collated submission on the inquiry into e-mobility safety and use in Queensland is from the perspective of trauma, emergency and rehabilitation experts that work in Queensland Health facilities and manage many patients each day with traumatic injuries from the use of e-mobility devices. The following summary has been provided in alignment with the eight key Terms of Reference of the Parliamentary Committee Inquiry.

1. **Benefits of e-mobility devices**
   - Environmental - reduction of air pollution.
   - Physical health - exercise benefits of power assisted e-bikes.

2. **Safety issues associated with e-mobility use**
   - Risk of injury to device users and pedestrians on shared paths, potentially causing long-term disability, chronic pain and psychological impact.
   - Community concern for personal, including safety for older persons navigating public areas.
   - No clear device speed limitations, particularly when modified after purchase, with limited research to determine the maximum safe speed for e-scooters.
   - Serious injury profiling from e-scooter users, with a disproportionate number of e-scooter crashes involving the face/head, when compared to other modes of transport such as pushbike, motor vehicles and motorbikes.
   - Individuals operating high-speed personal mobility devices while under the influence of alcohol pose safety risks.
   - Association between elevated blood alcohol levels and an increased likelihood of motorised vehicle crashes.
   - E-mobility devices often lack standardised requirements for headlights or visibility features, making them difficult for drivers to see at night until it is too late.

3. **Issues with e-mobility ownership**
    - There has been a significant increase in burn injuries resulting from the ownership and use of e-mobility devices with lithium-ion batteries (refer to **Attachment 1** for further details).
    - Users of hire e-bikes and e-scooters often neglect proper storage of the devices, frequently leaving them in positions that obstruct pedestrian pathways. This creates accessibility challenges, particularly for individuals using mobility aids such as manual wheelchairs or four-wheeled walkers.
    - Riders of shared e-bikes and e-scooters are generally less likely to wear helmets, due to limited availability and reluctance to use communal safety equipment.

4. **Suitability of current regulatory frameworks**
    - This should be informed by approaches in Australia and internationally.
    - Current regulation needs to specify areas for appropriate use of e-mobility devices, and licensing or competency requirements.

5. **Effectiveness of current enforcement approaches**
    - There is a continual increase in presentations related to e-mobility devices, further highlighting the importance of this review and any measures to improve safety.
    - A lack of community awareness or the current legislation highlights the need for a broad public safety campaign, and an increased enforcement of legislation.

6. **Gaps between Commonwealth and Queensland laws (importation)**
    - Jurisdiction regulation does not currently align which may cause confusion.

7. **Communication and education about device requirements**
    - There is currently limited communication and education about device requirements, legislation, and consequences for unsafe use.

8. **Broad stakeholder perspectives**
    - The increasing number of patients with e-mobility device injuries places pressure on Queensland Health Emergency Departments and hospital capacity.
    - These unplanned, high-acuity events often involve multiple subspecialty surgical and orthopaedic teams, further increasing demand and impacting other surgeries.
    - Emergency resources are strained with trauma presentations often requiring urgent attention, taking time and resources away from other patients.
    - In cases where an intensive care unit admission is required for an e-mobility device related injury, this causes further hospital capacity pressures and costs.
    - Injuries sustained from e-mobility devices may have lifelong consequences with impact on daily function, employment, mental health and long-term healthcare needs. Often prolonged rehabilitation is required, placing significant pressure on the system.
    - Further information could also be obtained from the Jamieson Trauma Institute, Translational Research Institute, Hopkins Centre, Australasian Faculty of Rehabilitation Medicine (RACP), Royal Australasian College of Surgeons (RACS), Motor Accident Insurance Commission (MAIC), and the National Injury Insurance Scheme Queensland (NIISQ).

Supporting data

- The Queensland Trauma Data Collection reported 6,342 e-mobility device presentations to Queensland Health facilities in 12 months to March 2025.
    - Average age of injury is 29 years for both males and females.
    - Notable trend of severe, disabling, and lifelong injuries.
    - Average age of mortality is 34 years, with the youngest just 13 years old.
    - Total estimated direct healthcare costs are over $15 million dollars (refer to **Attachment 2** for further data and costing breakdown).
- The Royal Brisbane and Women's Hospital reported 1,887 patients presenting from e-scooter injuries between January 2022 and December 2024 (36 months).
    - 860 (45%) sustained head or facial trauma, which is significantly higher than head and facial trauma sustained from other transport mechanisms (18% motor vehicle, 13% motor bike and 26% pushbike).
    - The 2023 Cycling Economy Report[1] reports 18% of Queenslanders use e-scooters and 28% use pushbikes as a mode of transport, inversely proportionate to injury presentations.
- The Queensland Children's Hospital reported an increase in children aged 16 years and under presenting with e-scooter injuries, particularly from 2021-2024[2].
    - Severe injuries in 26.4% of e-scooter presentations.
    - Median age of 13 years (males account for 75% of cases).
    - Most injuries included fractures, with 69% requiring surgery.
    - Refer to **Attachment 3** for full unpublished article.
- The Sunshine Coast University Hospital reviewed the 176 paediatric e-scooter presentations between January 2023 and December 2024[3], with key findings:
    - Median age of 14 years (males account for 71%).
    - Helmet non-compliance (42%), doubling (12%), speeding >25km/hr (36%).
    - Potential or actual life-threatening injuries in 11% of cases.

Recommendations

- **Strengthen and align Commonwealth and Queensland legislation** to prevent import of non-compliant e-mobility devices, specifically if exceeding safe power or speed thresholds.
- **Mandate by law:**
    - **Minimum safety equipment standards** for all e-mobility devices, with penalties for non-compliance. Fines for rental companies that fail to meet safety requirements. Safety equipment must include full-face helmets for all e-scooter riders, particularly for stand-up models.
    - **Minimum age and licensing/competency scheme** - consider a conservative minimum age e.g. 16 years, with online education to ensure riders understand road rules, speed zones and safety in areas shared with pedestrians.
    - **Compulsory third party insurance** for all e-mobility devices used in public areas, similar to current vehicle registration models.
    - **Limitations on e-bike use to roads only, and other devices in designated areas** in pedestrian-heavy community areas.

- **Targeted enforcement of:**
    - **Speed limits**, allowing transfer of penalties to motor vehicle-licenses. Determine minimum speed for each device, based on expert recommendation.
    - **Blood alcohol limits** equal to those applicable to motor vehicles, including drug testing, regardless of the e-mobility device speed capabilities.

    - **Unaccompanied rental devices** when equipment is left in places that endanger public safety. Improve process for reporting improperly discarded devices, e.g. a website or app to upload a photo and report.
- **Data enhancements:**
    - **Implement a standard data identifier** within health systems to capture all incidents and provide accurate surveillance, performance monitoring and inform policy changes.
    - **Invest** in a statewide injury surveillance program for real-time injury severity trends, agile policy response, infrastructure planning, and education.
- **Education:**
    - Cross-agency campaigns targeting young adults and addresses safe riding, protective equipment, dangers of modified devices, pre-ride briefings, real-time alerts, and community engagement strategies.
    - Include schools, higher education and research facilities, healthcare facilities, public service announcements and social media by consumers, consumer advocates, legal and healthcare professionals.
    - Encourage the purchase of sit-down models to reduce high-impact falls.
- **Review healthcare resources** in alignment with the increased demand on specialty services and hospital capacity.
- **Further research** is needed to determine the maximum safe operating speed for e-scooters.

Thank you for the opportunity to provide a submission from trauma healthcare experts, along with supporting data on e-mobility presentations in Queensland. A comprehensive and statewide approach to injury surveillance and research is essential to ensure Queensland is well positioned to monitor emerging risks, inform legislation, implement prevention strategies and target optimal system-level responses to maintain community safety with e-mobility devices.

Please do not hesitate to make contact if you require any further clarification of any information provided in this submission.

Kind regards,

[redacted]

[redacted]

Clinical Co-Chairs, Queensland Trauma Clinical Network
09 / 06 / 2025

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Submission to the Queensland Parliamentary Committee Inquiry on e-mobility safety and use in Queensland: Lithium-ion battery safety

24 May 2025

Submitted by:

[redacted], Royal Brisbane and Women's Hospital

Responding to:

2. Safety issues associated with e-mobility use, including increasing crashes, injuries, fatalities, and community concerns;

8. Broad stakeholder perspectives, including from community members, road user groups, disability advocates, health and trauma experts, academia, the e-mobility industry, and all levels of government.

Summary of Key Points

- There is a rising incidence of serious burns and injuries related to lithium-ion battery failures, particularly in devices such as e-scooters.
- Current injury and registry data systems do not capture detailed product-specific information, limiting surveillance and response capacity.
- Severe injuries disproportionately affect males aged 18–44 and commonly involve the lower limbs and inhalation injuries.
- E-scooter battery explosions are particularly dangerous, often leading to structural fires, deep burns, permanent scarring and even fatalities.
- National standards for lithium-ion battery manufacturing and use are inconsistent or lacking.
- There is an urgent need for prevention through design standards, user education, and centralized reporting mechanisms.

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1. Introduction

This submission is based on a recently published study in the *ANZ Journal of Surgery*, titled *"Lithium-ion battery related burns and emerging trends: a retrospective case series and data analysis of emergency presentations"*. The study, authored by myself and colleagues from the Royal Brisbane and Women's Hospital the Queensland Injuries Surveillance Unit (QISU) and the Jamieson Trauma Institute, identifies worrying trends in lithium-ion battery-related injuries in Queensland.

I submit this evidence in support of greater regulatory oversight and public health strategies to mitigate the growing risk posed by lithium-ion batteries.

2. Clinical Background and Data Summary

The study presents a retrospective analysis of 14 patients admitted with lithium-ion battery-related burns between 2014 and 2023. Key findings include:

- **E-scooters** were the most common device associated with inpatient burns from lithium-ion batteries (57.1%).
- Injuries were often **severe**, with median TBSA (total body surface area) burns higher for e-scooter incidents (median 12%) compared to other devices.
- Over **85% of cases** involved flame burns, with several leading to **house or structural fires**.
- One patient died following burns >90% TBSA from an e-scooter fire.
- A parallel review of **QISU emergency department data** identified 76 presentations over the same period, with a strong male predominance (87%).

This is of the largest **Australian case series** focused specifically on lithium-ion battery burn injuries.

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3. Gaps in Surveillance and Safety Measures

- Current injury surveillance databases (e.g., BRANZ, QISU) **do not consistently capture product-specific mechanisms**, impairing data-driven regulation.
- Despite increasing injuries, **battery product design and usage standards remain largely unregulated**.
- Devices such as **vapes and e-scooters** are marketed widely, often without sufficient public warnings or safe-use education.
- Injuries have occurred even when devices were **not in active use**, especially during **charging while unattended or overnight**.

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4. Recommendations

We urge the Committee to consider the following recommendations:

1. **Mandate national safety standards** for lithium-ion batteries in consumer devices, including e-scooters and vapes.
2. **Introduce clear labelling** and **consumer warnings** on packaging and online platforms.
3. **Develop a national injury reporting mechanism** that includes specific product and usage data.
4. **Educate consumers** about safe charging practices and risks associated with device modification or misuse.
5. **Implement import and sale controls** on devices that do not meet safety specifications.

5. Conclusion

The documented rise in lithium-ion battery-related burns — including life-threatening injuries — represents a preventable public health issue. Australia must act urgently to improve surveillance, standardization, and consumer safety education. These steps will mitigate injuries and save lives.

Financial impact of e-mobility devices on healthcare presentations

The following e-mobility healthcare data was provided by the Queensland Trauma Data Collection, Clinical Excellence Queensland, Queensland Health. All presentations to Queensland Health hospitals are included from 1 April 2024 to 31 March 2025.

	Presentations or admissions	**Annual costings***
Emergency Department (ED)	6,342**	$4,522,446[1]
Admitted hospital care	1,456	$9,900,800
Intensive Care Unit (ICU)	60	$604,800***
TOTAL		**$15,028,046**

*These costings do not include rehabilitation, outpatient services, or long-term care.

** Due to reliance on free-text triage descriptions and the absence of a structured data field, the true number of e-mobility-related ED presentations is likely to be significantly underreported. An additional 24,911 cases included device-related terms such as 'bike', 'scooter', or 'skateboard,' however could not be confirmed as electrically powered.

*** Based on an average 2-day ICU length of stay at $5,040 per bed day[2]

[1] Independent Hospital Pricing Authority (IHPA) Round 22 data for Queensland (https://www.ihacpa.gov.au/sites/default/files/2022-08/Round%2022%20Infographic%20-%20Emergency%20care.pdf)
[2] Australian Critical Care journal (https://www.australiancriticalcare.com/article/S1036-7314%2824%2900178-4/fulltext)

Paediatric surgical trauma secondary to electric scooters at a Level 1 trauma centre in Queensland: a 15-year review

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Abstract

Objectives: Since the introduction of electric scooters (e-scooters) there has been a rapid rise in related injuries and subsequent healthcare burden. At present, there is no data published investigating paediatric e-scooter injuries within Australia. This study aims to describe the incidence and severity of paediatric surgical trauma secondary to e-scooters at a Level 1 trauma centre in Brisbane, Australia.

Design, setting and participants: After obtaining ethics approval, a retrospective case review of paediatric surgical trauma related to e-scooters was performed from the Queensland Children's Hospital Trauma Registry between January 2009 and September 2024. Patients included were those 16 years and under admitted to hospital greater than 24 hours with injuries sustained from e-scooters and those presenting to the Emergency Department (ED) requiring surgery.

Main outcome measures: Primary outcome measures were mortality rate, injury characteristics and operative characteristics. Secondary outcomes were basic demographic data, helmet use, length of stay, admission to paediatric intensive care unit (PICU) and rehabilitation.

Results: There were 72 paediatric patients with injuries related to e-scooter use. There has been a rise in the number of injuries recorded over the study period. Males made up 75% of patients, with a median age of 13 (11-14). Most injuries sustained were minor trauma (73.6%). The head was the most common body region injured (45.8%), followed by external lacerations, contusions and abrasions (44.4%). Fractures were the most common injury type (76.4%). There were two deaths reported from traumatic brain injuries. Helmet use was documented in 69.6% of patients, of which over half of these patients (64.6%) were not wearing helmets. Surgery was required in 69.4% of patients, with 77.7% undergoing orthopaedic surgery, 29.6% requiring wound management and 16.7% requiring neurosurgery.

Conclusion: This study likely underreports total paediatric injuries secondary to e-scooters. However, it is clear these injuries are severe and on the rise. The morbidity and healthcare burden associated with e-scooter trauma remains a topical area of public safety discussion.

Summary box

Since the introduction of e-scooters, there has been a significant rise in paediatric trauma. Injuries are significant, with a high burden of surgical trauma generated. Little published evidence exists describing the incidence and severity of e-scooter trauma in a paediatric population in Australia. This is an important area of public safety discussion given the morbidity these recreational devices pose to our youth. This review describes the paediatric surgical trauma across a 15-year period at a level 1 trauma centre in Queensland, Australia.

Key words

Paediatric surgical trauma, electric scooter, injury, Injury Severity Score, trauma surgery

Introduction

Since the introduction of electric scooters (e-scooters) and ridesharing e-scooters in late 2017 worldwide, their popularity has surged, driven by their convenience, affordability, and environmentally friendly design[1]. However, this rapid growth has been accompanied by a significant increase in injuries and burden on the healthcare system[1,2]. E-scooter related emergency department (ED) presentations among 0–18-year-olds has increased as much as 616% in the United States since the introduction of hireable e-scooters[3]. Common injuries include head trauma and fractures, both of which pose considerable morbidity and mortality[4].

In Brisbane, hireable e-scooters were introduced in November 2018, with current Queensland laws stipulating riders must be at least 16 years old, or 12 years old with adult supervision. Helmet use is legally required, and speed limits of 12 km/h and 25 km/h on footpaths and bicycle paths are mandated respectively[5]. Despite these laws, there has been a rise in paediatric e-scooter injuries.

While literature exists describing e-scooter trauma in the adult population in an Australian context[6], international data suggests the majority of e-scooter injuries occur in paediatric patients[1]. Currently, there is no published research on the incidence or injury profiles from e-scooters in the Australian paediatric population. This study aims to examine the incidence, nature, and severity of paediatric surgical trauma secondary to e-scooters at a level 1 trauma centre in Queensland over a 15-year period. With e-scooters becoming a growing public health concern, we hope to provide information to facilitate evidence-based decision-making.

Methods

The Department of Paediatric General Surgery, Urology, Burns and Trauma maintains a prospective register of paediatric trauma-related admissions to Queensland Children's Hospital (QCH). The Trauma Registry records demographic and clinical characteristics of all major paediatric trauma cases admitted to QCH including all transfers and retrievals from Queensland and northern New South Wales. According to the Trauma Registry, admission to hospital is defined as a greater than 24 hours stay in hospital from time of admission.

A retrospective review of paediatric surgical trauma related to e-scooters was performed from the Queensland Children's Hospital Trauma Registry between January 2009 and September 2024. Patients included were those 16 years and under admitted to hospital for greater than 24 hours with injuries sustained from e-scooters. Separately, injury presentations to the ED related to e-scooters who also required surgical intervention (operations performed within less than 24 hours of their stay in hospital or as an elective procedure) were included in the study. Injuries sustained by e-scooters as the primary rider, secondary rider or pedestrian were included.

The primary outcome measures were mortality rate, body region injured, injury type and operative characteristics. Body regions were categorised as per the Abbreviated Injury Score (AIS). Secondary outcome measures were basic demographic data, helmet use, length of stay, admission to paediatric intensive care unit (PICU) and rehabilitation.

Descriptive statistics were performed for the data where appropriate. For continuous variables, median and interquartile range was calculated and for categorical variables, frequency and percentages were reported. Fisher's exact test was used to assess association between helmet use and head injury. $P < 0.05$ was considered statistically significant. All analyses were performed using GraphPad Prism software (Version 10.4.1.627).

The research proposal was approved by the Human Research Ethics Committee (HREC) chair as meeting the requirements of the National Statement of Ethical Conduct in Human Research (HREC/2024/QCHQ/112748). All data was de-identified and analysed in aggregate, in accordance with the National Statement 5.1.23.

Results

A total of 72 patients were in accidents involving e-scooters during the study period from 2009 to September 2024. There were 8 patients who presented to ED and required surgery and the remaining 64 were admitted to hospital. The number of admissions increased over the years since 2021 (see Figure 1), with 6 patients in 2021, 15 in 2022, 22 in 2023 and 18 up to the conclusion of the study period in September 2024. The median age was 13 years (IQR 11–14). The majority of patients were male (75.0%), and 12.5% identified as Aboriginal and/or Torres Strait Islander.

Most patients were classified as primary riders (94.4%), with only one identified as a secondary rider and three as pedestrians. Helmet use was documented in 69.6% of patients, of which 64.6% were not wearing a helmet at the time of injury.

Among those admitted, 15 (23.4%) were admitted to the Paediatric Intensive Care Unit (PICU). The median length of stay for admitted patients was 3.65 days (IQR 1.89–6.73). Most patients (88.9%) were discharged home, while 8.3% required admission to the rehabilitation unit. Two patients (2.8%) died due to severe brain injuries and were not wearing helmets at the time of the incident.

Injury Profile

Injury Severity Score (ISS) differed between groups, with a median ISS of 3 (IQR 2–4) among those discharged from ED requiring surgery, compared to 9 (IQR 4–14) for admitted patients. Minor trauma (ISS less than or equal to 12) accounted for 73.6% of all patients, while 26.4% were classified as major trauma (ISS greater than 12). Multi-trauma (defined as two or more body regions involved) was present in 44.4% of the cohort.

Falls were the most common mechanism of injury (73.6%), followed by collisions (26.4%). Injuries most frequently involved the head, face, or neck (45.8%) and external body surfaces (44.4%). Upper limb injuries were observed in 26.4% of patients and lower limb injuries in 25.0%. Thoracic, abdominal, and spinal regions were affected in fewer than 11% of patients.

Fracture was the most common type of injury in patients (76.4%), followed by external abrasions, lacerations or contusions (48.6%) and intracranial injuries (37.5%). External injuries were most commonly reported in the head, face or neck (42.1%) and lower limb (28.1%) regions. Skull

fractures accounted for 35.7% of all fractures, while upper and lower limb fractures accounted for 29.2% and 21.3%, respectively. 37.5% of patients suffered an intracranial injury, with intracranial bleeding reported in 86.2% of those patients, and severe traumatic brain injury in 13.8%. Other injuries included thoracic organ damage in five patients and abdominal injuries in four.

Lack of helmet use was significantly associated with head injury (defined as skull fracture or intracranial injury) (Table 1, $p<0.001$).

Operative Management

Operative intervention was required in 69.4% of patients, including all patients discharged from ED taken to theatre electively from the outpatient setting. A total of 54 operations were performed on 50 patients.

The most common procedures included wound washout, debridement, or dressing (29.6%); lower limb fracture open reduction internal fixation (ORIF) (18.5%); craniotomy (18.5%); and upper limb fracture ORIF (11.1%). Closed reductions were performed for both upper (7.1%) and lower limb fractures (5.4%). Less frequent procedures included ICP monitor insertion, insertion of intercostal catheters, and external fixation of pelvic or lower limb injuries.

Table 1: Characteristics of patients involved in electric scooter injuries

	Discharged from ED requiring surgery (n=8)	Admitted to hospital (n=64)	Total (n=72)
Age (median (IQR)) (years)	14 (13-15)	13 (11-14)	13 (11-14)
Sex (n (%))			
Male	5 (62.5%)	49 (76.6%)	54 (75.0%)
Female	3 (37.5%)	15 (23.4%)	18 (25%)
Indigenous status			
Identifies as Aboriginal and/or Torres Strait Island	2 (25%)	7 (10.9%)	9 (12.5%)
Does not identify as Aboriginal and/or Torres Strait Islander	6 (75%)	57 (89.1%)	63 (87.5%)
Patient type			
Primary rider	7 (87.5%)	61 (95.3%)	68 (94.4%)
Secondary ride	1 (12.5%)	0 (0.0%)	1 (1.4%)
Pedestrian/Non-rider	0 (0.0%)	3 (4.7%)	3 (4.2%)
Helmet use *			
Yes	2 (33.3%)	15 (35.7%)	17 (35.4%)
No	4 (66.7%)	27 (64.3%)	31 (64.6%)
Undocumented	2 (25.0%)	19 (31.1%)	21 (30.4%)
Admission to PICU	0 (0.0%)	15 (23.4%)	15 (20.8%)
Length of stay (median (IQR)) (days)	-	3.65 (1.89-6.73)	
Discharge destination			
Deceased	0 (0.0%)	2 (3.1%)	2 (2.8%)

Rehabilitation	0 (0.0%)	6 (9.4%)	6 (8.3%)
Home	8 (100.0%)	56 (87.5%)	64 (88.9%)

*Calculation of totals/percentage for these variables excluded the three non-riders

Table 2: Injury characteristics secondary to electric scooters presenting to Queensland Children's Hospital Emergency Department requiring surgery and those admitted to hospital

	Discharged from ED (n = 8)	Admitted to Hospital (n =64)	Total (n = 72)
ISS Score (median (IQR))	3 (2-4)	9 (4-14)	9 (4-12.25)
Severity (n (%))			
Minor trauma (ISS less than or equal to 12)	8 (100.0%)	45 (70.3%)	53 (73.6%)
Major trauma (ISS greater than 12)	0 (0.0%)	19 (29.7%)	19 (26.4%)
Multi-trauma*	2 (25.0%)	30 (46.9)	32 (44.4%)
Mechanism of injury			
Fall	8 (100.0%)	45 (70.3%)	53 (73.6%)
Collision	0 (0.0%)	19 (29.7%)	19 (26.4%)
Region injured (n (%)) †			
Head, face, or neck	0 (0.0%)	33 (51.6%)	33 (45.8%)
Upper limb	4 (50.0%)	15 (23.4%)	19 (26.4%)
Lower limb	1 (12.5%)	17 (26.6%)	18 (25.0%)
Thorax	0 (0.0%)	7 (10.9%)	7 (9.7%)
Abdomen	0 (0.0%)	3 (4.7%)	3 (4.2%)
Spine	0 (0.0%)	3 (4.7%)	3 (4.2%)
External**	5 (62.5%)	27 (42.2%)	32 (44.4%)
Pelvis	0 (0.0%)	4 (6.3%)	4 (5.6%)
Type of injury†			
External (n (% of total external injuries))**			

Total patients	5 (62.5%)	30 (46.9%)	35 (48.6%)
Total external injuries	7	51	57
Head, face, or neck	2 (28.6%)	22 (43.1%)	24 (42.1%)
Trunk	0 (0.0%)	4 (7.8%)	4 (7.0%)
Upper limb	3 (42.9%)	11 (21.6%)	13 (22.8%)
Lower limb	2 (28.6%)	14 (27.5%)	16 (28.1%)
Fracture (n (% of total number of fractures))			
Total patients	5 (62.5%)	50 (78.1%)	55 (76.4%)
Total fractures	5	65	70
Skull	0 (0.0%)	25 (38.5%)	25 (35.7%)
Upper limb	4 (80.0%)	15 (23.1%)	19 (29.2%)
Lower limb	1 (20%)	15 (23.1%)	16 (21.3%)
Thorax	0 (0.0%)	3 (4.6%)	3 (4.3%)
Pelvic	0 (0.0%)	3 (4.6%)	3 (4.3%)
Spine	0 (0.0%)	4 (6.2%)	4 (5.7%)
Intracranial injury			
Total patients	0 (0.0%)	27 (42.2%)	27 (37.5%)
Total intracranial injuries	0	29	29
Severe TBI	0 (0.0%)	4 (14.8%)	4 (13.8%)
Intracranial bleed	0 (0.0%)	25 (92.6%)	25 (86.2%)
Thoracic organ injury	0	5 (7.8%)	5 (6.9%)
Abdominal injury			
Total patients	0	4 (6.3%)	4 (5.6%)
Total abdominal injuries	0	6	6
Abdominal wall haematoma	0 (0.0%)	1 (16.7%)	1 (16.7%)
Grade I renal injury	0 (0.0%)	1 (16.7%)	1 (16.7%)
Grade III renal injury	0 (0.0%)	1 (16.7%)	1 (16.7%)
Grade III splenic injury	0 (0.0%)	1 (16.7%)	1 (16.7%)
Grade IV splenic injury	0 (0.0%)	1 (16.7%)	1 (16.7%)
Grade IV liver injury	0 (0.0%)	1 (16.7%)	1 (16.7%)

† A single patient may have sustained multiple injuries, to multiple sites. *Multi-trauma was defined as two or more body regions involved. **External body region includes lacerations, contusions, abrasions and burns as per AIS scoring system. Multiple external injuries were counted once per patient.

Table 3: Helmet use and head injury (defined as skull fracture and intracranial injuries)

	Helmet	No Helmet	Not documented
Head injury	6	22	5
No head injury	11	9	16

P <0.01 (Fisher's exact test)

Table 4: Operative characteristics of included patients

	Emergency Department (n=8) (%)	Admitted Patients (n=64) (%)	Total (n=72) (%)
Operative treatment (n (%))	8 (100.0%)	42 (65.6%)	50 (69.4%)
Number of operations †	8	46	54
Operation performed (n (%)) †			
Wound washout/debridement/ closure/dressing	3 (37.5%)	13 (28.3%)	16 (29.6%)
Upper limb fracture open reduction internal fixation (ORIF)	2 (25.0%)	4 (8.7%)	6 (11.1%)
Lower limb fracture open reduction internal fixation (ORIF)	0 (0.0%)	10 (21.7%)	10 (18.5%)
Craniectomy/craniotomy	0 (0.0%)	10 (21.7%)	10 (18.5%)
ICP insertion	0 (0.0%)	2 (4.3%)	2 (3.7%)
Insertion of ICC	0 (0.0%)	1 (2.2%)	1 (1.8%)
Lower limb external fixation	0 (0.0%)	1 (2.2%)	1 (1.8%)
Pelvic external fixation	0 (0.0%)	1 (2.2%)	1 (1.8%)
Upper limb closed reduction	2 (25.0%)	2 (4.3%)	4 (7.1%)
Lower limb closed reduction	1 (12.5%)	2 (4.3%)	3 (5.4%)

Nasal fracture closed reduction	0 (0.0%)	1 (2.2%)	1 (1.8%)

†A single patient may have had multiple operations.

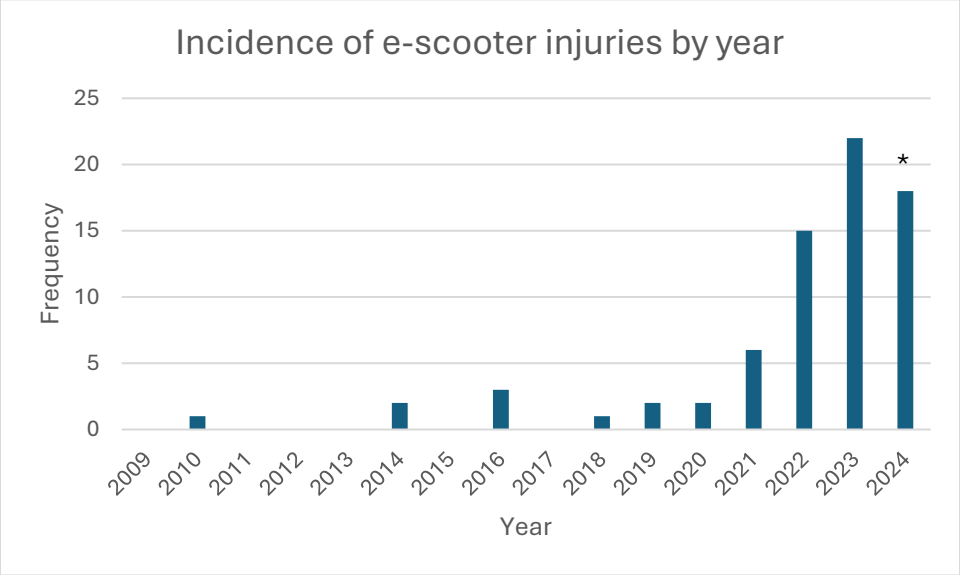

Figure 1: Frequency of paediatric electric scooter emergency department presentations requiring surgery and admissions from 2009 to September 2024*.

Discussion

This is the first study in Australia to examine paediatric e-scooter injuries at a level 1 trauma centre. The study's 15-year timeframe demonstrates a progressive rise in e-scooter related injuries since the introduction of e-scooters in Brisbane at the end of 2019. Reassuringly, 73.6% of injuries are in the minor ISS category and are likely not expected to cause long-term consequences. However, for the remaining 26.4%, there are documented severe injuries including intracranial bleeds, traumatic brain injuries, severe long bone fractures requiring operative intervention, and two fatalities. Our results offer insight into the nature and severity of these injuries in children and adolescents and provides valuable data for evaluating public health responses.

Our results align with international paediatric e-scooter studies[3,7,8]. A United States national database review of 902 paediatric e-scooter ED presentations over five years showed similar gender proportion (72% males), although slightly younger (11.3 years old)[3]. Unfortunately, in terms of assessing injury severity internationally, these paediatric studies did not report trauma severity by ISS or alike. Most common body region injured and injury type were the same compared to our study, with head injury (37.5%) and fracture (42.9%). However, we report much higher rates of both, highlighting the severe head injuries associated with e-scooters and likely high energy trauma resulting in fractures. This study is the first to document the severity of e-scooter head injuries in children, which has been well established in other wheeled recreational devices[9].

A two-year paediatric review of e-scooter presentations in the United Kingdom (UK) had higher reports of lack of helmet use, with 97% compared to our study in which 64.6% of patients had no helmet use in those documented[7]. This difference is likely explained by the lack of mandated helmet use in the UK[10]. Despite the legal requirement in Queensland, there remains poor helmet use, with significantly associated head injuries. In addition, a large proportion of riders in this study (21.7%), were under the legal age of 12 to be riding an e-scooter. Supervision was not consistently documented, and therefore we are unable to determine whether those over the age of 12 were supervised as per legislative requirements.

Operative rate was lower in this UK review, with 18% requiring emergency surgeries[7]. Another UK case series reported 50% operative rate on fractures[8], which was the most common type of

surgery performed in our cohort. The 2.8% mortality rate in our cohort cannot be understated, with international studies having not reported any fatalities in paediatric e-scooter populations. Admission to PICU, which accounts for a quarter of our population, carries significant association with higher mortality and severe injuries[11].

Australian adult e-scooter data shows an even gender proportion compared to our data in children. This may be explained by higher risk-taking activity in adolescent males compared to adults[12-14]. Intoxication was reported in up to 50% of patients in a Northern Territory study of 111 adults in 2022[13]. Intoxication was inconsistently documented in our paediatric data. A Melbourne review reported major and minor trauma as defined by ISS greater than 12, with 91.8% of adults sustaining minor injuries compared with our 73.6%[6]. A Tasmanian review of 161 adult e-scooter ED presentations and admissions over a six-month period was the only study to document median ISS, with a score of two[12]. Compared to our study's median score of nine, children may be likely to sustain more severe injuries when involved in e-scooter accidents. Body region injured remains consistent among adults and children, with extremity and head injuries the most common[6,13]. Operative intervention was also lower in these Australian adult reviews, with only 25% to 33% requiring operative management of their injuries compared to our 69.4%[12,13]. This difference in injury severity and operative intervention compared to adults may be somewhat explained by this study's focus on paediatric injuries requiring admission and surgical management.

While there is public health concern regarding the rise in injuries since the introduction of the hireable e-scooters, it should be noted privately owned e-scooters pose similar if not greater risk for injuries, with some studies reporting up to 92% of accidents involved private e-scooters[7]. Hireable e-scooters have regulations with speed limit controls[5], whereas private e-scooters are unregulated and have the capacity to be modified to dangerous speeds. Hireable or private e-scooters involved in this study were not differently recorded.

The strengths of this study include a nation-wide first assessment of paediatric e-scooter injuries spanning a time period prior to their gain in popularity and access. The use of prospective trauma registry data from a major trauma hospital in this study facilitated detailed and accurate injury reports. This study was able to report ISS while many similar studies did not. The inclusion of admissions and those requiring surgical management provides a focussed view of the severe

spectrum injuries and their management, which must be acknowledged when comparing to other studies.

There are several limitations to consider with this retrospective review. Our study does not capture all e-scooter-related injuries. Remaining emergency department visits not requiring surgery and injuries managed in primary care settings are not able to be obtained, underestimating the total number of injuries related to e-scooters. Additionally, healthcare costs related to e-scooter injuries were not quantified, and intoxication at the time of injury was not documented.

Future research should aim to include data from emergency departments, primary care, and other healthcare facilities to better understand the full scope of e-scooter injuries. A national registry could provide more accurate data, providing further resources for informing policy decisions and safety interventions.

This study highlights the alarming rise in paediatric e-scooter injuries. While the data may underreport the total number of injuries, it is clear that e-scooter accidents can result in fatal outcomes. The high rate of surgical intervention and the concerning lack of helmet use suggest more robust safety measures are needed. Despite regulations, we report cases of injury in children less than the legal age and with no helmet use. Efforts to promote helmet use, regulate e-scooter use, and improve public safety awareness will be critical in reducing the healthcare burden associated with these injuries. While e-scooters offer a convenient and environmentally friendly mode of transport, especially among children, their use must be evaluated to inform policymaking for the safety of the community.

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Conflict of Interest

There are no conflicts of interest.

Data sharing statement

The de-identified data we analysed are not publicly available, but requests to the corresponding author for the data will be considered on a case-by-case basis.

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Competing interests

No relevant disclosures.