Shared electric scooter injuries admitted to Auckland City Hospital: a comparative review one year after their introduction

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ABSTRACT

AIM: E-scooters were introduced to New Zealand in 2018 as a means of city transport. Since their introduction, their use has resulted in high injury rates. No studies have directly compared e-scooters to other forms of transport.

METHOD: The Auckland City Hospital trauma registry was retrospectively searched for patients admitted with an e-scooter injury. A comparison group of patients admitted with an injury secondary to cycling during the same period was collected.

RESULTS: 178 patients were identified: 69 with e-scooter injuries and 109 with injuries sustained while cycling. The hospitalisation rate for e-scooter injuries was 326 hospitalisations per million hours. There was a significant difference found in blood ethanol levels (18.6 vs 6.4% positive, p-value=0.01), mechanism of injury (isolated falls: 87 vs 60.6%), time of injury (55.1 vs 40.4% between 5pm–8am) and protective gear use (worn in 10.1 vs 78.9%). No differences were found in injury severity, ICU admissions, length of stay or mortality.

CONCLUSION: This study demonstrates a concerningly high e-scooter-related hospitalisation rate and suggests e-scooters are currently not as safe as cycling. Strategies to improve e-scooter safety are needed and could include zero tolerance for alcohol, mandatory protective gear, restricted operating times and changes in road laws.

An electric scooter (e-scooter) is a micro-mobility device with a small electric-powered motor allowing speeds exceeding 25km/hr. E-scooter popularity has increased worldwide following the introduction of shared e-scooter systems in the US in 2017. The shared e-scooter system was first introduced to Auckland in October 2018 following the decision by the Auckland City Council to grant a three-month trial period.[1]

Since their launch, there has been significant media attention covering the high rates of accidental injuries and fatalities associated with their use.[2] The Auckland City Hospital (ACH) trauma department has noticed a corresponding increase in admissions related to e-scooter use, and concern has been raised accordingly.

Multiple Auckland-based studies have investigated e-scooter-related injuries. The studies have included analysis of the pattern of injuries sustained, the impact on emergency department imaging, the regional healthcare cost and the burden of injury.[3–6] Because transport types have not been compared directly, it is currently unclear whether e-scooters pose a higher risk of injury when compared to similar, low-velocity methods of transport. The aim of this study is firstly to compare e-scooter- and bicycle-related injuries admitted to ACH, to determine whether the hospitalisation rate is truly higher, and secondly to compare injury factors, injury severity and hospital-specific factors.

Methodology

Study design

A retrospective analysis of patients admitted between 15 October 2018 and 15 October 2019 (the study period) was undertaken. Two groups, an e-scooter group and comparison group, were defined. The e-scooter group included any patient admitted with an injury caused while riding an e-scooter. The comparison group included patients admitted with an injury sustained while riding a bicycle in the same time period.

Data collection

The ACH trauma registry was retrospectively searched for injuries in the two groups defined above. The ACH trauma registry is a database that was established in 1994. The trauma department collects data prospectively on all admitted trauma patients. As of 31 December 2019, there were 35,821 patients in this database. Additional data was collected from clinical notes, discharge summaries and electronic records. This data included patient demographics, mechanism of injury, use of protective gear, time of injury, mode of transport to hospital, emergency department (ED) management, patient disposition, Injury Severity Score (ISS), Trauma and Injury Severity Score (TRISS), blood alcohol level, treatment details, length of hospital and intensive care unit (ICU) stay, discharge destination and mortality.

Auckland Transport was contacted to provide data regarding the number of e-scooter trips during the study period. During the study period, Auckland Transport were evaluating the licencing of e-scooter rentals and therefore were collecting data from the three operational shared e-scooter services: Lime, Flamingo and WAVE. Auckland Transport provided the data used as the denominator to calculate the hospitalisation rate.

Data analysis

Data was coded and entered into IBM SPSS for analysis. Descriptive statistics, including mean, frequencies and median, were calculated as appropriate. A Pearson Chi-Square test and, where appropriate, a Fisher's exact test was used to analyse nominal data, including ethnicity, sex, mechanism of injury, place of injury, whether protective gear was worn, time of injury, mode of transport to hospital, whether an ED trauma call was placed, patient disposition, blood alcohol level, whether an operation or a radiological intervention was required, discharge destination and mortality. Parametric data, including age, were analysed using a Student t-test. Non-parametric data, including ISS, TRISS and length of hospital and ICU stay, were analysed using Mann–Whitney U test. The null hypothesis was rejected when the p-value was less than 0.05.

Results

The ACH trauma registry contained 178 patients injured while riding e-scooters or bicycles during the study period. Of these, 69 were admitted with e-scooter related injuries and 109 were admitted with injuries sustained while riding a bicycle. 60 e-scooter injuries (87%) were confirmed to have occurred while on a ride-share e-scooter and in 9 (13%) patients it was unclear if this was a ride-share or personal e-scooter.

Group demographics

Table 1 shows a breakdown of demographic by group. There was no significant difference found for sex between groups. 71.3% of the study population were male, and a similar male predominance was seen in both groups: 69.6% of the e-scooter group and 73.4% of the cyclists. The median age of each group was significantly different: the median age of the e-scooter group was 31, and the median age for cyclists was 47 (p-value 0.002). A significant ethnicity difference was found (p-value 0.001).

Injury factors

The mechanism of injury was significantly different between the two groups (p-value 0.002), as seen in Table 2. There were more isolated falls in e-scooter riders (87 vs 60.6% for cyclists) and less collisions (11.6 vs 35.8% for cyclists). Protective gear was seldom worn in the e-scooter group (10 vs 78.9% for cyclists, p-value <0.001). For analysis purposes, the time of injury was divided into two groups: 8am to 5pm and 5pm to 8am. In the e-scooter group, more injuries happened between 5pm and 8am (55.1 vs 40.4% for cyclists, p-value 0.074); however, this was not statistically significant. Blood alcohol levels were tested in 39.1% of e-scooter

patients and 44.2% of cyclists. Of those tested, there was a significant difference in the number of patients who were positive for any detectable level of alcohol on testing: 48.1% in the e-scooter group and 15.2% in cyclists. (p-value 0.01). As seen in Figure 1, 18.8% of the e-scooter group and 6.4% of cyclist tested positive for ethanol. All those who tested positive in the e-scooter group were over the legal driving limit of 50mg/100ml of ethanol, and all but one in the cyclist group who tested positive were over the same legal limit for driving. In both groups, alcohol-related injuries predominantly happened between the hours of 5pm and 8am: 76.9% in the e-scooter group and 85.7% in cyclists.

Injury severity and inpatient care

As seen in Table 3, there were no statistically significant differences found between the two groups in any of the outcomes collected to measure injury severity. The median ISS was 5 in the e-scooter group and 9 in cyclists (p-value 0.097) and median TRISS was 0.994 in both groups (p-value 0.130). There was no difference in median inpatient length of stay or intensive care unit admission rate. There was no difference in number of deaths in each group, with one death in the e-scooter group and two in the cyclist group (p-value 0.846). The need for operative intervention was similar in the two groups: intervention was required in 62.3% of patients in the e-scooter group and 48.6% in the cyclist group (p-value 0.074).

Hospital-specific factors

Similar modes of transport to hospital were seen between the two groups. There was no difference in the rate of ambulance transfer for e-scooter riders (65.2 vs 64.2% for cyclists) or rate of private vehicle transfer (24.6 vs 21.1% for cyclists). There was a significant difference in the number of hospital emergency trauma calls placed (10.1 vs 26.6% for cyclists, p-value 0.025). The admitting team was significantly different between the two groups, with more e-scooter riders admitted under orthopaedics (73.9 vs 62.4% of cyclists), and more cyclists admitted under the trauma service at 28.4% compared with 13% of the e-scooter group (p-value 0.021). No difference in discharge destination or planned patient follow-up (including general practice, orthopaedics, hands service, neurosurgery, concussion clinic or other) was found.

Table 1: Group demographics.

	E-scooter (%)	**Cyclists (%)**	**Total (%)**	**p-value**
	69	109	127	
Age				0.002
Median	31	47	42.5	
IQR	23	23	26	
Sex				0.675
Male	48 (69.6%)	79 (72.5%)	127 (71.3%)	
Female	21 (30.4%)	30 (27.5%)	51 (27.8%)	
Ethnicity				0.001
Caucasian	39 (56.5%)	90 (82.6%)	129 (72.5%)	
Māori	4 (5.8%)	3(2.8%)	7 (3.9%)	
Pacific Island	2 (2.9%)	3 (2.8%)	5 (2.8%)	
Asian	20 (29%)	8 (7.3%)	28 (15.7%)	
Other	4 (5.8%)	5 (4.6%)	9 (5.1%)	

Figure 1: Blood alcohol test results by group.

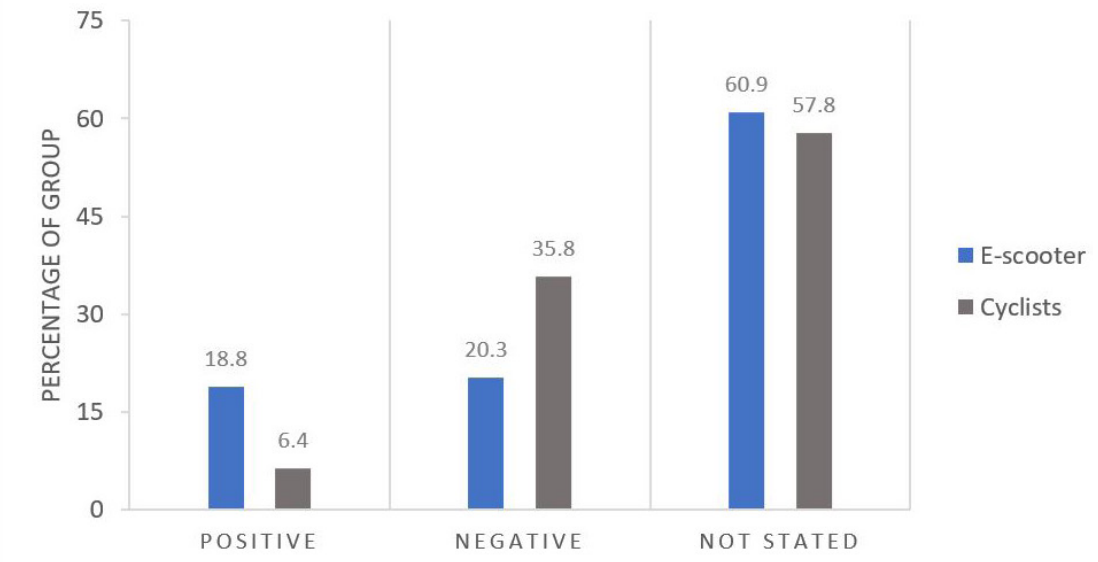

Table 2: Injury factors by group.

	E-scooter (%)	Cyclists (%)	Total (%)	p-value
Mechanism of injury				0.002
Isolated falls	60 (87%)	66 (60.6%)	126 (70.8 %)	
Collisions	8(11.6%)	39 (35.8%)	47 (26.4%)	
Other	1 (1.4%)	4 (3.7%)	5 (2.8%)	
Protective gear				<0.001
Yes	7 (10.1%)	86 (78.9%)	93 (52.2%)	
No	29 (42%)	12 (11%)	41 (23%)	
Not stated	33 (47.8%)	11 (10.1%)	44 (24.7%)	
Alcohol				0.010
Positive	13 (18.8%)	7 (6.4%)	20 (11.2%)	
Negative	14 (20.3%)	39 (35.8%)	53 (29.8%)	
Not stated	42 (60.9%)	63 (57.8%)	105 (59%)	
Time of injury				0.074
8am–5pm	29 (42%)	64 (58.7%)	93 (52.2%)	
5pm–8am	38 (55.1%)	44 (40.4%)	82 (46.1%)	
Unknown	2 (2.9%)	1 (0.9%)	3 (1.7%)	

Figure 2: Trend in number of admissions in 3-month time periods.

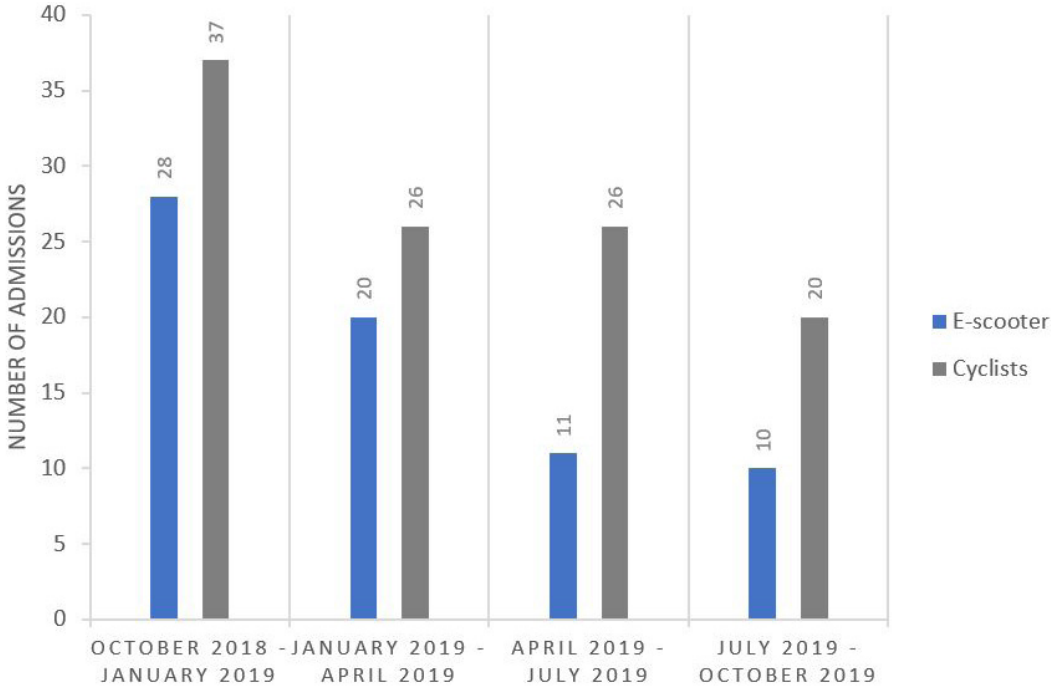

Table 3: Injury severity and inpatient care by group.

	E-scooter (%)	Cyclists (%)	p-value
Injury severity score			0.097
Median	5	9	
IQR	5	8	
Trauma and injury severity score			0.130
Median	0.994	0.994	
IQR	0.012	0.026	
Length of ward stay			0.556
Median	3	3	
ICU admission			0.296
Number of admissions	2 (2.9%)	7 (6.4%)	
Number of deaths			0.846
Fatality	1 (1.4%)	2 (1.8%)	
Number of operations			0.074
Operation	43 (62.3%)	53 (48.6%)	

Hospitalisation trend

As seen in Figure 2, the study period was divided into four quarters. A decreasing number of admissions in both groups was seen over the study period.

Hospitalisation rate

The hospital-admission rate for e-scooter accidents during the study period was calculated as 326 hospitalisations per million hours spent on an e-scooter and 115.5 hospitalisations per million e-scooter trips. This was calculated using data provided by Auckland Transport (1,674,575 shared-use e-scooter trips recorded during the study period, with an average trip length of 455 seconds).[7,8] Unfortunately, similar data were not available for the cyclists, so we were unable to calculate the hospitalisation rate for cyclists.

Discussion

E-scooters are a cheap and environmentally friendly way to travel short distances in cities. However, the high reported crash rates and the absence of relevant transport laws, have raised major concerns for the safety of the general public. Although the majority of the e-scooter injuries are treated and discharged from ED, patients admitted for e-scooter injuries add a burden to our public health system.[9] Becker et al estimated that, following the introduction of a shared e-scooter system to Auckland, the cost of the first seven months was approximately $1,303,155.[5]

The hospitalisation rate for e-scooter injuries was calculated as 326 hospitalisations per million hours spent on an e-scooter and 115.5 hospitalisations per million e-scooter trips. Tin et al found that, for cyclists in the Northland–Auckland region between 2003 and 2007, the hospitalisation rate was 78 per million hours spent cycling.[10] This comparison suggests a greater than four-fold higher risk of injury from e-scooters in the Auckland region. Only two additional studies were identified that reported a hospitalisation rate with a trip denominator for cyclists. Teschke et al reported a hospitalisation rate of 6.22 per million trips for cyclists in Canada, and Blaizot et al reported a rate of 4.43 per million trips for cyclists in France.[11,12]

Studies published locally and around the world have consistently found a lack of protective gear in hospitalised e-scooter patients.[3,13–15] This study supports these findings, with only 10.1% of the patients found to have been wearing protective gear. Comparatively, 78.9% of cyclists wore protective gear. It is a legislative requirement for a cyclist in New Zealand to wear a helmet—a requirement that is supported by literature that show wearing a helmet significantly reduces the severity of injuries.[16,17] Although no study to date has looked at the use of protective gear and its impact on injury severity in e-scooters, it is conceivable the results would mirror the reduction in severity seen in injuries sustained while cycling. This is especially pertinent given craniofacial injuries are common in e-scooter accidents and carry significant morbidity.[15]

The blood alcohol levels of patients admitted to ACH are only routinely tested if a trauma call is activated. Otherwise, blood alcohol levels are tested at the discretion of the treating physician. Less than half of patients admitted in both groups were tested for blood alcohol, which has likely resulted in an underrepresentation of the true percentage of alcohol-related injuries in the data. Despite this, there were almost twice as many alcohol related injuries in the e-scooter group. The association between e-scooter injuries and alcohol has been seen in national and international studies, and this association may in part account for the high hospitalisation rate.[3,14] Toxicology results were not examined, but illicit drugs may be a factor leading to injury. Kobayashi et al found positive urine toxicology in 31% of their US e-scooter cohort.[18]

E-scooter injuries were more likely to happen between the hours of 5pm and 8am, whereas cyclists were more likely to be injured between 8am and 5pm. Variation by weekday was not examined in our study; however, a peak in the time of injury—5pm on Friday to Sunday night—was noted by Vernon et al.[19] This peak in presentations, at a time when ED is already busy, may place additional strain on the hospital. Given the novelty of e-scooters in Auckland, e-scooters are likely more often used for recreation than for commuting, and vice versa in the comparison group.

The lack of protective gear and higher positive blood ethanol rates in e-scooter riders was not reflected in a higher ISS or TRISS on comparison, as would be expected. This is possibly due to the significant difference in mechanism of injury between the two groups, with more isolated falls in e-scooter riders and more collisions in cyclists. Collisions, compared with isolated falls, are associated with an increased blunt force and injury severity and, in this study, were predominantly cyclists traveling at high speeds.[20] The over representation of isolated falls is possibly due to the inexperience of e-scooter riders and the influence of alcohol. A study from the Austin Public Health Department after the introduction of a shared e-scooter system found that 33% of people in their study group were injured on their first time riding an e-scooter.[21] The trend of decreasing admission rates over the study period is expected and coincides with the change of season from summer to winter.[22] The decrease in admissions in the e-scooter group may in part be due to people gaining more experience and, subsequently, becoming less prone to injury. However, this will need further investigation.

The limitations of this study include the inability to directly compare the hospitalisation rate between the two groups, because a cyclist group denominator (million hours spent or number of trips on a bicycle) could not be collected. Tin et al's study used to provide a comparison hospitalisation rate for cyclist sets only an estimate of the current injury rate per million hours spent cycling. It studied Auckland and Northland together and the data was gathered between 2003 and 2007. Between 2015 and 2018, Auckland City Council invested $200 million in cycle lanes and road safety campaigns, which likely resulted in a lower injury rate than previously reported.[23]

ACH is one of the four hospitals servicing Auckland City. The hospital covers the central business district and almost all areas where e-scooters were available for public use. However, patients presenting to the other Auckland hospitals are not captured in the data. Therefore, this study likely underestimates the hospitalisation rate, as the data only includes injured patients presenting to ACH. Auckland's paediatric hospital was not included in this study, because e-scooters are prohibited for use by persons under the age of 18. Despite this, paediatric injuries should be investigated in the future because paediatric injuries have been observed in areas with similar prohibitions.[24] This study only evaluates patients admitted with an injury while operating an e-scooter and does not include non-rider injuries. Blomberg et al found 17% of patients presenting to hospital with an e-scooter related injury were non-riders. This group, who were often elderly patients sustaining moderate to severe injuries, are not captured in this dataset.[25]

In conclusion, this study demonstrates a concerningly high e-scooter-related hospitalisation rate, compared to the hospitalisation rate for cyclists. The high hospitalisation rate found in this study suggests e-scooter transport is currently not as safe as cycling. Shared e-scooter systems are becoming commonplace in many cities across New Zealand, and therefore investigation is required to understand this difference. Strategies to improve e-scooter safety are needed and could include zero tolerance for alcohol consumption, laws regarding protective gear, restrictions on using e-scooters after 5pm and changes in road laws.

Competing interests:
Nil.

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