



Safety Review

E-Scooters (Declaration Not to be Motor Vehicles) Notice 2018 Review

15 September 2023

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Purpose

This document presents safety data and summarises research from domestic and international sources on the use and safety of e-scooters. It contains ACC injury claims data from the time of the introduction of rental and private e-scooters in 2018. It contains Ride Report rental e-scooter usage data. A sample of hospital reports have also been included to assess New Zealand specific risk and injury relating to e-scooter use. Also included are survey statistics looking at public perceptions of safety of e-scooters in New Zealand.

Limitations

There have been limited reviews with a safety focus in New Zealand on e-scooters in the past 5 years since their use has become more frequent. We also acknowledge the bias of some articles, reports and assertions that can be found on e-scooters. For this reason, we have focused this assessment on quantitative studies conducted by third parties like hospitals and wider transport organisations for more accurate data and conclusions. Qualitative data has been included where considered necessary to understand public sentiment around safety.

Legal Settings

Section 168A of the Land Transport Act provides Waka Kotahi with the power to make a declaration that a device with a maximum power output of 300 W or lower is not a motor vehicle for the purposes of the Act.

In 2018 Waka Kotahi exercised that power to make the E-Scooters (Declaration Not to be Motor Vehicles) Notice 2018 (the **Notice**), which declares that certain low-powered e-scooters that fall within the definition of “wheeled recreational devices” in the Land Transport (Road User Rule) 2004 (the **Rule**) are not motor vehicles.

The effect of the Notice is that, for a period of five years commencing on 18 September 2018 and expiring on 30 September 2023, e-scooters that meet the criteria set out in the Notice have been deemed not to be motor vehicles and are therefore exempt from meeting the registration and licence requirements that would in practice prevent their use in public places.

As “wheeled recreational devices” e-scooters have been able to be used on footpaths under the Rule, subject to behavioural rules. The rules for the footpath are that the user must:

- operate the device in a careful and considerate manner;
- operate the device at a speed that does not put other footpath users at risk;
- give way to both pedestrians and drivers of mobility devices;
- park the device so that it does not obstruct other footpath users; and
- on the road, e-scooters must be operated as near as practicable to the edge of the roadway

For the avoidance of doubt, a helmet is not legally required to be worn when using an e-scooter.

ACC and Ride Report Data

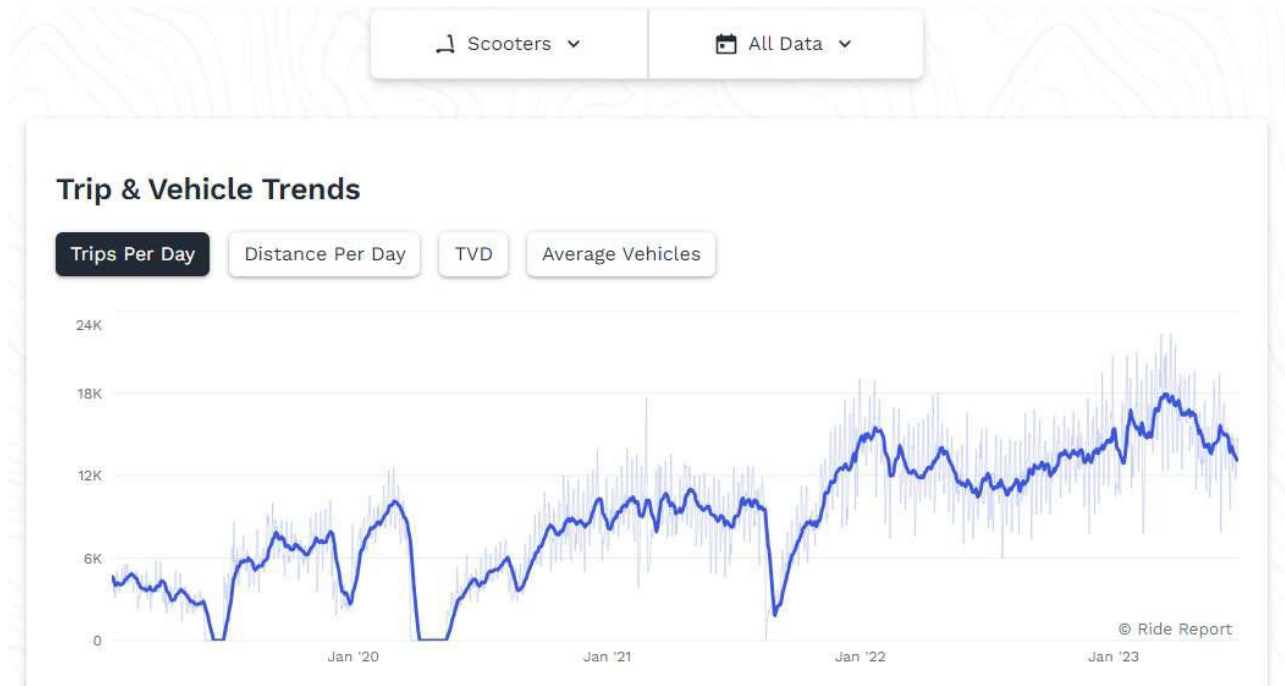
Riding uptake and injury pattern

ACC data covers the period from 1 October 2018 to 31 December 2022, as such, data for 2018 does not represent the full calendar year. Over the four-year period (2018 - 2022) there were over 10,000 claims and approximately \$30 million in injury treatment costs. An approximate average claim cost is therefore \$3,000.

The table below shows a significant spike in new claims in 2019 (3,181) before falling by 56% in 2020 (to 1,795). This data is based on lodgement date and does not reflect accident date.

	Lodgement Calendar Year				
Measure	2018	2019	2020	2021	2022
Number of Claims	622	3,181	1,795	2,139	2,574
Cost to Date	\$1,199,641	\$8,578,132	\$6,748,227	\$5,770,032	\$4,374,869

The graph below is from Ride Report and shows the trend in rental e-scooter trips per day in New Zealand over time. It shows a general increase in trips, and this could also be inferred for private e-scooter use. The overall increase in e-scooter (rental and private) use since the 2018 declaration is as expected as more and more people explore this new mode of transport.



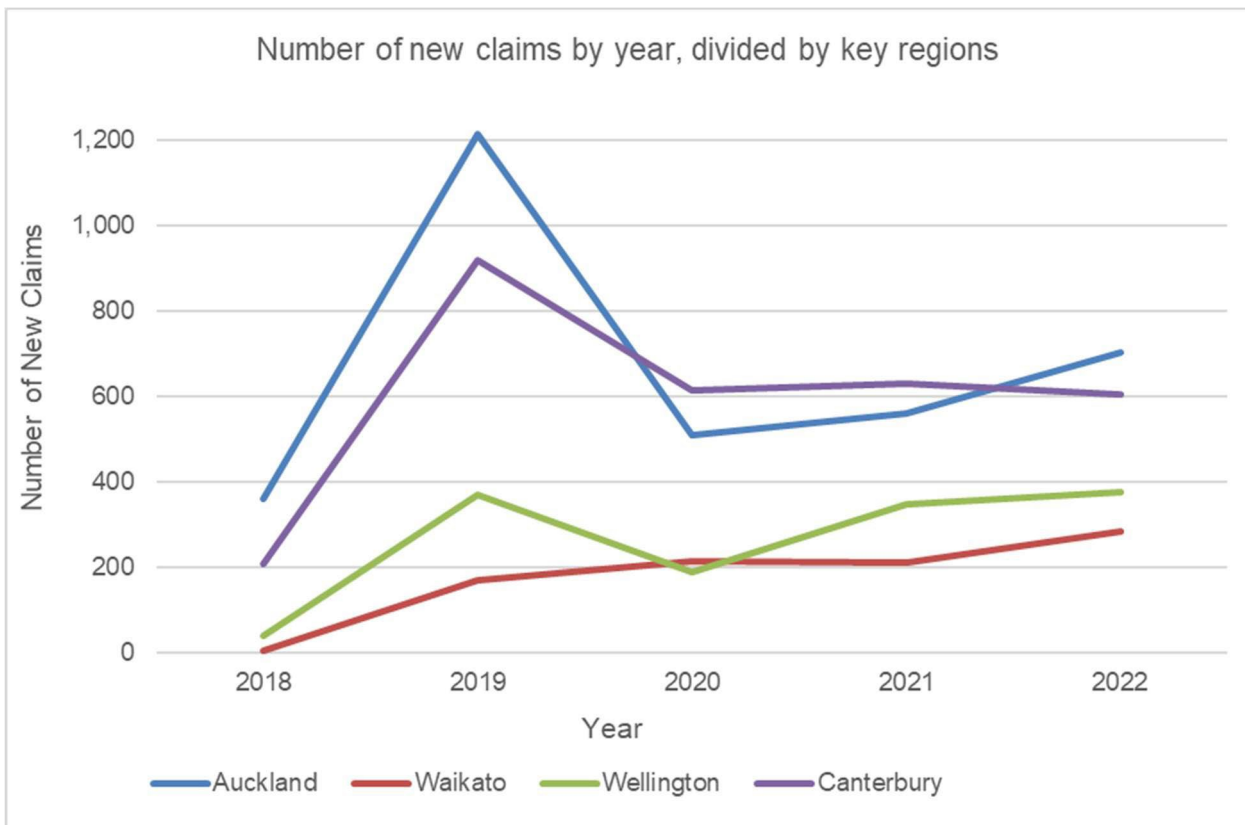
Two key observations can be made from the ACC and Ride Report data. The first is that from 2020, as e-scooter use has continued to increase, the number of ACC reported injuries has also increased. The second is that as the number of claims has increased (at least since 2020), the overall claim cost each year has fallen. These are expected results which fit with patterns seen overseas. In particular it is evident that as rider experience with e-scooters increases, riding skills increase, and the severity of injuries reduces. Average individual claim costs therefore come down even though the number of claims can be increasing as a result of increased e-scooter use.

The 2019 spike in both the number and cost of injuries is also likely evidence of rider skill deficiency during the initial roll-out of rental e-scooters following the 2018 declaration.

Depending on what the future potential growth in the e-scooter market is, and the number of people new to e-scooter use, it could be worth promoting more effective first-time user training sessions to prevent more serious accidents while riding skills are still being acquired.

Regional trends

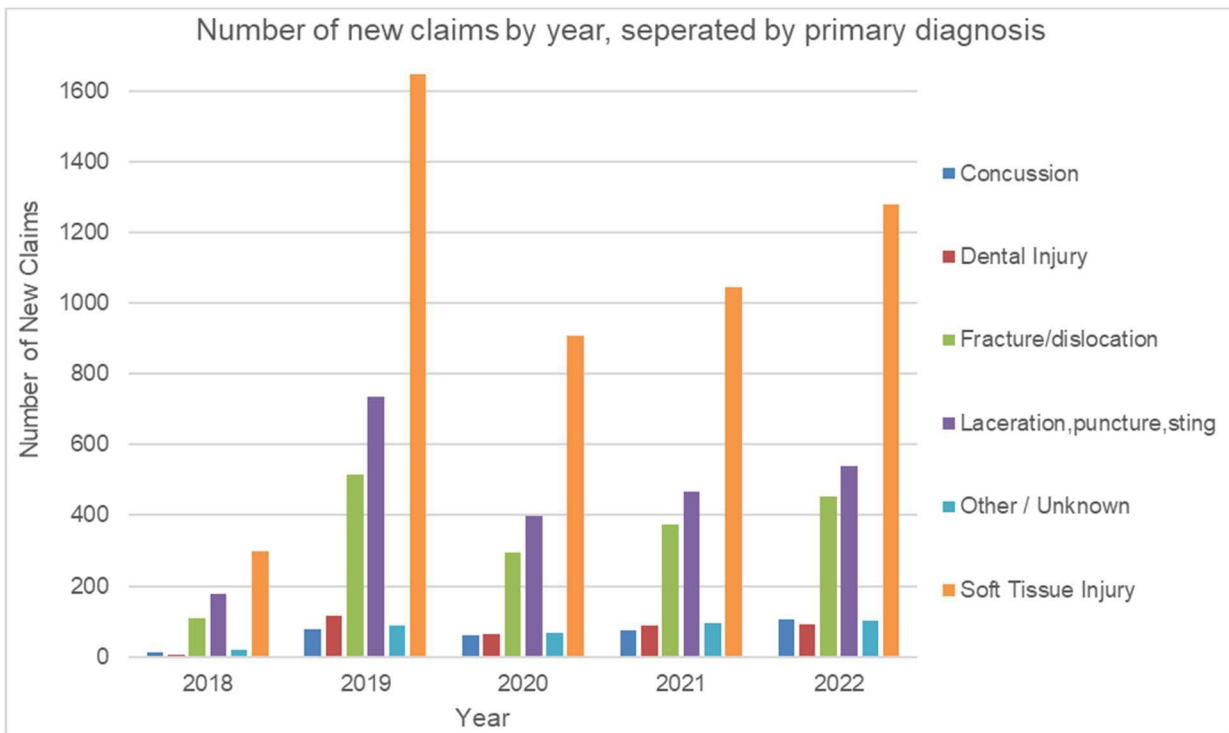
Based on a simple review of regional rental fleet sizes in Ride Report there does not appear to be any regionally specific injury issues associated with e-scooter use.



Injury diagnosis

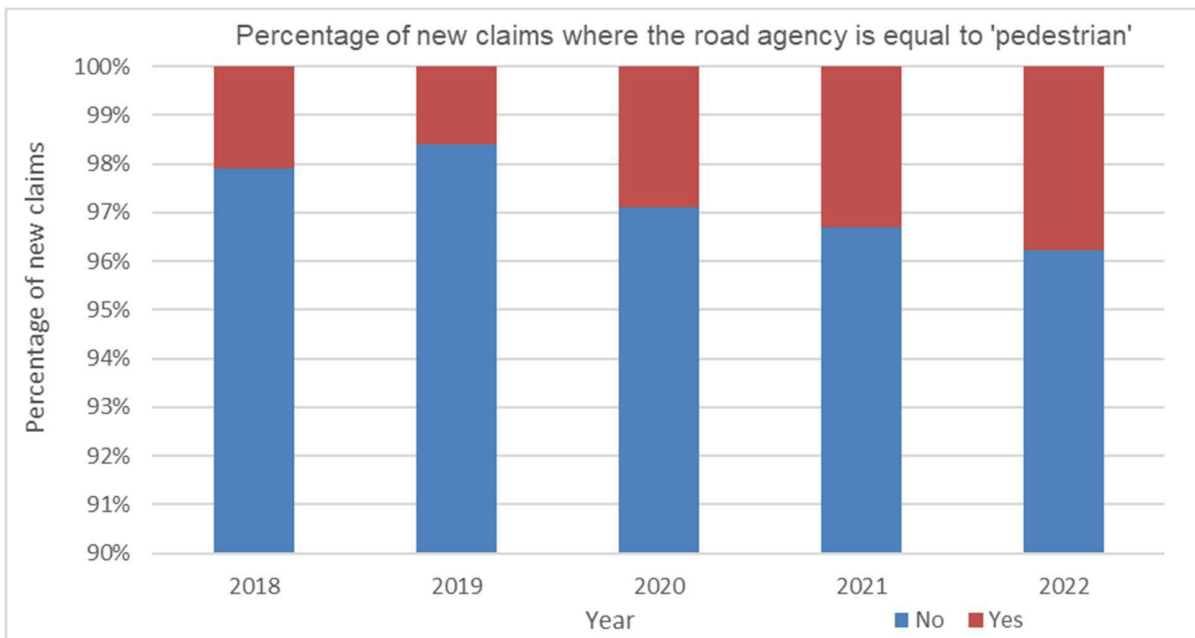
As shown in the graph below, the majority of new claims have resulted from soft tissue injury, laceration, puncture, or sting, and fracture or dislocation. On average, over the last 5 years 50% of the new claims primary diagnoses was soft tissue injury. 23% was laceration, puncture, or sting. 17% was fracture or dislocation.

While the dominance of soft tissue injuries, followed by fractures and dislocations shows many injuries are not too serious, there is cause for concern about the number of head injuries per annum. The concussion rate runs at about 50 incidents each year. These injuries have the potential to be life-changing.



Claims involving pedestrians

The graph below (showing only the top 10% of claims) shows the percentage of e-scooter claim crashes where a pedestrian was involved – only about 2% of e-scooter crashes involve a pedestrian. Note that in the ACC data when the road agency is 'pedestrian', this means a pedestrian accident was caused by an e-scooter. This result is consistent with many overseas studies which show there is a relatively low rate of e-scooter versus pedestrian crashes. Virtually all of these crashes happen on footpaths; and in virtually all cases the cause of the crash is the fault of the e-scooter rider.



People with disabilities and other vulnerable path users

It is clear from our engagement with advocacy groups and the results of our survey (see Stakeholder Engagement Report) that people with disabilities are concerned about e-scooters. A common position of advocacy groups is that footpaths should be preserved for the use of pedestrians, especially as this includes people with disabilities, people who are frail and small children.

The Disabled Persons Assembly NZ report that since the introduction of e-scooters, disabled people have been injured and hospitalised. There is no specific ACC data relating to people with disabilities who have been injured, however in submissions received via the public survey and from one of our stakeholders, there are several testimonies of accidents. In the stakeholder submission, 7 people mentioned being hit by an e-scooter and 5 mentioned tripping over or an accident caused by a stationary scooter.

“I am a lifelong totally blind person; I’ve met a couple of “run and dump” scooters in the central city on my walk Each time a kindly sighted person unraveled me and got me on my way safely. The first scooter was propped against the pedestrian pushbutton pole, and I met it when I was crossing the road. The other scooter was in a similar place.”

“I got shoulder charged by a scooter rider who never stopped to help me up.”

“as a blind citizen and a cane user I have run into e-scooter users and come off second best fracturing bones also the e-scooter users once finished with their e-scooter hire time they drop them and leave them on the footpath and they fall over littering the footpaths making very difficult for me to access the footpaths and I have fallen over these e-scooters and again ended up in A&E with injuries I did not bargain for.”

Submissions report that many disabled and older people say they feel unsafe and are afraid to walk in our city centres and their neighbourhoods because of the danger posed by e-scooters on footpaths.

People who are blind, deafblind, low vision or vision impaired are at greater risk of injury from falling over e-scooters left lying on the footpath or walking in areas e-scooters are being ridden. Deaf and hard-of-hearing people have reported being shocked at something they cannot hear suddenly rushing past them.

They note that even if only a few percent of e-scooter injuries are to pedestrians, there still needs to be recognition of the cost of lost opportunity and the risk of social isolation disabled and older pedestrians experience.

It is important to note that e-scooters also can be seen as a tool for specific disabilities. There is evidence that e-scooters have a positive impact on those with conditions like chronic fatigue syndrome, asthma, and multiple sclerosis as a few examples. There is little specific data, but the public survey saw responses from those with various conditions who considered e-scooters a valuable part of their independence, as quoted here: *“I have been diagnosed with chronic fatigue syndrome / long covid, I can’t walk more than a block unaided, and e-scooters give me so much more freedom.”*

Early in 2023, an article by Neuron was released claiming that a percentage of riders who used e-scooters suffered from several disabilities like chronic pain, Ehlers-Danlos syndrome and hip dysplasia. The article is brief but finds that rental scooters have improved accessibility to these riders who suffer from the above conditions. It mentions that 22% would not have made a trip if not for the availability of a rental scooter, and largely contributed to users running errands and commuting.

E-scooter safety reports

Summary of key findings in reviewed reports

- On average the main group experiencing e-scooter related injuries and incidents are males, often between the ages of 20-40 and of Caucasian ethnicity.
- There is a much higher rate of hospital admission of riders of rental e-scooters than private e-scooters. In part this reflects the lower level of operational skill and experience of rental users.
- Where it has been recorded, the vast majority of admissions to hospital are riders with injuries, not pedestrians. The 2019 Auckland ED report recorded 0.6% of admissions where e-scooter

incidents involved pedestrians. This trend is reflected in the other New Zealand report (Dunedin), with only 1 pedestrian admission out of 56 e-scooter related admissions.

- A 2021 comparative study by Auckland Hospital also shows that the highest reason for injury is isolated falls or collisions, and their 2019 report stated 91.7% of admissions were due to isolated falls.
- Most reports claim head injury is a serious issue for e-scooter use, and therefore encourage the use of helmets.
- There are claims that alcohol use leads to higher crash rates, but that current data is insufficient to confirm this. Alcohol and drug recording was poor throughout the New Zealand studies, although where it was recorded, alcohol levels were higher in e-scooter riders than cyclists when admitted to hospital.
- In Western Australia, helmets are legally required. Despite that, compliance has been low with only 43% of admitted patients recorded as wearing a helmet. Similarly, in California, helmets are required by law, but only 10 of 249 patients were recorded as complying.

Auckland City Hospital Emergency Department Report 2019

In February 2019, Auckland City Hospital conducted a retrospective study of patients admitted with e-scooter injuries. This report looked at a 19-week period since the introduction of shared e-scooters in October 2018. Data was extracted from ambulance, emergency and clinical notes, electronic discharge summaries, radiology reports and ACC claims.

During this 19-week timeframe, 180 patients were identified as having e-scooter-related injuries. Nearly half of patients were discharged from hospital care in under 4 hours (49.4%).

Out of those 180 cases,

- 144 were considered low on the severity scale (80%)
- 28 were considered medium level severity (15.4%)
- 8 were critical level (4.4%)

Head injury and helmet use

A common theme was head injury, with 17.2% of patients suffering from head impact. It was found 7 out of the 8 patients considered critical level in injury severity suffered significant head injury. Injuries included traumatic brain injury, several types of haemorrhaging and skull fractures. The report acknowledges that the quality of documentation around use of helmets is low, but in the cases where it was recorded only 3 patients (1.7%) had used head protection.

Injury data

Of the patients admitted to the ED, almost half of them experienced 1 or more fractures. These were mainly seen in the lower limbs (17.8%) and then the upper limbs (16.7%). Fractures around the head and neck were 12.2%.

Recording of rental scooter versus private scooters is not consistent across all reports, however in this report it was found 93.3% of admissions were using a rental scheme scooter. Only 1.1% of admissions were on a private scooter and 5.6% did not specify what kind of device.

In terms of mechanism of injury, 91.7% was an isolated fall, 3.3% reported scooter malfunction, 2.8% involved a car and 0.6% involved a crash with a pedestrian.

Alcohol data

A second key theme of this report was the consumption of alcohol in relation to injury. This report found that nearly 1 in 4 patients had a positive alcohol level or had admitted to the consumption of alcohol. They accept that as blood alcohol testing is not mandatory that this report could have underestimated the number of cases where alcohol was a factor. The relationship between alcohol and head injuries was

assumed to be closely connected, 23.3% of all patients had consumed alcohol and of those patients with head injuries, 41.9% had consumed alcohol.

The doctors involved in this report made several recommendations for future policy decisions. Due to the high risk of head injuries and consequently the strain that puts on hospital resources, they recommend greater regulation around alcohol consumption, and the use of protective head gear. They suggested an introduction of a night-time curfew to dissuade any intoxicated persons using the e-scooters and setting low speed limits due to their use of pedestrian zones.

Auckland City Hospital Trauma Registry Report 2021

This more recent report aimed to compare e-scooter and bicycle related injuries, to determine which hospitalisation rate is higher. This study retrospectively searched the hospital's trauma registry for patients admitted with an e-scooter injury. Then a comparative group of patients admitted with cycling injuries was also assessed during the same period (15 October 2018 to 15 October 2019). Both groups only included patients who were admitted for injury whilst riding either mode.

Demographics

The registry had 178 patients during this time. Of these 69 were admitted with e-scooter related injuries (60 rental and 9 private), and 109 with bicycle related injuries.

E-scooter statistics showed:

- 69.6% were male
- The median age was 31
- 56.5% were of Caucasian ethnicity

Cycling statistics were similar:

- 73.4% were male
- Median age was higher at 47
- 82.6% were Caucasian ethnicity

Injury factors and data

Injury factors between the two groups were reasonably different, e-scooter riders had a higher rate of isolated falls than cyclists (87% vs 60.6%), but they encountered fewer collisions (11.6% vs 35.8%). The recorded use of protective gear in e-scooter patients was very low compared with cyclists (10% vs 78.9%). Blood alcohol levels were not able to be tested in every patient, 39.1% of e-scooter patients were tested and 44.2% of cyclists. Of those tested 48.1% of e-scooter patients were positive for detectable levels of alcohol in their blood, whereas bicycle patients tested at 15.2%.

In terms of injury severity and length of care, there were no statistically significant differences between the e-scooter and the cycling injuries. The median injury severity score ranges from one to ten, in this data, across the e-scooter group was 5 and 9 in cyclists. There was no difference in median inpatient length of stay or intensive care unit admission. There was also no major difference in number of deaths between the two groups, with one death in the e-scooter group and two in the cyclist group.

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). Unfortunately, similar data was not available for the cyclists, so the study was unable to calculate the hospitalisation rate for cyclists. However, a study by 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. Using these data gives a relative serious injury risk factor of 326/78 times that of cycling. That is, the serious injury risk of e-scootering is 4.2 times that of cycling on a time exposure basis.

Latest comparative safety estimation with other modes

Since the publication of the 2021 Auckland City Hospital report, further data sources have been discovered and allow for further estimation of the relative risk of serious injury for e-scooter. The paragraphs below set out how data has been combined to derive another best estimate of e-scooter serious injury risk in New Zealand. The data used are generally taken from the years 2018-2021 because this was a common period when all required data for the calculation estimate were collected.

The method of assessment is to use the Auckland City Hospital administration rates for e-scooter and cycling in Auckland and compare these to the time spent e-scooter and cycling nationally to derive a ratio for each of the two modes. These ratios, although meaningless in themselves (i.e. regional numerator and national denominator), can then be used to estimate a relative risk factor for e-scooter by scaling against the *Deaths or injuries in motor vehicle crashes per million hours spent travelling* which is reported by the Ministry of Transport and shown in their graph below.

So, from [Ride Report](#) there were about 5000 (in 2019) shared e-scooter trips nationally per day.

From doi.org/10.6084/m9.figshare.8056109 data set there were 20 private e-scooter owners and 36 rental users. Therefore $(20/36 \text{ times } 5000) = 2800$ private e-scooter trips per day [it is acknowledged that this estimate of private e-scooter use is based on a small amount of data].

From Ride Report over the years 2019-2021 the average trip distance was 1.54 km and average trip speed was about 10 km/h.

1.54 km at 10 km/h gives an average travel time of approximately 9 minutes.

5000 + 2800 trips times 9 minutes equals 1170 hours/day across the country.

1170 hours/day times 365 equals 427,000 hours/year e-scooter nationally.

From Figure 1 of Environmental Health Indicators New Zealand (ehinz) [fact sheet](#) 2.1% commute cycling of 150.4 million hours travelling to work. This equals 3.1 million hours/year commute cycling.

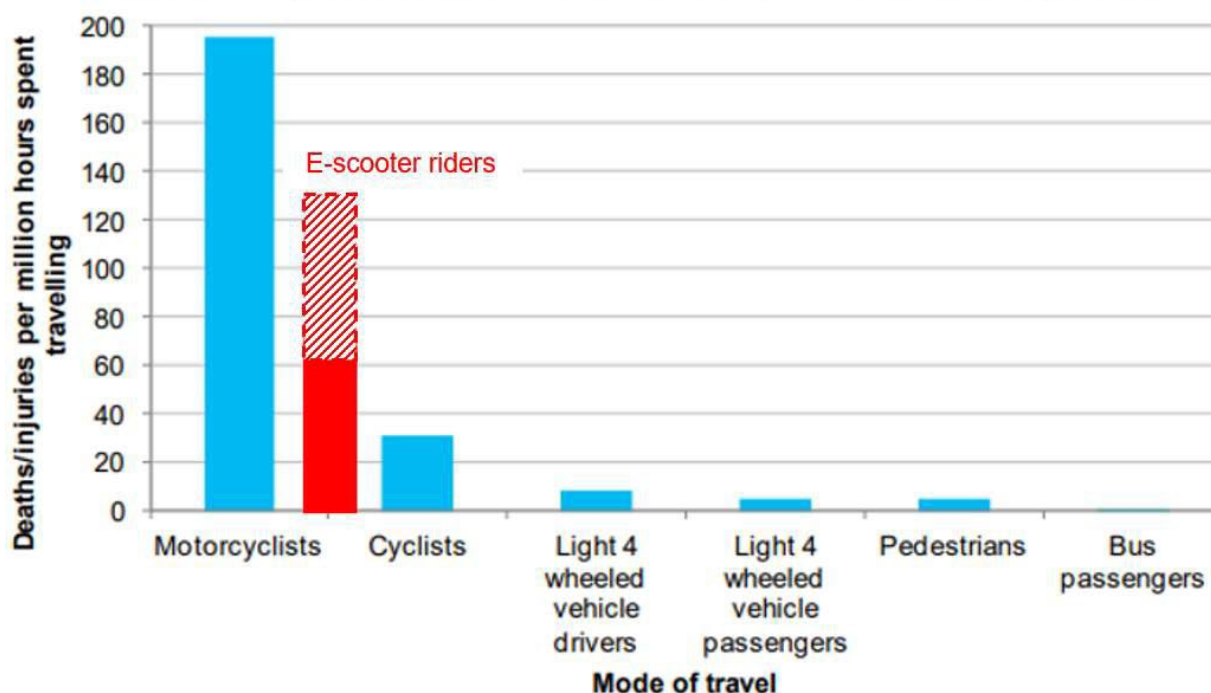
From the 2021 Auckland City Hospital report cited above, there were 69 private and shared e-scooter admissions and 109 cyclist admissions.

The above data therefore gives ratios of 69/427,000 for e-scooters, and 109/3.1 million for cycling. As mentioned above, these are meaningless ratios in themselves (i.e. regional admissions over national hours/year), however, on the basis that Auckland admission patterns would be indicative of national admissions these ratios can be used to scale the "cyclists" death or injury rate which is presented in the Ministry of Transport graph below to provide a relative figure for e-scooter.

So, on a million hours riding basis the death or serious injury risk of e-scooter is approximately 4.6 times that of cycling on a time exposure basis.

This estimate is overlaid on the Ministry of Transport mode of travel relative risk graph below.

Deaths or injuries in motor vehicle crashes per million hours spent travelling



The solid red bar combined with the top hashed section shows the relative risk of e-scooter riding at 4.6 times that of cycling based on the scaling estimate set out in the above calculation. This is probably an upper estimate of the relative risk because it uses data from 2019 when e-scooters were relatively new and factors like under-developed rider skill was more of an issue. The solid red bar (without the hashed top section) depicts a relative risk ratio of 2 times that of cycling. This is a typical value stated in several overseas risk assessment reports which compare the relative risk between e-scooter riding and cycling. Together, these estimates (2 to 4.6 times cycling) provide the likely range that the actual relative risk will currently lie within for New Zealand.

Several overseas studies report that injury rates are in fact higher for cycling than for e-scooter riding, however these studies compare injury rates on a distance travelled basis rather than time exposure basis. Time exposure is considered a more appropriate basis for risk and injury comparison.

Dunedin Hospital Emergency Department Report 2019

This report out of Dunedin's Emergency Department (ED) also took a retrospective look at e-scooter related injuries and the impacts on the Dunedin ED. They conducted a comparative study of vehicle related injuries over 2018 to 2019. Dunedin only has one ED therefore this study appears to display the most accurate data in terms of type and number of injuries for the region.

The ED compared the number of e-scooter presentations with other modes. 55 of the patients were e-scooter riders and 1 was a pedestrian. The table below shows other vehicle related injury presentations during the same period:

Car	Bicycle	Motorbike	E-Scooter
52	62	21	56

Demographics

Dunedin ED found similarities to the Auckland Hospital report whereby the majority of the injuries were considered minor. Most of patients required X-rays (78%) and CT scans (24%), this was a similar finding in Auckland Hospital, with over 200 requests for urgent radiology imaging and 47 CT scans in the first 2

months of e-scooter sharing schemes being introduced. The report concluded that whilst the injury severity was relatively low, the resources and time being put into e-scooter injuries was a concern to the ED. They noted that on average those patients took up 2 hours and 44 minutes of ED bed space per day during a 6-week period.

Some statistics gathered over the 6-week period included the following:

- the most common age range was 26-40 (37%),
- 41 riders were of European descent (76%), and
- 33 were male (61 %)
- 7 patients had alcohol related injuries

Helmet and injury data

These statistics mirror common trends across e-scooter use research, such as most riders are male, in their mid-20s to 40s and are not a part of an ethnic minority. Helmet use was only recorded for 1 patient, 10 were recorded as un-helmeted and 42 were not documented. Most common hours of presentation in the ED were between 7am-3pm (43%) and 3pm-11pm (44%), also 43% of patients were presented on the weekends. Imaging such as radiographs or CT scans were performed on 72% of patients.

Minor injuries without associated fractures, dislocations or head injuries were seen in 46% patients. Fourteen (26%) patients sustained a head injury, and of those, five were documented as un-helmeted and two were documented as having an alcohol associated injury. Five patients also required further hospital admission. Out of the five, one was for a severe head injury, the other four were bone related fractures or dislocations. Although most injuries were minor, over two thirds required imaging.

Injuries Associated with Standing Electric Scooter Use CA, USA, 2019.

This report is another retrospective study of e-scooter injuries within a one-year timeframe and is cited in both the Auckland and Dunedin reports. The authors looked at injuries associated with the newly introduced e-scooters in the California area in 2017-2018. This study was looking for patterns of injury type in two different urban emergency departments in Southern California.

Within the one-year period from 2017 to 2018, 249 patients were presented to the emergency departments, of which:

- 145 were males (58.2%);
- the average age was 33;
- 152 (61%) were between the ages of 18-40;
- 249 (91.6%) were riders;
- 21 (8.4%) were non-rider pedestrians, and of those non-riders:
 - o 11 were hit by a scooter;
 - o 5 had tripped over a parked scooter; and
 - o 5 were attempting to lift or carry a scooter not in use.

The majority of the ED visits occurred in the late afternoon and evening hours, between 3pm – 11pm (56.6%).

Injury data

The most common reason for injury was a fall (80.2%), collision with an object (11%), and being hit by a moving vehicle or object (8.8%). Only 10 riders were documented as wearing a helmet (4.4%) and 12 patients (4.8%) were found to have blood alcohol levels above 0.05% in their system. The majority of patients (80.3%) received imaging in the ED, with the most common imaging studies being radiographs or computed tomography of the distal upper extremity (36.5%), computed tomography of the head (29.7%), and radiographs or computed tomography of the distal lower extremity (20.1%).

A total of 8.4% of patients underwent a trauma-protocol computed tomography scan (head, cervical spine, chest, abdomen, and pelvis), indicating high concern for serious injury. Two hundred thirty-four patients (94.0%) were discharged home from the ED. The most common injuries were fracture (31.7%), head injury (40.2%), and contusions, sprains, and lacerations without fracture or head injury (27.7%). Ninety-five patients (38.2%) sustained a minor head injury (head injury without intracranial haemorrhage or skull fracture), and 5 patients (2.0%) had an intracranial haemorrhage. Five of 95 patients (5.3%) with a minor head injury were documented as wearing a helmet during the incident, while none of the 5 patients with an intracranial haemorrhage had such documentation.

This study found that comparatively, there were 195 visits for cyclist injuries and 181 visits for pedestrian injuries during the same time period at the two EDs.

Western Australia State Trauma Registry analysis of incidence and injury patterns associated with e-scooter injuries 2023

This study is another retrospective report which considers e-scooter related injuries in the state of Western Australia (WA) from 1 July 2017 to 30 June 2022. This time span is one of the more comprehensive studies which provides insight from the near introductory phase of the e-scooter to their arguably settled place within a transport system. As with the 2021 Auckland Hospital report, all the data was collected through the Western Australia State Trauma Registry. This is a state-based trauma registry that collects data from all six major hospitals in WA state.

Legal regulations for e-scooters differ per state in Australia but in WA all e-scooters are permitted on public paths and low speed public roads. Riders are subject to WA road traffic regulations including a maximum power output of no more than 200 watts and a speed limit of 10 km/h on level ground. Riders are subject to the Road Traffic Code 2000, including mandatory helmets, road speed limit of 25 km/h, and a minimum age requirement (16 years).

Injury and helmet use

This report found there were 81 e-scooter related admissions between the 1 July 2017 and 30 June 2022, but does not state whether or not pedestrian admissions are included. The data range of these 81 admissions is between 15 and 74 years old. Of these admissions, 80% were male and the median age was 40. 69% of admissions were considered a mild trauma and 31% as major trauma. Of all accidents, 91% occurred in a metropolitan area and 35% recorded either alcohol or illicit drugs in their system at the time of admission. Only 43% of patients were reported as wearing a helmet, despite it being a legal requirement for e-scooter use in WA. Head injuries were the most common injury with 49 patients sustaining some kind of head injury, followed by upper limbs and lower limbs. There was a significant difference in the odds of sustaining a head injury between helmet wearers and patients who did not wear helmets. There was no statistical difference in the odds of sustaining a head injury between patients who used alcohol or drugs and patients who did not use alcohol or drugs.

Like several other studies, this report confirms that that e-scooter riders who did not wear helmets had an association with increased risk of head injuries. The main cohort of patients sees a slightly older age demographic, however, is made up of mainly males, which is in line with the majority of data. This report showed a much higher rate of alcohol and drug use which interestingly did not seem to convert into statistically significant difference in injury rates between patients who were intoxicated and those who were not.

Surveys

Wellington City Council E-Scooter Survey 2019

In 2019, Wellington City Council conducted a survey on the recently implemented e-scooter share scheme. The survey was run in two waves, the first wave ran one month after the scheme was introduced

and the second wave ran 6 months after. In both waves, the council asked specific research panels, but after the second there was also data from a group of public responses collected via social media. The purpose of gathering data from the public was to understand the public sentiment on the scheme. It provides a thorough review of public opinion on e-scooters on a variety of subjects such as safety, e-scooters as a transport option, purpose of trips and insights into demographic use. For this safety assessment we have only summarised the safety data and issues.

Key data

- 60% of respondents in the first wave believed the scheme should continue. This was followed up by 58% in the second wave. 72% of the respondents via social media believed the scheme should 'maybe or definitely' continue.
- 43% of wave one and 42% of wave two panel respondents thought the scheme had a 'positive' or 'very positive' effect on Wellington.
- 47% of wave one panel respondents reported they felt 'unsafe' or 'very unsafe' sharing footpaths and other pedestrian areas that you are walking on with e-scooters. This increased slightly in wave two with 54% of respondents saying they felt 'unsafe' or 'very unsafe'.
- The general public felt less unsafe; 38% reported they felt 'unsafe' or 'very unsafe' sharing footpaths with e-scooters. However, the general public sample did have a greater number of e-scooter users than non-users, which would likely account for this difference.

Safety survey responses

Across all three samples the majority believe that at least most e-scooter users are riding e-scooters safely and responsibly. The survey asked questions relating to the feelings of safety as a rider as well as pedestrians and included data about safety in relation to motor vehicles and cyclists.

- 60% of wave one and 56% of wave two respondents believe that 'all' or 'most' are riding e-scooters safely and responsibly.
- 65% of the general public sample believe that 'all' or 'most' are riding e-scooters safely and responsibly.
- 65% of respondents who had rented an e-scooter felt safe when riding an e-scooter. 7% in wave one and 14% in wave two reported feeling unsafe whilst riding e-scooters, neither of the waves had any reports of feeling 'very unsafe'.
- Feeling unsafe or very unsafe as a pedestrian was at 47% in wave one and 54% in wave two. 38% of the general public survey reported feeling unsafe or very unsafe whilst sharing footpaths with e-scooters.
- Most of the respondents across both waves believed that most or all e-scooters had been ridden safely and/or in a responsible manner. This was 92% in the first wave with a slight decrease to 88% in the second wave.

Both waves were surveyed on the most commonly experienced issues whilst riding an e-scooter.

- 11% in both waves reported a near miss with a pedestrian, 4% in both waves had fallen off or crashed. 7% in the first and 9% in the second reported a narrowly avoided crash, and 3% in the first and 5% in the second recorded a near miss with a car.
- Whilst a percentage of riders had experienced a near miss with a pedestrian, no riders in the first wave had actually hit or collided with a pedestrian and only 1% in the second wave had actually hit a pedestrian.
- 82% of riders in the first wave and 77% in the second reported no issues experienced whilst riding an e-scooter.

In the public survey, results were similar.

- 12% has just avoided crashing and 11% had experienced a near miss with a pedestrian. None of the public in this survey had hit or collided with a pedestrian, or with a car. 5% had fallen or crashed isolated to either of those other modes.

- A slightly lower percentage of public responses had never experienced a safety related issue, with 74%, leaving 26% of the public responses experiencing some kind of safety issue.
- As a pedestrian, just under half (45%) of respondents reported they had experienced no safety related issues with people using e-scooters.
- This dropped to around a third (34%) in wave two. In wave two, the panel sample were more likely to report they had experienced safety issues as a pedestrian with 51% reporting they had been startled or frightened, and 31% saying they had had a near miss. A small number said they had been hit or collided with.

E-scooter use in New Zealand: Insights around some frequently asked questions 2019

This survey was conducted by the University of Otago in the first-year shared e-scooter schemes were introduced to New Zealand (2018-2019). It collected responses from 591 people in the city of Christchurch. This survey is not representative of NZ's population, but it does provide insights into the perspective of Christchurch as a city.

Key data

- 71% of respondents had used an e-scooter; 29% had not.
- Younger people between 18-24, and those of NZ European ethnicity in full-time employment were most likely to use e-scooters. Males were more likely to have used an e-scooter than females.
- 58% of e-scooter trips replaced trips that would otherwise have been made on foot, by bicycle, skateboard, or e-bike.
- 23% of e-scooter trips replaced a trip by private car or van, motorcycle, ride source vehicle, or taxi.
- The most common reason for using an e-scooter was for fun, however this survey was conducted in 2019 when e-scooters were still reasonably new. Quicker and more convenient than the alternative was the second most common reasoning for people using e-scooters. The survey did assert that first time users were most likely motivated by fun rather than practicality, but that people who had used them more than once were more likely to use them to travel to work, to social engagements, and shops or supermarkets.
- Over 90% of e-scooter users had ridden on the footpath, but most respondents did not think the footpath was a suitable environment for e-scooter use.
- Respondents were asked where would be best for e-scooters to operate, a common conclusion was that e-scooters travel too quickly to be ideal for use alongside pedestrians but are too slow and unstable for use on roads alongside faster, heavier vehicular traffic.
- The top 3 zones survey responses said e-scooters would travel best in were, cycleways, shared paths, and quiet streets.

Abley Report: Micro-mobility with Auckland Transport 2021 E-scooter Survey

The survey aspect of this report was conducted with 810 respondents. The survey's respondents are based solely in the Auckland region. This survey asked participants about any micro mobility incident they had been involved in, it focuses on both riders and non-riders of micro mobility devices.

Key data

- The Abley report survey received 1147 respondents. The majority of respondents had tried a micro mobility device: the most popular was the e-scooter at 44%. The demographic was skewed towards males at 53%, with female use at 36%. The most common age groups using e-scooters are 15-29, with 68% of respondents having used e-scooters, and also 30-44, with 56%.

- Incidents which resulted in collisions are mainly attributed to the behaviour of the e-scooter user, while falls or crashes with a non-moving object were mainly attributed to road features such as slippery or bumpy surfaces. Overall, 25% of responses were considered to be collisions, 24% were falls or near falls, and 51% were near misses.
- Rental devices were more likely to be involved in e-scooter crashes than private e-scooters, while e-bike crashes tended to be on private devices. Similarly, 50% of e-scooter incidents occurred within the user's first nine rides, while 60% of e-bike incidents occurred with a rider who had ridden more than 100 times.
- Across all device types, 35% of collision incidents resulted in injury, and 29% of fall incidents resulted in injury. While e-bike incidents tended to happen on road, and e-scooter incidents tended to happen on the footpath, there was a similar profile of injuries resulting from e-bike and e-scooter crashes.
- Environmental factors, such as road surface, are the leading cause of e-rider collisions with non-moving objects, accounting for 47% of collisions with non-moving objects. 39% of collisions with others are the result of rider behaviour.
- Regarding micro mobility incidents, one in two micro mobility riders have experienced an incident in the past 3 years, most commonly near misses or falling off, with only 5% having collided with another road user. 52% of users had not experienced any incidents.
- Out of the 810 incidents that were reported, half were near misses, one in four were collisions and one in four were rider falls or near falls. Just under half were reported by someone personally involved in the incident. Out of the 810 surveyed, 414 were near misses and 368 were near misses that involved another road user.
- One of research questions involves understanding the difference between rental micro mobility risk vs private micro mobility risk. This figure shows, out of the 688 reported, two in three (68%) incidents with e-scooter riders involved rental or shared e-scooters compared to only 20% of incidents involving e-bikes.

Reports

Abley Report: Micro-mobility with Auckland Transport 2021 General Statistics

This study is an extensive but broad overview of safety risks and issues. It draws from a wide range of data sources and findings. This study sought to understand the risk to all road users, especially vulnerable road users associated with new and emerging micro mobility. It looks to develop a practical approach to assessing risk and accommodating these modes on the network. This study has been conducted through a Safe Systems lens, with the four key elements – safe roads and roadsides, safe speeds, safe road use and safe vehicles.

Key report points

- Rental devices were more likely to be involved in e-scooter crashes (than private e-scooters), while e-bike crashes tended to be on private devices. Similarly, 50% of e-scooter incidents occurred within the user's first nine rides, while 60% of e-bike incidents occurred with a rider who had ridden more than 100 times.
- Across all device types, 35% of collision incidents resulted in injury, and 29% of fall incidents resulted in injury. There was a similar profile of injuries resulting from e-bike and e-scooter crashes.
- Helmet use is very low for e-scooters, at only 11% for shared devices and 44% for private devices.
- Skill level is a far more significant factor in e-scooter incidents than e-bike incidents. This is likely because a lot of the skills required to ride an e-bike are transferable from riding a traditional bicycle.
- Crashes occurring on the roadway (rather than footpath) tend to be more severe.

- Bike and e-scooter speeds below 20 km/h have a lower likelihood of resulting in a concussion if a collision with a pedestrian occurs, hence a lower risk of severe injury to the pedestrian.
- Higher micro-mobility speeds do, however, increase the likelihood of the higher severity injuries with traditional vehicles.

Key report recommendations

- Allow e-scooters to be used on road cycling infrastructure depending on their speed capability and helmet use.
- Consideration of low-speed zones should be made for roads with higher gradients for micro-mobility devices.
- Where speed limits exceed 30 km/h, seek segregation for micro-mobility or provide wider footpaths to allow more space for micro-mobility to avoid pedestrians, especially where pedestrian flows are high.
- Review requirements for helmet use in context of infrastructure use, speed capability of devices, and the forward fall mechanism specific to standing e-scooters. Where devices are capable of exceeding 20km/h, the risk of concussion is higher.
- Consideration of low-speed zones should be made for roads with higher gradients for shared-use micro-mobility devices.
- Priority for transport policy and design standards should be directed at reducing the likelihood of vehicle vs micro-mobility crashes.

European Transport Safety Council – Recommendations on Safety of E-scooters

Published in February of 2023, the European Transport Safety Council released a report of recommendations for the safe use of e-scooters. The organisation was aware that many European countries are still in the developmental stages of regulation, so this report was intended to set out, in the main, the safety implications to consider and basic regulations needed to mitigate those. It considers a wide variety of available data, hospital studies, vehicle safety testing and research from across Europe. The report explores injuries rates and commonalities, urban road safety, safety of vulnerable road users, comparison with bikes and technical standards. It analyses all these factors to produce a set of recommendations for countries with e-scooters.

Key report points

- Improving data collection is essential. Ensuring that data is compatible and able to be compared. If micro mobility is going to become a key transport mode, then data collection needs to be easier and more reliable, the report recommends a separate category in Police and hospital records.
- A summary of European statistics showed that 20-50% of hospital admissions were patients suffering head injuries, very few riders wore helmets. More riders fell in single vehicle collisions than with another road user, often caused by environmental factors, passenger carrying, or one handed/phone use. Many countries also had issues with users riding under the influence of alcohol.
- There is a lack of calibrated crash testing or computational modelling of e-scooters. Assessing stability during braking and the effectiveness of brakes is important. The stability over road imperfections is also important for e-scooter riders.
- Testing can provide insights to common crash results and how to create regulations to combat this. Some of the minor testing has shown that in a collision with a pedestrian when travelling at 20km/h or over, both the e-scooter rider and pedestrian are likely to suffer severe injuries, and the pedestrian injuries are more likely to be fatal. It also showed e-scooter stability over surface irregularities and potholes is improved with a larger wheel size. Acceleration and deceleration reduce the stability of an e-scooter. E-scooters are inherently less stable than bicycles in many circumstances: when accelerating, braking, and negotiating uneven road surfaces.

- More education campaigns are needed, and to be targeted at all road users who interact with micro-mobilities.
- E-scooter riders are more likely to impact their head when falling and the rate of serious head injury is higher than that for pedal cyclists. This is likely due to the culture and often legal requirements for cyclist to wear head protection, these same norms do not yet exist for e-scooters and contribute to this rate of injury.
- There is evidence that a high percentage of collisions occur the first time a rider uses an e-scooter. An e-scooter rider should be competent to use the e-scooter and understand the rules governing other road users.
- The weight of the e-scooter is a fundamental part of the risk which the e-scooter creates. Higher vehicle weight increases the kinetic energy of the e-scooter when ridden, increasing risk of injury to other road users, and causing braking to be less effective. Studies have found that adult e-scooter riders suffer abdominal injuries as a result of shock from the handlebars. It could therefore be implied that child passengers, standing in front of the rider, are at additional risk of head injury from impact with the stem and handlebars.

Technical & regulatory recommendations

- Recommendation: set a maximum 20 km/h speed for private e-scooters at the factory. Shared e-scooter providers, while limiting top speed to 20 km/h, should also apply lower speeds, for example in pedestrian zones, using GPS.
- E-scooters should have a maximum rated power of 250W.
- Anti-tampering mechanisms should be included at the factory for privately owned e-scooters and by the operator for shared e-scooters. Tampering should be prohibited by law.
- Set a minimum wheel size of 30.5 cm (12 inches) for private and shared e-scooters.
- Set a requirement for independent front and rear wheel braking devices for private and shared e-scooters.
- Require an audible warning device on all private and shared e-scooters.
- Set a requirement for independent front and rear lights on private and shared e-scooters. Indicator lights should be considered due to the difficulties of using hand signals.
- Helmet wearing should be mandatory for all private and shared e-scooter riders.
- No e-scooters should be ridden on pavements.
- E-scooters should only be ridden by one person at a time.
- E-scooter rider training is recommended, and consideration should be given to education of all road users in awareness of risk involving e-scooters and other micro mobility vehicles.
- E-scooter riders should be at least 16 years old, or the age restriction should be aligned with the national age requirement for a traditional moped.
- Riding under the influence of alcohol or drugs should be prohibited.
- Handheld use of a mobile phone while riding should be prohibited.

Safety of private e-scooters in the UK 2021

This report from the Parliamentary Advisory Council for Transport Safety in the UK was written during the rental e-scooter scheme in 2021 in response to TSC's recommendation of legalising private e-scooters. However, unlike the majority of the literature and data, this report focuses on the use of private e-scooters. Although it does not provide recommendations, it highlights relevant information and issues. The report admits the data is incomplete and the lack of data on private e-scooter use is an issue globally due to the lack of licensing and registration and other information catching systems.

Key points

- In 2021, it was estimated there was 500,000 privately owned e-scooters in the UK despite them being classed as motor vehicles which cannot get type approval, making them technically illegal.

- The difference in model to the rental scheme e-scooter can be huge, some privately owned models can exceed speeds of 50 mph and can be purchased with minimal certification to demonstrate their safe construction.
- Legislation around e-scooters must take into account these privately owned vehicles, they are not fitted with the speed limiters, geofencing control or no-go or go-slow areas or onboard diagnostics afforded by the rental e-scooters. There is no traceability of users and limited ability for enforcement authorities to penalise riders for irresponsible behaviour. Therefore, the legislation should be the tool used to protect private e-scooter users.
- Data on private e-scooters is scarce and difficult to produce, national travel surveys or usual data gathering tools like a census, Police databases, insurance claims do not have e-scooters as an option yet making them invisible in the system.
- PACTS used a variety of sources to attempt to better understand private e-scooter use, this included complying police reports, media and news sources and insurance claims. They found majority of private users were male, and were involved in single vehicle or isolated incidents, & helmet use was found not to be common.
- This report collated some views from various NHS staff & hospitals. Fractures were commonly seen in e-scooter injuries, usually in upper and lower limbs. Head injuries were also a common occurrence across the country, a London neurosurgeon saw eight e-scooter patients in an 8-month period, compared with 11 motorcyclists and 17 pedal cyclists during the same time period.
- There needs to be more access to data collection for private e-scooters.
- Key areas of concern are vehicle design, speed, user behaviours including training and roading & infrastructure.
- There are differences between rental and private e-scooters and their use, rider attitudes and injury concerns.

Summary

Actual vs perceived and overall safety

The rise of micro mobility, and e-scooters in particular, has occurred at considerable pace and brought many benefits in terms of transport system improvement. Today's most pressing urban problems – transport cost, congestion, pollution, and lack of public transport options – have caused many commuters in dense urban areas to move to e-scootering, on both privately owned and rented devices. One of the most important factors relating to e-scooter use is safety – of both riders and pedestrians.

Concerns about pedestrian safety has arisen consistently throughout this review. The safety of non-riders and vulnerable groups is an important factor in considering the ongoing use of e-scooters. We have seen throughout our public survey testimonies of pedestrians involved in crashes or near misses with e-scooters leaving them stressed or fearful whilst using the footpath.

However, the greatest risk to system safety is the safety of e-scooter riders themselves. In relative risk terms, the likelihood of serious injury while riding an e-scooter is second only to the riskiest transport mode - motorcycling. E-scootering has a relative risk factor of between two and four times greater than cycling, which is cause for concern and signals that safety attention and action is required.

Injury data can vary depending on the lens of a report, methods of data collection and the time period data was collected. Some studies were conducted for a relatively short period of time, and user and pedestrian behaviours have changed over the years. Many of the injury types, for instance head injuries, could be avoided with a shift in safety culture – in the same way as occurred with cycling and helmet wearing.

A Safe System approach effectively requires “all practicable steps” be taken to prevent or reduce harm. There are steps that can be taken with relative ease which would prevent or reduce the severity of certain injuries. The importance of feeling and being safe on footpaths, as a pedestrian or as a rider, is an essential part of the Safe System approach. There are sound safety principles and requirements set in our

legislation (in the Rule), but it is important to explore additional measures (e.g., further speed restrictions; mandating helmets) to improve levels of compliance to reduce risks and improve safety as well.

Alcohol and drug use

The use of substances and riding e-scooters under the influence has been identified as an issue of concern. Rental scooter companies have some initiatives in place to combat this, such as in-app reactionary testing, which is compulsory after a certain time at night, and failure to pass means the e-scooter will not unlock. Some local authorities have placed curfews on scooters, so they are unable to be ridden during certain times. Further use of these approaches would contribute to reducing e-scooter injuries and have few downsides.

Helmet use

Currently, there is no requirement to use a helmet when riding an e-scooter in New Zealand, both privately-owned and rented devices. The recommendation of helmet use is seen consistently throughout this sample of safety studies and others internationally. Helmets are an important factor in reducing the severity of injury, and in some cases can mitigate the injury entirely. The potential mandating of helmet use for e-scooters is something which could be further explored.

Speeds

Only one hospital reports on speed, and only in certain cases, and gives a rough figure that most admissions were travelling between 15-40 km/h. Currently, there is no ability to check the speed of an e-scooter unless it is a rental and travelling through a speed geofenced zone. Whilst a power output of 300 W means e-scooters are effectively speed-limited to about 30 to 35 km/h, this can vary based on terrain and weight of scooter and rider. Private e-scooters with a maximum power output in excess of 300 W can reach much higher speeds.

Speed is a factor both in terms of crash likelihood and severity. Globally, there is a trend toward lowering permitted e-scooter speeds to further improve both rider and pedestrian safety (and compatibility between the two modes). Work could be done to lower e-scooter speeds through mechanisms such as greater use of geofencing technology (share-scheme) and advisory or mandatory speed limit posting (share-scheme and private), especially in high pedestrian-use areas.

Research on the use of footpaths

The data available through the hospital reports indicates that the number of pedestrians admitted to hospitals is low.

There has been survey work done to understand pedestrian views on e-scooters. The Abley report, Wellington City Council survey and University of Canterbury report all look at public sentiment regarding the use of e-scooters on footpaths. Riders report feeling most comfortable on footpaths or in cycle ways, but report feeling unsafe if they were required to ride on roads. Some pedestrians are content with e-scooters on footpaths but would prefer them to be used on shared paths or cycleways. Other respondents feel unsafe with e-scooters being operated on the footpaths. Our public survey which ran alongside this safety review described a more recent view on the use of the footpath from a public perspective. Themes remain very similar to these older reports.

Rental and private scooters

There are claims that private e-scooter operators have higher levels of compliance with the Road User Rule requirements and are more likely to be wearing helmets. The lack of recording systems for private e-scooter means these claims are difficult to back up with quantifiable evidence and even anecdotally.

Casual observation does support the claims that private e-scooter operators are more likely to wear helmets, be more considerate of other path users, and are more familiar and skilful in terms of safe device operation.

However, privately-owned e-scooters are not subject to the geofencing lower speed and no-go zones that rental e-scooters are required to comply with.

RESOURCE LIST

Brownson AB, Fagan PV, Dickson S, Civil ID. Electric scooter injuries at Auckland City Hospital. *N. Z. Med. J.* 2019; 132: 62-72. https://assets-global.website-files.com/5e332a62c703f653182faf47/5e332a62c703f648f12fccca_Brownson%20FINAL.pdf

McGuinness MJ, Tiong Y, Bhagvan S. Shared electric scooter injuries admitted to Auckland City Hospital: a comparative review one year after their introduction. *N Z Med J.* 2021 Feb 19;134(1530):21-29. PMID: 33651774. <https://pubmed.ncbi.nlm.nih.gov/33651774/>

Beck, S., Barker, L., Chan, A. and Stanbridge, S. (2020), Emergency department impact following the introduction of an electric scooter sharing service. *Emergency Medicine Australasia*, 32: 409-415. <https://doi.org/10.1111/1742-6723.13419>

Trivedi TK, Liu C, Antonio ALM, et al. Injuries Associated with Standing Electric Scooter Use. *Jama Netw Open.* 2019;2(1):e187381. Doi:10.1001/jamanetworkopen.2018.7381/.

Fournier, Marion and Bailly, Nicolas and Schäuble, Andreas and Petit, Yvan, Head impact kinematics and injury risks during E-scooter collisions against a curb (April 2, 2023). Available at SSRN: <https://ssrn.com/abstract=4499244> or <http://dx.doi.org/10.2139/ssrn.4499244>

Raubenheimer, K., Dodd, J., Jarmin, M.J., Sarvepalli, R., Fatovich, D.M. and Weber, D.G. (2023), Western Australian State Trauma Registry analysis of incidence and injury patterns associated with e-Scooter injuries: 5-year retrospective case series. *ANZ Journal of Surgery.* <https://doi.org/10.1111/ans.18538>

Fitt, H., & Curl, A. (2019). E-scooter use in New Zealand: Insights around some frequently asked questions. Available from: <https://ir.canterbury.ac.nz/handle/10092/16336>

Recommendations on Safety of E-scooters, European Transport Safety Council. Parliamentary Advisory Council for Transport Safety. February 2023. <https://road-safety-charter.ec.europa.eu/content/etsc-and-pacts-set-out-safety-recommendations-e-scooters-and-their-riders>

Neuron Mobility. 17 April 2023. Neuron research highlights positive impacts of e-scooters on riders with disabilities or mobility impairments. <https://www.rideneuron.com/neuron-research-highlights-the-positive-impact-on-riders-with-disabilities-or-mobility-impairments/>

Tin Tin S, Woodward A, Thornley S, Ameratunga S. Cycling and walking to work in New Zealand, 1991-2006: regional and individual differences, and pointers to effective interventions. *Int J Behav Nutr Phys Act.* 2009 Sep 20;6:64. doi: 10.1186/1479-5868-6-64. PMID: 19765318; PMCID: PMC2754975.