



Electric scooters accidents: Analyses of two Swedish accident data sets

H. Stigson^{a,b,*}, I. Malakuti^c, M. Klingegård^a

^a Folksam Insurance Group, 106 60 Stockholm, Sweden

^b Division of Insurance Medicine, Department of Clinical Neuroscience, Karolinska Institutet, 171 77 Stockholm, Sweden

^c Department of Surgical Sciences, Odontology & Maxillofacial Surgery, Uppsala University, 751 85 Uppsala, Sweden

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ABSTRACT

Since august 2018 electric scooters (e-scooters) are available in selected cities in Sweden, operated by several different operators. There is a growing concern regarding their safety as they grow in popularity. The aim with this study was to investigate injuries associated with e-scooters in Sweden and to identify accident characteristics. In addition, the aim was to observe how different data collection procedures and samples may influence the results. Two complementary data sets were used; insurance data including all reported injuries to Folksam Insurance Group during the period January 2019 to May 2020 and the Swedish Traffic Accident Data Acquisition database (STRADA), the national system for road traffic injury data collection, was used to study accident related to e-scooter use in the Stockholm city area between May and the end of August 2019. Most of the injuries associated with e-scooters occurred in single crashes, but in 13% of the accidents another road user was injured, either due to interactions with e-scooters or due to a parked e-scooter being a hazard. In both data sets more than half of the accidents occurred during weekends. In total 46% of all who had visited an emergency department the accident occurred during night-time (10 pm to 6 am). The overall large proportion of injuries to the head and face indicates the need for actions aimed to increase helmet use among e-scooter riders. Local authorities should take a wider responsibility since one third of all accidents primarily occurred due to lack of maintenance or that the rider hit a curb stone. In comparison to hospital data, insurance claims include riders with all types of injuries irrespectively what type of healthcare the rider was seeking. Hence, to better understand the consequences and to make the right decisions regarding countermeasures aimed to improve the safety of e-scooter riding, data from different data source are needed.

1. Introduction

During recent years, shared electric scooters (e-scooters) have emerged as a transport vehicle around the globe. These vehicles are commonly promoted as a “last mile” service, known to often replace walking. Being a phenomenon from the early 2000s it is only since August 2018 shared e-scooters are available in selected cities in Sweden operated by several different companies. More specifically, by September 2019 a total of 10 operators were active across Sweden (Voi, Lime, Tier, Circ, Ozon, Bird, Aimo, Moow, Ayo and Vosh) (DN, 2020). During the current pandemic (Covid-19), 8 out of the 10 companies have withdrawn their operation from Stockholm and only two were left in May 2020 (Tier and Voi). In September 2019 about 9000 e-scooters were available to rent in Stockholm. Out of those, there were only approximately 2000 left in Stockholm in April 2020 due to Covid-19. A recent survey study Andersson, (2019) performed in Stockholm shows that e-

scooters were most often used for pleasure and for social purposes (68%) and only 12% was associated with work. In total 56% of the travels in that study were performed during weekends. It should be noted that the survey was performed in the central area of Stockholm with most respondents being in their twenties, which may influence the results.

As they grow in popularity, there is a growing concern regarding their safety by the authorities as accidents are starting to be reported. In May 2019, the first fatal accident from this kind of service occurred in Sweden when an e-scooter rider was hit by a passenger car in an intersection.

So far, studies on accidents are rare as there simply have not been any data available (Yang et al., 2020). However, during the last years several studies have been published from different countries, mainly based on hospitals data (e.g., (Badeau et al., 2019; Trivedi et al., 2019a; Trivedi et al., 2019b; Beck et al., 2020; Lin et al., 2020)). It can be seen that head injuries (including face) were common (28–58%) (Brownson

* Corresponding author at: Folksam Insurance Group, 106 60 Stockholm, Sweden.

E-mail addresses: helena.stigson@folksam.se (H. Stigson), iman.malakuti@akademiska.se (I. Malakuti), maria.klingegard@folksam.se (M. Klingegård).

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et al., 2019; Trivedi et al., 2019a; Blomberg et al., 2019; Namiri et al., 2020). The most typical accident type was single crashes (i.e., an isolated fall that did not involve another person or vehicles), e.g. Brownson et al (2019) saw that 92% (165/180) occurred due to skidding, breaking, swerving, or hitting a curb, drain, or pothole. However, regarding fatal accidents, 80% occurred when a motor vehicle was involved (OECD/ITS, 2020).

Based on observational data risky behaviours like non-helmet use and carrying a passenger were far higher among riders using a shared than a private e-scooter (Haworth et al., 2021). Furthermore, the e-scooter riders and the vehicle itself are a potential risk to other road users. A survey in, Australia, shows that 65% report that an e-scooter made them feel unsafe while sharing footpath (with elderly category standing out), (InsuranceSovedBlog, 2020). An observational study in Rosslyn, Virginia in the US shows that 16% e-scooters were not parked according to the instructions of the operator (James et al., 2019), being a potential safety hazard for pedestrians. A study by Trivedi et al. (2019b) showed that pedestrians accounted for 8% of the e-scooter related injuries (e.g. hit by a scooter, tripped over a parked scooter or injured while trying to lift or carry a scooter not in use). Sikka et al. (2019) have highlighted that there is a lack of knowledge regarding the injury distribution for pedestrians.

As data start to emerge globally, it is of interest to investigate the injury distribution in Sweden and how these injuries relate to the vehicle and infrastructure conditions. In Sweden, e-scooters are mostly used on city road networks where local authorities are responsible. E-scooters are classified as a bicycle in Sweden and the maximum speed of the scooter is limited to 20 km/h. Accordingly, e-scooter riders are subject to the same rules as cyclists; including a mandatory helmet usage for children below the age of 15. To get a broad understanding of e-scooter accidents and the current situation in Sweden the aim of this study was to investigate all injuries associated with e-scooters in Sweden and to identify their accident characteristics. In addition, the aim was to observe how different data collection procedures and samples can affect the results.

2. Method

Two complementary data sets were used. Insurance data including all reported injuries in Sweden to Folksam Insurance Group (Folksam) between January 2019 and May 2020. The insurance covers all injuries among individuals with a specific non-mandatory accident insurance. The second dataset was the Swedish Traffic Accident Data Acquisition database (STRADA), the national system for road traffic injury data collection. Included from STRADA were individuals who had been involved in e-scooters accidents in the Stockholm city area between May and the end of August 2019, and who visited the emergency department. These two data sets were used to be able to compare insurance claims with visits to the emergency departments.

2.1. Data sample based on insurance claims

A personal accident insurance is voluntary and covers personal injuries (including dental injuries) resulting from an accident. The policyholder is entitled to compensation if he/she is exposed to a sudden external event resulting in personal injury, in this case an e-scooter accident. The policyholder is covered 24 h a day, and regardless where the accident occurs. The insurance is a complement to the national health care systems and compensates costs directly in connection with the accident as well as non-recurring monetary compensation if the injury results in permanent medical impairment. If the policyholder has an agreement with more than one insurance company, all companies will compensate for the permanent medical impairment. The e-scooter accidents were reported to Folksam by the policyholder, or a parent if the injured was younger than 18 years of age, via telephone, email, or online. Included in the present study were all riders that have been

examined by a physician within one week from the accident date. Thereby, all injuries irrespective of healthcare and injury severity were included. Most of the injuries were diagnosed by a physician, but some were further examined by for example a physiotherapist. The definition of injury is an acute physical damage to the policyholder related to a specific identifiable event. The injuries were categorised in different categories regarding type of injury and body location. Type of injury was based on the classification made by the claims adjuster including the following seven groups: fracture; dislocation/rupture; sprain/strain; laceration/abrasion/contusion; traumatic brain injury; dental injuries and “multiple injury types”. The category “Multiple injury types” included several unspecified injury types where there was no further description in the digital insurance system. The injured body region was categorized into five groups: head (including face); spine; torso; upper extremities; lower extremities. To investigate accident causation, the description of the injury event from the claimant was used. This was then categorized into (1) *type of accident* (single crashes, e-scooter in collision with motor vehicle/bicycle/other e-scooters/pedestrian or nonriders injured by e-scooters (e.g. pedestrians that tripped over an e-scooter)) and (2) *the accident causation* (fall, accident involved handling of the e-scooter (getting on/off, problem with balance), surface feature (e.g. potholes, low friction; such as icy roads or gravel), malfunction to the e-scooter, maneuvers etc.). If there were some overlaps between causations (for instance, “Started to brake but the brakes did not work, started to lose balance and crashed into a tree”) then the first and the initial cause was chosen (this example was categorized as “malfunction of the e-scooter”). Personal information regarding age and gender as well as date when the accident occurred were available for all riders.

2.2. Data sample based on emergency department visits

The Swedish Traffic Accident Data Acquisition database (STRADA), is a nationwide database for road traffic injury based on hospital and police records. Hospital records available in STRADA normally include a few parameters describing the accident (brief self-reported description of the accident, accident type, location etc), personal information about the injured road user (age, gender, use of protective equipment etc) and full diagnoses classified according to the AIS 2005 scale (AAAM, 2005). The injuries were categorised into same categories regarding type of injury and body location as for the insurance data except from the categories “multiple injury types” and “dental injuries”. Dental injuries are not included in STRADA and since the injuries included in STRADA are classified according to the AIS scale, information regarding injury type was always known. In this study, the brief description of the accident included in the hospital records was reviewed and analysed to classify the main cause of the accident similar as for the insurance claims. The dataset used was limited to all injured e-scooter riders who had been involved in an accident within the road transport system from May to August 2019 (summer months in Sweden) and who had visited an emergency department in Stockholm. E-scooter accidents accounted for 14% of all traffic accidents (including pedestrian fall accident) reported to the hospitals in Stockholm during the study period.

2.3. Analysis

Descriptive statistics including frequencies and proportions were conducted on all available variables. The data were divided into different categories including sex, age, accident type, accident causation, type of injury and injured body region. Chi-squared test was used to study whether there was a difference in proportions between the categories. In all analyses 95 % confidence level was used, and p-values from chi-squared tests were calculated using SPSS (version 27). The project was approved by the Regional Ethical Review Board in Stockholm, Sweden.

3. Result

In total 321 individuals reported injuries associated with e-scooters to Folksam between January 2019 and May 2020, [Table 1](#). Out of these 278 were injured e-scooter riders, 28 injured pedestrians and 14 injured cyclist and one injured moped rider. In 83% of the cases the e-scooter riders were injured in a single crash but in 12% the accident also involved another road user and in 5% a pedestrian or a cyclist were injured while tripping over/cycling into a parked e-scooter.

Most of the accidents reported to Folksam occurred during the summer, [Fig. 1](#). In total 43% of the insurance claims were reported from May to August 2019. In detail, the results show that the average age was 30 years and males represented more than half of the injured riders (57 % in the insurance claims and 55% in the hospital data), [Table 2](#). The e-scooter riders were most often injured in a single crash (95% of the insurance claims and 90% of the accidents reported to hospitals) and the accident often occurred during weekends (54% of all accidents occurred Friday to Sunday in both datasets), in particular on Saturdays. In addition to the results presented in [Table 2](#), it was found that 46% of the accidents reported by hospitals occurred during night-time (10 pm to 6 am). Of all injured who visited an emergency department, 13% did use a helmet and among riders younger than 15 two of five used a helmet.

In total 18% of the accidents reported to Folksam where an e-scooter rider was injured involved handling of the e-scooter (getting on/off, problem with balance, braking too hard, speed too fast) and this accident causation was significantly more often reported by female riders (23%) compared to male riders (11%) ($p < 0.05$). The proportion of accidents related to the handling of the e-scooter was higher within STRADA (26%). One fifth of the accidents occurred when riding into a pothole in the road or on a road with other shortcomings like low friction, such as icy roads or gravel. The rider was often injured when falling after hitting a curb stone (12% in the insurance data and 15% in the STRADA data). The two complementary data sets show that 6% of the classified accidents occurred primarily due to malfunctions of the e-scooters, typically malfunctions of the brakes.

Most of the reported injuries via the insurance claims were minor injuries such as lacerations and contusions (38%), followed by fractures (28%) and dental injuries (18%). Like the reported injuries via the insurance claims most of the injuries reported in STRADA were minor injuries such as lacerations and contusions (46%). However, two out of five e-scooter riders who had visited an emergency department in Stockholm sustained a fracture.

Based on insurance claims the head was the most injured body region

Table 1
Injured road user associated to e-scooters reported to Folksam divided into different accident types.

Accident Type	Injured Road User			Pedestrian	Total
	E-scooter rider	Bicyclist	Moped rider		
Single crash	265				265
E-scooter in collision with motor vehicle	6		1		7
E-scooter in collision with bicycle	4	11			15
E-scooter in collision with other e-scooters	1				1
E-scooter in collision with pedestrian	1			14	15
E-scooter in collision with unknown road user	1				1
Pedestrian trip over/cycling into a parked e-scooter and falling		3		14	17
Total	278	14	1	28	321

(44%) followed by upper extremities (37%), and lower extremities (23%). When studying riders who visit an emergency department the most commonly injured body region differed from the insurance data. Forty-two percent of the e-scooter riders sustained injuries to the upper extremities and 30% of the riders injured the lower extremities. In total 31% sustained injuries to the head (10%) and/or the face (24%). In addition to the results presented in [Table 2](#), it was found that a significantly higher proportion of head injuries occurred during night-time. In total 69% of all head injuries occurred during night-time. In general, 75% of the riders injured night-time sustained a head injury compared to 28% during daytime ($p < 0,005$).

4. Discussion

This first Swedish study using two different data sets of injuries associated with e-scooters confirmed previous findings that males are more frequently involved in e-scooter accidents ([Yang et al., 2020](#); [Haworth and Schramm, 2019](#); [Brownson et al., 2019](#); [Liew et al., 2020](#); [Beck et al., 2020](#); [Bekhit et al., 2020](#)). It also confirmed that younger age-groups were more frequently involved in accidents than older age-groups ([Yang et al., 2020](#)), and the highest proportion of injuries was found in riders aged 15-34 years. It could be argued that this is only in relation to the amount of usage which is higher among males and younger age-groups ([OECD/ITS, 2020](#); [Andersson, 2019](#)). However, studies ([Axelsson and Kullgren, 2019](#); [Hagel et al., 2015](#)) have shown that both males and younger age-groups have a higher risk of both crash involvement and injury. There is a need for further research to clarify the issue. Furthermore, the results from the present study show that 82% of accidents resulting in injuries among e-scooters were single crashes, although in 13% of the accidents another vulnerable road user was injured, e.g. hit by an e-scooter or that a pedestrian or a cyclist was injured while tripping over/cycling into a parked scooter. [Tuncer et al. \(2020\)](#) found when studying the interactions between e-scooter users' and pedestrians in public space, that unused rental e-scooters hamper pedestrian mobility and poses a potential risk for pedestrians. Also [Trivedi et al. \(2019b\)](#) have highlighted that parked e-scooters were a threat for other vulnerable road users. It has been shown that 16 % of the e-scooters were not parked according to the instructions of the operators and 6% was blocking pedestrian right-of-way ([James et al., 2019](#)). An Australian public survey by Budget Direct identifies this a major safety concern ([InsuranceSolvedBlog, 2020](#)). This clearly shows that the operators and the local city authorities should take a wider responsibility for e-scooters when not in use. This also stress the need of using other data sources like insurance data since as [OECD/ITF \(2020\)](#) noted accidents with pedestrians may be under-reported due to that pedestrians injured in fall accident are outside the scope of the traditional definition of road traffic accident data ([STA, 2017](#)).

Similar as for bicycle crashes, a relatively large proportion of crashes were classified primarily to be caused by hazardous surface feature (21% in STRADA and 22% in insurance data). Previous studies in Sweden have shown that good maintenance of the bicycle network could reduce a large number of single-bicycle crashes ([Niska et al., 2013](#); [Rizzi et al., 2013](#); [Axelsson and Stigson, 2019](#)). Furthermore, 12–15% (insurance data respectively STRADA) of the e-scooter riders were injured when hitting a curb stone. This issue could be addressed in several ways; the e-scooters could be fitted with bigger wheels and/or better dampers, educate users to avoid trying to dive over a curb stone and that the city centre and road infrastructure could be designed differently.

The present study involved two different datasets in Sweden. Although, several similarities could be found, some interesting differences were identified when investigating the overall pattern of injuries. Based on insurance claims dental injuries accounted for 18% of all injuries. When studying hospital records this could not be seen since these injuries are not documented and thereby not included in STRADA. This shows the relevance of studying different types of data sets and the importance of being aware of how the inclusion criteria will influence

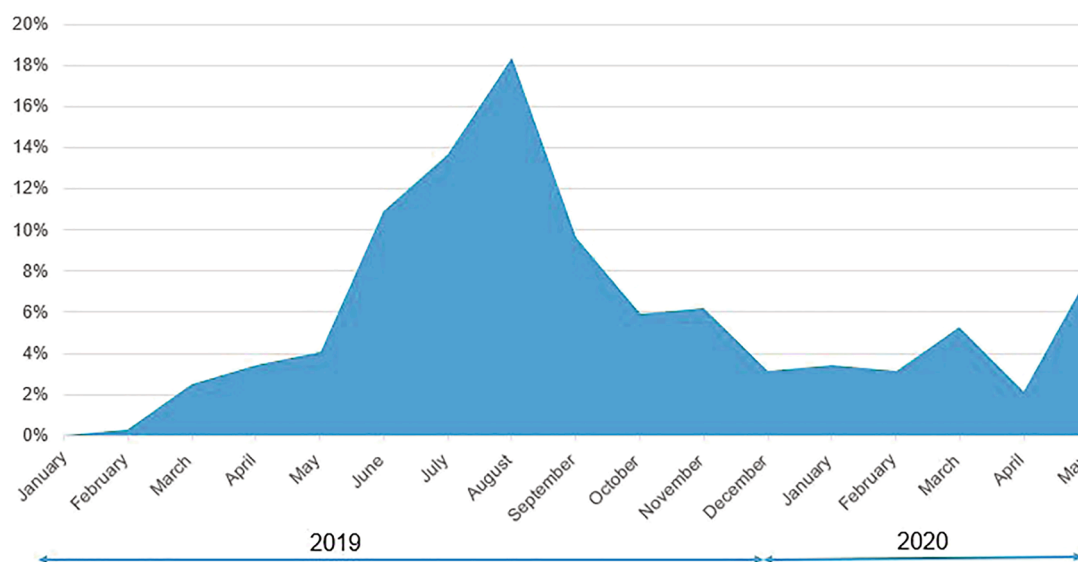


Fig. 1. Distribution of accidents with injured e-scooter riders from January 2019 to May 2020 reported to Folksam.

the results. In general, facial injuries were more common than other head injuries. In line with the sample including insurance data Lin et al. (2020) and Trivedi et al. (2019a) indicated that 20% respectively 12% of all facial injuries involved dental injuries. Since dental trauma account for almost one fifth of the injuries reported through insurance claims, increased knowledge and awareness among dentists about these accidents could lead to improved patient care. Previous studies have shown an overall large head and facial injury reduction with helmets for bicyclists (Thompson et al., 2009). However, only 13% of the injured e-scooter riders who had visited an emergency department used a helmet at the time of accident. Trivedi et al. (2019a) reported even lower usage (94% of the riders were not wearing a helmet). In accordance with other studies the present study shows that head injuries represent a high proportion of all injuries (31% in STRADA and 44% in Folksam). Wearing a helmet may aid in the reduction of the incidence and severity of head injuries in e-scooter related accidents. It can be argued whether it should be mandatory or not. One suggestion is that there should be an opportunity to rent helmets when renting an e-scooter. Several e-scooter operators encourage riders to wear a helmet and there are examples of operators that serve the rider with helmets by hanging helmets on the handlebars or have the scooters equipped with an integrated helmet box. Furthermore, in Australia it has been made mandatory to wear a helmet while riding (TAUR, 2020). However, more initiatives should be taken from e-scooter operators, the public and legislators to encourage helmet use. Based on the results of the study it could be argued that a helmet for e-scooters should be designed to better protect the face.

The study demonstrates a significant increase in e-scooter related accidents since the launch of e-scooter share programs in Sweden. Based on the insurance data this was not a road safety issue in Sweden before the spring 2019. The data set including all injuries due to a traffic accident in STRADA shows that 14% of all emergency department visits during the summer months were related to an e-scooter accident in Stockholm city. Future studies are needed to follow the development.

Strengths of the study are that data from high-quality nationwide insurance registers and hospital records were used. However, the analyses are based on a retrospective review of insurance claims or medical records limited by the self-reported description that was available in the electronic insurance system or in the STRADA database. Among the reported insurance claims 29% did not mention why they fell off the e-scooter. There are limited data available that reveal the actual risk of accidents. When including insurance policyholders' claim reports also less-injured riders will be included than if only hospital data were used. Hence, this make the data more accurate and prevents overestimation of

the injury severity, which could occur otherwise. However, it is not known how many e-scooter accidents that occur where the rider was not injured.

In the present study it was not possible to study the influence of sociodemographic factors. One of the datasets selected for the current study was limited to include only individuals injured in a e-scooter accident and holding a voluntary personal accident insurance. This population will therefore not be fully representative of the Swedish population. It is likely to believe that the income is higher among this group as well as higher education level etc. Furthermore, it was not known if the rider was injured while using a shared or a privately-owned e-scooter. Risky behaviour like not wearing a helmet or carrying a passenger has been shown to be more common among riders using a shared compared to a privately owned e-scooter (Haworth et al., 2021). Further studies should thereby include if it is a shared or private e-scooter.

Most of the accidents occurred during weekends in the two data sets (54%) and in total 46% of all e-scooter riders who had visited an emergency department the accident had occurred during night-time (10 pm to 6 am). No reliable data regarding use of alcohol or drugs were available. However, it is likely to believe that the proportion of alcohol or drugs related accidents are higher during both weekends and this time of the day. According to Blomberg et al. 2019, 37% of e-scooters accidents involve alcohol or drug use. It should be noted in the survey by Andersson (2019) of e-scooter usage in Stockholm the use of e-scooters was greatest during weekends. It could be argued whether it should be possible to rent an e-scooter during night-time or other solutions like reduced maximum speed during this time of the day. Recently one operator (VOI, 2020) introduced an in-app reaction test (i.e., tap helmets in random order) to minimize drunk riding on e-scooters at night. If a rider fails the test, that person will be advised to take an alternative transport mode. The effect is, however, yet to determine. To investigate the relevance of such initiative, it is important that future accident/injury registration collect reliable data regarding use of alcohol or drugs.

The second data set included all e-scooter riders who had visited an emergency department due to injuries from an e-scooter accident from May to August 2019 in Stockholm (STRADA). Due to the ongoing pandemic (Covid-19) and the limited resources at the Swedish Transport Agency it was not possible to obtain and extend the data set to the same study period and to cover the whole country as the insurance data. Therefore, only data for four months were used. It is important to be aware that these accidents occurred mainly during summer conditions. Some typical seasonal variations have been presented in previous

Table 2

Characteristics by data source reported to Folksam and in STRADA (NDA = No data available in the dataset).

E-scooters	Reported to Folksam N	row %	Reported in STRADA N	row %
<i>Sex</i>				
Female	117	42%	55	45%
Male	161	57%	68	55%
<i>Age</i>				
5–14	22	8%	5	4%
15–24	85	30%	36	29%
25–34	84	30%	38	31%
35–44	43	15%	24	20%
45–54	30	11%	19	15%
55–65	12	4%	1	1%
>65	2	1%	–	–
<i>Day</i>				
Monday–Thursday	127	46%	57	46%
Friday – Sunday	151	54%	66	54%
<i>Injury type</i>				
Dental injuries	49	18%	NDA	NDA
Dislocation/rupture	8	3%	8	7%
Fracture	78	28%	49	40%
Laceration/abrasion/ contusion	106	38%	56	46%
Multiple injury types	15	5%	–	–
Sprain/strain	8	3%	14	11%
Traumatic Brain Injury	14	5%	11	9%
<i>Injured Body Region*</i>				
Head (including face)	122	44%	38	31%
Spine	5	2%	–	–
Torso	21	7%	4	3%
Upper extremities	102	37%	52	42%
Lower extremities	65	23%	37	30%
<i>Main Accident Causation</i>				
Alcohol consumption	5	2%	2	2%
Fall no specified cause	82	29%	19	15%
Handling of the e-scooter (getting on/off, problem with balance)	49	18%	32	26%
Hit a curb stone	34	12%	19	15%
Interaction with another road user	13	5%	13	10%
Malfunction to the e-scooter	18	6%	8	6%
Manoeuvres	16	6%	5	4%
Surface feature (Surfaces with low friction e.g. icy roads or gravel)	62 (22)	22% (8%)	26 (24)	21% (19%)

* All injured body regions included.

studies (Blomberg et al., 2019; Ishmael et al., 2020). More injuries occurred during the summer months than during the winter months, indicating a possible increase in use during high-tourist summer months and due to better weather conditions for e-scooter usage. Future studies should investigate how the seasonal variations influence the outcome.

5. Conclusions

This is one of the first studies on accident outcomes of e-scooters in Sweden where insurance claims and data from emergency department were combined. Regardless of the two data sources most of the injuries associated with e-scooters occurred in single crashes. The overall large proportion of head and facial injuries indicates the need for actions aimed to increase helmet use among e-scooter riders. The finding that one third of the classified accidents occurred primarily due to hazard surface feature or infrastructure clearly show that local authorities should take a wider responsibility regarding improved maintenance. Furthermore, in 13% of the accidents another road user was injured either due to interaction with e-scooters or that a parked e-scooter was a hazard. To prevent these accidents further actions are needed from both the operators and the local authorities when it comes to separation of road user categories or how to park e-scooters safely. In comparison to

hospital data, insurance claims include riders with all types of injuries (for example dental injuries) irrespective type of healthcare. Hence, to better understand the consequences and to make the right decisions regarding countermeasures aimed to improve the safety of e-scooter riding data from different data source are needed.

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CRedit authorship contribution statement

H. Stigson: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft. **I. Malakuti:** Writing – review & editing. **M. Klingegård:** Validation, Visualization, Writing – original draft.

Declaration of Competing Interest

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

References

- AAAM, 2005. Abbreviated Injury Scale Barrington. Association for the Advancement of Automotive Medicine, IL, USA.
- Andersson, L. 2019. In Swedish: Studie av elsparkcyklar ur ett användarperspektiv. Independent thesis Advanced level (degree of Master (Two Years)) Student thesis.
- Axelsson, A. & Kullgren, A. Seat belt use and effectiveness of seat belt reminders among children and young adults in real-world crashes. *ESV*, 2019 Eindhoven, the Netherlands.
- Axelsson, A., Stigson, H., 2019. Characteristics of bicycle crashes among children and the effect of bicycle helmets. *Traffic Inj. Prev.* 13, 1–6.
- Badeau, A., Carman, C., Newman, M., Steenblik, J., Carlson, M., Madsen, T., 2019. Emergency department visits for electric scooter-related injuries after introduction of an urban rental program. *Am. J. Emergency Med.* 37, 1531–1533.
- Beck, S., Barker, L., Chan, A., Stanbridge, S., 2020. Emergency department impact following the introduction of an electric scooter sharing service. *Emerg. Med. Australas* 32, 409–415.
- Bekhit, M.N.Z., le Fevre, J., Bergin, C.J., 2020. Regional healthcare costs and burden of injury associated with electric scooters. *Injury* 51, 271–277.
- Blomberg, S. N. F., Rosenkrantz, O. C. M., Lippert, F. & Collatz Christensen, H. 2019. Injury from electric scooters in Copenhagen: a retrospective cohort study. *BMJ Open*, 9, e033988.
- Brownson, A. B., Fagan, P. V., Dickson, S. & Civil, I. D. 2019. Electric scooter injuries at Auckland City Hospital. *The New Zealand medical journal* [Online], 132. Available: <http://europepmc.org/abstract/MED/31697664> [Accessed 2019/11/].
- DN. 2020. In Swedish: Så ritas elsparkcykelbranschen om i krisen [Online]. Available: <https://www.dn.se/ekonomi/sa-ritas-elsparkcykelbranschen-om-i-krisen/>. [Accessed 20200430].
- Hagel, B.E., Romanow, N.T., Enns, N., Williamson, J., Rowe, B.H., 2015. Severe bicycling injury risk factors in children and adolescents: a case-control study. *Accid. Anal. Prev.* 78, 165–172.
- Haworth, N.L., Schramm, A., 2019. Illegal and risky riding of electric scooters in Brisbane. *Med. J. Aust.* 211, 412–413.
- Haworth, N., Schramm, A., Twisk, D., 2021. Comparing the risky behaviours of shared and private e-scooter and bicycle riders in downtown Brisbane, Australia. *Accid. Anal. Prev.* 152, 105981.
- INSURANCESOVEDBLOG. 2020. Only 40% of surveyed Australians favour electric scooters [Online]. Available: <https://www.budgetdirect.com.au/blog/only-40-of-surveyed-australians-favour-electric-scooters.html> [Accessed].
- Ishmael, C.R., Hsiue, P.P., Zoller, S.D., Wang, P., Hori, K.R., Gatto, J.D., Li, R., Jeffcoat, D.M., Johnson, E.E., Bernthal, N.M., 2020. An Early Look at Operative Orthopaedic Injuries Associated with Electric Scooter Accidents: Bringing High-Energy Trauma to a Wider Audience. *J. Bone Joint Surg. Am.* 102, e18.
- James, O., Swiderski, J., Hicks, J., Teoman, D., Buehler, R.lph, 2019. Pedestrians and E-Scooters: An Initial Look at E-Scooter Parking and Perceptions by Riders and Non-Riders. *Sustainability* 11 (20), 5591. <https://doi.org/10.3390/su11205591>.
- Liew, Y.K., Wee, C.P.J., Pek, J.H., 2020. New peril on our roads: a retrospective study of electric scooter-related injuries. *Singapore Med. J.* 61, 92–95.
- Lin, S., Goldman, S., Peleg, K. & Levin, L. 2020. Dental and maxillofacial injuries associated with electric-powered bikes and scooters in Israel: A report for 2014–2019. *Dent. Traumatol.*

- Namiri, N.K., Lui, H., Tangney, T., Allen, I.E., Cohen, A.J., Breyer, B.N., 2020. Electric Scooter Injuries and Hospital Admissions in the United States, 2014–2018. *JAMA Surg* 155, 357–359.
- Niska, A., Gustafsson, S., Nyberg, J. & Eriksson, J. 2013. Cyklisters singelolyckor - Analys av olycks- och skadedata samt djupintervjuer (Single bicycle accidents. Analysis of hospital injury data and interviews). Linköping, Sweden: VTI.
- OECD/ITS 2020. *Safe Micromobility Corporate Partnership Board Report*.
- RIZZL, M., STIGSON, H. & KRAFFT, M. Cyclist injuries leading to permanent medical impairment in Sweden and the effect of bicycle helmets. IRCOBI Conference, 2013 Gothenburg, Sweden.
- Sikka, N., Vila, C., Stratton, M., Ghassemi, M., Pourmand, A., 2019. Sharing the sidewalk: A case of E-scooter related pedestrian injury. *Am. J. Emergency Med.* 37, 1807.e5–1807.e7.
- STA 2017. In Swedish: Gemensam inriktning för säker gångtrafik 1.0 Borlänge: the Swedish Transport Administration.
- TAUR 2020. Do I Need to Wear a Helmet When Riding an Electric Scooter? 8 Feb, 2020 ed.
- Thompson, D. C., Rivara, F. P. & Thompson, R. 2009. Helmets for preventing head and facial injuries in bicyclists (Review). *Cochrane Database of Systematic Reviews* 1999.
- Trivedi, B., Kesterke, M.J., Bhattacharjee, R., Weber, W., Mynar, K., Reddy, L.V., 2019a. Craniofacial Injuries Seen With the Introduction of Bicycle-Share Electric Scooters in an Urban Setting. *J. Oral Maxillofac. Surg.* 77, 2292–2297.
- Trivedi, T.K., Liu, C., Antonio, A.L.M., Wheaton, N., Kreger, V., Yap, A., Schriger, D., Elmore, J.G., 2019b. Injuries Associated With Standing Electric Scooter Use. *JAMA Netw Open* 2, e187381.
- Tuncer, S., Laurier, E., Brown, B., Licoppe, C., 2020. Notes on the practices and appearances of e-scooter users in public space. *J. Transp. Geogr.* 85, 102702.
- VOI. 2020. *Tap the helmets: Voi introduces world's first reaction test for e-scooters to discourage drunk riding* [Online]. Voi Available: <https://www.voiscooters.com/blog/voi-reaction-test-game/>.
- Yang, H., Ma, Q., Wang, Z., Cai, Q., Xie, K., Yang, D., 2020. Safety of micro-mobility: Analysis of E-Scooter crashes by mining news reports. *Accid. Anal. Prev.* 143, 105608.