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REVIEW

Road Traffic Injury Prevention: Standing Electric Scooters

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Abstract

Purpose of Review Standing electric scooter (e-scooter) usage has risen dramatically over the last decade. This micromobility option, available for rent in over 150 cities across the nation, has become a popular and affordable method for short-distance travel. This article provides a comprehensive and up-to-date review of the existing literature on e-scooter injuries.

Recent Findings Analyses of national registry data demonstrate that there has been a significant increase in injuries and admissions related to e-scooter usage since their widespread adoption. Lacerations, abrasions, extremity fractures, and head injuries are commonly reported. Additionally, over 110 fatalities related to e-scooter incidents occurred nationwide from 2017 to 2022. Despite the emergence of outcomes data, there are few reports of initiatives designed specifically for e-scooter injury prevention and surveillance.

Summary E-scooter injuries contribute a substantial burden to national healthcare costs. Improved coding and surveillance of these injuries can help inform the development of injury prevention efforts.

Keywords electric scooter · micromobility · e-scooter · road traffic safety, injury surveillance · injury prevention

Introduction

Over the past decade, standing electric scooter (e-scooter) usage has risen dramatically across the United States (US). E-scooter rentals first emerged in Santa Monica, California in 2017 and expanded to over 158 cities by 2022 [1]. E-scooters can be privately owned by citizens or rideshare companies (e.g., Bird: Bird Rides, Inc., Lime: Neutron Holdings, Inc.) which provide the public with low-cost access to shared dockless rentals. E-scooters are a form of micromobility device, which refers to a variety of small, lightweight vehicles including bicycles, electric bikes (e-bikes), and electric skateboards (e-skateboards). Among these vehicle types, e-scooters have garnered significant popularity in urban environments as e-scooters have been shown to reduce traffic congestion, promote sustainable commutes, improve accessibility of transportation, and have positive well-being effects [2••, 3, 4]. E-scooters are typically rented for the purpose of commuting to work/school, recreational activities, or serving as a first- and last-mile connection to public transit [5–9]. Consequently, many urban cities have experienced a transition in the number of active pedestrians and public transit users since their widespread adoption [5–9]. Data acquired from the city of Indianapolis over a 3-month period in 2018 showed that more than 425,187 trips were made on more than 8,400 unique e-scooters [5]. The median duration, distance, and speed of e-scooter rides were 8 minutes, 0.7 miles, and 5.23 mph, respectively, suggesting that e-scooters are an attractive option for individuals seeking to travel short distances quickly [5].

Injury Pattern and Severity

Despite their benefits as a low-cost means of short-distance transportation, there has been a dramatic increase in injuries and admissions related to e-scooter use since their widespread adoption [2••, 10••, 11••]. Using data from the National Electronic Injury Surveillance System between 2014 to 2018, authors from the University of California, San Francisco reported a 222% increase in age-adjusted e-scooter injury incidence per 100,000, from 6 to 19 [11••]. During this timeframe, there was also a 365% increase in age-adjusted hospitalizations, from 0.4 to 1.8 admissions

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[11••]. E-scooter injuries tend have a male predominance and most often result in fractures, contusions, abrasions, and lacerations [11••, 12]. A retrospective analysis of e-scooter-related injuries at adult Level 1 trauma centers in the St. Louis metropolitan area during a 17-month period demonstrated that only 4% of injured patients reported wearing helmets and nearly 25% of injured patients were intoxicated with alcohol or drugs [12]. In total, 32.6%, 9.5%, and 8.1% of patients suffered an extremity fracture, head injury, and facial fracture, respectively. Overall, 38% of patients with fractures required surgery. After integrating ridership data from e-scooter rental companies in St. Louis, the authors estimated the overall incidence of emergency department (ED) visits related to e-scooters to be 2.1 per 10,000 trips and 2.2 per 10,000 miles. While no deaths were reported in this study, data from the US Consumer Product Safety Commission demonstrates that 111 (18 dockless/rental) fatalities occurred nationwide from e-scooter-related trauma from 2017 to 2022 [13].

The medical community and public's understanding of the safety and risk profiles of e-scooters is rather limited, resulting in a widespread notion that e-scooter injuries tend to be similar to those resulting from bicycle use. The biomechanics and injury patterns of e-scooter riders are similar to those of e-skateboard and hoverboard riders but differ significantly from bicyclists, which is largely due to having a lower center of gravity, smaller wheels, and the rider's legs being positioned with one in front of another [14, 15•, 16•]. Recently published analyses have also demonstrated that e-scooter injury patterns and outcomes differ significantly from other micromobility devices, including motorbikes and bicycles [15•, 16•]. In a retrospective analysis of 6,125 patients from the 2016 to 2020 National Inpatient Sample, patients with scooter-related injuries were more commonly younger than 18 years old (26.7% vs 16.4%, $p<0.001$) and frequently underwent major operations (55.8% vs 48.1%, $p<0.001$) when compared to patients with bicycle-related injuries [15•]. After risk adjustment for clinically relevant patient- and hospital-level factors, scooter-related injuries were also associated with greater risks of long bone fracture (risk-adjusted odds ratio 1.40, 95% CI 1.15 to 1.70) and paralysis (risk-adjusted odds ratio 2.06, 95% CI 1.16 to 3.69) compared with bicycle-related injuries. The risk of developing traumatic brain injury was similar in the scooter and bicycle cohorts. The authors conjectured that these findings may be attributable to a frequent lack of protective gear used by riders and the scooter's inability to absorb any significant impact without directly injuring the rider [15•]. Nationwide cohort studies from outside of the US, involving England and France, have also demonstrated that the proportion of patients with head injuries after e-scooter accidents is higher than or comparable to patients presenting after motorbike or bicycle accidents [16•, 17]. While other micromobility devices, such as e-bikes, e-skateboards, and hoverboards, exist and carry similar potential for serious traumatic injury, these devices have not yet penetrated the commercial shared rental market in the same manner that e-scooters have. While the number of fatalities attributable to micromobility devices continues to increase steadily nationwide (from 5 in 2017 to 76 in 2022), there remains a critical shortage of published data on injuries per trip and injuries per mile driven which could help inform safety policies and enact targeted interventions to reduce micromobility device-related injuries at a city or regional level [13].

Financial Burden

As the prevalence of e-scooter injuries has significantly increased in the US, it is apparent that e-scooter injuries contribute a substantial burden to national healthcare costs. Analyses of national hospital admission-level data have demonstrated approximately a five-fold increase in the annual total cost burden for scooter injuries between 2016 and 2020 (2016: $6,648,871 vs 2020: $35,500,000, nptrend <0.001) [15•]. Over one-third of patients evaluated for an e-scooter traumatic injury require an operation, which is a well-recognized contributor of increased healthcare costs [12, 15•]. Additionally, the typical hospitalization after a scooter injury ranges from one to four days in length and costs approximately $17,200 [12, 15•]. In addition to these direct costs incurred, it is also imperative to consider the potential economic costs to patients while they are unable to work during their recovery. The significant financial burden placed on the healthcare system by the uptick in e-scooter injuries highlights the critical need for reshaping policies for injury prevention.

Health Policy Efforts

To mitigate adverse events related to e-scooter usage, legislation specific to the use of micromobility devices exists in the US but varies on a state-by-state basis. In several states, renting and riding an e-scooter does not require a valid driver's license. Most states enforce a minimum riding age for e-scooters, most commonly 16 years old, and require riders under the age of 18 to wear a helmet when operating an e-scooter. There are no specific laws mandating adults 18 years or older to wear a helmet, despite compelling evidence that helmeting laws reduce the number of hospitalizations from motorcycle- and bicycle-related accidents [17–20]. Among published studies of patients with e-scooter-related injuries, rates of helmet use are dramatically low, ranging from 0-7% [12, 17, 21–24]. Additionally, a case study of one prominent e-scooter rental company social media habits

demonstrated that published posts rarely showed e-scooters being used with protective gear [25]. Even more concerning is the finding that approximately one in four patients presenting with an e-scooter-related injury are intoxicated with alcohol or drugs [12, 17]. A study conducted to assess the effects of alcohol on one's ability to drive an e-scooter demonstrated that subjects had a significant decrease in driving performance even at low blood alcohol concentrations (0.21–0.60 g/kg) [26]. E-scooters are considered motorized vehicles in several states and therefore riders can be convicted for criminal offenses operating an e-scooter while intoxicated. While these laws have been established to increase e-scooter safety, the degree to which they are enforced is quite variable at both the city and state level.

Injury Prevention Initiatives

There remains a paucity of published literature detailing the underlying causes of and contributing factors to micromobility-related injuries. Despite nationwide improvements in traffic safety over the past two decades, the US continues to perform worse on road safety metrics than European countries, such as England, Sweden, and the Netherlands [27, 28]. In the US, there are no lanes designated for e-scooters, forcing riders to often travel on busy roads with elevated speed limits alongside automobiles. This places e-scooter riders at an elevated risk for injury as they often navigate both vehicular and pedestrian traffic. Loss of balance appears to be the most common cause of injury while operating an e-scooter [23]. Additionally, some e-scooter riders may be inexperienced, unaware of traffic laws, or engage in risky behaviors such as speeding, using their phone, or riding while intoxicated, all of which increase the risk of accidents [29]. While a majority of injuries occur to individuals riding e-scooters, over 5% of patients with an e-scooter-related injury are either cyclists or pedestrians who collide with e-scooter riders or pedestrians who trip over parked e-scooters [23, 30]. Approximately 20–30% of e-scooter riders report riding on sidewalks, regardless of local laws, which may endanger nearby pedestrians [31]. Most e-scooter accidents occur in the street but approximately 17% still occur on the sidewalk [23]. Additionally, dockless e-scooters can be improperly parked on sidewalks allowing elderly pedestrians to trip over them [23]. Pedestrians can also be endangered when bypassing improperly parked e-scooters by walking on roads instead of sidewalks. Reducing traffic speed limits in high-usage areas, enforcing strict safety laws, preventing riders from accessing sidewalks, and designating clear riding lanes may help mitigate these injuries.

Despite the emergence of data on the injury patterns and outcomes of micromobility device-related injuries, there have only been a limited number of injury prevention initiatives that have been developed and implemented to improve e-scooter safety. For example, the State of Georgia recently enacted the Scoot Safe initiative, the first federally funded, evidence-based e-scooter safety campaign targeting best practices for e-scooter ridership including helmet use, refraining from alcohol and drugs, safe riding speeds, and first-time rider education [32]. There has yet been data published regarding the efficacy of these educational resources in reducing the number of micromobility-related injuries in Georgia. Other countries, such as Australia, have made progress in mandating helmets for all e-scooter riders by requiring rental companies to provide helmets with e-scooter rentals [33]. Finland has also recognized the need for effective e-scooter regulations. The local government of Helsinki set regulations for shared e-scooter usage in cooperation with the e-scooter rental companies in late 2021 [34•]. The regulations included a daytime top speed of 20 km/h (as opposed to the previous top speed of 25 km/h), the use of shared e-scooters was prohibited on Friday and Saturday nights between 12 am and 5 am, and the nighttime top speed was decreased to 15 km/h from Sunday to Thursday between 12 am and 5 am (as opposed to 25 km/h) [34•]. On retrospective review of available data, the number of e-scooter injuries decreased significantly (19 per 100,000 rides vs. 9 per 100,000 rides) after implementing restrictions on the top speed and nighttime usage of e-scooters [34•]. The odds ratio for shared e-scooter injuries was 0.5 (95% CI 0.4-0.6) during the restricted period after adjusting for hourly temperature, rain amount, wind speed, and visibility. These findings are encouraging; however, it remains unclear whether similar restrictions in cities in the US where rentable e-scooters are available would lead to similar results.

Improving Injury Surveillance

A major opportunity for future study related to micromobility device-related injuries includes leveraging publicly available road traffic data and private e-scooter rental company data to analyze injury patterns in the context of rider usage trends. In the 2022 Safety Research Report published by the National Transportation Safety Board, the National Highway Traffic Safety Administration was recommended to utilize the new data requirements outlined in the Infrastructure Investment and Jobs Act to analyze e-scooter ridership data to inform the development of public safety initiatives for micromobility use [35]. Additionally, the National Transportation Safety Board recommends prioritizing higher quality data, efficient research methods, and replicable results to better understand rider fatalities and injuries [35]. Based on currently existing data on micromobility device-related injuries, it is evident that injury prevention policies can positively impact our communities and patients. Opportunities

to reduce micromobility injury burden include a focus on mandating rental companies to provide helmets to riders, speed regulations, limiting sidewalk usage, time of day use restrictions, enforcement of laws related to riding while intoxicated, and redesigning bike lanes to be more inclusive of riders.

A significant barrier to our understanding of e-scooter injury patterns is related to inadequate coding of these injuries by emergency medical services (EMS) responders, healthcare practitioners, and hospital coders [35]. Improper coding of these injuries results in subsequent challenges with correctly identifying micromobility device-related accidents which can hinder future research and quality improvement endeavors. An opportunity for ongoing improvement for trauma systems and EDs nationwide involves utilizing International Classification of Diseases 10 (ICD-10) and National Electronic Injury Surveillance System (NEISS) codes to accurately record prevalence of these micromobility device-related injuries. Beginning in October 2020, the National Center for Health Statistics approved new micromobility codes, including "V00.84: Accident with standing micro-mobility pedestrian conveyance" and "V00.181: Accident on other rolling type pedestrian conveyance" for more accurate injury surveillance [36]. These accidents should be recorded in police crash data as well. The adoption of more robust coding practices for injury surveillance must involve education to pre-hospital care systems such as EMS responders. With these changes, the medical community will have an enhanced ability to collect high-quality data on injury mechanisms, patterns, and outcomes that can inform new policies aimed at reducing micromobility device-related injuries and improve road traffic safety.

Conclusions

While e-scooter usage has risen significantly over the last decade, there has been a concomitant increase in injuries and admissions related to their usage, contributing a substantial burden to national healthcare costs. The severity of these reported injuries ranges from minor lacerations and abrasions to more serious injuries including extremity fractures, head injuries, and even death. Despite the emergence of data on e-scooter injuries, there are few reports of initiatives designed specifically to prevent and monitor these injuries. Additionally, legislation specific to the use of micromobility devices exists in the US but varies on a state-by-state basis. Opportunities to improve the safety of riders include mandating rental companies to provide helmets to riders, speed regulations, limiting sidewalk usage, time of day use restrictions, enforcement of laws related to riding while intoxicated, and redesigning bike lanes to be more inclusive of riders. Improved coding and surveillance of e-scooter injuries can help inform the development of injury prevention efforts at both a regional and national level. Future research should explore the biomechanics of e-scooter injuries, implementation of injury prevention initiatives (e.g., mandating safety equipment use), and the impact of race and other socioeconomic factors on injury outcomes.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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