Title

Eye and Orbit Injuries Caused by Electric Scooters and Hoverboards in the United States

Journal

Clinical Ophthalmology, 18(8)

ISSN

1177-5467

Authors

Ruan, Merry ZC
Meer, Elana
Kaur, Gurbani
et al.

Publication Date

2021

DOI

10.2147/opth.s452750

Peer reviewed

Clinical Ophthalmology

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Eye and Orbit Injuries Caused by Electric Scooters and Hoverboards in the United States

Merry ZC Ruan[1,2], Elana Meer[1,2], Gurbani Kaur[2], Nikan K Namiri[2], Davin C Ashraf[3], Bryan J Winn[1,4], Robert Kersten[1,4], M Reza Vagefi[1,4], Seanna Grob[1,4]

[1]Department of Ophthalmology, University of California, San Francisco, San Francisco, CA, USA; [2]Department of Medicine, University of California, San Francisco, San Francisco, CA, USA; [3]Division of Oculofacial Plastic and Orbital Surgery, Department of Ophthalmology, Oregon Health & Sciences University, Portland, OR, USA; [4]Division of Oculofacial Plastic and Orbital Surgery, Department of Ophthalmology, University of California, San Francisco, San Francisco, CA, USA

Correspondence: Seanna Grob, Department of Ophthalmology, Academic Director, Oculofacial Plastic and Orbital Surgery, University of California, San Francisco, San Francisco, CA, USA, Tel +1 858-349-1813, Fax +1 415-476-0336, Email seanna.grob@ucsf.edu

Introduction: To evaluate eye and orbital injuries in non-powered scooter, electric-scooter (e-scooter), and hoverboard riders in the United States (US) between 2014 and 2019.

Methods: The National Electronic Injury Surveillance System (NEISS) was queried for head and neck injuries by body part codes related to non-powered scooters and powered scooters/hoverboards from 2014 to 2019. The NEISS complex sampling design was used to obtain US population projections of injuries and hospital admissions. Keywords were queried in case narratives to analyze trends in location, type, and mechanism of eye and orbit injuries.

Results: Since their introduction, a 586% ($p=0.01$) increase in e-scooter injuries and 866% ($p<0.001$) increase in hoverboard injuries were observed with an increase in hospital admissions seen in young adults (18–34) in urban areas (e-scooter: 5980% and hoverboard: 479%). Descriptive narratives of the trauma noted eye injuries in 242 unweighted NEISS cases with only 30 cases appropriately documented under body part code 77: eyeball. Eye injuries increased 96.9% during the study period ($p=0.23$). Specifically, the most common ophthalmic injuries reported included eyebrow (40.9%) and eyelid (11.3%) lacerations, periorbital contusions (18.7%), orbit fractures (6.6%), and corneal abrasions (5.1%).

Conclusion: There was a significant increase in both head and neck injury cases and hospital admissions related to e-scooters. Eye and orbit injuries similarly increased but were underreported by body part code compared to injury narratives. Orbital fractures were reported more frequently in injuries from e-scooters than non-powered scooters.

Plain language summary: From 2014 to 2019, there were significant increases in both head and neck injuries and hospital admissions related to e-scooters, with eye and orbital injuries similarly increased but underreported by body part code compared to the injury narratives.

Keywords: scooter, e-scooter, electric scooter, hoverboard, eye trauma, orbital fracture, orbit

Introduction

Driven by the advancement of technology, and the goal for greater efficiency and environmental sustainability, modes of transportation have been continuously evolving in the United States. Examples of such transportation include novel personal motorized vehicles, such as electric scooters (e-scooters) and hoverboards.[1,2] Around 2013, lithium battery powered e-scooters became available to consumers. In 2017, shared e-scooters first appeared in Santa Monica, California and quickly spread across urban areas in the United States in the following year.[3,4] Since then, with a maximum speed of 15 miles per hour, shared e-scooters are increasingly available to ease public transit without mandated safety gear.[5,6]

Previous studies have extensively reported on the increasing injuries associated with e-scooters. Badeau et al reported an increase in e-scooter-related trauma from 8 cases in 2017 to 50 cases in 2018 in two of the largest emergency departments (ED)

Received: 1 December 2023
Accepted: 9 February 2024
Published: 13 March 2024

in Salt Lake City, Utah.[1] Beck et al reported a more dramatic change from zero e-scooter-related ED visits in 2018 to 56 incidents in 2019 in one hospital in New Zealand. After the release of the 2019 National Electronic Injury Surveillance System (NEISS) data, Namiri et al and Farley et al both reported a dramatic increase in emergency room visits and related hospital admissions from 2017 to 2019.[2,7] Both studies concluded that neurological (eg, traumatic brain injury) and orthopedic injuries were the most common e-scooter related injuries. In the field of ophthalmology, Yarmohammadi et al reported rising facial trauma cases associated with e-scooter use between June 2018 and May 2019 in two EDs in San Diego.[8]

Although the head was the most frequently injured part of the body,[2,5,7] specific analysis of ophthalmic and orbital injuries in e-scooter and hoverboard accidents relative to non-powered scooters has yet to be reported. Therefore, the authors sought to evaluate eye and orbit injuries in non-powered, e-scooter, and hoverboard riders in the United States between 2014 and 2019.

Methods

This study was approved by the University of California, San Francisco Institutional Review Board (IRB number 20–30493) and was conducted in compliance with the rules and regulations of the Health Insurance Portability and Accountability Act of 1996 and all applicable federal and state laws, and in adherence to the World Medical Association's ethical principles for medical research involving human subjects outlined in the Declaration of Helsinki as amended in 2013.

A retrospective cohort study was conducted to examine eye and orbital injuries from non-powered scooters, e-scooters, and hoverboards using the National Electronic Injury Surveillance System (NEISS) database. The National Electronic Injury Surveillance System (NEISS) provides national estimates of injuries that are present to EDs across the US.[9] NEISS is a probability sample of hospitals in the US with at least six beds and an emergency department. Selection of EDs surveyed in the system occurs by stratified sampling with four general hospital strata and one stratum for children's hospitals. NEISS provides statistical weights for each sample to estimate national case numbers with corresponding confidence intervals (CIs). The NEISS analysts review medical records of sampled hospitals and code each injury with a product key. NEISS includes product keys for non-powered and e-scooters/hoverboards allowing for evaluation of injuries associated with these devices. During 2014–2019, NEISS assigned product key 5042 to e-scooters and 1329 to non-powered scooters.

NEISS was queried for injuries related to non-powered scooters (product key 1329) and powered scooters/hoverboards (product key 5042) from 2014 to 2019. Powered scooter and hoverboard cases were differentiated by searching for keyword "scooter" and "hoverboard", respectively, within product key 5042. A search with body part key 77 for eye was performed. To allow better capture of injuries specific to the eye and orbit, a search of each trauma narrative was performed with the following keywords in the case narratives: eye, oculo-, ocular, orbit, brow, cornea, and lid, ZMC, zygomatic. In addition, case narratives were coded and analyzed to comparatively assess trends in location, type, and mechanism of ophthalmic injuries.

The admitting status, body location of injury, diagnosis of injury, age, and sex was obtained. The NEISS complex sampling design was used to obtain US population projections of injuries and hospital admissions. Population estimates from the 2010 US Census Bureau were utilized for the direct method of age adjustment.[10,11] Linear regression tests were applied using Stata V15 (StataCorp, College Station, TX) to determine differences in injury characteristics across the study period. Descriptive statistics provided distributions of injury characteristics for non-powered scooters, e-scooters, and hoverboard injuries within each year of the study period. P-values less than 0.05 determined statistical significance.

Results

Based on population studies, from 2014 to 2019 in the United States, a total of 92,368 (95% CI, 65,633–119,107) and 22,217 (95% CI, 9761–34673) non-powered scooter and e-scooter head and neck injuries occurred respectively (3153 and 613 NEISS cases). Since the introduction of the hoverboard in 2015, 19,227 (95% CI, 11308–27148) attributed head and neck injuries due to hoverboards occurred in the United States (611 NEISS cases). In contrast to a 24% (p=0.002) decrease in non-powered scooters injuries from 2014 to 2019, there was a 586% (p=0.01) increase in e-scooter injuries. Since their introduction in the last quarter of 2015, hoverboard injuries increased by 866% (p<0.001) from 2015 to 2019 (Figure 1). Increases in hospital admissions were associated with both non-powered scooters (55.88%, p=0.03) and e-scooters, although not significant for e-scooter cases (1093%, p=0.47) (Figure 1). Among all age groups, young adults (18–34 years old) witnessed a dramatic increase in e-scooter injuries (5980%, p=0.002) and became the most injured

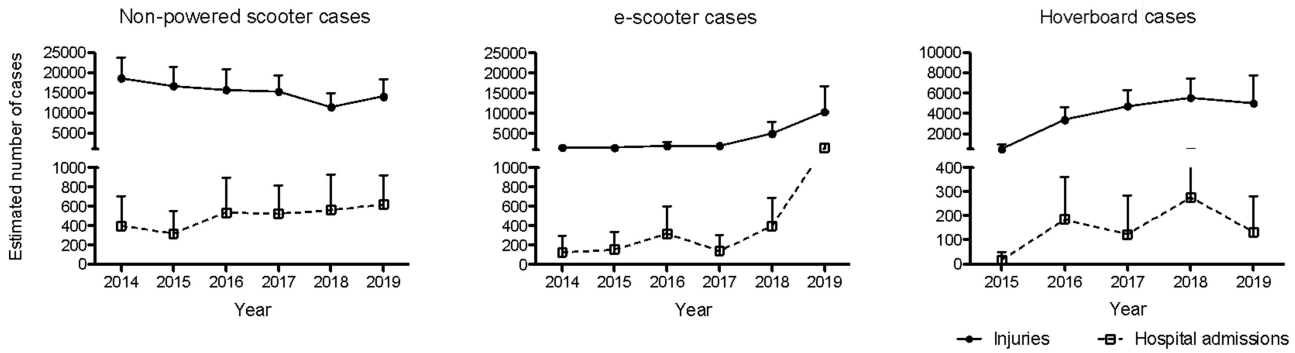

Figure 1 Head and neck injury cases and hospital admissions associated with non-powered scooter, e-scooter, and hoverboard.

group accounting for 43% of all e-scooter injuries in 2019 (Figure 2). The other age groups that showed significant changes in e-scooter injuries include 0–6 years old (−24%, p=0.002), 7–12 years old (185%, p=0.03), 13–17 years old (272%, p=0.03). There were no significant changes in age groups older than 34 years. There was an increase in urban cases by 830% related to e-scooters (Figure 3).

Although only 30 cases were documented under the body part code 77 for eyeball in non-powered scooter, e-scooter, and hoverboard combined, the descriptive narrative for each trauma mentioned eye injuries in 242 unweighted NEISS cases in the 3 categories above. Eye injuries increased by 96.9% during the study period (p=0.23). A breakdown of case types using descriptive narratives is shown in Figure 4.

During the 6-year period when non-powered scooter, e-scooter and hoverboard were queried, the most common location of ophthalmic injuries reported was the eyebrow (46%). The most common mechanism of injury was laceration

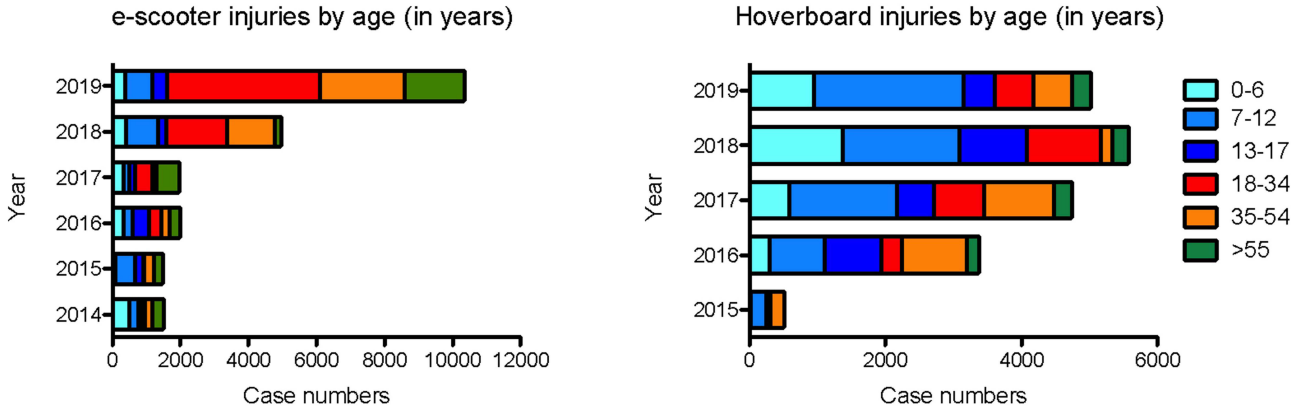

Figure 2 Head and neck injury cases associated with e-scooter and hoverboard by age group.

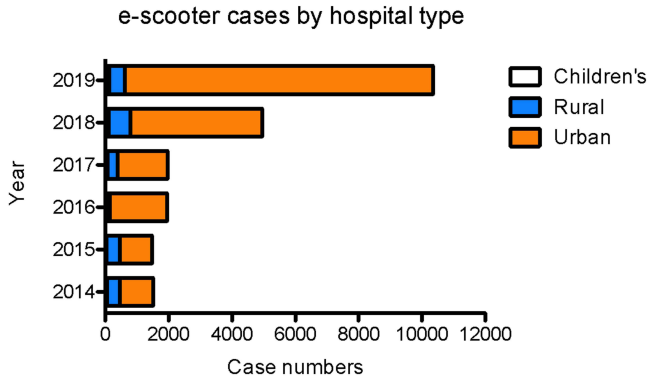

Figure 3 Head and neck injury cases associated with e-scooter by hospital type.

https://doi.org/10.2147/OPTH.S452750 DovePress

Figure 4 Types of eye and orbit injuries associated with non-powered scooter, e-scooter, and hoverboard.

(58%), and the most common cause of injury was fall (50%). Since e-scooter rideshares began in 2017, their riders' ophthalmic injury cases by reported number have exponentially grown, doubling by 2018 and nearly quadrupling by 2019 (Figure 4). Combined eyebrow and eyelid lacerations accounted for 54% of all ocular injuries in non-powered scooter riders, but only accounted for 37% of ocular injuries amongst e-scooter riders. Meanwhile, 46% of ocular injuries amongst e-scooter riders could be attributed to combined periorbital contusions and abrasions (Figure 4). E-scooter riders had approximately five times more orbital fractures than non-powered scooter riders: orbital fractures accounted for 21% of ophthalmic injuries in e-scooter riders but only 4% of ocular injuries in non-powered scooter users from 2014 to 2019. Non-powered scooter riders experienced four times more corneal abrasions than e-scooter riders in 2019 alone, and these were mostly due to striking the handlebars or ocular foreign bodies.

Among non-powered and e-scooter riders, the prevalence of ophthalmic injuries due to falls and collisions also increased (Figure 4). Collisions were segmented into automobile collisions, scooter versus scooter collisions, and scooter versus motorcycle collisions. Automobile collision injuries were due to direct collisions with automobiles as well as ejections from e-scooters while swerving to avoid direct collision with automobiles. Such collisions led to similar ophthalmic injury volume across all three groups (non-powered scooter, e-scooter, and hoverboard). In contrast, scooter versus scooter collisions accounted for three times as many ocular injuries in non-powered versus e-scooter users in 2019 (Figure 5). Scooter versus motorcycle collisions were far less common, with only one such collision over the five-year study period. In 2019, e-scooter riders were five times more likely to sustain an eye or ocular injury compared to

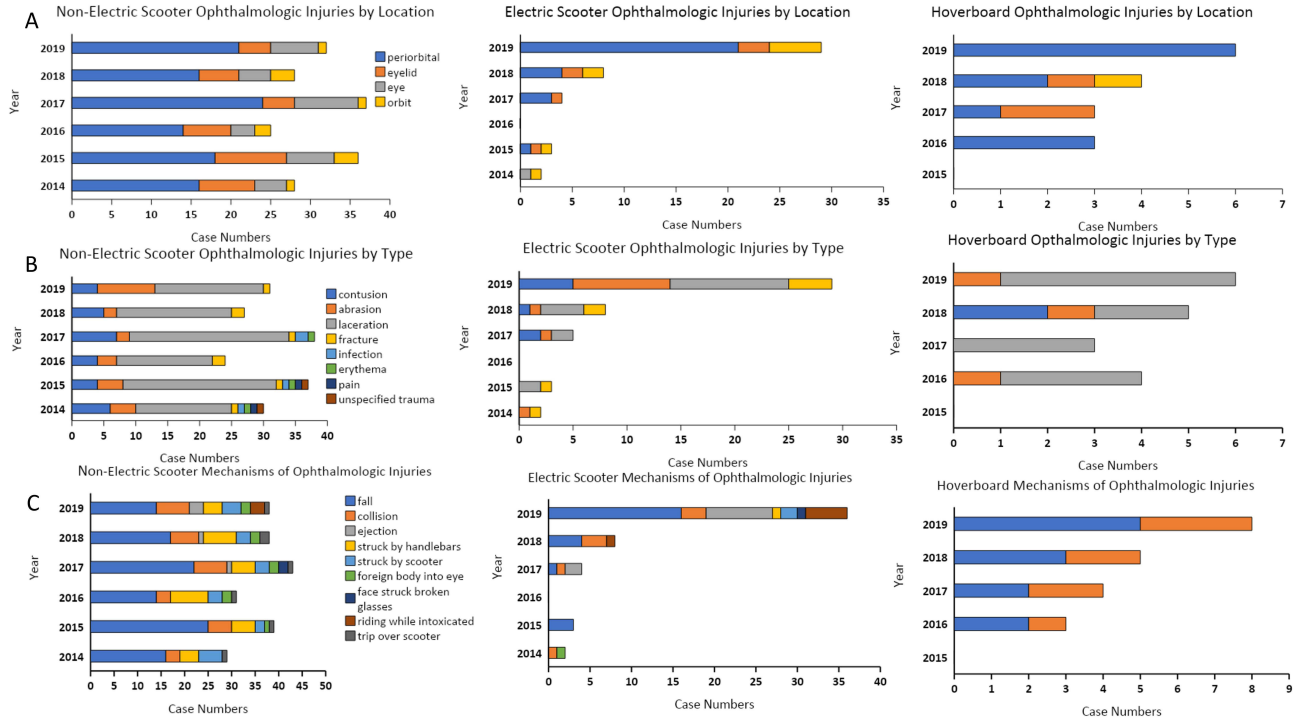

Figure 5 Non-Electric Scooter, Electric Scooter, and Hoverboard Opthalmologic Injuries by (**A**) Location (**B**) Type and (**C**) Mechanism of Injury.

hoverboard or non-powered scooter riders after falls (due to loss of control on uneven terrain or after striking an obstacle). Finally, intoxication was most associated with increased ophthalmic injuries secondary to falls, ejections, or collisions in the e-scooter population compared to the non-powered and hoverboard scooter population.

Discussion

In this retrospective review of the NEISS database, the authors sought to evaluate eye and orbital injuries in non-powered, e-scooter and hoverboard riders in the United States between 2014 and 2019. Review of hospital admissions and injuries demonstrated that compared to non-powered scooters, there were significant increases in both head and neck injury cases and hospital admissions related to e-scooters, with young adults being the most injured group from e-scooters. This is in line with past retrospective reviews of trauma databases and trauma centers, which have shown the head and face to be one of the most frequently injured body part in electric scooter falls or collisions, followed by the extremities[12–14].

To the authors' knowledge, this study is the first to specifically investigate orbital and ophthalmic injuries caused by e-scooters using the NEISS database. The most common eye injuries reported in the NEISS database sustained across all powered and non-powered scooters (including non-electric scooters, e-scooters, and hoverboards) between 2014 and 2019 were eyebrow (41%) and eyelid (11%) lacerations, periorbital contusions (19%), orbit fractures (7%), and corneal abrasions (5%). Lacerations were more prevalent in non-powered scooters than e-scooters while e-scooter riders were more likely to sustain periorbital contusions and abrasions, although this conclusion was limited by low overall numbers. Past studies using data on scooter injuries from the electronic Canadian hospitals injury reporting and prevention program (CHIRPP) have found orbital fracture to be the most frequent injury (36.9%) between 2012 and 2019.[15] The difference in presentation may be derived from a variety of factors including differences in reporting between the NEISS database and the CHIRPP as well as differences in presentation/usage and regulations across the United States and Canada. Other studies have similarly shown that orbital floor fractures were the most common injury (60%), followed by ocular contusion (30%), eyelid laceration (20%), and other ocular wounds (7%), with riders without helmets being at greater risk for orbital floor fractures.[8,16] Interestingly, e-scooter riders were found to suffer from ocular injury more than motorcycle riders.[16] Yarmohammadami et al performed a retrospective review to characterize facial trauma associated with standing e-scooter injuries and found 34 patients over a year with facial injuries, none of whom wore a helmet, and three quarters of whom were intoxicated or impaired. Among the cohort, greater than 90% presented with at least one type of facial fracture, 56% with lateral orbital wall fractures, 53% with orbital floor fractures, 28% with orbital roof fractures, and 25% with medial orbital wall fractures.[8] Lid laceration was observed in 15% of patients.[8] While the demographics of affected patients (male, young adults) in the present study were similar to other reports, the most frequent ocular injuries differed slightly. Other studies focusing on personal motorized vehicles unanimously found orbital fractures to be the most common ocular injury (with a lower percentage presenting with eyelid or other overlying lacerations); however, most of these orbital fractures occurred concomitantly with other facial fractures.[8] Therefore, it is possible that the present study reports a lower percentage of orbital fractures because the case narratives queried did not specifically mention orbital fractures associated with polytrauma.

In addition, the authors' study demonstrated that e-scooter ophthalmic injuries were increasingly associated with ejections and riding while intoxicated compared to non-powered scooters. This is in line with prior studies comparing e-scooter and bicycle-related accidents in facial fracture patients that found alcohol involvement was significantly higher in e-scooter trauma injuries with accidents twenty times more likely to occur under the influence of alcohol.[17] This is particularly troubling provided that well-delineated regulations and legal consequences exist for operating motorized vehicles while intoxicated in the US and thus poses a public safety concern. This is especially important in urban areas, where e-scooter related injuries were demonstrated to be increased by over 800%. However, although frequently used in the same lanes as motorized vehicles on the road, e-scooters are categorized as nonmotorized vehicles.[18] This is a public safety concern, especially given the severity of associated injuries. As redemonstrated in the present study, helmet use was only observed in a minority of riders.[13] Prior studies have also demonstrated that riders often misunderstand traffic laws that guide e-scooter use,[5,14,19,20] which likely contributes to injuries.

The present study has limitations known of retrospective, observational analyses. This includes the possible inaccurate estimation of injuries. Since estimates with low numbers of weighted cases are used, the projected case

numbers may be inaccurate. In addition, NEISS database gathers information in approximately 100 EDs selected as a probability sample of more than 5000 EDs in the US. Unfortunately, the names of the participating hospitals are not publicly available. Comparing NEISS sampling map to the map of the US, the authors observed that NEISS included areas such as San Francisco bay area, Los Angeles metropolitan area, Seattle, New York City, and Boston.[21] However, the database omitted cities where e-scooters have been historically more popular such as San Diego and Austin. Since the shared e-scooter business model is more popular in some cities than others, the population-based estimate in the present study may not represent the true national incidence. Although, the authors believe the year-to-year trend likely reflects the national trend. One additional limitation is the timeline included in this study as it is possible that trends in e-scooter and hoverboard use have changed since 2019. However, more recent data was not added to this study because the authors perceived more recent years to not be comparable to previous years due to the pandemic changing people's patterns and the coding in the database changing as well. Therefore, for this particular study, the authors focus on usage pre-pandemic, with goals for future studies to examine post-pandemic usage.

Furthermore, eye injuries could be underreported in the trauma database. Due to the nature of the keyword search in the trauma narratives, it is possible to underestimate the incidence of eye injuries because it is impossible to ensure all injuries that involve the eye and orbit were reported in the submitted narrative or were extracted by the search words we used. Similarly, only one body part and one diagnosis code were reported per patient before 2018 in the database and in 2019, 2 body parts were allowed to be reported per patient with their own associated diagnosis code reported. NEISS was queried for narratives focusing on eye, oculo-, ocular, orbit, brow, cornea, and lid; however, other eye-related injuries may not have been captured due to the lack of common language used by non-ophthalmology trained clinicians to describe ocular trauma/injuries. This is further supported by the low yield of the search with the body part key for eye (lower than that found in the reports/narratives), suggesting that even the most basic anatomic language may not capture ophthalmic injuries in the narrative found in ED notes and be recorded under body part injury for eye. Also, if the patient has more severe injuries, a non-vision threatening eye injury may not be documented in the narrative. In summary, the discrepancy between actual eye injuries and extracted eye injuries from this database is therefore potentially from: 1) eye injuries documented in the narratives, but not included in the body part code search, 2) eye injuries not documented initially in the ED notes and therefore not transferred to trauma narrative or body part code in the database, or 3) eye injury was documented in the ED notes, but due to inconsistent terminology or other reason, was not transferred to the trauma narrative or body part code in the trauma database.

Finally, it is important to consider the effects of the COVID pandemic and post-pandemic times on these results. While the frequency of use of e-bike and e-scooters was demonstrated to decrease during the pandemic, this was shown to be offset by an increase in the average duration and trip distance.[22] Furthermore, due to the impacts of social distancing, studies have suggested that e-bike and e-scooter usage has and will continue to increase as it serves as both a reliable and safe substitution for public transport in the post-pandemic world.[23,24] It is also important to note that the results are limited by the change in coding system of the data base after 2019, limiting comparison of the data beyond 2019.

The authors demonstrate significant increases in head and neck injury cases and hospital admissions related to e-scooters. With the usage of e-scooters continuing to increase, the results of the study further emphasize the importance of discussions about mandatory protective equipment and regulations to reduce injuries and riding under the influence. Continued efforts should be made to investigate whether these strategies, together with safety education, would mitigate periocular or potentially vision threatening injuries.

Ethics and Consent

This study adhered to the tenets of the Declaration of Helsinki and was performed in accordance with the Health Insurance Portability and Accountability Act. The study was approved by the Institutional Review Board at the University of California, San Francisco.

Acknowledgments

The Association for Research in Vision and Ophthalmology Annual Meeting 2021; American Society of Ophthalmic Plastic and Reconstructive Surgery, Fall 2020.

Funding

This research was supported, in part, by the UCSF Vision Shared Resource Core Grant (NIH/NEI P30 EY002162) and an unrestricted grant from Research to Prevent Blindness to the Department of Ophthalmology at UCSF.

Disclosure

Dr Bryan Winn is an independent medical reviewer for a clinical trial on thyroid eye disease for Genentech. All authors report no other conflicts of interest, financial or otherwise in this work. The authors alone are responsible for the content and writing of the paper.

References

1. Badeau A, Carman C, Newman M, Steenblik J, Carlson M, Madsen T. Emergency department visits for electric scooter-related injuries after introduction of an urban rental program. *Am J Emerg Med*. 2019;37(8):1531–1533. doi:10.1016/j.ajem.2019.05.003
2. Namiri NK, Lui H, Tangney T, Allen IE, Cohen AJ, Breyer BN. Electric scooter injuries and hospital admissions in the United States, 2014–2018. *JAMA Surg*. 2020;155(4):357–359. doi:10.1001/jamasurg.2019.5423
3. Bird scooters flying around town – santa Monica Daily Press. Available from: https://www.smdp.com/bird-scooters-flying-around-town/162647. Accessed March 13, 2022.
4. Robinson M Electric scooters for grown-ups are taking over San Francisco, and tech workers are annoyed. Business Insider. Available from: https://www.businessinsider.com/electric-scooters-take-over-san-francisco-2018-4. Accessed March 13, 2022.
5. Trivedi TK, Liu C, Antonio ALM, et al. Injuries Associated With Standing Electric Scooter Use. *JAMA Network Open*. 2019;2(1):e187381. doi:10.1001/jamanetworkopen.2018.7381
6. Hollister S The electric scooter war continues. Here's how they work (FAQ). CNET. Available from: https://www.cnet.com/culture/electric-scooters-bikes-dockless-ride-share-bird-lime-jump-spin-scoot/. Accessed March 13, 2022.
7. Farley KX, Aizpuru M, Wilson JM, et al. Estimated Incidence of Electric Scooter Injuries in the US From 2014 to 2019. *JAMA Network Open*. 2020;3(8):e2014500. doi:10.1001/jamanetworkopen.2020.14500
8. Yarmohammadi A, Baxter SL, Ediriwickrema LS, et al. Characterization of facial trauma associated with standing electric scooter injuries. *Ophthalmology*. 2020;127(7):988–990. doi:10.1016/j.ophtha.2020.02.007
9. Schroeder T, Ault K The NEISS Sample (design and implementation) from 1979 to 1996; 2001.
10. Bureau UC Population and Housing Unit Estimates Datasets. Census.gov. Available from: https://www.census.gov/programs-surveys/popest/data/data-sets.html. Accessed March 13, 2022.
11. Naing NN. Easy way to learn standardization: direct and indirect methods. *Malays J Med Sci*. 2000;7(1):10–15.
12. Ocular injuries associated with two-wheeled electric transportation devices and motorcycle accidents. Scientific Reports. Available from: https://www.nature.com/articles/s41598-022-23860-z. Accessed February 9, 2023.
13. Dhillon NK, Juillard C, Barmparas G, et al. Electric scooter injury in Southern California trauma centers. *J Am College Surg*. 2020;231(1):133. doi:10.1016/j.jamcollsurg.2020.02.047
14. Aizpuru M, Farley KX, Rojas JC, Crawford RS, Moore TJ, Wagner ER. Motorized scooter injuries in the era of scooter-shares: a review of the national electronic surveillance system. *Am J Emerg Med*. 2019;37(6):1133–1138. doi:10.1016/j.ajem.2019.03.049
15. EBSCOhost | 159639702 | characteristics of outdoor motorized scooter-related injuries: analysis of data from the electronic Canadian Hospitals Injury Reporting and Prevention Program (eCHIRPP). Available from: https://web.p.ebscohost.com/abstract?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=2368738X&AN=159639702&h=7FHVfrNTctbHU%2fvv9Ahg723BghWV6krK8XIS50BDZGEVjTBwHdEjIX%2bT4eltBi%2fgRE7kE6GpzfoHZD4cShD5mQ%3d%3d&crl=c&resultNs=AdminWebAuth&resultLocal=ErrCrlNotAuth&crlhashurl=login.aspx%3fdirect%3dtrue%26profile%3dehost%26scope%3dsite%26authtype%3dcrawler%26jrnl%3d2368738X%26AN%3d159639702. Accessed January 17, 2023.
16. Lev Ari O, Shaked G, Michael T, Givon A, Bodas M, Tsumi E. Ocular injuries associated with two-wheeled electric transportation devices and motorcycle accidents. *Sci Rep*. 2022;12(1):20546. doi:10.1038/s41598-022-23860-z
17. Murros O, Puolakkainen T, Abio A, Thorén H, Snäll J. Urban drinking and driving: comparison of electric scooter and bicycle related accidents in facial fracture patients. *Med Oral Patol Oral Cir Bucal*. 2022;25662. doi:10.4317/medoral.25662
18. Mitra B, Charters KE, Spencer JC, Fitzgerald MC, Cameron PA. Alcohol intoxication in non-motorised road trauma. *Emerg Med Australas*. 2017;29(1):96–100. doi:10.1111/1742-6723.12682
19. 8 Deaths now tied to e-scooters - consumer reports. Available from: https://www.consumerreports.org/product-safety/deaths-tied-to-e-scooters/. Accessed March 13, 2022.
20. Chiland E. Gov Jerry Brown signs bill removing helmet requirement for e-scooters; 2018. Available from: https://la.curbed.com/2018/9/21/17884220/bird-lime-scooters-rules-helmets-california. Accessed March 13, 2022.
21. CPSC (2018). NEISS Hospital Map. NEISS_Hospital_Map_2018.pdf. Available from: https://www.cpsc.gov/s3fs-public/NEISS_Hospital_Map_2018.pdf?6gAfTlFla.YEZWTkBH5hF6zcHm.1eweZ. Accessed March 13, 2022.
22. Mehzabin Tuli F, Nishita Nithila A, Mitra S Examining the Impact of the Covid-19 pandemic on shared E-Scooter Usage: a spatial panel model; 2022.

23. Kazemzadeh K, Koglin T. Electric bike (non)users' health and comfort concerns pre and peri a world pandemic (COVID-19): a qualitative study. *J Trans Health*. 2021;20:101014. doi:10.1016/j.jth.2021.101014
24. Mitra R, Hess PM. Who are the potential users of shared e-scooters? An examination of socio-demographic, attitudinal and environmental factors. *Travel Behav Soc*. 2021;23:100–107. doi:10.1016/j.tbs.2020.12.004