Pediatric E-Scooter and Traditional Scooter Injuries
Emergency Department Visits 2015-2024

Katherine E. Douglas, MD, Alexander W. Hirsch, MD, Andrew M. Fine, MD, MPH, and Todd W. Lyons, MD, MPH

Objectives: Electronic scooters (e-scooters) are increasing in popularity. We sought to compare pediatric e-scooters to traditional scooter injuries, analyze risk factors for non-home disposition, and evaluate injury trends.

Methods: We performed a retrospective, cross-sectional study of ED visits for scooter injuries from 2015 to 2024, utilizing the National Electronic Injury Surveillance System, utilizing product codes to identify mechanisms. We compared e-scooter to traditional scooter injuries, and home disposition to non-home disposition (resulting in hospitalization, transfer, or death), using proportion differences and multivariable modeling adjusting for age, sex, and injury characteristics. We described time trends in ED visits for e-scooter injuries.

Results: We identified 18,254 (population estimate 502,324) ED visits for scooter injuries, of which 3094 [population estimate 91,523 (18.2%)] were e-scooters. E-scooter injuries were more common among males and in older children (age 12 to 18 y). Compared with traditional scooter injuries, e-scooter injuries were more likely to result in admission (adjusted OR: 1.73; 95% CI: 1.2-2.42) and internal injuries (12.1% e-scooter, 9.0% traditional scooter; $P < 0.05$). E-scooter injuries were associated with increased odds of non-home disposition compared with traditional scooters (adjusted OR: 2.99, 95% CI: 1.66, 5.41). Overall, e-scooter injuries made up an increasing percentage of pediatric ED visits over the study period (annualized OR: 1.22; 95% CI: 1.17-1.28).

Conclusions: E-scooter injuries, compared with traditional scooter injuries, are associated with more non-home disposition and specific injury patterns, and are increasing as a proportion of ED injury visits over the past 10 years. These findings inform providers and the public of risks associated with pediatric e-scooter use.

Key Words: e-scooter, electric scooter, micromobility devices, trauma

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The rise in popularity of electric scooters (e-scooters) over the past decade has been accompanied by injuries associated with their use. Many studies have focused on adult populations and found increasing emergency department (ED) visits and admissions related to e-scooter use.[1–4] Pediatric-focused studies have looked at specific injury types, showing increases in musculoskeletal[5–7] and head/neck[8] injuries. In recent years, there have been continued increases in e-scooter use and need for high-acuity care for trauma received in the United States and worldwide among both adult[9] and pediatric patients.[10]

However, limited data exist on how e-scooter injuries differ from traditional scooter injuries, in terms of demographics of affected pediatric patients, injury-specific patterns including body parts injured and diagnoses, and location of these injuries. To this end, we sought to evaluate how e-scooter injuries differ from traditional nonmotorized scooter injuries, to understand potential modifiable risk factors. Our secondary aims were to describe characteristics of pediatric e-scooter injuries requiring non-home disposition, including hospitalization, transfer, or death; and to evaluate trends in overall ED visits for pediatric e-scooter injuries over the past 10 years, extending beyond published literature.[10]

METHODS

We performed a retrospective, cross-sectional study of United States scooter-related injuries from 2015 to 2024, using the National Electronic Injury Surveillance System (NEISS) database. NEISS participating hospitals report patient information for all injury visits they receive each year, with sampling methods that allow for national population-level estimates.[11] This study followed STROBE reporting guidelines and was deemed non-human subject research by our Institutional Review Board.

We included all injury-related ED visits over the 10-year sample for patients 18 years or younger. Scooter-related injuries were defined by product coding, confirmed by product coding crosswalk,[12] and consistent with recent research.[13] Narrative descriptions for scooter injuries were queried to resolve any questions of product coding (Supplement 1, Supplemental Digital Content 1, http://links.lww.com/PEC/B658). Injuries were categorized into 3 groups: e-scooter, traditional scooter, and non-scooter injuries. Narrative documentation included in NEISS was reviewed to ensure accurate coding of injury types. Notably, hoverboards were clearly delineated in product code 5024—our team designated these as "non-scooter injuries."

We used Stata 19 (College Station, TX: StataCorp) survey estimation to obtain population-level estimates,[14] which are found to be reliable at providing national-level estimates.[15] The unit of observation was the ED visit. We calculated frequencies of patient-level injuries by age, sex, and injury-specific characteristics, reporting proportion differences comparing e-scooter to traditional scooter injuries. To evaluate trends over time, we compared

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From the Division of Emergency Medicine, Boston Children's Hospital and Harvard Medical School, Boston, MA.
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Reprints: Katherine E. Douglas, MD, Boston Children's Hospital, 300 Longwood Avenue, Boston, MA 02115 (e-mail: kedouglas17@gmail.com).
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e-scooter to total pediatric injuries (including non-scooter) and to other scooter injuries (traditional scooter or unspecified scooter), with logistic regression using year as a continuous variable to assess for temporal trends. Disposition was compared using logistic regression, adjusting for age group, sex, and year of presentation, due to limited clinical and demographic factors available in NEISS. We, in addition, performed proportion differences comparing characteristics of e-scooter injuries classified as non-home disposition (those ED visits resulting in hospital admission or transfer, or ending in mortality, as a marker of populations that cannot safely be discharged due to medical or other factors) compared with home disposition (those ED visits resulting in ED discharge or left without being seen), and created an exploratory multivariable model to evaluate factors associated with non-home disposition for e-scooter injuries, adjusting for age, sex, and injury details including body area injured, diagnoses, and location injury took place, as factors that we hypothesize could impact the odds of requiring non-home disposition. Missing data made up < 1% for the variables used, and, therefore, we used complete case analysis.

RESULTS

From 2015 to 2024, there were 1,524,933 ED visits for pediatric injuries in the NEISS database, corresponding to a population estimate of 43,650,211 (95% CI: 32,490,469, 54,809,954) ED visits for injuries. Among pediatric patients, there were 18,254 ED visits for pediatric scooter injuries [national estimate 502,324, 95% CI: 385,502, 619,146]. E-scooters comprised 3094 of the ED visits for pediatric scooter injuries [national estimate 91,523, (95% CI: 71,267, 111,779), 18.2%].

Characteristics of children with ED visits for scooter injuries are described in Table 1. Males (66.4%) and older children accounted for most pediatric e-scooter ED visits (56.6% among 12 to 18-year-olds, 37.7% among 6 to 11-year-olds). Of the total, 32% of pediatric ED visits for e-scooter and traditional scooter visits were head/neck injuries, and 62% involved extremity injuries; e-scooters had higher rates of lower extremity injuries compared with traditional scooters. Internal injuries accounted for 12.1% of e-scooter injuries compared with 9.0% of traditional scooter injuries (Table 1).

E-scooter compared with traditional scooter injury ED visits had increased odds of non-home disposition (admission, transfer, or mortality) with aOR 1.66 (95% CI: 1.31, 2.10) in multivariable modeling, adjusting for age group, sex, and year. Increased admission rates (5.2% vs. 2.4%, $P < 0.001$) drove this finding, with increased odds of admission (aOR: 1.74, 95% CI: 1.24, 2.45) in the adjusted multivariable model. Mortality was noted in a total of 5 scooter-related injuries in the database sample—3 in e-scooter and 2 in traditional scooter—precluding further analysis. We found no significant difference in transfer (aOR: 1.29, 95% CI: 0.81, 2.05). There were lower odds of home disposition for e-scooter compared with traditional scooter injuries (aOR: 0.68, 95% CI: 0.54, 0.85).

Among e-scooter injuries, when comparing non-home disposition (admission, transfer, or mortality) to home disposition, there were important differences. Males made up 81% of injuries with non-home disposition. While bone/joint diagnoses were proportionally similar between non-home and home disposition, internal injuries made up 25% of injuries with non-home disposition, compared with a much smaller proportion of injuries discharged home (11%), with a higher adjusted odds ratio of 2.97 (95% CI: 1.65, 5.37). 47% of injuries with non-home disposition occurred on a street, whereas among home disposition, street location only comprised 26% of e-scooter injuries, with a significant association between street location and non-home disposition (aOR: 2.14, 95% CI: 1.00, 4.55; Table 2). Comparing patients with non-home disposition related to e-scooters versus traditional scooters, there were increased odds of e-scooter injuries in older age groups. E-scooter injuries with non-home disposition were associated with decreased odds of having occurred in sports compared with traditional scooter injuries with non-home disposition (Supplement 2, Supplemental Digital Content 2, http://links.lww.com/PEC/B659).

Over the 10-year period, ED visits for pediatric e-scooter injuries increased from 170 [national estimate 6365 (95% CI: 3456, 9273)] in 2015 to 824 [national estimate 27,468 (95% CI: 18,795, 36,140)] in 2024. Each year saw 24% increased odds in ED visits for e-scooter injury as a proportion of all ED visits for injuries (annualized OR: 1.24, 95% CI: 1.19, 1.29) and 19% increased odds of ED visits for e-scooter injuries as a proportion of all ED visits for pediatric scooter injuries (annualized OR: 1.19, 95% CI: 1.15, 1.23; Fig. 1).

DISCUSSION

In this multiyear, national cross-sectional study, pediatric e-scooter injuries requiring ED care occurred predominantly among males and older children. Injuries to the head/neck and extremity were the most common reason for ED visits from scooter injuries. E-scooter injuries, compared with traditional scooters, had increased odds of non-home disposition (admission, transfer, or mortality), mostly driven by higher rates of admission. There were distinct injury patterns, including higher rates of internal injury and injuries occurring on the street. Factors associated with e-scooter injuries resulting in non-home disposition included male sex, torso injuries, internal injuries, and injury occurring on the street. Pediatric e-scooter injuries increased from 2015 to 2024, constituting an ~20% year-over-year increase as a proportion of total ED visits for pediatric injuries and of ED visits for scooter-related injuries.

The demonstrated continued uptrend in e-scooter injuries in the post-COVID era[5] further adds to the recent publication of data through 2023, both at a national level and within pediatric trauma centers,[10,13,16] with a significant spike in 2024 seen in our data. Since 2020, there has been a significant uptrend in e-scooter injuries that, while requiring more years of data, suggests an increased popularity of these e-scooters and other micromobility devices. Early research suggested changes in behavior around transportation related to the pandemic, with an increase in micromobility devices.[17] One systematic review found this was related to decreased infection risk that would otherwise be seen with public transport, as well as government support for micromobility and increase in active travel pathways (such as bike lanes) in post-COVID years.[18] Reports show a continued increase in the number of people using micromobility devices over these post-COVID years.[19] Our research is novel in demonstrating that e-scooter injuries are associated with increased odds of

TABLE 1. Demographics and Descriptors of Pediatric Scooter Injuries 2015-2024

	E-Scooter		Traditional Scooter		
	Sample Number (n-3094), n (%)	**Population Estimate (n = 91,523), n (%)**	**Sample Number n = 15,160, n (%)**	**Population Estimate (n = 410,801), n (%)**	**Proportion Difference* (95% CI)**
Age group (y)					
0-5	197 (6.4)	5238 (5.7)	3715 (24.5)	88,583 (21.6)	**−15.8% (−17.7, −14.0)**
6-11	1183 (38.2)	34,488 (37.7)	8593 (56.7)	232,280 (56.5)	**−18.9% (−22.7, −15.0)**
12-18	1714 (55.4)	51,797 (56.6)	2852 (18.8)	89,938 (21.9)	**34.7% (30.5, 38.8)**
Sex					
Unknown	4 (0.1)	171 (0.2)	1 (0.0)	78 (0.0%)	0.2% (−0.1, 0.3)
Male	2054 (66.4)	60,808 (66.4)	9137 (60.3)	255,517 (62.2)	**4.2% (0.1, 7.6)**
Female	1036 (33.5)	30,545 (33.4)	6022 (39.7)	155,206 (37.8)	**−4.4% (−7.7, −1.1)**
Body area injured					
Head/neck	1064 (34.4)	29,783 (32.5)	5255 (34.7)	139,112 (33.9)	−1.3% (−4.2, 1.4)
Upper extremity	1065 (34.4)	31,758 (34.7)	6045 (39.9)	161,112 (39.2)	**−4.5% (−7.1, −1.9)**
Lower extremity	787 (25.4)	24,661 (26.9)	3143 (20.7)	91,792 (22.3)	**4.6% (2.2, 7.0)**
Torso	154 (5.0)	4686 (5.1)	670 (4.4)	17,389 (4.2)	0.9% (−0.5, 2.3)
Multiple	7 (0.2)	132 (0.1)	10 (0.1)	224 (0.1)	0.1% (−0.1, 0.3)
Unknown	17 (0.5)	504 (0.6)	37 (0.2)	1174 (0.3)	0.2% (−0.1, 0.6)
Selected diagnoses					
Bone/joint	1768 (57.2)	51,660 (56.4)	8474 (56.0)	231,343 (56.4)	0.1% (−3.0, 3.2)
Skin/soft tissue	458 (14.8)	14,948 (16.3)	3045 (20.1)	82,859 (20.2)	−3.8% (−5.8, −1.9)
Concussion	154 (5.0)	3293 (3.6)	413 (2.7)	10,436 (2.5)	**1.1% (0.0, 2.1%)**
Internal injury	352 (11.4)	11,094 (12.1)	1318 (8.7)	37,084 (9.0)	**3.1% (1.2, 5.0%)**
Bleeding	306 (9.9)	9595 (10.5)	1471 (9.7)	40,934 (10.0)	0.5% (−1.4, 2.4)
Location injury took place					
Home	306 (9.9)	12,287 (13.4)	2780 (18.3)	92,089 (22.4)	**−9.0% (−12.5, −5.5)**
Street	788 (25.5)	24,934 (27.2)	1285 (8.5)	47,729 (11.6)	**15.6% (10.8, 20.5)**
Public	310 (10.0)	9083 (9.9)	1010 (6.7)	27,797 (6.8)	**3.2% (0.4, 5.9)**
School	12 (0.4)	371 (0.4)	427 (2.8)	11,179 (2.7)	**−2.3% (−3.1, −1.6)**
Sports	69 (2.2)	2308 (2.5)	834 (5.5)	28,263 (6.9)	−4.4% (−6.0, 2.8)
Unknown	1609 (52.0)	42,540 (46.5)	8822 (58.2)	203,734 (49.6)	−3.1% (−7.8, 1.5)
Disposition					
Discharge	2791 (90.2)	83,857 (91.6)	14,228 (93.9)	390,271 (95.0)	**−3.4% (−5.2, −1.6)**
Transfer	32 (1.0)	1502 (1.6)	98 (0.6)	5544 (1.3)	0.3% (−0.4, 1.0)
Hospitalization	224 (7.2)	4731 (5.2)	646 (4.3)	9885 (2.4)	**2.8% (1.2, 4.3)**
Mortality	2 (0.1)	154 (0.2)	3 (0.0)	77 (0.0)	**0.2% (0.0, 0.4)**
Left without being seen	45 (1.5)	1278 (1.4)	185 (1.2)	5024 (1.2)	0.2% (−0.5, 1.0)

*Proportion differences utilize population estimates. Bolded numbers represent statistically significant differences (reference group is traditional scooter).

non-home disposition, which are related to important injury patterns. These data can inform providers, patients, and families about the risks associated with e-scooter injuries, as well as inform future efforts by policy makers and product designers aimed at reducing these injuries.

E-scooter injuries in our study had higher rates of non-home disposition than traditional scooter injuries, driven mostly by hospital admission. This may reflect patient acuity, hospital capability, or regional care. Nonetheless, patients with e-scooter injuries were more likely to exceed the care capabilities of the original ED of presentation compared with those children with traditional scooter injuries. This is consistent with tertiary pediatric trauma center findings, which showed admission rates around 15% for e-scooter and e-bike injuries, with a high need for surgical intervention or severe trauma presentation.[16]

Higher maximum speed may contribute to this, with e-scooters going above 15 miles per hour in almost half of injuries in one study.[20] In addition, while a total of one-quarter of e-scooter injuries took place on a street, these injuries on the street made up almost one-half of e-scooter injuries with non-home disposition, and had a significant association with this outcome. The street location is concerning, as children are at risk of collision with high-velocity, high-mass motor vehicles, with prior research demonstrating increased likelihood of traffic accidents when using e-scooters.[21] While most riders were in the older age group (12 to 18), over one-third of patients were 11 years or younger, which is well below driving age anywhere in the United States. This is an important area for future advocacy, as electric scooters and bicycles have become substantially more common, leading to increased interactions between motor vehicles and micromobility devices. Future work should study the impact of age restrictions, traffic patterns in crowded locations, and training for both riders and vehicle drivers is necessary to mitigate injuries related to e-scooter utilization.

Compared with traditional scooters, there were increased rates of internal injuries, and decreased rates of skin and soft tissue injuries, with e-scooter injuries. Internal injuries were found to make up a disproportionate number of e-scooter cases with non-home disposition, at one quarter of patients, and were significantly associated with this outcome, consistent with literature showing that traumatic internal injury is associated with higher force.[14,15] This mirrors bicycle data comparing electric to

TABLE 2. Differences Between e-scooter Injuries With Non-home Disposition (Admission, Transfer, or Mortality) Versus Home Disposition (Discharge or Left Without Being Seen), Using National Estimates

	Non-home Disposition (n = 6388), n (%)	Home Disposition (n = 885,135), n (%)	Proportion Difference (95% CI)	aOR* (95% CI)
Age group (y)				
0-5	316 (4.9)	4922 (5.8)	−0.8% (−4.6, 2.9)	Referent
6-11	1826 (28.6)	32,662 (38.4)	**−9.8% (−17.9, −1.6)**	1.04 (0.39, 2.74)
12-18	4246 (66.5)	47,551 (55.9)	**10.6% (2.8, 18.4)**	1.19 (0.46, 3.04)
Sex				
Unknown	0	171 (0.2)	−0.2% (−0.4, 0.0)	NA†
Male	5173 (81.0)	55,634 (65.3)	**15.6% (9.3, 21.9)**	**2.02 (1.31, 3.11)**
Female	1214 (19.0)	29,330 (34.5)	**−15.4% (−21.7, −9.2)**	Referent
Body area injured				
Head/neck	2287 (35.8)	27,496 (32.3)	3.5% (−5.2, 12.3)	0.89 (0.50, 1.60)
Upper extremity	1518 (23.8)	30,239 (35.5)	**−11.7% (−19.7, −3.8)**	Referent
Lower extremity	1675 (26.2)	22,987 (27.0)	−0.8% (−8.5, 6.9)	1.63 (0.96, 2.74)
Torso	836 (13.1)	3849 (4.5)	**8.6% (0.8, 16.3)**	**3.59 (1.63, 7.95)**
Multiple	71 (1.1)	61 (0.1)	1.0% (−0.9, 3.0)	**35.56 (1.92, 656.68)**
Unknown	0	504 (0.6)	**−0.6% (−1.0, −0.2)**	NA†
Selected diagnoses				
Bone/joint	3551 (55.6)	48,109 (56.5)	−1.0% (−9.7, 7.8)	Referent
Skin/soft tissue	414 (6.5)	14,534 (17.1)	**−10.6% (−15.0, −6.1)**	**0.41 (0.20, 0.86)**
Concussion	305 (4.8)	2989 (3.5)	1.3% (−2.5, 5.1)	1.88 (0.72, 4.90)
Internal injury	1623 (25.4)	9470 (11.1)	**14.3% (7.4, 21.1)**	**2.97 (1.65, 5.37)**
Bleeding	488 (7.6)	9107 (10.7)	−3.1% (−8.7, 2.5)	**0.48 (0.25, 0.91)**
Location injury took place				
Home	561 (8.8)	11,727 (13.8)	−5.0% (−11.5, 1.5)	Referent
Street	3005 (47.0)	21,929 (25.8)	**21.3% (11.8, 30.8)**	**2.14 (1.00, 4.55)**
Public	536 (8.4)	8547 (10.0)	−1.6% (−0.9, 6.0)	1.23 (0.34, 4.49)
School	0	371 (0.4)	**−0.4% (−0.8, −0.1)**	NA†
Sports	139 (2.2)	2169 (2.5)	−0.4% (−2.4, 1.6)	1.16 (0.37, 3.69)
Unknown	2148 (33.6)	40,392 (47.4)	**−13.8% (−24.3, −3.3)**	1.00 (0.44, 2.28)

*Adjusted odds ratio, using national estimates and adjusted for all other covariates listed in this table.
†Zero patients in one category, therefore, unable to perform the calculation.
Statistically significant ($p < 0.05$).

traditional bicycles and showing a higher rate of internal injuries among electric bicycles, and higher injury severity scores.[22,23] An emerging concern is around head injury for patients on e-scooters.[1] In our study, almost one-third of e-scooter patients had head/neck injuries. Prior research has shown increased risk of head injury when riding e-scooter compared with traditional scooters,[21] and limited helmet use with e-scooters.[1,6,24] Although NEISS cannot determine the severity of the diagnosed injuries, the high prevalence of head/neck injuries highlights the urgent need for continued discussion around policy and helmet use.[3,25]

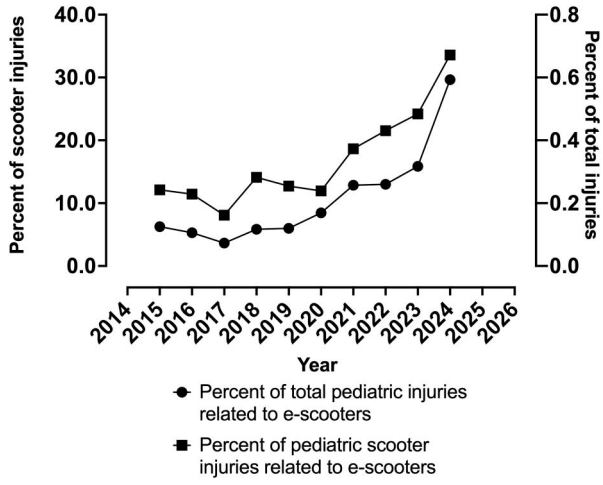

FIGURE 1. Pediatric E-scooter injuries over time. This figure shows the increase in pediatric e-scooter injuries as a proportion of all pediatric scooter injuries and as a proportion of all pediatric injuries from 2015 to 2024.

Our study must be interpreted in the context of its limitations. NEISS allows national-level estimates that are not available in other data sources, but with relatively small sample sizes for some outcomes/predictors, we found relatively wide confidence intervals among some results, which must be interpreted with caution. We are limited in clinical information available for each patient, meaning we cannot identify patients based on clinical severity, including trauma activation,[26] need for ICU admission, surgery, or critical procedures. We further cannot identify injuries by ICD-10 codes, and are limited to the diagnosis codes given by NEISS, including "internal injury" as a broad category, consistent with prior studies.[12,27] In the absence of clinical data, we do not know how the mechanism of injury may have impacted the decision to admit or transfer a patient. Given the limited clinical and individual-level data, residual confounding is possible. We cannot assess helmet use, which will be important in future studies. In 2020, NEISS introduced an "unspecified" scooter injury category which we categorized as "traditional scooter"—while including

these in traditional scooter injuries likely biases us towards the null (hypothesizing that at least some of the unspecified scooter injuries are from e-scooters), this is consistent with prior work that has similarly categorized this product code,[28] and emphasizes the need for other data sources that describe mechanism of injury to study this population further. Finally, our study is limited to those scooter injuries severe enough to result in an ED visit. We, therefore, cannot comment on other injuries that might have resulted in care not sought, care sought in other settings, or in mortality that did not survive to ED arrival.

CONCLUSIONS

Pediatric e-scooter injuries are associated with higher odds of non-home disposition and specific injury patterns, including increased risk of internal and torso injuries. Our data show ED presentations for e-scooter injuries are continuing to rise, and this will become a more salient concern in future years. These data inform policymakers and families of risks associated with increasingly popular e-scooters and can help inform future efforts aimed at reducing these injuries.

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