


# Alcohol-related injuries from e-scooter and e-bike use in the US (2019–2022): a retrospective study

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## ABSTRACT

**Background** The use of electric-powered scooters and bikes (e-scooters/bikes) is rising, but little is known about associated injuries and substance use. This study analysed the trends and factors associated with e-scooter/bike-related injuries and alcohol/substance use emergency department (ED) visits from 2019 to 2022.

**Methods** A retrospective analysis of US ED visit data from the 2019–2022 National Electronic Injury Surveillance System (NEISS) identified visits for e-scooter/bike-related injuries. NEISS data were collected using stratified, multistage sampling, and the analysis accounted for this complex sampling design. Outcomes included yearly visits, patient demographics, injury details and alcohol/substance use associations. Multivariable logistic regression analysed factors associated with e-bike/scooter-related injury ED visits and alcohol/substance use.

**Results** Of 4020 e-scooter/bike injury ED visits, 3700 (weighted estimate 279 990) were e-scooters and 320 (weighted estimate 16 600) were e-bikes. Visits increased three-fold from 2019 (n=22 835) to 2022 (n=65 892). Most of the injuries involved males, with 79.6% of e-scooter injuries and 79.7% of e-bike injuries), aged 18–39 years (51.5% e-scooter, 48.5% e-bike) and non-Hispanic White (34.9% e-scooter, 38.8% e-bike). Alcohol use was reported in 8.6% of e-scooters and 2.5% of e-bike injury-related ED visits. Males had 2.6 times higher odds of alcohol use (OR: 2.61, 95% CI: 1.84 to 3.69) and 2.2 times higher odds of substance use (OR: 2.23, 95% CI: 1.19 to 4.16) associated ED visits, compared with females. Compared with the 18–39-year age group, those aged 10–17 years had 7.5 and 4.1 times higher odds of alcohol and substance use leading to e-scooter and e-bike injury-related ED visits, respectively.

**Conclusions** E-scooter injuries are increasing rapidly, especially among younger males, with a three-fold increase from 2019 to 2022. Alcohol and substance use both contribute significantly to morbidity. Strengthening policy and prevention approaches like the use of helmets are warranted to improve e-scooter/bike safety.

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ E-scooters and e-bikes have grown in popularity, raising safety concerns due to increased alcohol and drug use and reduced helmet usage, but comprehensive research on substance-related injuries across the US has been limited.

## WHAT THIS STUDY ADDS

⇒ This study provides a nationwide analysis of e-scooter and e-bike injuries related to alcohol and substance use, revealing higher rates among males, older individuals and Black populations.

## HOW MIGHT THIS STUDY AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings can inform targeted safety policies, guide intervention strategies for vulnerable groups, serve as a foundation for future research on electric micromobility device safety, and help develop public health strategies that mitigate injury risks to alcohol and substance use.

## INTRODUCTION

Electric scooters (e-scooters) and electric bikes (e-bikes) are micromobility devices that have become increasingly popular means of short-distance transportation in major urban areas worldwide due to their environmental benefits, cost-effectiveness and convenience.<sup>1–3</sup> This surge in popularity can be attributed to several factors, including their zero emissions, the availability of more bicycle infrastructure, the impact of higher fuel prices, and their relatively lower travel costs

compared with fuel-powered vehicles, making commuting easier in congested areas and offering more convenient parking.<sup>4–6</sup>

Although e-scooters and e-bikes quickly gained popularity in most parts of the world, the United States (US) was relatively slow to adopt them.<sup>1</sup> However, this changed during the COVID-19 pandemic, when street closures, a significant decline in public transport usage, and a widespread search for alternative transportation led to a significant increase in e-scooter ride use.<sup>5,7</sup> Studies from various regions, including Indiana and Italy, have shown shifts in travel habits and usage patterns for e-scooters and e-bikes during the pandemic.<sup>8,9</sup>

The increased popularity of micromobility devices (e-scooters/bikes) has necessitated further safety concerns for this mode of transportation. Data from the US Consumer Product Safety Commission (CPSC) describes injuries associated with all micromobility devices as increasing by nearly 21% in 2022 from 2021, which may partly reflect the growing adoption and increased use of e-scooters and e-bikes. Additionally, micromobility-related injuries have trended upward since 2017, growing an estimated average of 23% annually,<sup>10</sup> with the most commonly reported injuries including head trauma, fractures and dislocations.<sup>7</sup>

Recent literature also describes an increased use of alcohol and other illicit drugs, as well as a



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reduced usage of protective helmets during the usage of these electric micromobility devices, leading to increased injury severity, mortality and hospital resource utilisation.<sup>11 12</sup> Crocker *et al* found that alcohol use occurred in one in five bicycle trauma patients and tripled the odds of head injury.<sup>13</sup> However, comprehensive research on the impact of alcohol and substance use on e-scooter- and e-bike-related injuries across the US remains limited. This study aimed to add to the existing body of literature on e-scooter and e-bike injuries by providing further details on their nature, particularly with concomitant alcohol and illicit substance use. This information is crucial to developing and implementing effective prevention strategies and enhancing safety measures to collectively reduce these electric micromobility device injuries associated with alcohol or substance abuse in the US.

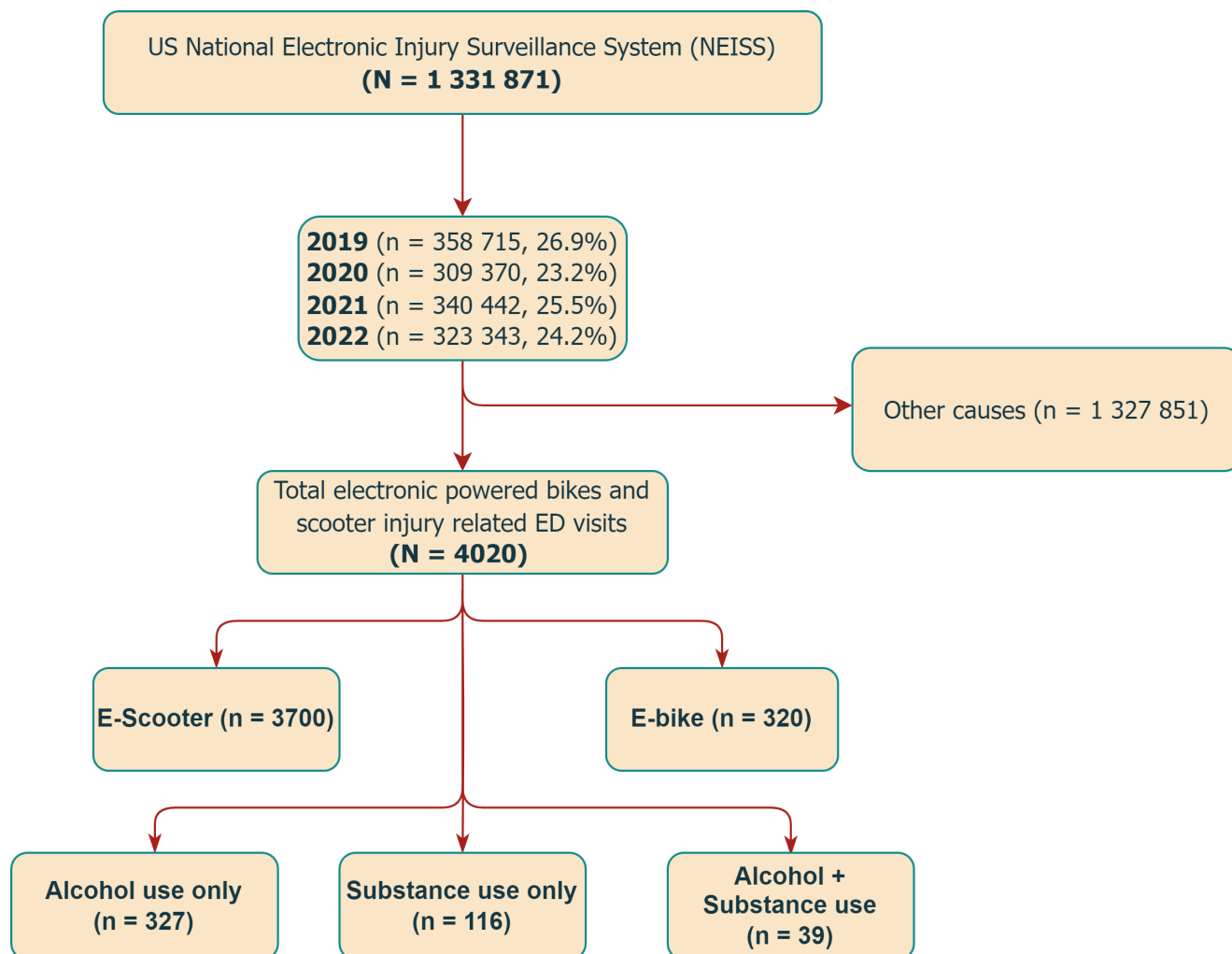
## METHODS

This retrospective cross-sectional study utilised data from the US CPSC's National Electronic Injury Surveillance System (NEISS) spanning from 2019 to 2022. The NEISS database collects injury-related data from approximately 100 hospital emergency departments (EDs), selected through a stratified, multistage probability sampling method to represent all hospital EDs across the nation. Each injury case in the NEISS is assigned a weight based on the inverse probability of selection, which allows for

national estimates from the sample. The sampling approach uses a complex survey design, incorporating stratification and clustering to ensure a nationally representative sample. Over 100 hospitals out of more than 5000 nationwide contributed data. For detailed information on NEISS sampling and weighting procedures refer to the 2021 NEISS Coding Manual from the US CPSC.<sup>14</sup> This research used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to ensure comprehensive and transparent reporting of the research process and findings.

## Identification of cases

Patients aged 10 years and older were included. To establish our initial cohort of electric-powered scooters and bikes, an indicator variable was created using the NEISS product codes 5035 (Mini-bikes, Powered Scooters, e-Bikes, Mopeds) and 3215 (Powered Mopeds or Power-Assist Cycles), designated for 'minibikes, powered or e-bikes, and powered mopeds or power-assist cycles'. These codes were used specifically to identify electric scooters and mopeds. Additionally, narratives associated with product codes 5035 and 3215 were manually reviewed to include injuries specifically related to electric bikes, while excluding references to other forms of transport such as skateboards, hoverboards and non-powered bicycles and mountain bikes. Injuries linked to



**Figure 1** Temporal trend of alcohol and substance use and e-scooter/bike-related emergency department visits in 2019–2022. ED, emergency department.

electric bikes were identified by searching for the terms 'elect' or 'batt' in these observations.

### Variables

Independent variables were stratified as follows: age (10–17, 18–29, 30–39, 40–49, 50+ years); sex (male/female); race/ethnicity (non-Hispanic White (NHW), non-Hispanic Black (NHB), Hispanic, and others); year of injury (2019, 2020, 2021, 2022); location of injury (not stated, street, other public property, other places); exposure to alcohol (consumed alcohol prior to or during the incident) and substance use (use of drugs or medication contributed to the incident or the severity of the injury); and ED disposition (treated, admitted to hospital, transferred, left without being seen, held for observation, and died).

Anatomic injury locations were categorised as follows: ear, elbow, eyeball, face, fingers, head, lower arm, lower trunk, lower limbs (ankle, foot, knee, lower leg, toe, upper leg), mouth, neck, pubic region, shoulder, upper trunk, wrist, unknown, and all body parts.

### Statistical analysis

Descriptive analyses included a total count with weighted estimates of the proportion of e-scooter and e-bike injuries by patient characteristics, mechanisms of injury, hospital admissions and anatomic injury locations. Weighted samples were used to estimate national trends of alcohol and substance use, and e-scooter/e-bike-related ED visits. Multivariable logistic regression analysis, controlling for independent variables, was used to estimate the strength of the association between alcohol/substance use and e-powered scooter-related injuries leading to ED visits. Covariates adjusted for in the regression models including age, sex, race/ethnicity and year of injury.

All analyses accounted for the complex survey design of NEISS by using 'svy' command in the STATA MP 16.1 (StataCorp, TX, USA). This approach adjusts for stratification, clustering and unequal probabilities of selection, ensuring accurate national estimates. Odds ratios (ORs) with 95% confidence intervals (CIs) were used to report the strength of the association. A  $p$ -value  $<0.05$  was considered statistically significant.

### RESULTS

From 2019 to 2022, a total of 1 331 871 injury-related visits were reported to the EDs. Of these, 4020 injuries were associated with e-scooters and e-bikes. Specifically, 3700 injury-related visits were associated with e-scooters and 320 were related to e-bikes. Among these, 327 injuries were related to alcohol use only, 116 were related to substance use only, and 39 were related to both alcohol and substance use. More details are provided in [figure 1](#).

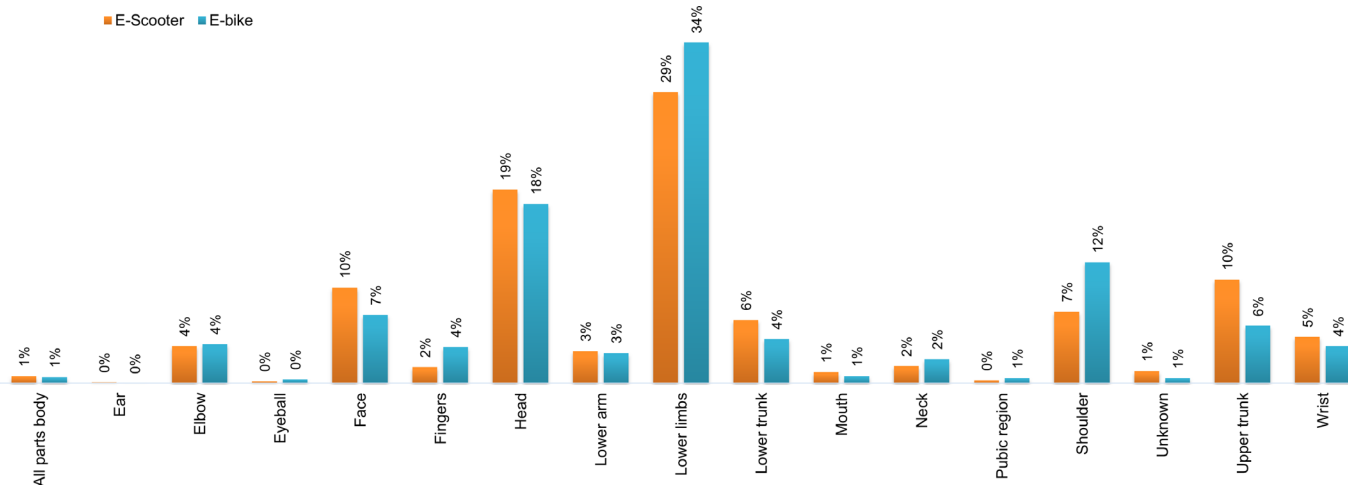
The characteristics of patients presenting to US EDs with e-scooters and e-bikes injuries are detailed in [table 1](#). About 3700 e-scooter-related injuries, corresponding to a weighted estimate of 279 990, and 320 observed e-bike-related injury visits, corresponding to a weighted estimate of 16 600 nationwide, were reported. The e-scooter-related injury visits increased three-fold from 2019 ( $n=20\,260$ ) to 2022 ( $n=62\,983$ ), while the e-bike-related injury visits showed marginal changes from 2019 ( $n=2575$ ) to 2022 ( $n=2909$ ). The highest number of recorded e-scooter injury ED visits was in 2022 ( $n=62\,983$ ), and for e-bikes it was in 2021 ( $n=4223$ ). The majority of patients were males (79.6% e-scooters, 79.7% e-bikes), aged 18–29 years (31.4% e-scooters, 29.4% e-bike) and NHW (34.9% e-scooters, 38.8% e-bikes). Most e-scooter injuries occurred on the street

(72.3%), whereas e-bike injuries occurred on the street (30.6%). Alcohol exposure was associated with 8.6% of ED visits due to e-scooter injuries, followed by substance use at 3.1%, and both alcohol and substance use at 1%. For e-bike injury-related ED visits, 2.5% were exposed to alcohol and 0.9% to substance use. There are few cases of exposure to both alcohol and substance use in e-bike injury-related ED visits ( $n=56$ ). A large proportion of the cases were treated in the hospital (75.7% e-scooters, 81.3% e-bikes). About 17.7% of e-scooter injury-related ED visits and 12.5% of e-bike injury-related ED visits were admitted to the hospital. Additionally, 1.0% of e-scooter injuries and 2.0% of e-bike injuries were transferred. Moreover, 4.7% and 3.1% of

**Table 1** Descriptive characteristics of the patients presenting to US emergency departments with electric-powered scooter and bike injuries in 2019–2022 (N=4020)

Characteristics	Electric-powered scooter and bike-related ED visits (n, %)			
	E-scooter		E-bike	
	Number (weighted number)	%	Number (weighted number)	%
Total ED visits	3700 (279 990)	100.0	320 (16 600)	100.0
Year				
2019	521 (20 260)	14.1	65 (2575)	20.3
2020	716 (45 862)	19.4	78 (2991)	24.4
2021	1101 (45 862)	29.8	101 (4223)	31.6
2022	1362 (62 983)	36.8	76 (2909)	23.8
Sex				
Male	2944 (125 384)	79.6	255 (9990)	79.7
Female	756 (33 523)	20.4	65 (2710)	20.3
Age group (years)				
10–17	370 (13 446)	10.0	98 (3135)	30.6
18–29	1160 (50 714)	31.4	94 (3783)	29.4
30–39	744 (32 024)	20.1	61 (2773)	19.1
40–49	499 (21 181)	13.5	32 (1375)	10.0
50+	927 (41 539)	25.1	35 (1631)	10.9
Race/ethnicity				
Missing information	934	25.2	94	29.4
Non-Hispanic White	1290 (63 440)	34.9	124 (5121)	38.8
Non-Hispanic Black	1149 (54 112)	31.1	59 (2162)	18.4
Hispanic	232 (5716)	6.3	40 (1518)	12.5
Others	95 (411)	2.6	3 (139)	0.9
Location				
Not stated	720 (28 380)	19.5	158 (6022)	49.4
Street	2675 (117 471)	72.3	98 (3677)	30.6
Other public property	216 (8390)	5.8	25 (1146)	7.8
Other places	89 (4665)	2.4	39 (1853)	12.2
Exposure				
Alcohol use	319 (13 869)	8.6	8 (452)	2.5
Substance use	113 (5239)	3.1	3 (130)	0.9
Alcohol+substance use	38 (1760)	1.0	1 (56)	0.3
ED disposition				
Treated	2801 (123 817)	75.7	260 (10739)	81.3
Admitted to hospital	655 (241 22)	17.7	40 (11773)	12.5
Transferred	36 (2145)	1.0	6 (319)	2.0
Left without being seen	175 (7821)	4.7	10 (299)	3.1
Held for observation	19 (688)	0.5	4 (168)	1.2
Died	14 (312)	0.4	–	–

ED, emergency department.



**Figure 3** Proportion of e-scooter/bike-related emergency department visits for injury location associated with alcohol and substance use, 2019–2022

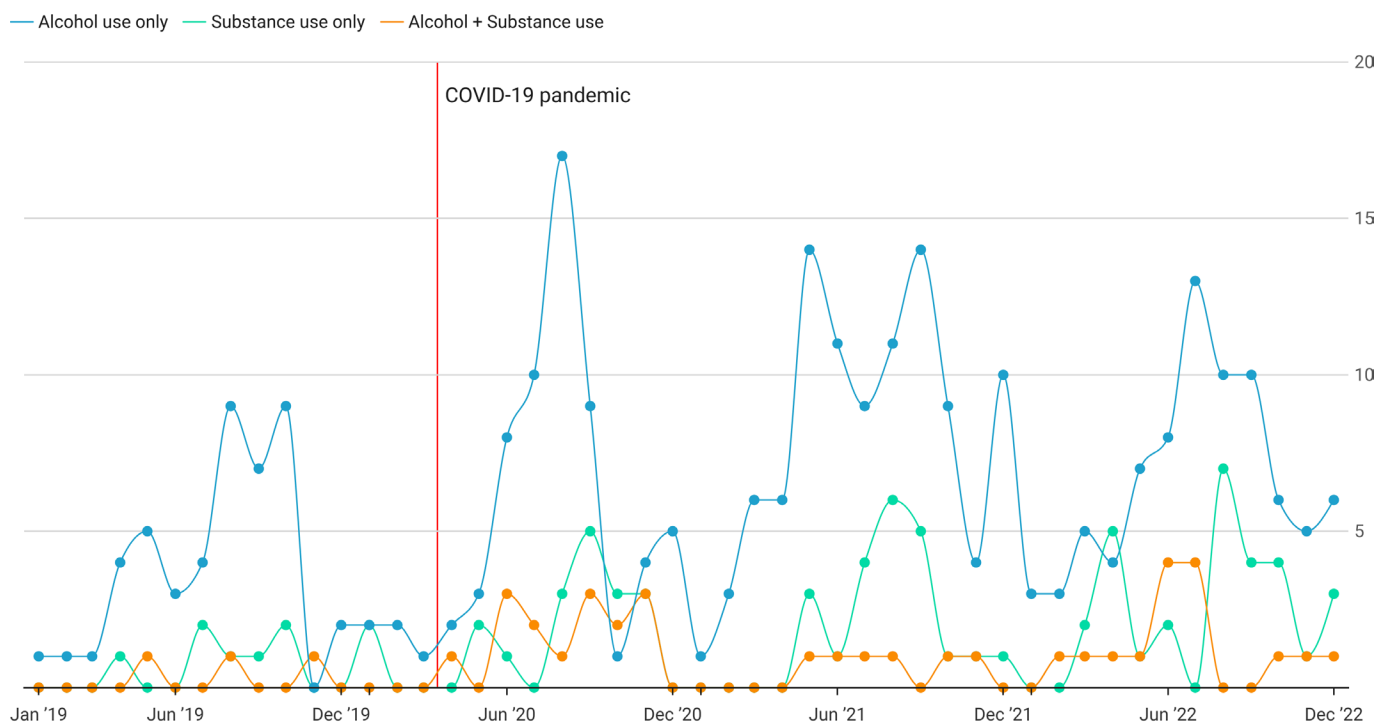
e-scooter and e-bike injuries, respectively, were left unattended. Approximately 0.4% of individuals injured by e-scooters died.

Figure 2 illustrates the temporal trend of alcohol and substance use and e-scooter/bike-related ED visits from 2019 to 2022. In early 2019, alcohol use alone contributed to the majority of e-scooter/bike-related injuries. By May 2019, both alcohol and combined alcohol+substance use contributed to the majority of the e-scooter/bike-related ED visits. Between June 2019 and October 2019, alcohol-related ED visits remained consistently higher. After November 2019, ED visits involving both alcohol use and substance use started to appear, though alcohol-only ED visits remained the highest contributor. By mid-2020, exposure

to both alcohol and combined alcohol+substance use was the leading cause of e-scooter/bike-related ED visits, peaking in July 2020 and September 2020. From June 2021, substance use had risen, contributing significantly to e-scooter/bike-related ED visits alongside alcohol. In June 2022, the combined use of alcohol and substances led to the leading cause of ED visits. However, in December 2022, substance use alone was the greatest exposure for e-scooter/bike-related ED visits, followed by combined alcohol+substance use.

Figure 3 details the proportion of e-scooter/bike-related ED visits for injury locations associated with alcohol and substance use. Lower limbs and head injuries were associated with the

Number of ED visits due to e-scooter/e-bike injury



Created with Datawrapper

**Figure 2** Temporal trend of alcohol and substance use and e-scooter/bike-related emergency department visits in 2019–2022. ED, emergency department.

majority of alcohol and drug misuse-associated e-scooter injury-related ED visits (29% and 19%), followed by injuries to the upper trunk (10%), face (10%), shoulder (7%) and lower trunk (6%). For alcohol and substance misuse-associated e-bike injury-related ED visits, the most frequent injury locations were the lower limbs (34%), head (18%), shoulder (12%) and face (7%).

Table 2 presents the associations between alcohol and substance use and electric-powered scooter and bike injuries related to ED visits. In comparison to females, alcohol was associated with 2.6 times greater odds of e-scooter and e-bike-related injury ED visits (OR: 2.61, 95% CI: 1.84 to 3.69) in males and substance use was associated with 2.23 times greater odds of e-scooter and e-bike-related injury ED visits (OR: 2.23, 95% CI: 1.19 to 4.16) in males. Individuals aged 10–17 years had 7.5 times greater odds of e-scooter and e-bike-related injury ED visits from alcohol use (adjusted OR (AOR): 7.46, 95% CI: 2.46 to 22.54) and 4.1 times greater odds from substance use (AOR: 4.06, 95% CI: 1.05 to 15.73) than individuals aged 18–39 years. In contrast, individuals aged 40 years and older had 35% lower odds of alcohol-related injury ED visits (OR: 0.65, 95% CI: 0.52 to 0.81) and 40% lower odds of substance-related injury ED visits (OR: 0.60, 95% CI: 0.36 to 0.98) compared with those aged 18–39 years. Compared with NHW, alcohol usage in NHB was associated with 30% higher odds of e-scooter and e-bike-related injuries (OR: 1.30, 95% CI: 1.04 to 1.63).

## DISCUSSION

The growing popularity of electric-powered scooters and bikes (e-scooters/bikes) for urban mobility has created significant safety concerns, particularly in terms of alcohol and substance use.<sup>7 10 12</sup> Our study, which examined 4020 individuals who presented to an ED in the US with e-scooter/bike-related injuries between 2019 and 2022, uncovered several noteworthy findings.

Our findings showed a temporal pattern in increasing ED visits for e-scooter/bike-related injuries caused by alcohol and substance use from 2019 to 2022. Based on weighted estimates, there were approximately 279 990 e-scooter-related injuries and 16 600 e-bike-related injuries during this period, highlighting the growing magnitude of this public health concern. This trend aligns with recent research highlighting the rising prevalence of electronic micromobility injuries in diverse urban settings.<sup>15–18</sup> Our study demonstrated that e-scooters are associated with a

higher rate of injuries compared with e-bikes. The smaller wheel size of e-scooters, compared with bicycles, likely contributes to a higher likelihood of losing balance and sustaining injuries.<sup>19</sup>

These injuries predominantly involved males (79.6% for e-scooters and 79.7% for e-bikes), individuals aged 18–29 years (31.4% for e-scooters and 29.4% for e-bikes) and NHW. These demographic trends are consistent with previous studies that found males and young adults to be the most affected populations.<sup>20 21</sup> The significant representation of NHW among those injured also aligns with findings from earlier research.<sup>15 18 20–23</sup> Our findings underscore the importance of targeted safety interventions and regulatory measures to address escalating injury rates among these groups.

Our study also revealed that alcohol and substance use were significant contributors to e-scooter and e-bike injury-related ED visits, particularly among males. Alcohol, even at lower concentrations, impairs judgement and driving performance, increasing the odds of injury.<sup>13 24</sup> Males are generally more likely to consume more alcohol than females, which correlates with the higher incidence of injuries observed in our study.<sup>20 25</sup> However, these findings are specific to the ED visits in our study and do not imply a general trend in alcohol consumption between genders.

Furthermore, the odds of e-scooter and e-bike injuries associated with alcohol and substance use were higher in early and mid-adolescent age groups than in older individuals. Younger individuals are more likely to be intoxicated, and this impairs their mental and physical health, leading them to engage in risky activities while riding these micromobility devices that can result in injuries.<sup>26 27</sup> Therefore, there is a need to enforce the law against the use of alcohol and substance use among these adolescents. Our findings also indicated that NHB had higher odds of e-scooter and e-bike injuries associated with alcohol and substance use. It is known that NHB individuals are more likely to drop out of alcohol and substance abuse treatment, necessitating close monitoring of drug toxicity levels to reduce injury risks.<sup>28 29</sup>

The study highlighted a concerning trend in injury sites linked to alcohol and substance use in e-scooter and e-bike-related ED visits. The head was the most common injury site among injured e-scooter and e-bike users in this cohort. This pattern aligns with other studies and underscores the need for helmet use and safety education for e-scooter/bike riders.<sup>11 13 30 31</sup> Alcohol

**Table 2** Associations between alcohol and substance use and electric-powered scooters and bikes injury-related emergency department visits

Factor	E-scooter and E-bike injuries leading to ED visit			
	Alcohol use		Substance use	
	COR (95% CI)	AOR (95% CI)	COR (95% CI)	AOR (95% CI)
Sex				
Female	1	1	1	1
Male	2.60 (1.82 to 3.70)	<b>2.61 (1.84 to 3.69)</b>	2.35 (1.26 to 4.37)	<b>2.23 (1.19 to 4.16)</b>
Age group (years)				
18–39	1	1	1	1
10–17	9.13 (3.28 to 25.40)	<b>7.46 (2.46 to 22.64)</b>	5.13 (1.26 to 20.80)	<b>4.06 (1.05 to 15.73)</b>
40+	0.64 (0.50 to 0.80)	<b>0.65 (0.52 to 0.81)</b>	0.72 (0.48 to 1.07)	<b>0.60 (0.36 to 0.98)</b>
Race/ethnicity				
White	1	1	1	1
Black	1.28 (1.01 to 1.64)	<b>1.30 (1.04 to 1.63)</b>	1.08 (0.67 to 1.74)	1.11 (0.67 to 1.83)
Hispanic	0.54 (0.25 to 1.17)	0.61 (0.27 to 1.38)	0.30 (0.08 to 1.13)	0.36 (0.10 to 1.38)
Other	1.05 (0.30 to 3.66)	1.11 (0.28 to 4.40)	1.24 (0.36 to 4.30)	1.31 (0.35 to 4.93)

Covariates adjusted for age, sex, location, year and race. Significance at  $p < 0.05$  is indicated by bold type. AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio; ED, emergency department.



and drug intoxication suppress protective reflexes, making the head particularly vulnerable to e-scooter injuries.<sup>22</sup> Our findings also pinpoint the critical importance of targeted interventions to address the combined risks of micromobility device use and substance abuse, with an emphasis on preventing head and other injuries through improved safety measures, education and potentially stricter regulations on impaired riding.

Our analysis is limited by its retrospective nature and inherent limitations of the NEISS database, such as the lack of detailed information on the units of alcohol and substance use, and data on helmet usage. The NEISS database does not include the mechanism of injury, which could help explain the severity of the injuries, nor does it provide more details on the injury type, limiting our ability to draw specific conclusions regarding the nature of the injury. This study also only focused on patients who presented to EDs, potentially underestimating the total burden by excluding those treated in other hospital departments.

Nevertheless, this study used a national dataset (NEISS), which enhances the generalisability of our findings and provides valuable insights into e-scooter and e-bike injuries across the US.

Future prospective studies with detailed patient profiling could provide more definitive evidence on the impact of alcohol and substance use on e-scooter and e-bike-related injuries.

## Conclusions

Our findings emphasise the critical and pressing issue of alcohol and substance use in relation to e-scooter and e-bike injuries. As these forms of transportation gain popularity, institutions, governments, healthcare practitioners and the general public must work together to develop effective risk mitigation strategies. By addressing this issue early, we can reduce the frequency and severity of e-scooter-related injuries and improve overall public safety.

**Contributors** Conceptualisation: ASB. Data curation: EA, SPO, ASB. Formal analysis: EA, ASB. Funding acquisition: ASB. Methodology: ASB. Project administration: ASB. Resources and software: ASB. Supervision: ASB. Writing—original draft: EA, SPO, ASB. Writing—review and editing: EA, SPO, ASB. Guarantors: EA, SPO, ASB.

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**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Ethics approval** Institutional review board (IRB) approval was not needed for this study as data were obtained from the US Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS) as aggregate and deidentified.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request. Data related to this research can be obtained by contacting the corresponding author with suitable reason.

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