EAST BAY MUNICIPAL UTILITY DISTRICT

DATE: August 6, 2026

MEMO TO: Board of Directors

THROUGH: Clifford C. Chan, General Manager CCC

FROM: Michelle L. Workman, Manager of Natural Resources MW

SUBJECT: Response to July 14, 2026 Planning Committee Public Comment Regarding E-Bike Accident Rates in California

SUMMARY

On July 14, 2026, staff provided an update at the Planning Committee meeting on a proposed pilot program to introduce bicycles to recreational trails on the Mokelumne watershed. The Committee received several letters and oral comments related to the proposed pilot program, some of which included information related to e-bike accidents in California. This memorandum provides additional information on e-bike accidents.

DISCUSSION

One of the letters received by the Committee stated that e-bike use and injuries are rising nationwide and that California leads the nation with over 20,000 e-bike injuries annually. While e-bike related incidents are increasing, the 20,000 injuries annually represent the nationwide total reported in 2023 (Fernandez, 2024). According to recently published research from the American Association for the Surgery of Trauma, in California, a total of 1,566 e-bike injuries were reported in 2024 (Austin, 2026). This study was based on an analysis of California Highway Patrol (CHP) accident reports from 2018 to 2024.

Overall, the number of deaths related to e-bike collisions was statistically similar to that of traditional bikes over the study period, but e-bike related injuries and deaths have been increasing. The study also concluded that e-bike injuries were more severe compared with those related to traditional bikes due to unsafe speed and improper turning violations. The study was limited to e-bike accidents reported to and investigated by the CHP and does not reflect accidents that occur off public roadways and outside of CHP jurisdiction. There is little citable information available regarding e-bike accidents on rural recreational trails.

CCC:MLW:asu

Attachment: Trauma Surgery and Acute Care Open: An exponential increase in e-bike injuries in California

References: Fernandez AM, Li KD, Patel HV, et al. Electric Bicycle Injuries and Hospitalizations. JAMA Surg. 2024;159(5):586–588. doi:10.1001/jamasurg.2023.7860

Austin J, Perkins L, Haines LN, Kobayashi L, Berndtson AE, Weaver JL, et al. An exponential increase in e-bike injuries in California. Trauma Surgery & Acute Care Open. 2026;11:e002099. https://doi.org/10.1136/tsaco-2025-002099

Trauma Surgery & Acute Care Open

An exponential increase in e-bike injuries in California

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ABSTRACT

Background Electric bicycle (e-bike) sales are growing exponentially worldwide. These vehicles are faster and heavier, with younger riders using e-bikes more frequently, reports of inconsistent helmet use, and increased deaths and injuries. We hypothesized that California has experienced significant annual increases in e-bike rider injuries and injury severity compared with injured traditional bicyclists, using a transportation injury registry and geospatial mapping system, including socioeconomic factors.

Methods We conducted a retrospective analysis of the California Highway Patrol Statewide Integrated Traffic Records System (SWITRS) from 2018 to 2024, identifying e-bike collisions through reporter coding and vehicle brand names. We analyzed demographics, injury severity, fault status, traffic violations, and scene census tract Social Vulnerability Index (SVI). All non-e-bike traditional bicycle collisions served as the comparison group.

Results We identified 4035 e-bike and 58 332 bicycle collisions. E-bike injuries increased sharply over the study period, from two incidents in 2018 to 1566 in 2024 ($p<0.001$), while bicycle collisions remained stable. E-bike riders were younger (median 33 vs 36 years; $p<0.001$), with a significantly greater proportion aged ≤14 years (15.6% vs 10.2%). Moderate-to-severe injuries were more common among e-bike riders (15.8% vs 11.9%; $p<0.001$). Although overall mortality was similar (2.0% vs 1.7%), a significant divergence emerged in 2024, with higher e-bike mortality ($p=0.027$) and a significant interaction between year and vehicle type. E-bike collisions demonstrated more unsafe speed and improper turning violations and occurred in census tracts with lower social vulnerability. Spatial analysis showed tighter clustering of e-bike collisions relative to bicycles.

Conclusions E-bike injuries are rapidly increasing in California and are associated with a higher severity of injuries compared with traditional bicycles. Urgent efforts are needed for targeted prevention, regulatory alignment, and rider education.

Level of evidence Level III, retrospective case-control study.

To cite: Austin J, Perkins L, Haines LN, *et al*. *Trauma Surg Acute Care Open* 2026;**11**:e002099.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Electric bicycle (e-bike) use is rapidly increasing worldwide, with sales growing exponentially in both Europe and North America. Previous research has shown that injuries from e-bikes tend to be more severe than those from traditional bicycles due to higher speeds and increased vehicle weight. Case series and regional studies have highlighted a rising rate of pediatric e-bike injuries, raising concern among healthcare providers and policymakers. However, earlier studies have often been limited in scope, focusing on single hospitals, short periods, or narrowly defined populations. Standardized epidemiological data at the state or national level, particularly those linked to socioeconomic and geographic patterns, remain scarce.

INTRODUCTION

Electric bicycle (e-bike) sales are growing exponentially worldwide, with a US$62 billion market in 2024, and global sales projected to reach US$113 billion by 2030. Sales of e-bikes in the USA increased from 325 000 units in 2018 to 1.7 million in 2024.[1 2] There are reports of increasing numbers and severity of injuries related to e-bikes, including injuries among children.[3–8] E-bikes are faster and heavier than traditional bicycles, and are often used by younger riders. Regulations for e-bikes vary significantly across regions, with no national regulation governing their labeling of speed capabilities.

Data on death and injury rates, comparisons of e-bike injury severity with traditional bike injuries, and e-bike injury socioeconomic factors remain sparse in the relevant literature, despite the rapid growth in e-bike sales. Injury trends are largely unknown, although there are several anecdotal reports in the media. Deaths of children riding e-bikes have focused media attention on e-bike safety. These deaths have spurred advocacy and legislative efforts in several states.[8–10]

We hypothesized that, using a transportation injury registry and mapping system, California experienced significant yearly increases in e-bike rider collision deaths, injuries, and injury severity from 2018 to 2024 compared with traditional bicycle rider collisions. Differences between traditional bicycles and e-bikes were also examined in the context of socioeconomic epidemiology. Finally, we compared e-bike collision locations with those of traditional bicycles using geospatial analysis (GIS), with the hope of informing advocacy for targeted prevention efforts.

METHODS

We conducted a retrospective study using the California Highway Patrol (CHP) Statewide Integrated Traffic Records System (SWITRS) covering the years

WHAT THIS STUDY ADDS

⇒ This study offers the largest statewide epidemiological analysis of e-bike injuries to date, covering a 7-year period of rapid adoption in California. It shows a sharp and statistically significant rise in e-bike injuries and deaths, both in absolute numbers and as a share of all cycling injuries. Compared with traditional cyclists, e-bike riders are younger, incur more severe injuries, and are more often at fault, with notable violation patterns like unsafe speeds and improper turns. Notably, the study indicates that injuries are disproportionately centered among children aged ≤14 years, and occur more frequently in less socioeconomically deprived areas, suggesting that access and adoption patterns differ from those of traditional bicycle riders.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE, OR POLICY

⇒ These findings emphasize urgent gaps in safety policies and injury prevention strategies for e-bike riders. For clinicians, the evidence highlights the need for proactive guidance, especially for parents of young riders, and for trauma systems to prepare for more serious injury patterns. For policymakers and advocates, the results bolster the case for standardizing e-bike classification and labeling, establishing minimum age limits, promoting helmet use, and investing in safer infrastructure such as protected lanes and school-zone speed limits. From a research standpoint, the study underscores the importance of combining traffic registry data with hospital and trauma data, and of assessing natural experiments as new policies roll out. Collectively, these actions could inform evidence-based measures to reduce injuries and fatalities as e-bike use continues to grow.

2018 to 2024. The SWITRS data and Codebook is available at https://tims.berkeley.edu/help/SWITRS.php. We identified all bicycle incidents using the “L—Bicycle” Incident Vehicle Type.

We identified e-bike incidents based on reporting officer coding of e-bike vehicle brand and model names. Starting in 2021, if the code "91 – electric bicycle" was used in the "CHP Primary/Towing Vehicle" Party field, then these were also identified as e-bikes. We identified possible brand and model names through web and manual searches, and using artificial intelligence tools, including ChatGPT. A copy of the syntax file used for the SWITRS text searches is available in the online supplemental file 1. We used a comparison group of all non-e-bike bicycle injury incidents in SWITRS for the same period.

Demographic data, mortality, rider-at-fault status, traffic violations, and the Social Vulnerability Index (SVI) for the collision site census tract were analyzed. The SVI, developed by the US Centers for Disease Control and Prevention (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR), is a composite measure designed to identify communities that may be more susceptible to adverse social, economic, and health outcomes in the face of stressors such as natural disasters or disease outbreaks. The SVI incorporates US Census data across four major domains: (1) socioeconomic status (eg, poverty, unemployment, income, educational attainment), (2) household composition and disability (eg, age, disability status, single-parent households), (3) minority status and language (eg, race/ethnicity and English proficiency), and (4) housing type and transportation (eg, multi-unit structures, crowding, vehicle access). For each US Census tract, variables are ranked and aggregated into theme-specific and overall percentile scores, with higher values indicating greater social vulnerability. SVI has been widely used to assess community-level disparities and to guide resource allocation in public health and emergency preparedness. In this study, the overall SVI score for each census tract was calculated from the American Community Survey and geolocation data from latitude-longitude scene geolocators provided by the Transportation Injury Mapping System (TIMS) developed by UC Berkeley SafeTREC, and map-merged in ArcGIS Pro 3.5.3 (esri, Redding, CA).

To prevent type 1 errors from multiple comparisons over the 7-year period, we analyzed temporal trends in mortality between e-bike and traditional bicycle collisions using a generalized linear model (GLM). The year was modeled as a continuous predictor (treated as a linear trend), with group (e-bike vs bicycle) as a categorical factor. We specified a binomial distribution with a logit link to account for the binary outcome, aggregated by year and group. The GLM model included main effects of group and year, along with their interaction term (group×year) to assess whether the rate of change over time differed between groups. Analyses were conducted in SPSS version 30 (IBM Corp., Armonk, NY) using the GENLIN procedure.

SWITRS Victim Degree of Injury was used to determine injury severity. SWITRS reports use either the old SWITRS scale or the new scoring system based on the National Highway Traffic Safety Administration Model (NHTSA) Minimum Uniform Crash Criteria (MMUCC) fifth edition, published in 2017. The MMUCC provides a standardized method for reporting traffic crashes, including details about vehicles, involved individuals, and the surrounding environment. As SWITRS has a mix of old and new injury scoring, we followed TIMS guidelines and merged new injury categories with old categories as follows:

- New category 5—"Suspected Serious Injury" was merged with old category 2 – "Severe Injury".
- New category 6—"Suspected Minor Injury" was merged with category 3 – "Other Visible Injury".
- New category 7—"Possible Injury" was merged with old category 4 – "Complaint of Pain".

We used a GIS hotspot analysis tool in ArcGIS Pro to compare e-bike with traditional bicycle collision locations. Each mapped point represents a collision location from SWITRS located via TIMS. The analysis was performed using a fixed distance band of 500 m, which defined each feature’s neighborhood. The tool provides z-scores and p-values for each feature, classifying locations as statistically significant hot spots (clusters of high values) or cold spots (clusters of low values) at 90%, 95%, and 99% confidence levels.

To evaluate the level of agreement between the two hotspot analyses, we reclassified the outputs into three categories: hot spots ($p<0.05$), cold spots ($p<0.05$), and non-significant areas. The layers for traditional bicycle and e-bike collisions were overlaid on a standard spatial grid and each unit was assigned the classification from both analyses. Agreement between groups was measured using overall similarity (percent agreement) and Cohen’s κ, which adjusts for agreement expected by chance.

Analyses were conducted using complete case analysis; observations with missing data were excluded from the relevant analyses (listwise deletion). No imputation was performed.

We generated GIS heat maps of e-bike and traditional bicycle collision locations in SWITRS using the TIMS geolocation data and the Kernel Density Estimation tool in ArcGIS Pro. The input data consisted of point features representing collision sites. Kernel density was calculated with a search radius of 500 m and an output cell size of 1 km. On the resulting raster surface,

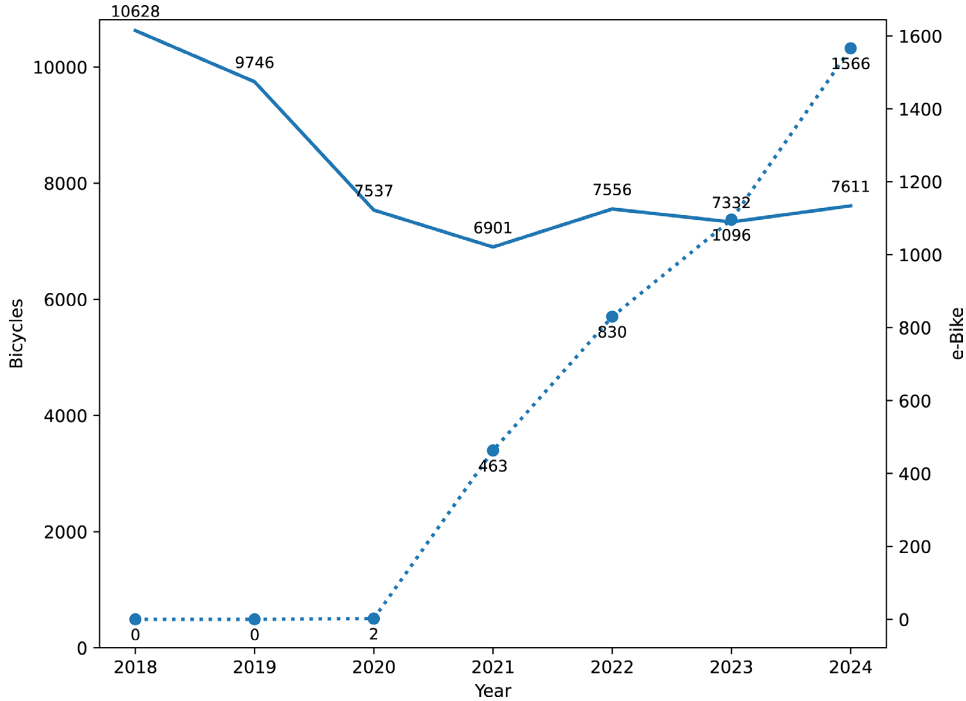

Figure 1 California SWITRS (Statewide Integrated Traffic Records System) annual bicycle and e-bike injury events, 2018–2024.

higher density values indicate locations with a greater concentration of weighted points. Separate heat maps were created for each group, enabling visual comparison of clustering patterns between groups.

Date was analyzed in SPSS, categorical data were analyzed by χ^2 analysis, and continuous variables via t-test using two-sided tests with $p<0.05$ considered statistically significant. The study was deemed exempt from review by the UC San Diego Human Research Protections Program under Institutional Review Board number 809 179.

RESULTS

We identified 62 367 collision incidents in SWITRS from 2018 to 2024, of which 58 332 involved traditional bicycles and 4035 involved e-bikes. E-bikes were identified using vehicle code "91" only in 521 cases, from brand and/or model name only in 2756 cases, and from both sources in 758 cases. E-bike injuries increased significantly from 2018 to 2024 ($p<0.001$), both in numbers and as a proportion of all cyclist injuries during this period ($p<0.001$, figure 1), rising from two incidents in 2018 to 1566 in 2024. Traditional bicycle collisions appeared to be static or decreasing in numbers during the same period, from 10 628 in 2018 to 7611 in 2024. Among all injury collisions from 2018 to 2024, e-bike riders were younger than bicyclists, with a median age of 33 years (IQR 17–53) versus 36 years (IQR 22–54) ($p<0.001$, table 1). A greater proportion of e-bike riders were ≤14 years old (15.6% vs 10.2%; $p<0.001$). A significant number of e-bike injuries occurred in riders aged ≤14 years, and the number of injured children is rising annually (figure 2). The age group with the highest number of e-bike injuries is those ≤14 years old, and this is proportionally and significantly higher than in traditional bicyclist collisions (figure 3, table 1).

Female riders were in the minority and the proportion of female riders was similar between groups (18.6% vs 18.1%; $p=0.25$). Moderate-to-severe injuries occurred more frequently among e-bike riders (15.8%) than bicyclists (11.9%; $p<0.001$). E-bike riders were more often deemed at fault (58.4% vs 51.2%; $p=0.036$) and had a slightly higher prevalence of alcohol involvement (1.6% vs 1.2%; $p=0.035$). Collisions involving traditional bicycles occurred in census tracts with higher mean SVI percentile scores compared with those involving e-bikes (52% vs 45%; $p<0.001$).

Mortality was comparable overall (2.0% vs 1.7%; $p=0.21$), but in 2024 alone, e-bike riders had a slightly higher death rate (2.1% vs 1.4%; $p=0.03$). While the overall categorical difference in deaths across 7 years between e-bikes and traditional bicycles was not statistically significant, the number of e-bike deaths has been increasing annually, while bicyclist deaths remain relatively steady (figure 4). Looking at the difference between groups by single years, the death rate for e-bike users was higher than that of traditional bicyclists in 2024 (table 1). In the GLM, there was a significant main effect of year (Wald $\chi^2=16.2$, $p<0.001$), indicating an overall increasing temporal trend in deaths. The main effect of e-bike versus traditional bicycle was not significant over this period (Wald $\chi^2=0.21$, $p=0.646$). Notably, the e-bike group×year interaction was significant (Wald $\chi^2=9.7$, $p=0.012$), suggesting that trends over time differed between groups. Post-hoc estimated marginal means indicated that mortality was similar between groups during the first 6 years (all $p>0.05$) but diverged in the final year, with e-bikes showing higher odds of mortality compared with traditional bicycles ($p=0.027$). Follow-up comparisons examining the effect of e-bike versus traditional bicycle within each individual year did not reach significance after correction for multiple comparisons (all $p>0.05$). This suggests that while there is an overall pattern of group differences over the study period, these differences are not yet significant enough in any single year to be statistically detectable by the GLM.

Wrong-side-of-road infractions were the most frequent primary or contributing rider violations for both e-bike and traditional bicycle riders, occurring in 16.5% and 17.0% of collisions, respectively ($p=0.06$). Unsafe speed and improper turning were significantly more common among e-bike riders than traditional bicyclists (11.2% vs 7.1% and 9.5% vs 6.3%,

Table 1

All injury collisions, 2018–2024	E-bikes (n=4035)*	Traditional bicycles (n=58 332)*	P value
Median age, years (IQR)	33 (17–53) Missing: 6 (0.1%)	36 (22–54) Missing: 313 (0.6%)	<0.001†
Age ≤14 years	630/4035 (15.6%) Missing: 6 (0.1%)	5957/58 332 (10.2%) Missing: 313 (0.6%)	<0.001†
Female	742/3998 (18.6%) Missing: 37 (1%)	10 289/56 739 (18.1%) Missing: 1593 (2.7%)	0.25
Moderate–severe SWITRS Injury Score	615/3340 (15.8%) Missing: 695 (17.2%)	6796/50 517 (11.9%) Missing: 7815 (13.3%)	<0.001†
Death of rider—2018–2024	80/4035 (2.0%) Missing: 0	1019/58 332 (1.7%) Missing: 0	0.21
Death of rider—2024 only	34/1600 9 (2.1%) Missing: 0	107/7718 (1.4%) Missing: 0	0.03†
Rider at fault	2360/4035 (58.4%) Missing: 11 (0.7%)	30 884/58 332 (52.9%) Missing: 431 (1.4%)	0.0002†
Rider using alcohol	63/4035 (1.6%) Missing: 0	689/58 332 (1.2%) Missing: 0	0.035†
Scene Social Vulnerability Index, mean (SD)	45% (28) Missing: 0	52% (29) Missing: 0	<0.001†
Top 5 rider primary or contributing vehicular code violations**			
Wrong side of road	666/4035 (16.5%)	10437/58 332 (17.0%)	0.06
Unsafe speed	451/4035 (11.2%)	4164/58 332 (7.1%)	<0.001†
Improper turning	387/4035 (9.5%)	3688/58 332 (6.3%)	<0.001†
Traffic lights and signals violations	268/4035 (6.6%)	4648/58 332 (8.0%)	0.005†
Automobile had right of way	298/4035 (7.3%)	4530/58 332 (7.8%)	0.41
Other violations	225/4035 (5.5%)	3822/58 332 (6.5%)	0.022†
None/other driver	1616/4032 (42.5%)	23586/58 332 (46.3%)	0.75
Missing data	124 (3.0%)	3457 (5.9%)	<0.001†

*Denominators vary due to missing data.
†P<0.05.
SWITRS, Statewide Integrated Traffic Records System.

respectively; both p<0.001), representing the most significant relative differences. In contrast, violations involving traffic lights or signals were less frequent among e-bike riders compared with traditional bicyclists (6.6% vs 8.0%, p=0.005). Right-of-way violations showed similar proportions between groups (7.3% vs 7.8%, p=0.41). Other specified violations were slightly less

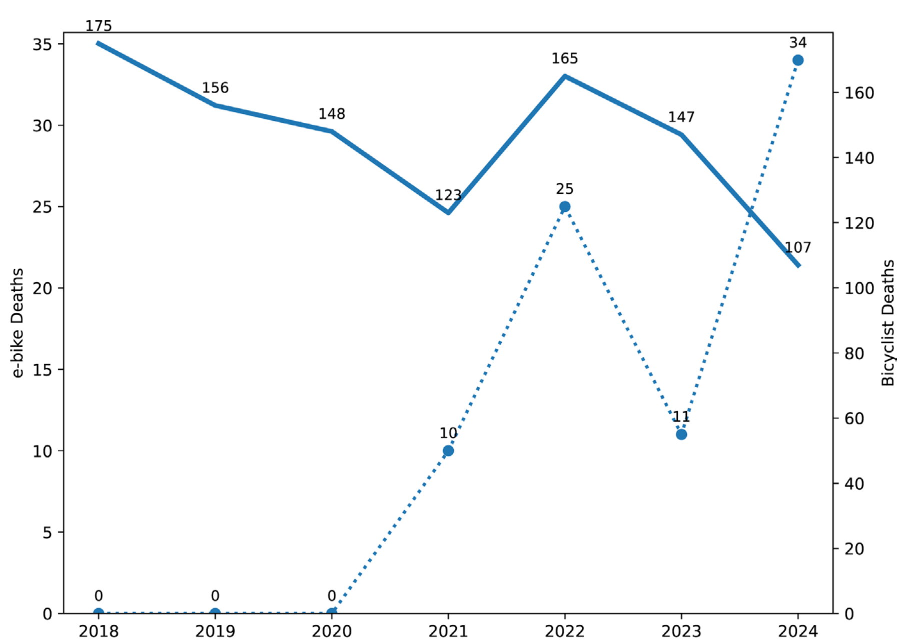

Figure 2 California SWITRS (Statewide Integrated Traffic Records System) annual bicycle and e-bike injury and death events, under 18 years (dotted line) and total (solid line), 2018–2024.

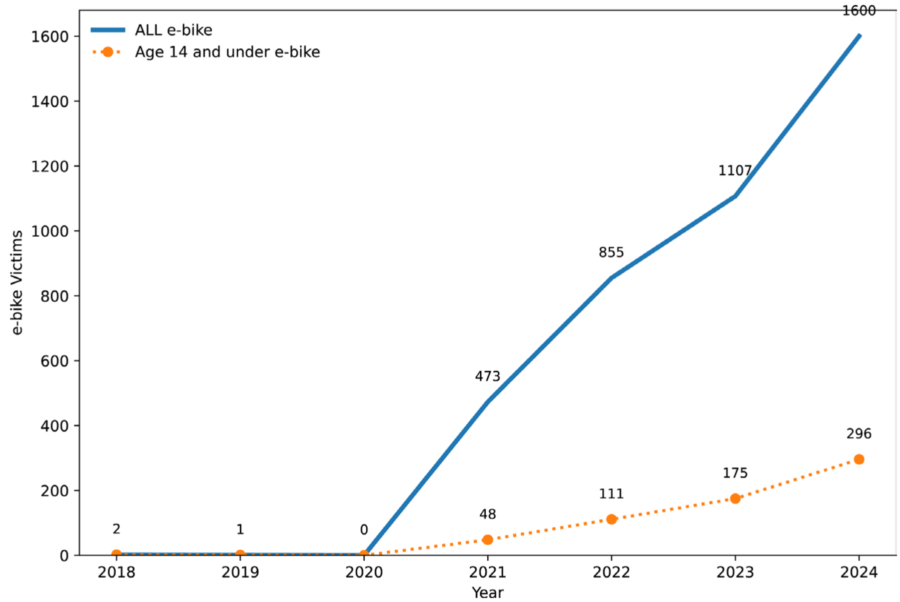

Figure 3 California SWITRS (Statewide Integrated Traffic Records System) bicycle and e-bike injury by age group, 2018–2024.

common among e-bike riders (5.5% vs 6.5%, p=0.022). Overall, e-bike collisions demonstrated a higher proportion of speed and turning related violations, whereas traditional bicycle collisions showed modestly higher rates of signal and miscellaneous violations (table 1).

Helmet-use patterns differed between e-bike and traditional bicycle victims across all ages and within the subgroup aged ≤14 years and younger (table 2). At every age, e-bike riders had lower documented helmet non-use than traditional bicycle drivers (25.4% vs 34.2%, p<0.0001), while helmet use was similar between groups (24.6% vs 22.1%). There were a considerable number of non-responsive entries: “Not required” occurred less often for e-bike than traditional bicycle victims (8.8% vs 12.9%), whereas “none in vehicle” was more frequently recorded for e-bike cases (4.5% vs 2.3%). Missing helmet-use information accounted for 16.1% of e-bike and 18.3% of traditional bicycle cases. Among victims aged ≤14 years, e-bike drivers again demonstrated lower helmet non-use rates than traditional bicycle drivers (18.1% vs 33.4%, p<0.0001), with similar proportions of documented helmet use (28.1% vs 29.0%). "Not required" entries were less common for e-bike than traditional bicycle victims (2.2% vs 7.3%), while "none in vehicle" was slightly more frequent for e-bikes (4.0% vs 2.9%). Missing data accounted for a larger share of e-bike incidents (39.8%) than traditional bicycle incidents (19.2%). While the differences in helmet use between groups are small, they are significant by χ^2 tests, if only positive and negative use responses are included. However, the large amount of missing and non-responsive helmet use data limits confidence in such statistical testing.

The hotspot comparison showed that 61% of spatial units were classified identically between the two groups, indicating some overlap in collision locations. However, when accounting for agreement expected by chance, Cohen’s κ indicated only fair agreement (κ=0.28, 95% CI 0.17 to 0.36, p<0.001). Overall, the z-scores for e-bikes (mean z=5.2) indicated stronger clustering compared with traditional bicycle collisions (mean z=−1.4), suggesting that e-bike collisions are more tightly spatially clustered. In contrast, traditional bicycle collisions

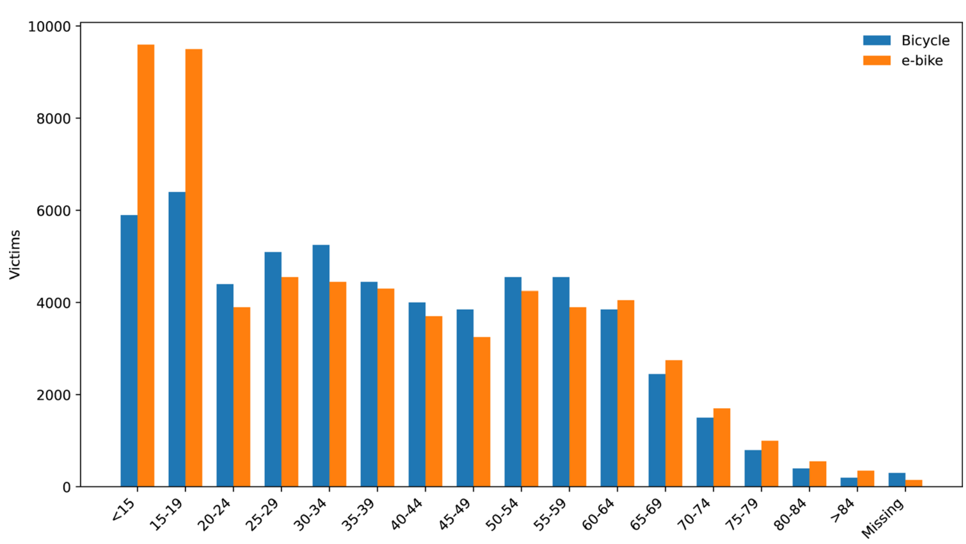

Figure 4 California SWITRS (Statewide Integrated Traffic Records System) annual bicycle and e-bike death-only events, 2018–2024.

Table 2

Victim helmet use reported*	E-bikes	Traditional bicycles	P value
All ages	n=4035	n=58 332	
Driver: helmet not used	1025 (25.4%)	20 002 (34.2%)	<0.001†
Driver: helmet used	996 (24.6%)	12 869 (22.1%)	
Passenger: helmet not used	51 (1.3%)	711 (1.2%)	
Passenger: helmet used	30 (0.74%)	308 (0.52%)	
"Not required" only	357 (8.8%)	7574 (12.9%)	
"None in vehicle" only	131 (4.5%)	1625 (2.3%)	
Unknown	17 (0.42)	170 (0.29%)	
Other	31 (0.76%)	30 (0.05%)	
Missing data	648 (16.1%)	10 704 (18.3%)	
Ages ≤14	n=630	n=5957	
Driver: helmet not used	114 (18.1%)	1990 (33.4%)	<0.001†
Driver: helmet used	177 (28.1%)	1728 (29.0%)	
Passenger: helmet not used	3 (0.5%)	87 (1.46%)	
Passenger: helmet used	1 (0.15%)	50 (0.84%)	
"Not required" only	14 (2.2%)	432 (7.3%)	
"None in vehicle" only	25 (4.0%)	172 (2.9%)	
Unknown	0 (0)	37 (0.62%)	
Other	2 (3.1%)	10 (0.16%)	
Missing data	251 (39.8%)	1144 (19.2%)	

*Percentages do not add to 100% due to multiple riders, rounding.
†P<0.05, excluding 'Not required', 'None in vehicle', Unknown, Other, and Missing data.

are more randomly distributed. The heat maps for traditional bicycle collisions revealed the highest density of clustering in downtown and urban areas (ie, downtown San Francisco), while e-bikes exhibited tighter patterns in more suburban areas and smaller 'bedroom' communities (ie, Marin County). Heat map comparison for e-bikes and traditional bicycle collisions for the San Francisco Bay area is shown in figure 5A,B. Other area maps and a temporal animation of the regional heat maps can be found in online supplemental file 2.

DISCUSSION

This statewide analysis, conducted in California and the largest database study to date on e-bike injuries, reveals a sharp increase from 2018 to 2024 in both the total number of e-bike injuries and their proportion of all cyclist injuries. E-bike riders tend to be younger, sustain more severe injuries, and are more often at vehicle code fault than traditional bicyclists. E-bike injuries occur more frequently in areas with lower social vulnerability, indicating greater e-bike access and usage among less disadvantaged socioeconomic groups. Overall, from 2018 to 2024, the death rate for e-bike-related collisions was not statistically different from that of traditional bicycles. However, in 2024, e-bike-related fatalities were slightly higher than those involving traditional bicycles, and there is a significant increasing trend of deaths from e-bike collisions over the study period.

Our findings align with previous reports documenting a global increase in e-bike-related injuries and their greater severity compared with traditional bicycle injuries.[3–5] The

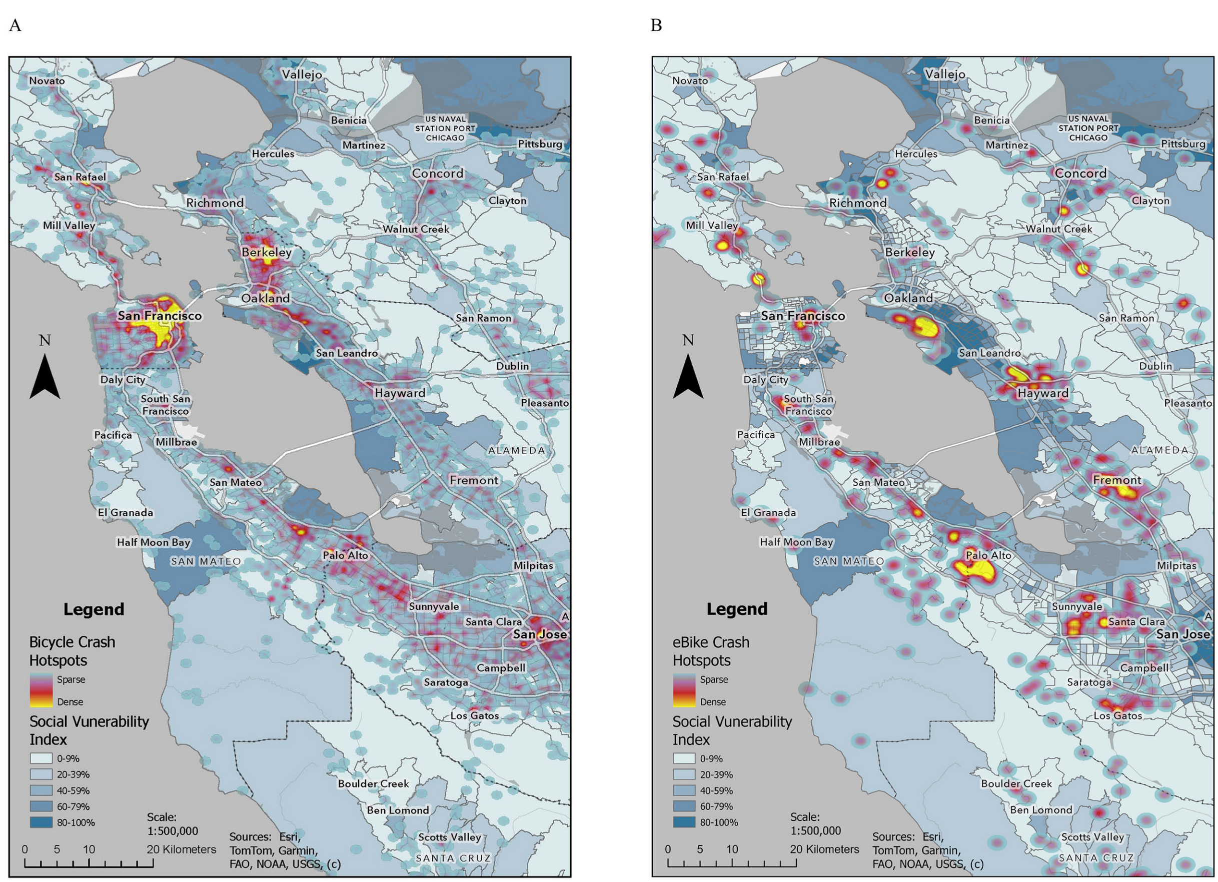

Figure 5 Heat map comparison for bicycle and e-bike collisions in the San Francisco Bay Area. Additional city maps and animations are given in online supplemental file 3. SVI, Social Vulnerability Index.

disproportionate representation of children aged ≤14 years among e-bike injuries concurs with earlier pediatric case series that highlight the vulnerability of younger riders.[6] The higher at-fault rate and rates of unsafe speed and improper turning violations support prior research findings indicating that the higher speeds and motorized operation patterns of e-bikes elevate the risk of injury crashes. Additionally, the observation that e-bike collisions are concentrated in less disadvantaged census tracts diverges from our earlier SWITRS and trauma registry-matching studies on traditional bicycle injury epidemiology, which reported a greater bicycle injury burden in deprived neighborhoods.[11] This discrepancy may be attributable to the higher purchase costs and early adoption trends associated with e-bikes, and this geospatial pattern should be considered when developing advocacy and policy measures for e-bike safety.

The literature suggests helmet use among e-bike riders may be lower than that among traditional bike riders.[12] In California, helmet use is required based on rider age and the class of e-bike (Class III, pedal assist until the e-bike reaches 28 mph). According to California Vehicle Code (CVC) §21212, anyone under 18 riding a bicycle, e-bike, or e-scooter must wear a helmet. Helmet use is mandatory for both drivers and passengers. Adults (≥18 years) must wear a helmet when riding a Class III e-bike; helmet use among adults is otherwise voluntary. While SWITRS provides only a limited evaluation of helmet use in e-bike and traditional bicycle collisions, we believe this evidence shows that helmets were likely worn by only a minority of victims, including children. Overall, e-bike riders showed slightly higher helmet use rates than bicyclists, likely because more were <18 years old, possibly due to the helmet requirement for Class III e-bikes, or possibly because of better helmet availability in less disadvantaged SVI census tracts.

Younger riders may perceive less risk when using micromobility devices (ie, e-bikes, e-scooters, e-skateboards, etc).[13] The higher speeds and new interactions with other vehicles on the road can lead to more severe injuries and higher-energy collisions.[3,14] The capabilities of e-bikes may be surprising to other vehicle drivers. Trauma surgeons were among the first to recognize the increased risk of injury posed by new micromobility devices.

Surgeon advocacy should continue urging policymakers to harmonize e-bike classification and labeling requirements, thereby improving enforcement and raising parental and public awareness of e-bike speed capabilities. Educational initiatives targeting young riders and parents, promoting helmet use, and infrastructure improvements (such as speed-limited bike lanes and school safety zones) could help reduce risks. Our data may also support ongoing legislative efforts in California and across the country to better regulate e-bike use, including setting minimum age limits and safety standards. California State e-bike vouchers currently used to encourage micromobility purchases should also be tied to safety education, avoid sponsoring models with trivially easy upgrades to Class III e-bike speeds, and provide support for affordable helmet purchases. The authors have collected interventions to improve e-bike safety used in advocacy efforts in California and elsewhere in Box 1. Several of these interventions are incorporated into a bipartisan Congressional bill, H.R. 5265, "The Safe RIDE Act", introduced in September 2025.[15]

Several limitations should be considered when interpreting our findings. SWITRS only records vehicle collisions reported by law enforcement; incidents not involving a police report are excluded. This includes many solo accidents off highways or public roadways, and cases not requiring ambulance activation, regardless of hospitalization or disability outcomes.

Box 1

Suggested surgeon advocacy targets for the reduction of e-bike-related injuries and deaths.

1. Rider age and licensing
   Minimum age laws: set clear age thresholds for riding different e-bike classes (eg, 14+ for Class I/II, 16+ for Class III).
   Graduated licensing: require younger riders to complete an online or in-person safety course before operating higher-speed e-bikes.
   Parental consent: mandate parental consent for minors purchasing or registering e-bikes.
2. Training and education
   Mandatory safety education: include e-bike modules in driver's education or school health curricula.
   Community programs: fund school or community-based e-bike skills training (helmet fitting, braking, speed management).
   Retailer responsibility: require bike shops to provide safety information and demonstrations at the point of sale.
3. Equipment and vehicle standards
   Helmet laws: require helmets for all riders (or at least under 18, or for higher-speed Class 3 bikes).
   Speed regulation: standardize maximum assisted speeds (20 mph for Class 1/2, 28 mph for Class 3).
   Safety labeling: mandate clear labeling of e-bike class, power and speed capability on frames.
   Lighting and reflectors: require daytime running lights, reflectors, or integrated visibility features.
   Battery/fire safety: adopt UL 2849/2271 certification requirements for e-bike batteries to reduce fire risk.
4. Road use and infrastructure
   Pathway rules: define where each e-bike class may operate (bike lanes, shared-use paths, or roadways).
   Speed-limited zones: allow municipalities to impose lower speed caps in dense urban areas or on shared paths.
   Dedicated infrastructure: invest in protected bike lanes and low-speed networks that accommodate e-bike traffic.
5. Enforcement and accountability
   At-fault tracking: require police crash reports to distinguish e-bike classes and violations.
   Insurance/registration (debated): consider registration or liability coverage for higher-speed e-bikes.
   Retail compliance: enforce penalties for retailers who mislabel or sell non-compliant e-bikes.
6. Data and research
   Crash reporting standards: ensure e-bike involvement is a distinct variable in police and hospital records (such as SWITRS).
   Exposure data: fund travel surveys to track e-bike miles traveled.
   Evaluation mandates: require health/safety impact studies before expanding e-bike subsidy or voucher programs.
7. Public health and equity
   Subsidy conditions: tie e-bike voucher or rebate programs to completion of a safety course or helmet purchase.
   Equity focus: ensure safety interventions reach both high-income and low-income communities.
   School zone protections: establish rules for e-bike use near schools, including speed caps or dismount zones.

Continued

Box 1 Continued

Framing: frame policies as injury prevention, not restriction. Emphasize shared responsibility (riders, drivers, cities). Highlight that e-bikes still offer net health and environmental benefits.

Misclassification may occur due to incomplete reporting of e-bike brand and model information, as well as missing, uncommon, or misspelled e-bike names. Variations in reporting and coding across different police jurisdictions, along with increased awareness of e-bike collisions, may contribute to temporal and geographical inconsistencies in the data. Exposure data, such as miles traveled and trips taken, were unavailable. This limitation prevents the calculation of injury rates per rider, ownership years, or per mile. Deaths occurring later in hospitalization may not be captured. Injury severity was assessed using police-reported categories rather than clinical assessments, such as the injury severity score. Reporting of e-bike incidents in SWITRS was not standardized because e-bike vehicle codes ("91") are inconsistently used. Instead, reporters often used the "Primary/Towing Vehicles" field as a secondary method to facilitate e-bike coding, both before and after the 2021 addition of the "91" vehicle code. If the reporting officer failed to use an e-bike brand or model name or a "91" code starting in 2021, then that e-bike case would appear to be a traditional bicycle case, which would weaken our comparison. Coding issues have precluded us from making a broader, statewide comparison of overall micromobility injury events, such as e-scooter injuries, as SWITRS does not have a single discrete code for e-scooters. Micromobility injury trends must be studied at the county or hospital level by merging trauma registry data with SWITRS. Tracking micromobility injuries in this way has led to successful advocacy efforts in reducing preventable injuries.[15 16] Future versions of SWITRS are expected to have improved micromobility incident coding as these modes of transportation become increasingly common in California. Another limitation is that we cannot stratify the SWITRS data by manufacturers' e-bike classifications, nor do we know whether the bikes were modified in any way. An emerging concern is the recent appearance of "out-of-class" higher-power e-bikes with high-power batteries and motors. These are sold online, equipped with motors exceeding 750 W, and possibly capable of speeds over 62 mph/100 km/h.[17–19] "E-motos" or light electric, "dirt bike" motorcycles with 2 kW to 12 kW power, are not street legal but are often sold alongside e-bikes, and these may be visually mistaken for e-bikes and not be accurately identified by reporting agencies. Increasingly, there is a limitation that anything bicycle-shaped and electric identified as an e-bike, may not necessarily be a Class I–III e-bike. Finally, causal inference is limited by the study's observational, retrospective design.

Further research is needed to study e-bike crash biomechanics, helmet use compliance, and the long-term outcomes for injured riders, especially among pediatric populations. It is crucial to include specific fields for micromobility devices, such as e-bikes and e-motos, in SWITRS. Connecting SWITRS data with hospital and trauma registry records could enhance injury severity evaluations, as well as analyses of mortality, disability, and costs. The authors are already working on such a project. Natural experiments following new policies, like speed limiters and mandatory labeling, could assess their effects on injury patterns. We will keep advocating at the state and federal government levels for policies aimed at reducing deaths and injuries caused by new micromobility technologies.

CONCLUSION

E-bike injuries are increasing rapidly in California, especially among children, and are associated with inadequate helmet use, higher injury severity, and distinctive traffic violation patterns. A significant trend of increased deaths in e-bike collisions in California, compared with bicyclist collisions, has emerged. There are significant differences in age, neighborhoods, and socioeconomics between e-bike and traditional bicycle injury collisions. Coordinated legislation, regulations, youth and parent education, and infrastructure improvements may be needed to reduce e-bike-related injuries and deaths. Trauma surgeons and their allies' advocacy with policymakers will be crucial to ensure the successful adoption of evidence-based policy measures.

Contributors JA, JJD designed this study. JA, JM, JJD searched the literature. JJD collected the data. JA, JM, JJD analyzed the data. All authors participated in data interpretation and manuscript preparation. JJD is acting as the guarantor. ChatGPT was used to identify additional brand names and model names of electric bicycles (e-bikes) sold in the United States in addition to e-bike names already found in the SWITRS database and those found through Google search queries. The syntax file used for SWITRS e-bike names generated by manual, Google, and ChatGPT searches is attached in supplemental files.

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