November 14, 2022 Safety Research Report SRR-22-01

Micromobility: Data Challenges Associated with Assessing the Prevalence and Risk of Electric Scooter and Electric Bicycle Fatalities and Injuries

Abstract: This safety research report examines the data collection and analysis challenges associated with two of the most common types of micromobility devices: electric scooters (e-scooters) and electric bicycles (e-bikes). To do this, the National Transportation Safety Board (NTSB) conducted a scientific literature review; held discussions with subject matter experts; performed an independent analysis of e-scooter and e-bike crashes, fatalities, and injuries in the United States between 2017 and 2021; assessed e-scooter and e-bike injury coding; and reviewed the Infrastructure Investment and Jobs Act, which contains new requirements about collecting data on vulnerable road users, such as e-scooter and e-bike riders.

The NTSB identified the following safety issues: (1) the need to add e-scooter and e-bike device codes to police crash data and guidance, (2) the need for e-bike-specific coding in injury surveillance data and guidance, and (3) the need for e-scooter and e-bike trip data to assess injury and fatality risk. The NTSB also examined the complexities of using collected data to conduct safety research on e-scooters and e-bikes.

As a result of this safety research, the NTSB makes new recommendations to the National Highway Traffic Safety Administration, the Federal Highway Administration, the US Consumer Product Safety Commission, the National Center for Health Statistics, and the Governors Highway Safety Association.

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Acronyms and Abbreviations

CFR	*Code of Federal Regulations*
CPSC	US Consumer Product Safety Commission
CPSRMS	Consumer Product Safety Risk Management System
CSCRS	Collaborative Sciences Center for Road Safety
e-bike	electric bicycle
e-scooter	electric scooter
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
GHSA	Governors Highway Safety Association
ICD-10-CM	International Classification of Disease, Tenth Revision, Clinical Modification
IIJA	Infrastructure Investment and Jobs Act
MMUCC	*Model Minimum Uniform Crash Criteria*
NACTO	National Association of City Transportation Officials
NCHS	National Center for Health Statistics
NEISS	National Electronic Injury Surveillance System
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
TMG	*Traffic Monitoring Guide*

Executive Summary

Safety Research Topic

Protecting vulnerable road users, such as pedestrians, motorcyclists, and bicyclists, through a Safe System approach, is a priority for the National Transportation Safety Board (NTSB). This issue area is highlighted on our 2021–2022 Most Wanted List of Transportation Safety Improvements. We have also published five reports that addressed vulnerable road user safety since 2013; the topics included crashes involving single-unit trucks, speeding-related crashes, motorcycle crashes, pedestrian safety, and bicyclist safety.

Successfully implementing a Safe System approach requires quality data to help us understand the unique risks associated with vulnerable road users. Recently, emergent transportation modes in the form of electric micromobility devices have expanded the list of people considered to be vulnerable road users, specifically electric scooter (e-scooter) and electric bicycle (e-bike) riders.

Although data are often collected and analyzed to craft safety initiatives for those typically considered to be vulnerable road users, such as pedestrians, motorcyclists, and bicyclists, less data are collected on vulnerable road users who rely on modes of transportation that are emergent, such as those who operate e-scooters and e-bikes.

In 2020, the International Transport Forum, an intergovernmental organization of more than 60 member countries including the United States, identified e-scooter, e-bike, and other micromobility trip data as essential for assessing and monitoring risks associated with these devices. For this reason, the International Transport Forum called on national governments to start collecting measures of trip data from e-scooters and e-bikes. However, these measures for e-scooters and e-bikes are not being systematically collected at the federal or state level in the United States.

In our 2019 report *Bicyclist Safety on US Roadways: Crash Risks and Countermeasures*, we found that transportation safety professionals were becoming increasingly concerned about the exponential growth in the use of e-scooters and e-bikes and the safety of those riding these devices, given their motorized components. Because we had addressed issues related to conventional bicycle data collection in our 2019 report, we focused this report on the emergent data issues related to e-scooters and e-bikes and how the current lack of standardized national data on e-scooter and e-bike fatalities and injuries prevent meaningful and generalizable analysis of the safety issues associated with the use of these devices.

In response, we conducted this research to proactively evaluate how limitations in available e-scooter and e-bike data present challenges for assessing the safety of these micromobility devices, including the prevalence and risk of fatalities and injuries. The goal of this research was to evaluate issues related to these challenges and to make recommendations to standardize the collection and analysis of data related to e-scooters and e-bikes. Improving data quality leads to better decision-making about how to improve safety for e-scooter and e-bike riders. Accurate data can provide useful information to help us identify safety trends and patterns, gain insights into safety and usage, make comparisons with other transportation modes, evaluate policy, and educate the traveling public.

To accomplish our goal, we did the following: reviewed relevant scientific literature; spoke with micromobility subject matter experts; conducted our own analysis of e-scooter and e-bike crashes, fatalities, and injuries in the United States between 2017 and 2021; evaluated current e-scooter and e-bike injury coding; and reviewed the Infrastructure Investment and Jobs Act, which contains new requirements about collecting data on e-scooter and e-bike riders that complement our efforts in this report.

What We Found

The NTSB found that at least 119 e-scooter and e-bike fatalities occurred between 2017 and 2021. While conducting our research, we identified the following data challenges that prevent an accurate understanding of how common and likely e-scooter and e-bike fatalities and injuries are:

- a lack of complete, consistent, and reliable data
- inadequate data coding that leads to difficulty in correctly identifying crashes involving e-scooter and e-bike riders
- poor quality trip data that makes assessing risk nearly impossible

To address these data challenges, we identified the following needs:

- adding e-scooter and e-bike device codes to police crash data and guidance
- adding e-bike-specific coding in injury surveillance data and guidance
- collecting e-scooter and e-bike trip data to assess injury and fatality risk

Police crash data and emergency room admission data—sources that contain the most information on crashes, fatalities, and injuries—were found to be inadequate. Both the National Highway Traffic Safety Administration and the US Consumer Product Safety Commission manage databases that have inadequate coding related to e-scooters and e-bikes. The Infrastructure Investment and Jobs Act requires agencies to collect more robust data on micromobility devices, specifically e-scooters and e-bikes, and provides some guidance about how to do so. However, guidance related to the use of the data does not account for this emergent industry. The *Model Minimum Uniform Crash Criteria*, the *Traffic Monitoring Guide*, and the International Classification of Disease, Tenth Revision, Clinical Modification either do not contain codes for e-scooters, e-bikes, or both or some of the codes are not structured in a way to allow for useful safety analyses of these devices.

What We Recommended

As a result of this research, the NTSB issued seven new recommendations. We recommended that the National Highway Traffic Safety Administration work together with the Governors Highway Safety Association to do the following:

- Ensure that revisions to the *Model Minimum Uniform Crash Criteria* include data elements for e-scooters and e-bikes.

We recommended that the National Highway Traffic Safety Administration do the following:

- Use the new data requirements outlined in the Infrastructure Investment and Jobs Act to analyze e-scooter and e-bike rider data and provide strategies to increase e-scooter and e-bike rider safety in *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices*.

We recommended that the Federal Highway Administration do the following:

- Implement a program to acquire from states annual trip counts and miles traveled from e-scooters and e-bikes and make the aggregate data publicly available for estimating crash, serious injury, and fatality rates.
- Revise the *Traffic Monitoring Guide* to include technical guidance on the collection of aggregate trip data for e-scooters and e-bicycles.

We recommended that the US Consumer Product Safety Commission do the following:

- Add a specific e-bike product code in the National Electronic Injury Surveillance System.

We recommended that the National Center for Health Statistics do the following:

- Define e-bike riders as nonmotorists in the International Classification of Disease, Tenth Revision, Clinical Modification to be consistent with current classifications used in crash data guidance.

1. Introduction

The term "micromobility" refers to a form of transportation involving the use of small mobility devices with limited power that operate at slower speeds and are used for shorter travel distances when compared to motor vehicles or motorcycles.[1] The term is often used to describe electric scooters (e-scooters), electric bicycles (e-bikes), and other single-user electric transportation devices.[2] Although e-scooters and e-bikes are available for private purchase, recently, such devices have become available as part of rental systems that rely on GPS technology and cellular phone applications to locate, rent, and drop off devices in the public right-of-way (NACTO and IMLA 2019).

Recent news reports have noted the rise of crashes occurring on e-scooters and e-bikes (Hu and Marcius 2021; Krauth 2022; Sisson 2022). These reports are often accompanied by estimates of e-scooter and e-bike fatalities and injuries that do not account for standardization issues in national data sources. Additionally, measurement and coding of e-scooter and e-bike crashes in the data are evolving.

Inadequate data currently hinders our understanding of potential safety risks, such as fatalities and injuries, related to the use of these devices. This National Transportation Safety Board (NTSB) safety research report examines the data collection and analysis challenges associated with two of the most common types of micromobility devices: e-scooters and e-bikes.[3]

Over the past decade, the NTSB has published five reports that addressed the safety of vulnerable road users and has made protecting such users through a Safe System approach a priority on its 2021–2022 Most Wanted List of Transportation

[1] See sections 1.3.1.1 and 1.3.1.2 for the definitions of electric scooters (e-scooters) and electric bicycles (e-bikes) used in this report as well as a discussion of device speeds associated with the federal definition of different e-bike classes.

[2] (a) Although e-scooters and e-bikes often operate on the road with motor vehicles, in most states, they are not treated as motor vehicles. The US Consumer Product Safety Commission (CPSC) is largely responsible for regulating these devices as consumer products. (b) Other examples of micromobility devices include self-balancing scooters and electric skateboards.

[3] Visit ntsb.gov to find additional information in the public docket for this NTSB safety research (case number DCA20SS001). Use the CAROL Query to search safety recommendations and other safety research.

Safety Improvements (NTSB 2013, 2017, 2018a, 2018b, 2019).[4] A Safe System approach refers to a holistic and comprehensive view of our complex transportation system that strives to make roadways safer for all users—that is, motor vehicle drivers and all vulnerable road users alike—by "building and reinforcing multiple layers of protection to both prevent crashes from happening in the first place and minimize the harm caused to those involved when crashes do occur" (DOT 2022). Implementing this approach requires quality data to help us know who is using our transportation system and how we might make the system safer for them.

E-scooter and e-bike riders, like bicyclists, motorcyclists, and pedestrians, are considered vulnerable road users. In its 2019 report *Bicyclist Safety on US Roadways: Crash Risks and Countermeasures*, the NTSB found that transportation safety professionals were concerned about the rapid growth of shared-use micromobility devices, particularly e-scooters and e-bikes, and the safety of those riding such devices. However, the current limitations of e-scooter and e-bike data make it difficult to analyze traffic safety issues involving these devices (BTSCRP 2022). The Infrastructure Investment and Jobs Act (IIJA) also recognizes the need for obtaining reliable and standardized data on all vulnerable road users, including e-scooter and e-bike riders.[5]

This report addresses e-scooter and e-bike data challenges, including the complexities of e-scooter and e-bike fatality and injury data collection and coding, the limitations related to identifying e-scooters and e-bikes in available data sources, and the difficulties involved in interpreting, reporting, and analyzing these data. Because of the lack of consistent, standardized, and reliable data, the NTSB had to use numerous methods to conduct this research. As a result, although the NTSB provides high-level insights about e-scooter and e-bike rider fatalities and nonfatal injuries from the data it could obtain, we also highlight areas where the data needs to be better before more advanced safety analyses are conducted. Further, we note where current initiatives to improve micromobility data are useful and where additional interventions are needed.

[4] (a) The term *vulnerable road user* refers to those travelers who lack an external structure to protect them when crashes occur. Vulnerable road users include pedestrians, bicyclists, motorcyclists, wheelchair users, and others that use an unenclosed means of transportation. Because vulnerable road users lack substantive protection, they are more likely to suffer a serious injury or even death. (b) The five NTSB reports addressed crashes involving single-unit trucks, speeding-related crashes, motorcycle crashes, pedestrian safety, and bicyclist safety.

[5] IIJA, Public Law 117–58, 135 Stat. 429 (2021).

1.1 Scope

This research focuses on e-scooter and e-bike data challenges and the unique problems the lack of quality—that is, consistent, standardized, and reliable—data presents. It does not readdress recent NTSB report topics, safety issue areas, or recommendations related to other vulnerable road users. It also does not make distinctions between riders of privately owned or rented e-scooters and e-bikes. This research uses several methods and data sources, including a mix of methods to gather and evaluate available data concerning e-scooter and e-bike crashes, fatalities, and injuries in the United States between 2017 and 2021.[6] The recommendations address issues of e-scooter and e-bike data inaccuracies, coding ambiguities, and access problems.

1.2 Goals

The goals of this research are to (1) describe the prevalence and characteristics of fatal and nonfatal crashes involving e-scooters and e-bikes; (2) evaluate issues related to the analysis of available data, and (3) make recommendations to standardize and analyze trip, crash, fatality, and injury data for e-scooter and e-bike riders.[7]

1.3 Micromobility: A Brief Overview

Below is a brief overview of the following micromobility topics: the devices discussed in this report, industry growth and ridership, e-scooter and e-bike fatalities and injuries, and data standards.

[6] The methods used for this research included conducting searches for the terms "e-bike" and "e-scooter" in existing data; combining datasets from various sources, including news reports and publications from government and academic institutions; and cross-referencing data found across these sources. See section 2 of this report for further discussion of all the methods used to conduct this research.

[7] Trip data are traffic data used to monitor motorized and nonmotorized travel, including pedestrians and bicyclists, on public roads. This measure is referred to as vehicle miles traveled and is based on individual state reports on traffic data counts collected through permanent automatic traffic recorders. Vehicle miles traveled per capita is calculated as the total annual miles of vehicle travel divided by the total population in a state or in an urbanized area. These data are reported by the states to the Federal Highway Administration (FHWA), which then publishes the monthly *Traffic Volume Trends* report via its Office of Highway Policy Information.

1.3.1 Devices

The definition of a micromobility device varies across states, regulating bodies, and research leading to inconsistent information. In general, mobility devices in the "micro" category are small, have limited power and speeds, and are commonly used for short-distance travel (Kwangho and others 2021). In the United States, micromobility device is a catch-all term that includes e-scooters, e-bikes, and other small, single-user electric-powered devices like self-balancing scooters.[8] Although not all micromobility devices are motorized, in this report, the term micromobility device refers to a device that is either fully motorized or motor-assisted (Sandt 2019).[9] Below are definitions and examples of the two types of micromobility devices discussed in this report: e-scooters and e-bikes.

1.3.1.1 E-Scooters

In this report, the NTSB defines e-scooters as electric-powered devices that include a small, two-wheeled floorboard for a rider to stand on and a vertical steering column with handlebars and a hand-activated throttle and brake. This description is consistent with the definition used in the *SAE J3194: Taxonomy and Classification of Powered Micromobility Vehicles* (SAE International 2019). See figure 1 for an example of an e-scooter.

[8] Commonly known under the trademarked term "hoverboard," *self-balancing scooters* are powered devices with a floorboard, no seat, and no operable pedals. Self-balancing is a term that refers to dynamic stabilization achieved via the device (SAE International 2019).

[9] A *fully motorized device* is capable of movement without human power. A *motor-assisted device* is one for which a rider provides some human-powered propulsion, such as by pedaling or kicking (Sandt 2019).

Figure 1. Example of an e-scooter (Source: Bird).

1.3.1.2 E-Bikes

In this report, the NTSB defines an e-bike as "a two-or three-wheeled cycle with fully operable pedals and an electric motor of less than 750 watts" that provides propulsion assistance, in accordance with Title 36 *Code of Federal Regulations* (*CFR*) Parts 1 and 4.[10] In 36 *CFR* 1.4, e-bikes are further defined into three classes by their

[10] This US Department of the Interior, National Park Service regulation expands what was once the only existing federal definition of e-bike, first defined by the CPSC, by classifying e-bikes into three categories.

speed and how much assistance is provided by the motorized component of the bike.[11] See figure 2 for an example of an e-bike.

Figure 2. Example of an e-bike (Source: Lime).

Note: This e-bike is considered a class 2 e-bike as it can reach the speed of 20 mph.

[11] (a) A class 1 e-bike refers to an e-bike equipped with a motor that provides assistance only when the rider is pedaling and that ceases to provide assistance when the e-bike reaches the speed of 20 mph. A class 2 e-bike refers to an e-bike equipped with a motor that may be used exclusively to propel the e-bike and that is not capable of providing assistance when the e-bike reaches the speed of 20 mph. A class 3 e-bike refers to an e-bike equipped with a motor that provides assistance only when the rider is pedaling and that ceases to provide assistance when the e-bike reaches the speed of 28 mph. (b) As of May 2022, 26 states have created their own individual three-tiered e-bike classification systems that align with federal definitions and share similar safety and operation requirements. E-bikes are often exempt from registration, licensure, and insurance requirements, differentiating them from other motorized vehicles, such as mopeds (National Conference of State Legislatures 2021).

1.3.2 Industry Growth and Ridership

There is no national source for calculating the total number of trips taken on e-scooters and e-bikes in the United States, meaning that the risk associated with the use of e-scooters and e-bikes is not yet estimated. However, some organizations have attempted to create estimates of e-scooter and e-bike ridership that give more insight into the growth of the industry.

Micromobility device use has seen rapid growth in the past 5 years, as evidenced by a marked increase in sales, availability, and ridership (NABSA 2021; Boudway 2021), and the micromobility market is predicted to be worth between $200 to $300 billion by 2030 in the United States alone (CBInsights 2021).

The National Association of City Transportation Officials (NACTO) and the North American Bikeshare and Scootershare Association, provide estimates of ridership from 2017 through 2020. In 2019, 136 million trips were completed using shared-use micromobility devices, an increase of 289% when compared to the 35 million trips completed in 2017 (NACTO 2020). For e-scooters, ridership increased from 39 million trips in 2018 to 86 million in 2019, and, for e-bikes, ridership increased from 7 million to 10 million over the same period (NABSA 2021; NACTO 2020). There was a noticeable decrease for all micromobility ridership in 2020, which has been attributed in part to the COVID-19 pandemic.[12] Still, industry estimates suggest that by December 2020 e-scooter and e-bike use rebounded quickly to within 20% of the previous year's trip numbers compared to other transportation modes (NABSA 2021).

1.3.2.1 Rider Characteristics

Growth in e-scooter and e-bike ridership is seemingly spurred by the popularity of these devices in urban areas. In fact, the rebound of e-scooter and e-bike use in 2020 was concentrated in cities like Chicago, Illinois; Boston, Massachusetts; San Francisco, California; and New York City, New York (Hu and Marcius 2021). These findings are consistent with other studies that highlight the urban nature of e-scooter and e-bike use in the United States (Fong, McDermott, and Lucchi 2019; Cherry and others 2021; Flores and Jansson 2021). Further, e-scooter and e-bike ridership was often found to be prevalent on and around college campuses, due to their accessibility and affordability (Fong, McDermott, and Lucchi 2019; Cherry and others 2021). For example, in a study conducted in Knoxville, Tennessee, e-scooter ridership was found to occur predominantly on campus.

[12] The COVID-19 pandemic began in late 2019. See the Centers for Disease Control and Prevention's "CDC Museum COVID-19 Timeline" and "Basics of COVID-19" sites for further information.

1.3.3 Rise in E-Scooter and E-Bike Fatalities and Injuries

According to the US Consumer Product Safety Commission (CPSC), emergency department visits related to all micromobility devices increased from 34,000 in 2017 to 57,800 in 2020; this was driven by a marked increase in e-scooter injuries, which more than tripled from 7,700 in 2017 to 25,400 in 2020 (CPSC 2021b). Further, findings from the CPSC's preliminary 2021 data analysis indicate even larger potential increases in micromobility injuries (57,800 in 2020 to 77,200 in 2021), with e-scooter injuries continuing to drive that increase (CPSC 2022).[13] E-bike riders in the United States saw similar increases in injuries over the same period. These trends are not restricted to the United States. For example, a Dutch study of e-bike injuries found that e-bike injuries were not only on the rise, but that Dutch e-bike riders were 1.6 times more likely to be injured than those riding conventional bicycles (Ricker 2022).

Fatalities associated with e-scooter and e-bike use followed similar patterns to those of injuries. According to analysis conducted by the CPSC, e-scooter fatalities had the largest percentage increase in deaths from 2017 to 2021 (CPSC 2022). Additionally, the Collaborative Sciences Center for Road Safety (CSCRS) recorded 106 e-scooter fatalities internationally, and 63 e-scooter fatalities in the US alone. Fatalities associated with e-bike ridership have also increased exponentially (CSCRS 2022). In fact, a study conducted using data from 180 University of California, Los Angeles, outpatient clinics, found that e-bikes may have a higher rate of fatalities than motorcycles and cars (Kimon and others 2022).

1.3.4 Data Standards Outpaced by Industry Growth

E-scooter and e-bike growth as an industry and a popular form of transportation is clear. What is less clear, is how transportation safety professionals best go about assessing the safety of these devices as a form of transportation and the safety of the riders who use them. As e-scooter and e-bike riders are considered vulnerable road users and ridership is increasing, the NTSB believes that these riders should be able to operate safely within the wider transportation network. The data issues associated with this rapidly expanding industry is a well-documented problem, both nationally and internationally, as described below. In fact, findings from research conducted in various cities across the United States lead to the same conclusion: e-scooter and e-bike fatality and injury data lack standardization and need improvement in crucial areas if they are to allow for factual safety assessments that lead to actionable safety countermeasures (Cherry and others 2021). Additionally,

[13] The CPSC notes that its reporting for 2020-2021 is ongoing and that its counts of e-scooter and e-bike injuries and fatalities may change (CPSC 2022).

there is currently no system in place that allows for the collection of aggregate e-scooter and e-bike trip data at the federal level, further hindering the ability to assess fatality and injury risk associated with riding e-scooters and e-bikes at a national level.

The lack of standardization in e-scooter and e-bike fatality and injury data has also been identified by research conducted internationally. For example, findings from Germany, one of the only countries to collect data on e-scooters as an independent device category, indicated that structural data issues, such as only relying on police crash reports without the ability to link them to emergency room admissions, likely lead to underreporting of e-scooter injuries (European Transport Safety Council 2022). Echoing sentiments reflected in Germany's findings and after a review of existing literature, researchers in British Columbia, Canada, reached a similar conclusion: standardized data collection is vital for identifying the safety risks associated with e-scooter injuries (Toofany and others 2021). Research conducted on e-bike fatalities and injuries have yielded similar data findings to that of e-scooters. A review of scientific literature examining the nature of e-bike crashes in European countries such as Denmark, Sweden, and the Netherlands, concluded that better crash data, specifically the ability to link police and emergency room data, are needed to improve understanding of factors related to e-bike crashes and injuries (Utriainen, O'Hern, and Pöllänen 2022).

Examining the state of the data associated with e-scooters and e-bikes and how well the data allow us to assess prevalence and risk are necessary initial steps for the successful implementation of a Safe System approach (Harmon 2020; FHWA 2022). This report shows that we must begin with an assessment of the data required to understand the safety risks e-scooter and e-bike riders encounter in order to implement countermeasures to ensure their safety.

2. Methodology

This section describes the methods the NTSB used to conduct this research. The details of what we found will be discussed in sections 3 and 4.

2.1 Methods

2.1.1 Scientific Literature Review

The NTSB reviewed relevant scientific literature concerning methods for defining and categorizing micromobility devices, identifying differences in micromobility device classification systems, and collecting and managing micromobility data. The NTSB also reviewed suggested best practices in the literature for generating consistencies in micromobility data. Information gathered from the literature review provided context for some of the discussions found in sections 3 and 4 of this report.

2.1.2 Micromobility Subject Matter Expert Discussions

Given the emergent nature of the micromobility industry, the NTSB invited subject matter experts who conduct research on micromobility safety topics to participate in a series of meetings. The meetings took place from July 7 to 23, 2020. The invited experts gave presentations and participated in discussions on the following topics:

- micromobility definitions and taxonomy, safety behavior data, and crash typing, with presenters representing three transportation centers at the University of North Carolina: the Highway Safety Research Center, the CSCRS, and the Pedestrian and Bicycle Information Center (Sandt and Thomas 2020)
- injury surveillance, emergency service data, and data linkage, with a presenter from the University of North Carolina's Highway Safety Research Center (Harmon 2020)
- evolution of micromobility rental operations data aggregation for safety evaluation, with a presenter from Populus (Clewlow 2020)[14]
- strategies and challenges with managing micromobility data, with presenters from NACTO (Bharadwaj and Payne 2020)

[14] Populus is a third-party company that manages shared mobility data.

- micromobility safety data limitations and opportunities, with a presenter from the University of Tennessee (Cherry 2020)

The purpose of these discussions was to gain qualitative insights on the complexities of micromobility data. Some of the discussion themes highlighted in this report include (1) the limitations of micromobility data collection and analysis, (2) improving police crash data and injury surveillance data, and (3) ways that transportation safety agencies can estimate miles traveled to calculate risk and, ultimately, improve safety in alignment with the Safe System approach.

After conducting these meetings, the NTSB continued to consult these subject matter experts throughout the development of the report, culminating in a May 2022 peer review of the draft report by 12 external subject matter experts, representing the following institutions: the CSCRS, NACTO, the CPSC, the *Model Minimum Uniform Crash Criteria* (*MMUCC*) internal review team, the National Highway Traffic Safety Administration (NHTSA), the Federal Highway Administration (FHWA), and the National Center for Health Statistics (NCHS). Revisions suggested by these peer reviewers have been considered and incorporated into the report as appropriate.

2.1.3 E-Scooter and E-Bike Fatality Data Review

E-scooter and e-bike fatality data lack standardization at the national, state, and municipal levels (Harmon 2020; Sandt and Thomas 2020). For this reason, many published estimates of e-scooter and e-bike fatalities have used multiple methods to account for this lack of standardization (Aizpuru and others 2019; Farley and others 2020; Trivedi and others 2019; Yang and others 2020). Each of the federal datasets vary in their methodology, resulting in inconsistent estimates.

For example, the CPSC, the agency responsible for regulating these devices as well as recording fatalities associated with their use, uses various sources, including consumer complaints, news clips, state and local authorities, medical examiners, national death certificates, manufacturers, and retailers, among others to populate its Consumer Product Safety Risk Management System (CPSRMS) (CPSC 2021c). Further, the CPSC notes that the CPSRMS data are anecdotal and not nationally representative. Similarly, the CSCRS also relies on multiple sources to maintain its fatality data on e-scooters. These include compiling incidents retrieved from media reports, trauma data, emergency department data, and police calls or collision reports.[15] NHTSA's Fatality Analysis Reporting System (FARS) is derived from police crash reports and is the official US census of traffic fatalities that occur on public

[15] See the CSCRS's webpage on "Understanding Micromobility Safety Behavior and Standardizing Safety Metrics for Transportation System Integration" for a detailed discussion of the CSCRS's e-scooter fatality data.

roads; it is widely used and cited. Data captured in the police crash reports are aggregated into the state crash data used in FARS and are used to make decisions about where to make traffic safety improvements. However, FARS does not contain specific categories for recording when e-scooter and e-bike riders are fatally injured in a motor vehicle-related crash. Yet, current literature shows that at least 80% of e-scooter and e-bike fatalities are due to collisions with motor vehicles (Harmon 2020; Cherry 2021).

Given the limited and differing nature of the data, the NTSB attempted to replicate current methods to produce estimates found in the CPSRMS, the CSCRS, and FARS. The NTSB performed an independent analysis of e-scooter and e-bike crashes, fatalities, and injuries in the United States between 2017 and 2021. This analysis focused on testing current methods used for data collection, the ease with which these methods can be used, and comparing results returned from this analysis with those of existing data sources.[16] Results from these comparisons are detailed in sections 3 and 4. The NTSB found that the results derived from our independent analysis vary from those cited and distributed by trusted institutions, including those tasked with monitoring vulnerable road user safety.[17]

2.1.4 Assessment of E-Scooter and E-Bike Injury Coding

The NTSB reviewed e-scooter and e-bike injury coding to determine whether recent updates have been successful, specifically the 2020 implementation of a product code specific to e-scooters in the CPSC's National Electronic Injury Surveillance System (NEISS) data (CPSC 2020; CPSC 2021a).[18] The NTSB also reviewed how the absence of a specific e-bike code contributed to discrepancies in the identification of e-bikes and related injuries in the data.[19]

[16] See appendix A for details on all data sources used in this report.

[17] A full list of all cases found in the NTSB's analysis and how they compare with existing data sources available in appendix B.

[18] A *product code* is a number used by the CPSC to identify consumer goods associated with injuries resulting in emergency room admissions, as recorded in NEISS (CPSC 2021a).

[19] See appendix C for more information about how the NTSB analyzed NEISS data for this report.

2.1.5 Review of the IIJA

The NTSB conducted a review of the IIJA, which was passed by Congress on November 15, 2021, and requires the collection of standardized crash data within specific guidelines and timelines that are relevant to this report.[20] The act pays special attention to vulnerable road users, and it also specifies the agencies responsible for implementing these new data collection guidelines.[21] The act expands the definition of vulnerable road users to include e-scooter and e-bike riders and allows states to secure federal funds to improve vulnerable road user safety, which is also on the NTSB's Most Wanted List.

[20] IIJA, section 24108, "Crash Data." Specifically, the act states that "the Secretary [of Transportation] shall revise the crash data collection system to include the collection of crash report data elements that distinguish individual personal conveyance vehicles, such as electric scooters and bicycles, from other vehicles involved in a crash."

[21] NHTSA and the FHWA were among the agencies tasked with implementing the new data collection requirements specified in the IIJA.

3. Results

This section discusses what we found during our review and exploratory analysis of the fatality and injury data for e-scooters and e-bikes.

3.1 Independent Analysis of E-Scooter and E-Bike Fatalities and Comparison to Existing Data Sources

As noted in section 2.1.3, to assess the standardization and reliability of existing data sources, the NTSB created a unique dataset to conduct comparisons among the publicly available datasets. To do this, the NTSB gathered news media-reported e-scooter and e-bike fatal crash information using a method developed by Yang and others (2020).[22] This method used keyword searches to find e-scooter and e-bike crash information mentioned in news media published on the internet. This approach was employed to compile and analyze reports from Google News on e-scooter and e-bike crashes involving one or more fatalities that occurred in the United States between January 1, 2017, and December 31, 2021. News reports were then merged with other published data sources and used to identify fatal crashes involving e-scooters and e-bikes that occurred in the United States between 2017 and 2021.[23]

To determine which fatalities involved an e-scooter or e-bike, the NTSB used the information collected, such as the date and location of the crash and the age and gender of the people fatally injured, from news reports and other published sources. For some crashes, there were several media outlets reporting on the same event. When multiple reports described the same crash, the narratives were checked for general consistency, redundant reports were removed, and reports with new details were merged with the data collected for that crash.

The NTSB then validated the data by checking for duplicates and cross checking the data against other micromobility databases, including those maintained by NHTSA, the CSCRS, and the CPSC. The NTSB also reviewed data from the Federal

[22] These reports included all crash types, such as a fall to the roadway, sidewalk, or ground, and collisions with motor vehicles, pedestrians, bicyclists, trains, parked cars, or fixed roadside objects like trees, fences, and concrete medians and barriers.

[23] There are limitations associated with this approach. For example, news coverage may be biased toward major events, reporting can vary across cities and states depending on what other topics are trending, and specific crash and victim characteristics may be more likely to generate reports (Shah and others 2021).

Railroad Administration and the Federal Transit Administration for fatal crashes involving e-scooters and e-bikes and transit vehicles.[24]

Results derived from the NTSB's independent search of news reports and other published sources yielded 61 e-scooter and 52 e-bike fatal crashes. After cross-referencing the CSCRS, the CPSRMS, and FARS, the NTSB found an additional 6 crashes, resulting in a total of 66 e-scooter and 53 e-bike fatal crashes for analysis in this report.[25] In total, the NTSB found that at least 119 fatalities involving e-scooters or e-bikes have occurred in the United States between 2017 and 2021. However, this is likely an underestimate because some incidents involving fatally injured riders may not have received media coverage or may not be contained in databases cross referenced by the NTSB.[26] Further, when comparing fatalities found when conducting our independent analysis to databases maintained by the CSCRS, the CPSC, and NHTSA, there were clear differences in reported fatalities. Results of this analysis are shown in the following table.

Table. Comparison of e-scooter and e-bike fatalities found by the NTSB with existing data sources.

Year	E-Scooter				E-Bike				All Devices			
	NTSB	CSCRS	CPSRMS	FARS	NTSB	CSCRS	CPSRMS	FARS	NTSB	CSCRS	CPSRMS	FARS
2017	1	1	1	1	1	n/a	1	1	2	1	2	2
2018	6	6	5	3	5	n/a	5	3	11	6	10	6
2019	24	23	18	14	6	n/a	5	5	30	23	23	19
2020	6	5	n/a	4	11	n/a	n/a	4	17	5	n/a	8
2021	29	23	n/a	n/a	30	n/a	n/a	n/a	59	23	n/a	n/a
Total	66	58	n/a	n/a	53	n/a	n/a	n/a	119	58	n/a	n/a

Note: The CSCRS does not yet track e-bike fatalities.

[24] Transit vehicles include freight, passenger, and commuter rail, and transit rail and buses.

[25] Although some crashes in FARS contain more than one fatality, those occurring on e-scooters and e-bikes contain one fatality each.

[26] The final total is reported as at least 119 fatalities involving e-scooters and e-bikes because of the possibility that some incidents involving fatally injured riders may not have generated a newspaper article, television news report, or some other type of public media coverage or may not be contained in the other databases that the NTSB cross referenced.

In all cases, the number of events found by the NTSB exceeded those reported in the other databases, indicating an underreporting of data in those databases. The data discrepancies revealed by the NTSB's analysis of existing data compared to its own further underscores the need for databases, especially those maintained by government agencies, to incorporate standardized ways to identify e-scooter and e-bike fatalities. Current data are variable and incomplete, further hindering the ability of transportation safety professionals to communicate reliable fatality statistics to the public or make relevant safety improvements.

3.2 Assessing E-Scooter and E-Bike Injury Coding

Given the variability found within fatality estimates, the NTSB conducted an analysis of available injury data retrieved from NEISS from 2017 to 2021. CPSC's NEISS is based on a national probability sample of hospitals in the United States and its territories. NEISS data are collected from about 100 hospitals and classified into five groups: four representing emergency departments of differing sizes and a fifth representing emergency departments from children's hospitals.[27]

Patient information is collected from each NEISS hospital for every emergency visit involving an injury associated with consumer products. Hospitals follow their normal data collection protocols during a patient visit. NEISS coders then review emergency room data and transcribe the data into the required format for inclusion in NEISS. This information provides the basis for national estimates of the number and severity of emergency room treated injuries.

The CPSC uses broad product codes, and its guidance directs users to analyze many device types under broad categories, even when devices are dissimilar. In 2020, the CPSC added an e-scooter specific product code. However, there is still no e-bike specific product code, which has led to a lack of classification for e-bikes in NEISS injury surveillance data. This lack of classification might potentially lead to inaccurate estimates of e-bike injuries because the methods needed for determining which devices fall under what product codes are variable.[28]

Thus, the NTSB's exploratory analysis examined whether (1) the lack of a unique product code for identifying e-bikes presented challenges when estimating injuries associated with that device type and (2) the implementation of a unique e-scooter product code improved consistency in the data.

[27] NEISS data can be biased toward severe injuries because they were collected from hospital emergency department visits.

[28] For a more in-depth discussion of methods used to assess nonfatal injuries in NEISS data, please see appendix C.

First, the NTSB analyzed how well current codes suggested by the CPSC to identify e-scooters and e-bikes matched the descriptions captured in patient narratives. Figure 3 displays the yearly percentage of the device types that had the product code NEISS uses to categorize e-bikes. Figure 4 displays the yearly percentage of the device types that had the product code used to categorize e-scooters.[29]

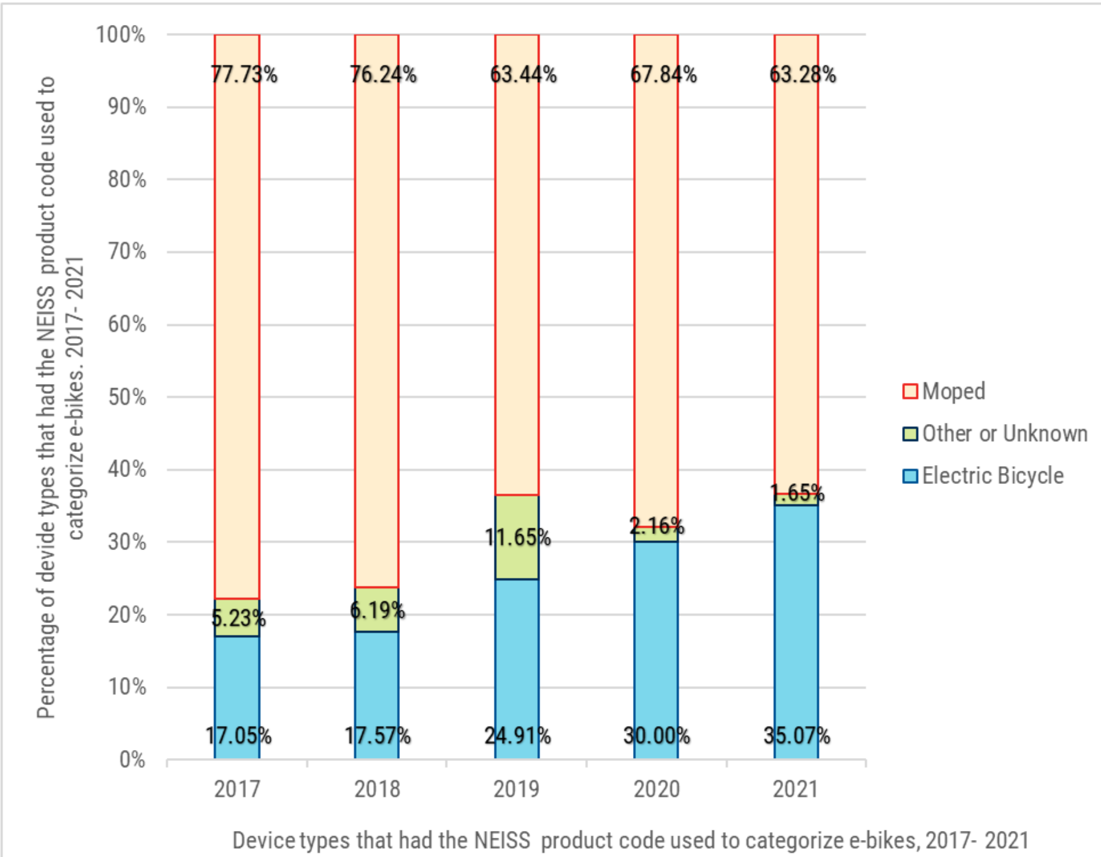

Figure 3. Device types that had the NEISS product code used to categorize e-bikes, 2017-2021.

As shown in figure 3, in 2017, mopeds represented 78% of the devices that had the product code used to categorize e-bikes, with e-bikes representing 17%. Further, e-scooters represented 5% of devices that had the product code used to

[29] Keyword searches were applied to the patient narratives to identify those devices that were not e-scooters or e-bikes. The NTSB then identified four categories of devices commonly found in the patient narratives across the product codes for e-bikes and e-scooters: e-bikes, e-scooters, self-balancing scooters or electric skateboards, and mopeds. Keyword searches were reliant on the description of the incident given by the patient, which was then entered into NEISS. Thus, there were possible instances where the keyword searches did not comprehensively find every e-scooter or e-bike within the NEISS product codes specified.

categorize e-bikes. By 2021, moped and e-scooter representation dropped to 63% and 2%, respectively, while e-bike representation increased to 35%. However, there continues to be no coded differentiation between mopeds and e-bikes in the NEISS data. The lack of a specific e-bike code results in mopeds still representing the majority of devices that had this product code, even though mopeds are significantly different from e-bikes.

Although mopeds and e-bikes share similarities in their construction, they have essential differences that require distinct representation in data sources. For example, moped drivers are more likely to need a license and insurance to operate on public roads, while e-bike riders do not have those requirements in most states. The CPSC continuing to categorize e-bikes and mopeds under the same product code means that it will continue to be difficult to assess safety risks specific to e-bikes.

E-scooters were originally grouped in a product code with several other device types. Figure 4 shows the percentage of each device type (e-scooters, self-balancing scooters or electric skateboards, and other or unknown) categorized under the CPSC-recommended NEISS product code for e-scooters between 2017 and 2019.

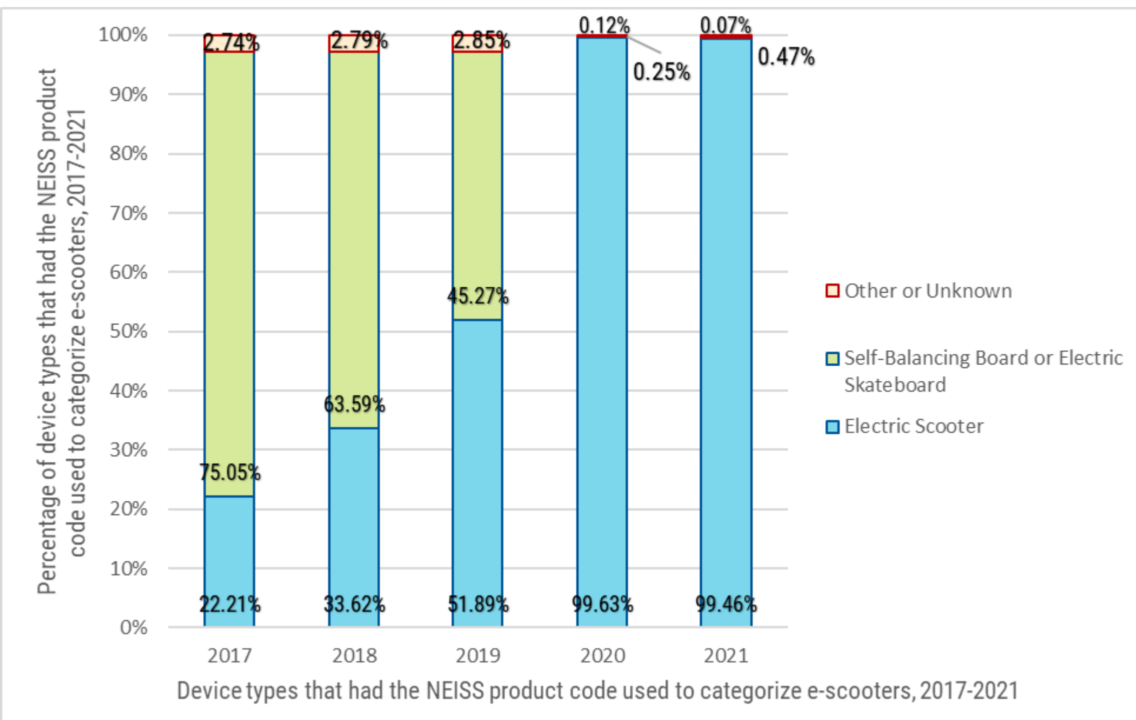

Figure 4. Device types that had the NEISS product code used to categorize e-scooters, 2017-2021.

Note: (a) The "other or unknown" category represents cases where devices were not identified or were not e-scooters, self-balancing scooters, or electric skateboards. (b) The total percentages in this figure may not add up to 100 due to rounding.

In 2017, e-scooters represented only 22% of the device types that had the product code used to categorize e-scooters, with self-balancing scooters and electric skateboards comprising most of the category at 75%. By 2019, the number of e-scooters had increased to nearly 52%; still, almost half of the cases (about 45%) were not e-scooters. However, as noted in section 1.3.3, the rise in emergency department visits related to micromobility devices was driven by e-scooter injuries. Thus, given their predominance, in 2020, the CPSC added a separate code for e-scooters to allow for ease of analysis and the rightful delineation of e-scooters from self-balancing scooters and electric skateboards. Figure 4 further illustrates how the inclusion of a separate e-scooter product code successfully captures e-scooter injuries as a standalone category.

Because e-scooters were no longer categorized with self-balancing scooters and electric skateboards after 2019, users can analyze injuries related to e-scooter use by only using the specific e-scooter product code, and without the need to use keyword searches of patient narratives to verify that an e-scooter was the product associated with an injury.

The NTSB's exploratory analysis of the accuracy of product codes showed that grouping several device types under a single product code could lead to inaccuracies in injury estimation. Although this issue was remedied for e-scooters in 2020, it remains a problem for e-bikes. See section 4.2.1 for further discussion.

3.3 Summary

In its analysis of existing scientific literature and available e-scooter and e-bike data, the NTSB confirmed the following deficiencies:

- a lack of complete, consistent, and reliable data
- inadequate data coding that led to difficulty in correctly identifying cases where emergency department admissions were related to e-bikes and e-scooters

The NTSB concludes that although the existing scientific literature indicates an increase in the use of e-scooters and e-bikes as well as an increase in e-scooter and e-bike rider fatalities and injuries, better quality data, efficient research methods, and replicable results are needed to improve our understanding of e-scooter and e-bike safety. The NTSB addresses these issues in detail in the next section by discussing the current state of e-scooter and e-bike data and providing recommendations for better quality data and how to use it.

4. Safety Issues

As a result of this research, the NTSB identified the following safety issues: (1) the need to add e-scooter and e-bike device codes to police crash data and guidance, (2) the need for e-bike-specific coding in injury surveillance data and guidance, and (3) the need for e-scooter and e-bike trip data to assess injury and fatality risk. In this section, the NTSB also touches on the importance of standardized data when implementing a Safe System approach and discusses the complexities of using collected data to conduct safety research on e-scooters and e-bikes.

4.1 Need to Add E-Scooter and E-Bike Device Codes to Police Crash Data and Guidance

For e-scooter and e-bike safety, being proactive about implementing a Safe System approach begins with standardized data coding. Establishing a common understanding of what constitutes an e-scooter or e-bike crash or fatality and consistently coding those instances in collected data improves not only the accuracy of that data but also our understanding of these potential safety issues.

4.1.1 E-Scooter and E-Bike Police Crash Data

The NTSB found that at least 119 fatalities involving e-scooters and e-bikes have occurred in the United States between January 1, 2017, and December 31, 2021.[30] That estimate included 66 e-scooter-related fatalities and 53 e-bike-related fatalities. The NTSB then compared its results with widely cited estimates to assess the precision of current methods, finding that current methods have led to inconsistent and incomplete fatality statistics in available data.[31]

Motor vehicle crashes involving vulnerable road users, like e-scooter and e-bike riders, are underreported in police records, which is a widely known problem (Venkatraman and others 2021; Cherry and others 2018). Because of FARS' importance and widespread use, cases not found in FARS highlight potential

[30] This number of fatalities is reflective of the available data the NTSB could collect and analyze as of May 2022.

[31] (a) These methods included using web searches of news media to find cases where an e-bike or e-scooter fatality occurred as well as using existing data sources to supplement this analysis. See section 3.1 of this report for further discussion. (b) The CPSC notes that its data are incomplete (CPSC 2021b).

deficiencies in the nonstandard methods used to identify e-scooter and e-bike fatalities. The NTSB found examples of this underreporting in its own analysis.[32]

The NTSB's determination that there were at least 119 fatalities involving e-scooter and e-bike riders between 2017 and 2021 differs from other current published estimates. The differences between the NTSB's independent analysis and existing data also highlight issues that point to possible over or underestimation of e-scooter and e-bike fatalities. This further underscores the need for better quality data collection and standardization. Therefore, the NTSB concludes that at least 119 e-scooter and e-bike fatalities occurred between 2017 and 2021; however, because the crash data are not standardized, they do not provide a robust representation of e-scooter and e-bike safety.

4.1.2 E-Scooter and E-Bike Police Crash Data Guidance

Effective monitoring of traffic safety issues relies on consistent, timely, and accurate police crash reports. Data captured in these crash reports are aggregated into state crash data. There is no national standard for state crash data. However, NHTSA and the Governors Highway Safety Association (GHSA) jointly publish a voluntary guideline, known as the *MMUCC*, that represents a minimum model set of variables (data elements) that describe a motor vehicle traffic crash.[33]

The *MMUCC* guideline identifies a minimum set of data elements and their attributes that states should consider collecting and including in their state crash data system. The *MMUCC* fifth edition was the result of an 18-month collaboration between NHTSA, the FHWA, the Federal Motor Carrier Safety Administration, the GHSA, and subject matter experts from state departments of transportation, local law enforcement, emergency medical services, safety organizations, industry partners, and academia. The traffic records community and the general public also contributed through external forums, such as the annual Traffic Records Forum organized by the Association of Transportation Safety Information Professionals.

The *MMUCC* fifth edition was published in 2017 and does not include data elements that capture persons using micromobility devices, such as e-scooters and e-bikes. The *MMUCC* internal review team, comprised of NHTSA, FHWA, and Federal Motor Carrier Safety Administration employees, has recognized that there is an immediate need to address inconsistent police crash reporting involving

[32] Further discussion of the comparisons between the NTSB's analysis and cases found in FARS appear in section 3.1 and appendix B.

[33] See NHTSA's webpage "*MMUCC Model Minimum Uniform Crash Criteria–5th Edition*" for more information.

micromobility device users. As a result, the *MMUCC* is currently undergoing an extensive review and restructuring before the release of the sixth edition, including proposed changes to improve the ability to assess nonfatal injuries, fatalities, and risk among e-scooter, e-bike, and other micromobility device users.

The proposed changes include adding data elements for e-scooters and e-bikes in the “nonmotorist” section of the *MMUCC*. These proposed changes would allow for police crash reports to record a crash involving an e-scooter or an e-bike on public roads (National Center for Statistics and Analysis 2022). This would not only improve the collection of data in police crash reports but also allow for linkage to injury surveillance and other postcrash data (Cherry and others 2021).

The *MMUCC* is widely regarded as the national standard for state crash data collection. In fact, NHTSA requires states to confirm that they are making progress towards meeting *MMUCC* guidelines before NHTSA grants are recertified (see the IIJA). Given the importance of the *MMUCC*, along with the noted growth of e-scooters and e-bikes navigating the road, the *MMUCC* will serve as a guide for many states hoping to comply with the requirements of the IIJA. However, because the *MMUCC* is currently undergoing extensive review and restructuring and the next edition of the *MMUCC* will not be published until 2024, there is the potential for subsequent revisions, and thus no guarantee that the final publication of the *MMUCC* will include the current data element changes proposed to include information on e-scooter and e-bike involved crashes.

The adoption of the proposed changes is critical to improving the data collected through police crash reports, which in turn will improve state and national traffic fatality and injury data. That improved data collection would enhance the ability of transportation safety professionals to assess crash prevalence and risk factors involving these devices. Further, provisions in the IIJA that are relevant to the NTSB’s e-scooter and e-bike data concerns noted in this report also affirm that the proposed changes to the *MMUCC* should be made. Consequently, the failure to include data elements in the *MMUCC* for e-scooters and e-bikes would undermine the crash and injury data improvements outlined in the IIJA.

The NTSB concludes that the proposed updates to the *MMUCC* adding data elements for e-scooters and e-bikes will substantially improve the collection of data, thereby allowing for the assessment of prevalence and risk related to e-scooter and e-bike fatalities and injuries. Therefore, the NTSB recommends that NHTSA and the GHSA work together to ensure that revisions to the *MMUCC* include data elements for e-scooters and e-bikes.

NHTSA is responsible for programs aimed at reducing fatalities and serious injuries on public roads in the United States. It collects and analyzes police crash report data and other data from states to support transportation safety research and provide technical expertise and guidance on the design and implementation of evidence-based countermeasures. NHTSA also produces the biennial report *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices*, which is widely used by states in their highway safety plans (Venkatraman and others 2021). In fact, a 2021 review by the Government Accountability Office found that 38 of 52 state highway safety plans cited NHTSA's report as a resource used to inform the selection of projects for NHTSA grants (GAO 2021).

Through discussions with stakeholders and other experts in the field, the NTSB understands that efforts are underway at the state level to improve police crash data and better identify crashes involving e-bikes, e-scooters, and other vulnerable road users in national databases like FARS.[34] However, the IIJA does not include a provision for the analysis of the unique safety risks among the vulnerable road users added to data collection standards, specifically e-scooter and e-bike riders. NHTSA itself acknowledges that these differences likely exist, as noted in its most recent publication of *Countermeasures that Work.* For example, NHTSA notes that motorcyclists likely need different strategies than road users who ride low-powered e-bikes (Venkatraman and others 2021). The data collection requirements of the IIJA provide an opportunity to analyze new data about the heterogeneous nature of the vulnerable road user population.

Therefore, the NTSB concludes that the new data collection requirements of the IIJA will aid in the analysis of data specific to e-scooter and e-bike crashes and the development of evidence-based safety countermeasures that account for risks unique to e-scooter and e-bike riders as a part of the wider vulnerable road user population. Therefore, the NTSB recommends that NHTSA, using the new data collection requirements in the IIJA, update *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices* to include analysis of e-scooter and e-bike rider data and provide strategies to increase e-scooter and e-bike rider safety, similar to what is already published for other vulnerable road users, like pedestrians and bicyclists. After satisfying the requirements of the IIJA at the end of 2024, the NTSB believes it will be feasible for NHTSA to analyze and report findings from newly retrieved e-scooter and e-bike rider data in *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices*, which is typically updated every other year.

[34] These improvements should be implemented by 2024, as specified by the IIJA.

4.2 Need for E-Bike-Specific Coding in Injury Surveillance Data and Guidance

To implement the IIJA while using a Safe Systems approach, data standardization and data linkage between crash and injury surveillance data are necessary. Data standardization is a key component of the Safe System approach, especially concerning the ability to link crash and injury surveillance data, which are pivotal to improving safety. Because of the limited scope of e-scooter and e-bike data sources, implementing standardized codes into crash and injury surveillance data will allow transportation safety professionals to have a more accurate understanding of the risks faced by vulnerable road users who use micromobility devices, and to link injury surveillance data to police crash data, when device codes are aligned (Waller 2019).

4.2.1 CPSC NEISS Data

NEISS data are currently the only available source for national injury estimates. The NTSB found that NEISS data from 2017 to 2019 contained many inaccuracies related to using the correct product codes to record e-scooters and e-bikes. This was likely due to the lack of separate codes for different types of micromobility devices and to the *NEISS Coding Manual* encouraging users of the data to categorize dissimilar devices within the same code. From 2017 to 2019, this practice led to a lack of classification for e-scooters and continues to be a problem for e-bikes.

The NTSB recognizes that the CPSC remedied this problem by including a new product code specific to e-scooters in 2020. As a result, the accuracy of e-scooter identification in NEISS data, through the use of product codes, rose to almost 100% in 2020 and 2021, compared with 22% in 2017. The introduction of this separate product code led to improvements in data accuracy and helped eliminate the need to employ keyword searches that may not detect all relevant injury cases. However, because the product code within which e-bikes are found is still dominated by mopeds, the results do not reflect the most accurate injury trends related to e-bike crashes.

Much like the issues the NTSB encountered when attempting to estimate e-scooter and e-bike fatalities, methods required for deriving injury estimates have accuracy and precision challenges.[35] The CPSC itself was also unable to produce

[35] See appendix C.

2020 estimates related to e-bikes, citing too much variability in its data.[36] The NTSB experienced the same difficulties producing e-bike injury estimates, due in part to e-bikes being categorized with other device types. However, the problem could be mitigated by introducing more specificity to the data.

The CPSC's NEISS data represent the only source of national estimates of injuries involving micromobility devices like e-scooters and e-bikes. The NTSB strongly believes that the lack of explicit product codes to distinguish e-bikes from mopeds is undermining the usefulness of e-bike national injury estimates, especially given evidence that greater specificity in coding yields more reliable results, as seen in the case of the specific product code added for e-scooters (CPSC 2020). To determine e-bike injury trends and improve our understanding of how to prevent e-bike injuries, a separate code for these devices is necessary to help aid in the proper reporting of e-bike-related injuries. The NTSB concludes that the addition of a NEISS product code for e-scooters improved injury data accuracy, but the lack of a specific NEISS product code for e-bikes limits the ability to develop national injury estimates for these devices. Therefore, the NTSB recommends that the CPSC include an explicit product code for e-bikes in NEISS.

4.2.2 International Classification of Disease, Tenth Revision, Clinical Modification

Injury surveillance data are necessary to monitor safety issues involving road users that are not adequately captured in police crash reports. Hospitals primarily rely on the International Classification of Disease, Tenth Revision, Clinical Modification (ICD-10-CM) classification and coding procedures to capture injury diagnostic information. The Centers for Disease Control and Prevention's NCHS maintains the ICD-10-CM.[37]

In October 2020, the ICD-10-CM was modified to include an external cause code for e-scooters. Currently, e-scooter rider injuries are categorized under pedestrian conveyance accidents. In September 2021, the ICD-10-CM committee was made aware of the need for an external cause code specific to e-bikes at the ICD-10-CM Coordination and Maintenance Committee meeting, where several

[36] Searches conducted for product code 3215—the code suggested in the *NEISS Coding Manual* for e-bike but also the code used for moped and many other devices—through the NEISS online query system did not return estimates for 2020. When the NTSB sought to validate the results, the CPSC confirmed estimates for this product code could not be produced because the coefficient of variation was above 33%, meaning that there is too much variability to provide an accurate estimate, and further hinting at the need to separate out device types contained within this product code.

[37] See the NCHS's webpage "International Classification of Diseases, Tenth Revision (ICD-10)" for more information.

organizations, including medical, academic, and professional safety institutions, proposed adding a code for e-bikes given its importance (CDC 2021).[38] This proposal was approved, and an external cause code for e-bikes will be available with the 2023 release of the ICD-10-CM (CDC 2022). Although e-scooter and e-bike riders share many similarities, especially in the shared micromobility space, the 2023 release of the ICD-10-CM will categorize e-bike riders as a subset of motorcycle riders, unlike e-scooter riders who are categorized as a subset of pedestrians.

Classifying e-bike riders as a subset of motorcycle riders in the ICD-10-CM will hinder understanding of the distinct safety issues associated with e-bikes compared to motorcycles. E-bikes and motorcycles are regulated differently, have different average speeds, operate on different parts of the public right-of-way, and attract different ridership. Without a coding system that distinguishes e-bikes from motorcycles, injuries associated with e-bikes will continue to be misclassified, impeding an accurate assessment of injury occurrence, risk factors, and potential protective factors related to e-bikes.

Further, although data users may be able to isolate e-bikes during the data retrieval process, the NCHS's proposed coding structure problematically groups e-bikes under the broader category of motorcycles, giving the impression that they are more similar than they are different. Additionally, because one aspect of data improvement is the ability to link data, classifying e-bikes under the category of motorcycles, when other datasets do not, may impede the ability of data users when attempting to analyze these data across datasets. Thus, although the 2023 inclusion of e-bike coding in the ICD-10-CM is an important step, it is insufficient for improving our understanding of specific issues related to e-bike safety.

E-bike use is expanding at an unprecedented rate, and injuries associated with e-bikes will also likely increase. Recent and forthcoming changes to the ICD-10-CM include external cause codes for e-scooters and e-bikes, but e-bike riders will be classified as a subset of motorcycle riders. However, proposed changes to other data guidance used to assess characteristics of injuries and fatalities associated with crashes, such as the *MMUCC*, use a framework that captures riders of e-scooters and e-bikes as persons on personal conveyances, with more detailed categorization

[38] Those presenters included the University of North Carolina's Highway Safety Research Center; Vision Zero San Francisco Injury Prevention Research Collaborative and Zuckerberg San Francisco General Hospital and Trauma Center and San Francisco Department of Public Health; the University of Tennessee, Knoxville, Department of Civil and Environmental Engineering; the University of California, Davis, Institute of Transportation Studies; the American College of Surgeons, the Committee on Trauma, Injury Prevention and Control; and the Portland State University, Transportation Research and Education Center.

indicating the specific micromobility device type.[39] NHTSA's *Guide to Updating State Crash Data Systems* provides examples of how states can best align their crash data with *MMUCC* guidelines to improve standardization in crash data collection, linkage, and analysis (Brown and others 2021). Further, in NHTSA's *Guide to Updating State Crash Data Systems*, data linkage is defined as "the connections established by matching at least one data element from a record in one file with the corresponding element or elements in one or more records in another file or files" (Brown and others 2021). The 2023 modifications to the ICD-10-CM, which include an external cause code for e-bikes, will still make data linkage difficult because the data coding structure for e-bikes does not match the structure of the *MMUCC* and thus deviates from the structuring and data linkage recommendations provided by NHTSA. Therefore, the NTSB concludes that classifying e-bike riders as a subset of motorcycle riders in the 2023 release of the ICD-10-CM limits the ability of analysts to accurately link injury details from emergency services and hospitals to crash data. Therefore, the NTSB recommends that the NCHS use data structuring that defines e-bike riders as nonmotorists in the ICD-10-CM, in alignment with current classifications used in crash data guidance.

4.3 Need for E-Scooter and E-Bike Trip Data to Assess Injury and Fatality Risk

A Safe System approach necessitates systems-level access to e-scooter and e-bike trip data. That is, to prioritize a human-centered transportation system, we have to prioritize access to aggregate data about how humans, in this instance e-scooter and e-bike riders, are operating within the broader transportation system. However, these data for e-scooters and e-bikes are not being systematically collected at the federal or state level in the United States.

According to the US Department of Transportation, the proactive identification and mitigation of risks is a core principle of its Safe System approach to eliminating fatal and serious injuries for all road users in the United States (DOT 2022). However, effective risk management is a continuous process, and safety improvements depend on influencing risk factors that affect the likelihood of harmful outcomes.

National trip data estimates for e-scooter and e-bikes are needed to accurately characterize safety trends and evaluate crash and injury risk factors. For example, measures like trip counts, mileage, and duration, and the number of devices being operated on public rights-of-way can be used to calculate rates like yearly crashes,

[39] These proposed changes to *MMUCC* data elements also include updating the definition of personal conveyance as follows: "a device, other than a transport device, used by a pedestrian for personal mobility assistance or recreation. These devices can be motorized or human powered, excluding nonmotorized bicycles" (*MMUCC* Internal Review Team 2021).

fatalities, and nonfatal injuries per trip. In addition to calculating crash and injury rates and estimating risk, transportation safety professionals also use trip data to evaluate roadway and other infrastructure needs, assess the effectiveness of safety countermeasures, and develop new legislation and sources of funding.

4.3.1 E-Scooter and E-Bike Trip Data Collection Guidance and Reporting

The Traffic Monitoring System, overseen by the FHWA's Office of Highway Policy Information, has national programs to track traffic trends. These programs include the collection and analysis of traffic data directly from state departments of transportation, which are used to meet data requirements in federal highway legislation.[40] Further, the FHWA's Office of Highway Policy Information also publishes the *Traffic Monitoring Guide* (*TMG*), a guide on the collection of traffic data, where guidance concerning the collection of trip data for e-scooters and e-bikes could be incorporated. As e-scooter and e-bike devices become more popular, reliable and standardized data will become especially important, given the yearly growth in ridership.

As part of the requirements of Title 23 *CFR* Part 500, subpart B, all 50 states must have a traffic management system for collecting traffic activity data, such as trip data, as well as a system for submitting that data to the FHWA. To report the data effectively, states must follow the guidance and data formats prescribed in the FHWA's *TMG* (FHWA 2016). The *TMG* covers both motorized and nonmotorized traffic monitoring and provides technical information on methods, data formats, and data processing, as well as information about how to submit data to the FHWA to fulfill the requirements of the federal aid highway program.

The *TMG* is reviewed and updated as new legislation is enacted or when new technologies or transportation business practices emerge. Although there are current proposed changes relevant to the collection of trip data for e-scooters and e-bikes, including revising the definition of nonmotorized travel to include e-scooter and e-bike trip data, as well as providing methods for collection of trip data from rental operators (FHWA 2021), there is still no current or official guidance for states to collect and report e-scooter or e-bike trip data to the FHWA, as is done for other vulnerable road users like pedestrians, bicyclists, and motorcyclists.

[40] See the FHWA's "Travel Monitoring and Traffic Volume" webpage for a broader overview of the FHWA's traffic data collection program.

Thus, the NTSB concludes that including e-scooters and e-bikes in the 2022 *TMG* is a critical first step toward capturing trip data associated with these devices. The NTSB further concludes that to improve evaluation of e-scooter and e-bike safety trends and risks within the wider transportation network and to produce safety countermeasures, providing states with guidance on the collection of e-scooter and e-bike trip data, specifically vehicle miles traveled and traffic volume trends, is imperative.

Trip data from e-scooters and e-bikes are not being aggregated at the federal level. Fortunately, there are systems in place that allow for the collection of such data, in the form of the FHWA's Traffic Monitoring System, which uses vehicle miles traveled to produce its *Traffic Volume Trends* report.[41] Even though the FHWA has been collecting and reporting traffic volume trends for pedestrians and bicyclists for years, the FHWA does not have a program that allows for the easy transmission of trip data from e-scooters and e-bikes to the federal government, which hinders evaluation of the safety of e-scooters and e-bikes.

The NTSB concludes that the collection of trip data, such as vehicle miles traveled and traffic volume trends, for e-scooters and e-bikes is an essential step toward assessing the risks associated with riding e-scooters and e-bikes. Therefore, the NTSB recommends that the FHWA implement a program to acquire from states annual trip counts and miles traveled from e-scooters and e-bikes, and to make the aggregate data publicly available in its monthly *Traffic Volume Trends* report for estimating crash, serious injury, and fatality rates. The NTSB further recommends that the FHWA revise its *TMG* to include technical guidance on the collection of aggregate trip data from e-scooters and e-bikes.

4.4 Summary of E-Scooter and E-Bike Data Challenges

To conduct this research, the NTSB had to rely on a mix of methods, such as text mining news reports and cross-checking information with other nonstandardized data sources because comprehensive quality data are not available for e-scooters and e-bikes. Although the results were not ideal, they provided the NTSB with high-level insights about e-scooter and e-bike rider fatalities and nonfatal injuries from the data we could obtain.

Use of e-scooters and e-bikes is increasing as are fatalities and injuries associated with their use. We could identify 119 reported fatalities resulting from crashes involving e-scooters and e-bikes between 2017 and 2021, and that is likely an underestimation. As evidenced in this report, attempts at approximating safety prevalence and risk within the emergent micromobility industry tend to yield

[41] See the FHWA's webpage on "Traffic Volume Trends" for more information.

variability in the data that leads to an inability to accurately determine how to best improve safety.

The foundation of a Safe System approach is knowing who is using our roadways and how, so that we might better protect them. From a data perspective, the best way to improve safety for vulnerable road users who ride micromobility devices is to ensure that crashes, injuries, and fatalities are recorded accurately. Data derived from these records provide needed information about the device, operator, and operating environment to determine the best evidence-based countermeasures and interventions that improve the safety of e-scooter and e-bike riders. The FHWA states that “safety is proactive,” meaning that rather than reacting after a crash occurs, transportation agencies should use data-driven tools to preemptively assess underlying risks in the system and provide countermeasures to reduce those risks (FHWA 2022). For assessing the safety of e-scooters and e-bikes, one of the underlying risks in the system is the inability to produce standardized and reliable fatality and injury statistics, upon which countermeasures are based. This report proactively addresses issues in the existing data so that future countermeasures developed for e-scooter and e-bike riders are accurate and effective.

5. Conclusions

5.1 Findings

1. Although the existing scientific literature indicates an increase in the use of electric scooters and electric bicycles as well as an increase in electric scooter and electric bicycle rider fatalities and injuries, better quality data, efficient research methods, and replicable results are needed to improve our understanding of electric scooter and electric bicycle safety.

2. At least 119 electric scooter and electric bicycle fatalities occurred between 2017 and 2021; however, because the crash data are not standardized, they do not provide a robust representation of electric scooter and electric bicycle safety.

3. The proposed updates to the *Model Minimum Uniform Crash Criteria* adding data elements for electric scooters and electric bicycles will substantially improve the collection of data, thereby allowing for the assessment of prevalence and risk related to electric scooter and electric bicycle fatalities and injuries.

4. The new data collection requirements of the Infrastructure Investment and Jobs Act will aid in the analysis of data specific to electric scooter and electric bicycle crashes and the development of evidence-based safety countermeasures that account for risks unique to electric scooter and electric bicycle riders as a part of the wider vulnerable road user population.

5. The addition of a National Electronic Injury Surveillance System (NEISS) product code for electric scooters improved injury data accuracy, but the lack of a specific NEISS product code for electric bicycles limits the ability to develop national injury estimates for these devices.

6. Classifying electric bicycle riders as a subset of motorcycle riders in the 2023 release of the International Classification of Disease, Tenth Revision, Clinical Modification limits the ability of analysts to accurately link injury details from emergency services and hospitals to crash data.

7. Including electric scooters and electric bicycles in the 2022 *Traffic Monitoring Guide* is a critical first step toward capturing trip data associated with these devices.

8. To improve evaluation of electric scooter and electric bicycle safety trends and risks within the wider transportation network and to produce safety countermeasures, providing states with guidance on the collection of electric scooter and electric bicycle trip data, specifically vehicle miles traveled and traffic volume trends, is imperative.

9. The collection of trip data, such as vehicle miles traveled and traffic volume trends, for electric scooters and electric bicycles is an essential step toward assessing the risks associated with riding electric scooters and electric bicycles.

6. Recommendations

6.1 New Recommendations

As a result of this research, the National Transportation Safety Board makes the following new safety recommendations.

To the National Highway Traffic Safety Administration:

> Work with the Governors Highway Safety Association to ensure that revisions to the *Model Minimum Uniform Crash Criteria* include data elements for electric scooters and electric bicycles. (H-22-26)
>
> Using the new data collection requirements in the Infrastructure Investment and Jobs Act, update *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices* to include analysis of electric scooter and electric bicycle rider data and provide strategies to increase electric scooter and electric bicycle rider safety, similar to what is already published for other vulnerable road users, like pedestrians and bicyclists. (H-22-27)

To the Federal Highway Administration:

> Implement a program to acquire from states annual trip counts and miles traveled from electric scooters and electric bicycles, and to make the aggregate data publicly available in your monthly *Traffic Volume Trends* report for estimating crash, serious injury, and fatality rates. (H-22-28)
>
> Revise the *Traffic Monitoring Guide* to include technical guidance on the collection of aggregate trip data from electric scooters and electric bicycles. (H-22-29)

To the US Consumer Product Safety Commission:

> Include an explicit product code for electric bicycles in the National Electronic Injury Surveillance System. (H-22-30)

To the National Center for Health Statistics:

> Use data structuring that defines electric bicycle riders as nonmotorists in the International Classification of Disease, Tenth Revision, Clinical Modification, in alignment with current classifications used in crash data guidance. (H-22-31)

To the Governors Highway Safety Association:

> Work with the National Highway Traffic Safety Administration to ensure that revisions to the *Model Minimum Uniform Crash Criteria* include data elements for electric scooters and electric bicycles. (H-22-32)

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Appendixes

Appendix A: Overview of Data Sources

The following table provides an overview of the data sources used in this report.

Table A-1. Overview of data sources used in this report.

Name of Data Source	Collected From	United States	Fatal Crashes	Nonfatal Crashes	Injury Details	Report Use	Time Period
Fatality Analysis Reporting System (FARS), National Highway Traffic Safety Administration (NHTSA)	Police crash reports of fatal motor vehicle traffic crashes on US public roads	Yes	Yes (census)	No	No	Descriptive comparison to NTSB's independent analysis	2017–2020
National Electronic Injury Surveillance System (NEISS), US Consumer Product Safety Commission (CPSC)	Patient narratives for every emergency visit involving an injury associated with consumer products, taken from a sample of 100 US hospitals	Yes	No	Yes	Yes (diagnoses, dispositions, injury levels, case narratives; given the word count for narratives, data may not have captured all details)	Descriptive analysis of utility of NEISS coding	2017–2021
Consumer Product Safey Risk Management System (CPSRMS), CPSC	Various sources, including consumer complaints, news clips, state and local authorities, medical examiners, national death certificates, manufacturers, and retailers, among others; anecdotal, not nationally representative	Yes	Yes	No	Yes (data were collected from sources that may not have captured all details)	Descriptive comparison to NTSB's independent analysis	2017–2019

Name of Data Source	Collected From	United States	Fatal Crashes	Nonfatal Crashes	Injury Details	Report Use	Time Period
Collaborative Sciences Center for Road Safety (CSCRS) E-Scooter Fatality Database	Various sources, including incidents retrieved from media reports, emergency department data, and police calls or collision reports; e-scooter fatalities only	Yes (international cases are also included in the database, but were excluded for the purposes of NTSB's analysis)	Yes	No	Yes (data were collected from sources that may not have captured all details)	Descriptive comparison to NTSB's independent analysis	2017–2021
NTSB's Independent Analysis	News media reports published on the internet, which were then compared to and merged with other published data sources (FARS, NEISS, CPSRMS, CSCRS)	Yes	Yes	Yes	Yes (data were derived from sources that may not have captured all injury details, including CSCRS, CPSMRS, FARS, and news reports)	Analysis of e-scooter and e-bike crashes, fatalities, and injuries in the United States between 2017 and 2021, derived from news reports	2017–2021

Appendix B: Comparison of E-Scooter and E-Bike Fatalities Found in NTSB's Independent Analysis with Existing Data Sources

Table B-1. Comparison of e-scooter and e-bike fatalities found in NTSB's independent analysis with existing data sources.

Found by NTSB	Year	Device	City	State	CSCRS	CPSC CPSRMS	NHTSA FARS
1	2017	E-scooter	Rancho Cordova	CA	Yes	Yes	Yes
2	2017	E-bike	Lower Southhampton	PA	n/a	Yes	Yes
3	2018	E-scooter	Unknown	CA	Yes	Yes	No
4	2018	E-scooter	Cleveland	OH	Yes	No	Yes
5	2018	E-bike	Unknown	PA	n/a	Yes	No
6	2018	E-scooter	Chula Vista	CA	Yes	Yes	Yes
7	2018	E-bike	Danville	CA	n/a	Yes	No
8	2018	E-scooter	Unknown	Unknown	Yes	Yes	No
9	2018	E-bike	Stanton	CA	n/a	Yes	Yes
10	2018	E-bike	Tuscon	AZ	n/a	Yes	Yes
11	2018	E-scooter	Dallas	TX	Yes	Yes	No
12	2018	E-scooter	Washington	DC	Yes	Yes	Yes
13	2018	E-bike	Tuolumne City	CA	n/a	Yes	Yes
14	2019	E-scooter	Fort Lauderdale	FL	Yes	Yes	Yes
15	2019	E-scooter	Hollywood	CA	Yes	Yes	No
16	2019	E-scooter	Tulsa	OK	Yes	No	Yes
17	2019	E-scooter	Denver	CO	Yes	Yes	Yes
18	2019	E-scooter	East Point	GA	Yes	Yes	Yes
19	2019	E-scooter	Hartford	CT	Yes	No	No
20	2019	E-bike	Manhattan	NY	n/a	Yes	No
21	2019	E-scooter	Austin	TX	Yes	Yes	Yes
22	2019	E-bike	Brooklyn	NY	n/a	Yes	Yes

Found by NTSB	Year	Device	City	State	CSCRS	CPSC CPSRMS	NHTSA FARS
23	2019	E-scooter	Atlanta	GA	Yes	No	Yes
24	2019	E-scooter	New Haven	CT	Yes	Yes	No
25	2019	E-scooter	Atlanta	GA	Yes	Yes	Yes
26	2019	E-scooter	Tampa	FL	Yes	Yes	Yes
27	2019	E-scooter	San Diego	CA	Yes	Yes	No
28	2019	E-bike	Manhattan	NY	n/a	No	Yes
29	2019	E-scooter	San Diego	CA	Yes	Yes	No
30	2019	E-scooter	Santa Monica	CA	Yes	No	No
31	2019	E-scooter	Key West	FL	Yes	Yes	No
32	2019	E-scooter	Unknown	GA	Yes	Yes	No
33	2019	E-scooter	Unknown	FL	Yes	Yes	No
34	2019	E-scooter	Nashville	TN	Yes	No	Yes
35	2019	E-scooter	Atlanta	GA	Yes	Yes	Yes
36	2019	E-bike	Anaheim	CA	n/a	Yes	Yes
37	2019	E-scooter	Lexington	KY	Yes	Yes	Yes
38	2019	E-scooter	Elizabeth	NJ	Yes	No	Yes
39	2019	E-scooter	Spokane	WA	Yes	Yes	Yes
40	2019	E-scooter	Unknown	AZ	No	Yes	No
41	2019	E-scooter	Boise	ID	Yes	Yes	Yes
42	2019	E-bike	Brooklyn	NY	n/a	Yes	Yes
43	2019	E-bike	Penn Township	PA	n/a	Yes	Yes
44	2020	E-bike	Bronx	NY	n/a	No data	No
45	2020	E-bike	Stillwater	MN	n/a	No data	No
46	2020	E-bike	Northfield	MN	n/a	No data	No
47	2020	E-bike	Brooklyn	NY	n/a	No data	Yes
48	2020	E-bike	Brooklyn	NY	n/a	No data	No
49	2020	E-bike	San Jose	CA	n/a	No data	No

Found by NTSB	Year	Device	City	State	CSCRS	CPSC CPSRMS	NHTSA FARS
50	2020	E-scooter	Fairfax	CA	Yes	No data	Yes
51	2020	E-scooter	Salt Lake City	UT	Yes	No data	No
52	2020	E-bike	Manhattan	NY	n/a	No data	Yes
53	2020	E-bike	Manhattan	NY	n/a	No data	Yes
54	2020	E-scooter	Jersey City	NJ	Yes	No data	Yes
55	2020	E-scooter	Denver	CO	Yes	No data	Yes
56	2020	E-scooter	Great Neck Estates	NY	Yes	No data	No
57	2020	E-scooter	Louisville	KY	No	No data	Yes
58	2020	E-bike	Bronx	NY	n/a	No data	No
59	2020	E-bike	Chicago (Lakeview)	IL	n/a	No data	Yes
60	2020	E-bike	Bronx	NY	n/a	No data	No
61	2021	E-scooter	Austin	TX	Yes	No data	No data
62	2021	E-scooter	Salt Lake City	UT	Yes	No data	No data
63	2021	E-bike	Bronx	NY	n/a	No data	No data
64	2021	E-bike	Manhattan	NY	n/a	No data	No data
65	2021	E-bike	Brooklyn	NY	n/a	No data	No data
66	2021	E-scooter	Iron Mountain	MI	Yes	No data	No data
67	2021	E-scooter	Brooklyn	NY	No	No data	No data
68	2021	E-scooter	Caldwell	ID	No	No data	No data
69	2021	E-bike	Easton	PA	n/a	No data	No data
70	2021	E-bike	Shelter Island	NY	n/a	No data	No data
71	2021	E-bike	Gainesville	VA	n/a	No data	No data
72	2021	E-bike	Bronx	NY	n/a	No data	No data
73	2021	E-bike	Manhattan	NY	n/a	No data	No data
74	2021	E-bike	Honolulu	HI	n/a	No data	No data
75	2021	E-scooter	Roseburg	OR	Yes	No data	No data

Found by NTSB	Year	Device	City	State	CSCRS	CPSC CPSRMS	NHTSA FARS
76	2021	E-bike	South San Francisco	CA	n/a	No data	No data
77	2021	E-scooter	Denver	CO	Yes	No data	No data
78	2021	E-bike	Brooklyn	NY	n/a	No data	No data
79	2021	E-bike	Bronx	NY	n/a	No data	No data
80	2021	E-bike	Madeira Beach	FL	n/a	No data	No data
81	2021	E-bike	Santa Cruz	CA	n/a	No data	No data
82	2021	E-scooter	Long Beach	CA	Yes	No data	No data
83	2021	E-scooter	Tampa	FL	Yes	No data	No data
84	2021	E-bike	Bronx	NY	n/a	No data	No data
85	2021	E-bike	Manhattan	NY	n/a	No data	No data
86	2021	E-bike	Walnut Creek Township	OH	n/a	No data	No data
87	2021	E-bike	San Diego	CA	n/a	No data	No data
88	2021	E-scooter	Homestead (SW Miami-Dade)	FL	Yes	No data	No data
89	2021	E-scooter	Bronx	NY	Yes	No data	No data
90	2021	E-scooter	Denver	CO	Yes	No data	No data
91	2021	E-bike	Crosby	TX	n/a	No data	No data
92	2021	E-scooter	Fort Lauderdale	FL	Yes	No data	No data
93	2021	E-scooter	San Jose	CA	No	No data	No data
94	2021	E-scooter	Portland	OR	Yes	No data	No data
95	2021	E-scooter	Grand Rapids	MI	Yes	No data	No data
96	2021	E-scooter	Queens	NY	No	No data	No data
97	2021	E-scooter	Venice	CA	Yes	No data	No data
98	2021	E-bike	Queens	NY	n/a	No data	No data
99	2021	E-bike	Cincinnati	OH	n/a	No data	No data
100	2021	E-bike	Queens	NY	n/a	No data	No data
101	2021	E-scooter	St Petersburg	FL	Yes	No data	No data

Found by NTSB	Year	Device	City	State	CSCRS	CPSC CPSRMS	NHTSA FARS
102	2021	E-scooter	Las Vegas	NV	No	No data	No data
103	2021	E-scooter	Northwest Jacksonville	FL	Yes	No data	No data
104	2021	E-bike	Laguna Beach	CA	n/a	No data	No data
105	2021	E-scooter	Nashville	TN	Yes	No data	No data
106	2021	E-scooter	Brooklyn	NY	Yes	No data	No data
107	2021	E-scooter	Bronx	NY	No	No data	No data
108	2021	E-scooter	Oakland	CA	Yes	No data	No data
109	2021	E-bike	Bronx	NY	n/a	No data	No data
110	2021	E-bike	Queens	NY	n/a	No data	No data
111	2021	E-bike	Queens	NY	n/a	No data	No data
112	2021	E-bike	Pennsville Township	NJ	n/a	No data	No data
113	2021	E-scooter	Hartford	CT	Yes	No data	No data
114	2021	E-scooter	Austin	TX	Yes	No data	No data
115	2021	E-scooter	San Diego	CA	Yes	No data	No data
116	2021	E-scooter	Bowie	MD	Yes	No data	No data
117	2021	E-bike	Manhattan	NY	n/a	No data	No data
118	2021	E-bike	San Juan Capistrano	CA	n/a	No data	No data
119	2021	E-bike	Brooklyn	NY	n/a	No data	No data

Note: (a) In this table, n/a means "not applicable" and indicates the data for the device in question were not collected by the listed source; no data indicates that the source did not include data for the years listed. (b) In this table, CSCRS denotes the Collaborative Sciences Center for Road Safety's continuously updated list of e-scooter fatalities; CPSC CPSRMS denotes the US Consumer Product Safety Commission's Consumer Product Safety Risk Management System, which records e-scooter and e-bike fatalities; and NHTSA FARS denotes the National Highway Traffic Safety Administration's Fatality Analysis Reporting System.

Appendix C: Narrative Keyword Searches of NEISS

The NEISS online query system allows users to download data from NEISS for specific variables. The CPSC recommends that users consult the *NEISS Coding Manual* to identify the correct code for the product they hope to analyze. The coding manual is used by NEISS hospitals and contains descriptions of reporting criteria and definitions of current product codes. Because product codes change frequently, the CPSC also recommends using the Product Code Comparability Table to ensure that analysis reflects the most up-to-date coding.[42]

For the purposes of this report, data were retrieved for the past 5 years using the NEISS online query system. Using the coding manual and code comparability table, code 3215 was used to retrieve records for e-bike injuries treated in emergency departments. Because updates have occurred for e-scooters, there were two different product codes used to retrieve results for e-scooters. Code 5042 was used for years 2017–2019, and code 5022 was used for years 2020–2021.

NEISS records include physicians' notes taken as part of patient intake evaluations; these notes were text mined using keywords to search for events that fit the definition of an e-scooter or e-bike for the period 2017–2021. The narratives searched were from cases that had the following product codes:[43]

- 3215—mopeds and power-assisted cycles (years 2017–2021)
- 5042—self-balancing scooters, skateboards, and powered scooters (years 2017–2019)
- 5022—powered scooters (years 2020–2021)

Consistent with previous studies looking at nonfatal injury patterns related to e-scooters and e-bikes (Aizpuru and others 2019; Farley and others 2020; Trivedi and others 2019), the narratives were reviewed to identify patterns. From that, the following list of keywords was created and applied to the data:

- electric
- electric scooter
- motorized
- motorized scooter

[42] See the "Instructions for Using the NEISS Estimates Query Builder" for more information.

[43] NEISS product codes and their definitions were taken from the 2017, 2018, 2019, 2020, and 2021 *NEISS Coding Manuals*.

- motorized bike
- motorized bicycle

The following additional keywords were applied to exclude data that did not meet the definition of an e-scooter or an e-bike:

- moped
- minibike
- motorbike
- motor bike
- wheelchair

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