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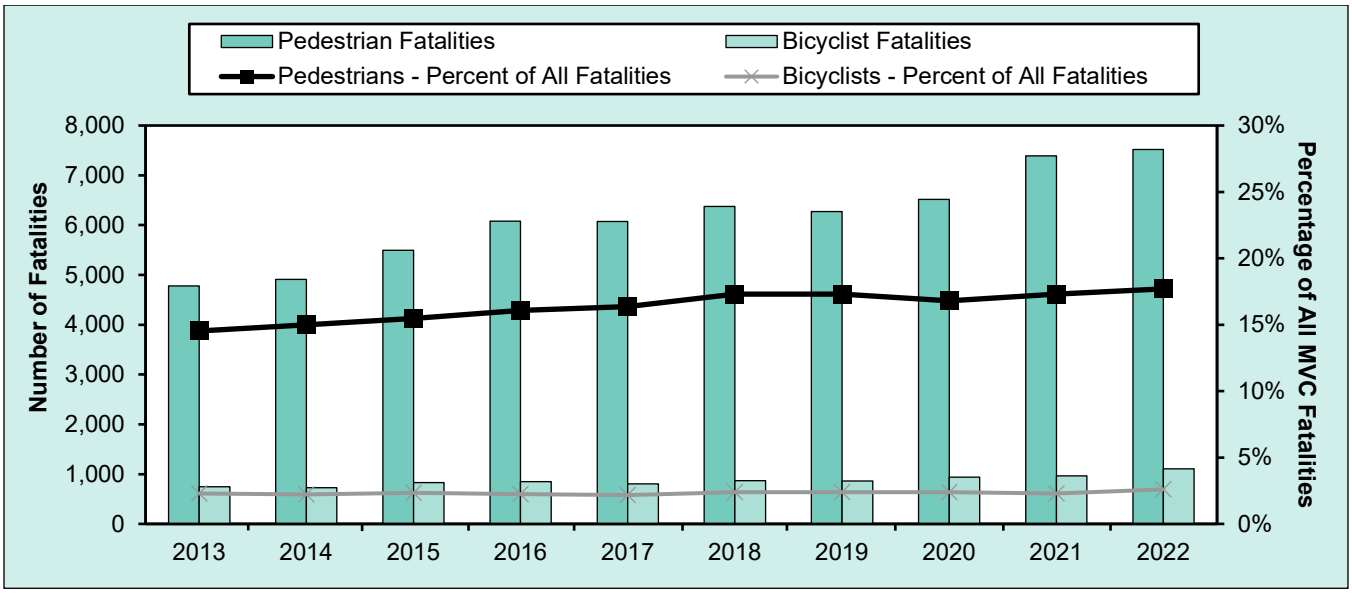
Pedestrian and Bicyclist Safety – Literature Review

Background

Pedestrian and bicyclist fatalities in the United States constitute 20% of traffic fatalities (NCSA, 2024), despite these modes only comprising an estimated 13% of travel mode share (Buehler et al., 2020). Pedestrians and bicyclists are far more susceptible to risks in the built environment than are motor vehicle occupants. Pedestrian and bicyclist fatalities have grown consistently over the past decade (2013 to 2022), with pedestrian fatalities increasing 57% (from 4,779 to 7,522 deaths) and bicyclist fatalities increasing 48% (from 749 to 1,105 deaths) (NCSA, 2022a, 2022b, 2024). This disparity in traffic safety is a major concern of both the United States Department of Transportation and traffic safety partners around the country. While new data sources and analysis methods are available for measuring safety risks to pedestrians and bicyclists, research is still limited in many ways.

Figure 1. Pedestrian and Bicyclist Fatalities – 2013-2022



The Literature Review

This report was developed to help readers understand the risks pedestrians and bicyclists face so appropriate data can be collected, and adequate countermeasures selected. This report builds on both the National Highway Traffic Safety Administration's existing resources about pedestrian and bicyclist safety and on academic and government literature, primarily collected from 2013 to 2020. Seminal sources prior to that period and important works after that period have been cited.

The focus of this report is traffic safety, so concepts like walkability or bikeability may be referenced, but broad discussion of these topics is beyond the scope of this report. Other determinants of safety, such as pedestrian falls, are also referenced but are not central to the report.

This report uses NHTSA's definition for pedestrian: any person not in or upon a motor vehicle or other vehicle, specifically, any person on foot, walking, jogging, hiking, sitting, or lying down in a public traffic way (NCSA, 2022a), but broader definitions based on injury surveillance are referenced (Injury Surveillance Workgroup 8, 2017). A bicyclist is defined as a rider on two-wheel vehicles, tricycles, and unicycles powered primarily by pedals, but may include electric-assist bicycles (e-bikes) (NCSA, 2022b).

Pedestrian and bicyclist crashes involving motor vehicles produce a spectrum of crash outcomes, including fatalities, injuries (which may or may not be debilitating), and non-injuries. However, the absence of a crash does not necessarily indicate the presence of safety. Pedestrians and bicyclists may be dissuaded from using certain roadway facilities due to perceived or actual threats to their safety. Pedestrian and bicyclist safety analysis sometimes involves the use of surrogate safety measures to capture those latent risks where crash data is sparse.

Crash trends for pedestrians and bicyclists vary across geographic and sociodemographic lines, and safety risks are not consistent for all pedestrians and bicyclists. Some examples cited in the report include:

- Sunbelt states such as New Mexico, Florida, and Arizona have had the highest population-based pedestrian fatality rates (Schneider, 2020).
- Pedestrian injuries and fatalities are not equitably distributed by race and ethnicity, with Black, Hispanic, and American Indian or Alaska Natives struck by motorists while walking at disproportionate rates to population (CDC, 2013; Zaccaro, 2019).
- Although pedestrian fatalities among children younger than 15 have decreased over the last few decades, this trend change may be due more to falling rates of walking by children (Schneider, 2020).
- Some research indicates that Black bicyclists are involved in the most crashes per person per distance traveled, indicating a potential disparity based on population size, but this finding was limited to one geographic area (Barajas, 2018).
- Men are three times more likely to ride bicycles than women, but they are eight times more likely to be involved in fatal bicycle crashes (Buehler et al., 2020; NCSA, 2022b).

To help readers understand pedestrian and bicyclist safety, the risks to safety, and the countermeasures that can be used to improve safety, this report synthesizes the body of literature on key topics that are organized into four sections. These sections and main topics include:

1. Introduction to Pedestrian and Bicyclist Safety, including crash patterns and trends, exposure to crashes and risk, the Safe System Approach, media coverage, and frameworks for understanding behaviors.
2. What Creates and Mitigates Risk for Bicyclists and Pedestrians, including the role of people and their behaviors, the environment, and the vehicle on pedestrian and bicyclist safety, and emerging safety concerns.
3. Effectiveness of Safety Interventions for Pedestrians and Bicyclists, including laws and policies, behavior change programs, crossing- and corridor-specific safety interventions, and technology-based interventions.
4. Measuring and Monitoring Bicyclist and Pedestrian Safety, including defining key terms (exposure, risk, and crash severity), data collection improvements, safety data sources, and analysis methods.

Substantial research has been dedicated to understanding the safety concerns of pedestrians and bicyclists, but more research is needed. Crash data remains limited and often inaccurate, and the relationship between exposure and crashes remains complex. New methods such as the Safe System Approach have been developed to allow agencies to proactively address the many risks pedestrians and bicyclists face in the complex roadway environment, but the emergence of new technologies will add additional complexity to the transportation system. Complicating the risks in the existing transportation system are changes in motorized traffic, non-vehicle technologies, and emergent modes. Transportation is changing, and although new technologies may mitigate some risks by improving detection, the interactions between motorists and other road users will remain complicated.

More research will be needed to quantify the safety impacts of increasingly larger vehicles, transportation network companies, vehicle automation, smartphones, infrastructure devices, e-scooters, and more. Readers are encouraged to explore this report as a guide for future research while considering the most fundamental methods for improving pedestrian and bicyclist safety, namely eliminating risks before they emerge by providing high-quality facilities for humans who want to walk or bicycle to their destinations. The troubling high incidence of pedestrian and bicyclist fatalities in the United States requires this level of consideration and demands more research.

References

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How to Order

The final report, *Pedestrian and Bicyclist Safety – Literature Review* (Report No. DOT HS 813 568) was prepared by the University of North Carolina's Highway Safety Research Center. It can be downloaded at https://rosap.ntl.bts.gov/

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