U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA

DOT HS 813 463 July 2023

Comparative Study of Communities With High Rates of Pedestrian Injuries

DISCLAIMER

Suggested APA Format Citation:

Okyere, D., Murdoch, J., Gelinne, D., Davis, M., Harmon, K., Kumfer, W., & Ma, C., (2023, *July*). *Comparative study of communities with high rates of pedestrian injuries* (Report No. DOT HS 813 463). National Highway Traffic Safety Administration.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 813 463		

4. Title and Subtitle
Comparative Study of Communities With High Rates of Pedestrian Injuries

5. Report Date
July 2023

6. Performing Organization Code

7. Authors
Dennis Okyere, Ph.D., James Murdoch, Ph.D., Dan Gelinne, Madison Davis, Katherine J. Harmon, Ph.D., Wesley Kumfer, Ph.D., Cheng Ma

8. Performing Organization Report No.

9. Performing Organization Name and Address
2M Research
1521 N. Cooper St, Suite 600
Arlington, TX 76011

UNC Highway Safety Research Center
University of North Carolina at Chapel Hill
730 M.L.K. Jr. Blvd #300
Chapel Hill, NC. 27514

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
693JJ921F000023

12. Sponsoring Agency Name and Address
National Highway Traffic Safety Administration
Research and Program Development, Office of Safety Programs
1200 New Jersey Avenue SE
Washington, DC 20590

13. Type of Report and Period Covered
Final

14. Sponsoring Agency Code

15. Supplementary Notes
Ruth Esteban-Muir was the contracting officer's representative (task order) for this project.

16. Abstract
A primary challenge facing many communities across the United States is understanding, developing, and deploying effective strategies for preventing and minimizing the incidence of pedestrian deaths and injuries. This guidebook documents strategies that communities actively implement to achieve successful pedestrian safety outcomes. A company called 2M Research and the University of North Carolina Highway Safety Research Center identified 12 communities with successful track records of declining pedestrian fatalities. They studied these communities against those with similar populations, density, incomes, geographic regions, and other factors. Their analysis resulted in a discrete set of strategies and best practices that may help to explain the communities' successes. The researchers describe their study, the results, specific strategy, countermeasures, and solutions in this guidebook for communities seeking solutions most appropriate to address their pedestrian safety problem.

17. Key Words	18. Distribution Statement
pedestrian, safety, communities, countermeasures	Document is available to the public from the DOT, BTS, National Transportation Library, Repository & Open Science Access Portal, rosap.ntl.bts.gov.

19 Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	77	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Table of Contents

List of Tables

List of Figures

Executive Summary

A primary challenge facing many communities across the United States is understanding, developing, and deploying effective strategies for preventing and minimizing pedestrian deaths and injuries. This guidebook documents strategies that communities are actively implementing to achieve successful pedestrian safety outcomes. By discovering and documenting the norms, policies, and procedures related to successful communities' transportation, law enforcement, community engagement, and land use efforts, the study team sought to obtain relevant and promising factors based on comparing communities and improving pedestrian safety outcomes as a ready model of adoption for other cities across the country. After performing a rigorous analysis of the most populous U.S. cities, the study team identified and narrowed the initial sample set to 12 communities with successful track records of declining pedestrian fatality rates. Taken together, these communities establish a foundation to explore the common factors explaining their collective success in greater detail.

The study team matched these successful communities with peer communities that were similar across population size and density, income, geographic region, and other factors. Matching successful communities with their peers provided the study team with a stratified short list of exemplary case studies that enabled a more granular analysis and comparison. From conversations with these communities, an objective assessment of their programs, and subsequent data analysis, the study team arrived at a discrete set of strategies and best practices that may help to explain the pedestrian safety successes these cities and towns have achieved. These strategies fall into various categories and reflect local efforts, policies, and best practices that may be contributing to the declining rates of pedestrian deaths and injuries in some communities across the country. While the study team recognizes that other factors may play a role in reducing pedestrian deaths and injuries, these strategies represent encouraging and promising measures that any community can take to begin addressing its pedestrian safety problems.

Table 1 lists the strategies and the level of use for each strategy among the group of communities. These strategies are classified into one of three categories, common, uncommon, and rare. "Common" indicates that at least 50 percent of communities in the sample employed given strategies. "Uncommon" indicates that 25 to 49 percent of communities deployed strategies. "Rare" indicates that less than 25 percent of communities in the sample used given strategies. Overall, successful communities were more likely to use these strategies than the comparison communities, indicating that these can be effective at improving pedestrian safety. Many of these strategies are already being implemented in communities beyond those examined in this study. In the sections on strategies, the report references examples of implementation both within and beyond the 12 successful communities to demonstrate their broad applicability.

Table 1. Pedestrian Safety Strategies Observed Across Study Communities[1]

	Comparison Communities	Successful Communities
Community Engagement Strategies		
Connect with community members using social media or other online tools	Common	Common
Coordinate pedestrian safety messaging through a communications group	Uncommon	Common
Engage law enforcement for community engagement	Rare	Uncommon
Countermeasure Strategies		
Deploy context-appropriate pedestrian and bicycle facilities	Common	Common
Develop adequate buffers and circulation networks for pedestrians and bicyclists	Uncommon	Common
Develop regular sidewalk and street maintenance and upgrade programs	Uncommon	Common
Engage law enforcement for speed control and education	Uncommon	Common
Facilitate behavioral change through positive reinforcement	Rare	Uncommon
Reduce interaction between motorists and pedestrians	Rare	Common
Data Analysis Strategies		
Develop staff capacity to identify, analyze, and respond to safety issues	Rare	Common
Engage law enforcement for data collection efforts	Rare	Uncommon
Use data-driven methods for targeting safety improvements	Common	Common
Organizational Structure Strategies		
Coordinate between city departments to capitalize on projects with safety components	Common	Common
Convene citizen and staff committees focused on pedestrian and bicyclist safety	Uncommon	Common
Devote staff to safety projects or establish safety roles and teams	Uncommon	Common
Project Funding Strategies		
Apply for grants and other available funding opportunities	Common	Common
Establish or identify a dedicated funding source for pedestrian-focused projects	Uncommon	Common

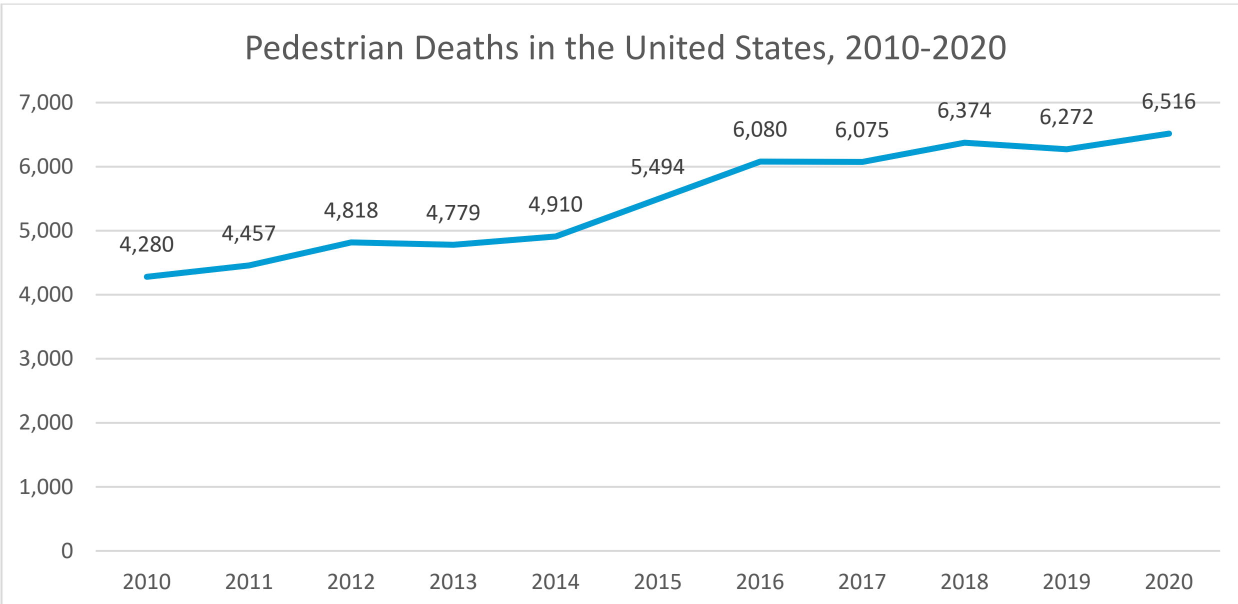
[1] These classifications are based on how many communities within a given group showed evidence of employing a strategy in their community.

	Comparison Communities	**Successful Communities**
Project Prioritization and Support Strategies		
Prioritize children, elders, and other vulnerable populations	Uncommon	Common
Prioritize opportunities to improve non-motorized travel conditions	Uncommon	Common

The study team set out to define and describe each of the strategies as well as provide examples of how community leaders are implementing them to achieve better pedestrian safety outcomes (e.g., declining pedestrian fatality trends). This guidebook also offers a self-assessment framework, providing a tool for community and transportation leaders to assess their current capabilities and needs, enabling them to prioritize how best to reorient their safety programs and mobilize resources to align with these strategies. Pedestrian safety is a complex and dynamic public issue, and the study team recognizes that solutions and policy responses take time, staff, and financial resources. For this reason, leaders and advocates are encouraged to exercise due diligence and take a long-term approach as they look closely at their existing policies and practices and begin to formulate their strategies for improving pedestrian safety in their communities.

Introduction and Background

In recent decades the United States has experienced a dramatic rise in the number of deaths among pedestrians involved in motor vehicle crashes. From 2010 to 2020, the last year for which data was available, pedestrian fatalities increased by 51.5 percent (Figure 1). During the 2000s pedestrians accounted for roughly 11 percent of total traffic deaths. During the 2010s that share grew steadily and reached 17 percent by 2020 (National Highway Traffic Safety Administration, 2022).



(Source: NHTSA, 2022)

Figure 1. Pedestrian Deaths in the United States, 2010–2020

Pedestrian deaths and injuries occur in densely populated urban areas and their suburbs to rural communities and tribal lands. However, pedestrian fatalities have become increasingly concentrated in urban areas. In 1975 some 59 percent of pedestrian deaths occurred in urban areas. In 2020 pedestrian deaths in urban areas rose to 82 percent, outpacing the population growth in urban areas during this period.

A primary challenge for many communities is understanding, developing, and deploying effective strategies for preventing and minimizing pedestrian death and injury. This guidebook documents actionable strategies communities are currently implementing to achieve successful pedestrian safety outcomes. Despite the widespread rise in pedestrian fatalities nationwide, some cities and towns are experiencing declining rates of pedestrian deaths. Many reports and specific programs have drawn attention to areas where pedestrian safety problems are highly concentrated. This project focused on understanding those communities that have experienced success in creating safer places to walk. The intent was to find these successful communities, compare them with their peers, and identify the strategies they used to achieve success.

To accomplish this task the study team employed a "mixed-methods positive deviance" study. The organizing premise of positive deviance is the observation that certain people and groups—such as planning, engineering, health, emergency medical services, law enforcement departments, or coalitions—demonstrate more beneficial outcomes than their peers, despite facing similar challenges and having similar access to resources (Mertens et al., 2016). By discovering and documenting the norms, policies, and procedures related to positively deviating communities' transportation, law enforcement, community engagement, and land use efforts, the study team sought to obtain relevant and promising factors based on comparing communities and improving pedestrian safety outcomes as a ready model of adoption for other cities across the country.

The first phase of this work involved identifying the "positive deviants," or communities experiencing successful outcomes with respect to pedestrian safety despite their similar characteristics with other communities. "Success" in this case was defined as experiencing declining pedestrian fatality rates from 2008 to 2019. Due to constraints related to an ideal sample size for the analysis, the sample was limited to the 350 largest cities by population as pedestrian fatalities are more common in higher-population communities. Among the 350 largest cities, 346 met the criteria for inclusion in the k-means cluster analysis. Beginning with these 346 cities, the study team performed a k-means cluster analysis using a set of 49 variables across pedestrian and total traffic fatalities, population measures, socio-demographic and economic factors, built environment[2] and travel behavior measures, and many others that have been shown to correlate with pedestrian safety outcomes.

After analyzing and sorting communities based on these variables, the study team identified and narrowed a pool of 12 successful communities to serve as the primary sites of interest to explore in greater detail. These 12 were identified through their reduction in pedestrian deaths over the study period (2008 to 2019), a trend the study team concluded was unexplainable by factors such as population density, socio-demographic characteristics, economic measures like income levels, and other built environment factors. In other words, these communities were the most likely set of communities that had success in reducing pedestrian deaths based on some other action, intervention, or practice that was found worthy of further examination. They represented "positive deviants," or communities that stand out from others by their achieving positive pedestrian safety outcome.[3] Table 2 lists the 12 successful communities with some key details that demonstrate the range in population sizes, population densities, and geographic variability.

Table 2. Successful Communities Identified Through K-Means Cluster Analysis

Community Name	NHTSA Region	2019 Total Population	2019 Population Density per Square Mile
El Monte, CA	9	115,517	12,080.39
Escondido, CA	9	151,300	4,054.74
Fargo, ND	8	121,889	2,450.36
Hollywood, FL	4	152,511	5,592.80
Joliet, IL	5	147,826	2,304.31
Lafayette, LA	6	126,666	2,282.45

[2] Built environment refers to land use patterns, infrastructure, roadway facilities and elements, and all man-made structures.

Community Name	NHTSA Region	2019 Total Population	2019 Population Density per Square Mile
McKinney, TX	6	182,055	2,719.69
New Bedford, MA	1	95,239	4,761.97
Orem, UT	8	96,725	5,234.98
Springfield, MO	7	167,051	2,027.52
Sunrise, FL	4	94,060	5,812.13
Washington, DC	3	692,683	11,330.28

The study team matched these successful communities with peer communities that were similar across many factors: population size and density, income, geographic region, etc. Three comparison communities were matched to each of the 12 successful communities based on variables and factors that were most strongly associated with being "successful" in the prior analysis: measures of walkability, property values, share of Black population, education levels, poverty measures, geographic region, and prevalence of English as a second language (ESL). Matching successful communities with their peers gave the study team a narrowed pool of communities for a more detailed comparison. The study team used a data collection process to collect information about these successful and comparison communities to better understand their pedestrian safety practices. To begin, the study team conducted a systematic review of available documents, plans, policies, as well as other elements of pedestrian programs for the study communities, focusing on the following sources:

- pedestrian, transportation, and road safety plans,
- policies impacting pedestrian safety and walkability,
- comprehensive programs and campaigns focused on pedestrian safety, and
- design manuals and standards that dictate how streets are constructed.

To learn more about these communities, the study team conducted targeted interviews and panel discussions to learn more about strategies that were not formally documented but nevertheless influence how pedestrian safety is addressed. The community representatives sought to understand their approaches to the following:

- staffing capacity and departmental structure,
- funding, political, and community support for pedestrian safety activities,
- collaboration and coordination between departments, and
- engagement with the community and the resulting input to steer future programs.

While speaking with these communities, the study team performed additional analyses to review emergency medical service (EMS) response data related to pedestrian injuries and to further compare the successful and comparison communities based on a wide range of factors related to the built environment, policy landscape, land use and development, and socio-demographic factors. Additional details about the analysis conducted and detailed findings are available in Appendix A.

From conversations with these communities, an objective assessment of their programs, and subsequent data analysis, the study team identified a discrete set of strategies that may help to explain the pedestrian safety successes that these cities and towns have achieved. Although other factors may also play a role in their pedestrian fatality reductions, these strategies represent promising steps that any agency can take to begin addressing and improving their pedestrian safety problems.

Community Engagement

- Strategy 1: Connect with community members using social media or other online tools.
- Strategy 2: Coordinate pedestrian safety messaging through a communications group.
- Strategy 3: Engage law enforcement for community engagement.

Countermeasures

- Strategy 1: Deploy context-appropriate pedestrian and bicycle facilities.
- Strategy 2: Develop adequate buffers and circulation networks for pedestrians and bicyclists.
- Strategy 3: Develop regular sidewalk, street maintenance, and upgrade programs.
- Strategy 4: Engage law enforcement for speed control and education.
- Strategy 5: Facilitate behavioral change through positive reinforcement.
- Strategy 6: Reduce interaction between motorists and pedestrians.

Data Analysis

- Strategy 1: Develop staff capacity to identify, analyze, and respond to safety issues.
- Strategy 2: Engage law enforcement for data collection efforts.
- Strategy 3: Use data-driven methods for targeting safety improvements.

Organizational Structure

- Strategy 1: Coordinate between city departments to capitalize on projects with safety components.
- Strategy 2: Convene citizen and staff committees focused on pedestrian and bicyclist safety.
- Strategy 3: Devote staff to safety projects or establish safety roles and teams.

Project Funding

- Strategy 1: Apply for grants and other available funding opportunities.
- Strategy 2: Establish or identify a dedicated funding source for pedestrian-focused projects.

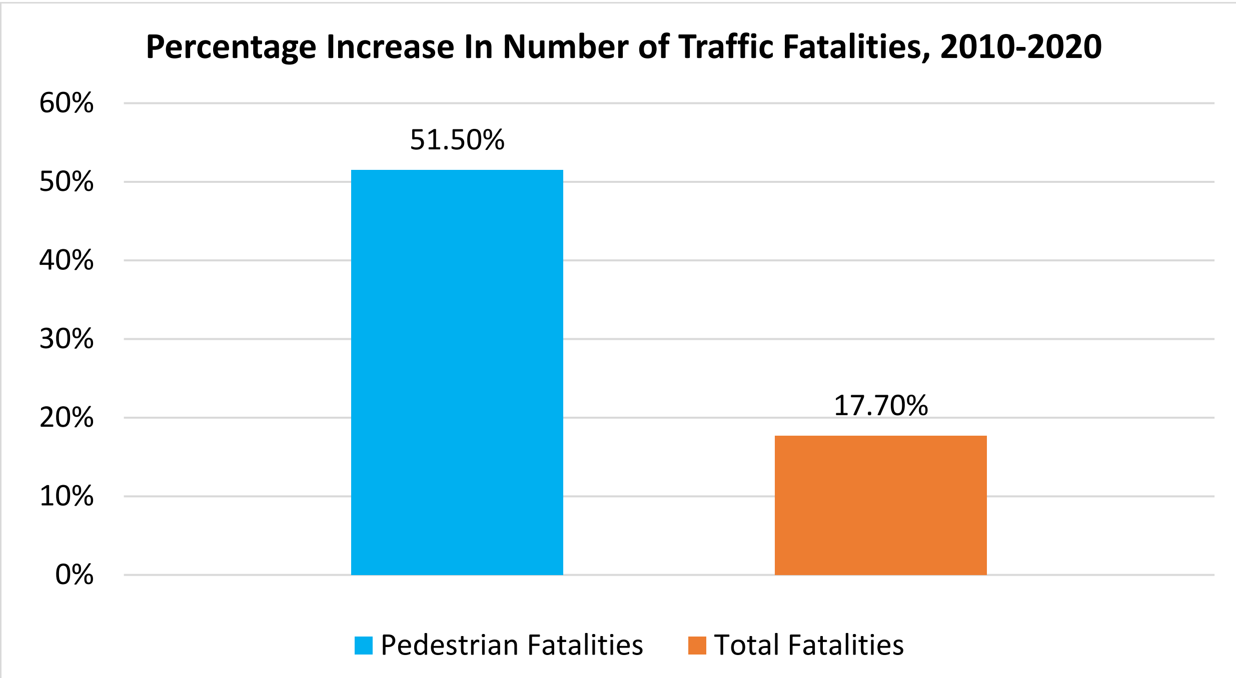
Project Prioritization and Support

- Strategy 1: Prioritize children, elders, and other vulnerable populations.
- Strategy 2: Prioritize opportunities to improve non-motorized travel conditions.

The study team breaks these strategies down in greater detail throughout this guidebook. The guidebook also provides a proposed self-assessment that communities can use to better understand their readiness and capabilities for adopting and implementing these strategies to prevent or minimize pedestrian deaths and injuries.

Pedestrian Safety Trends

As noted above, deaths among pedestrians in the United States have been trending upward for more than a decade. The 6,516 pedestrians killed in 2020 represented a 51.5 percent increase since 2010, when 4,302 pedestrians were killed. This is much larger than the increase in the overall traffic fatalities. The 38,824 traffic fatalities in 2020 represented a 17.7 percent increase since 2010, when all traffic fatalities numbered 32,999 (see Figure 2). During that same period, pedestrian deaths as a share of total traffic fatalities grew from 13 percent in 2010 to 17 percent in 2020 (NHTSA, 2022).

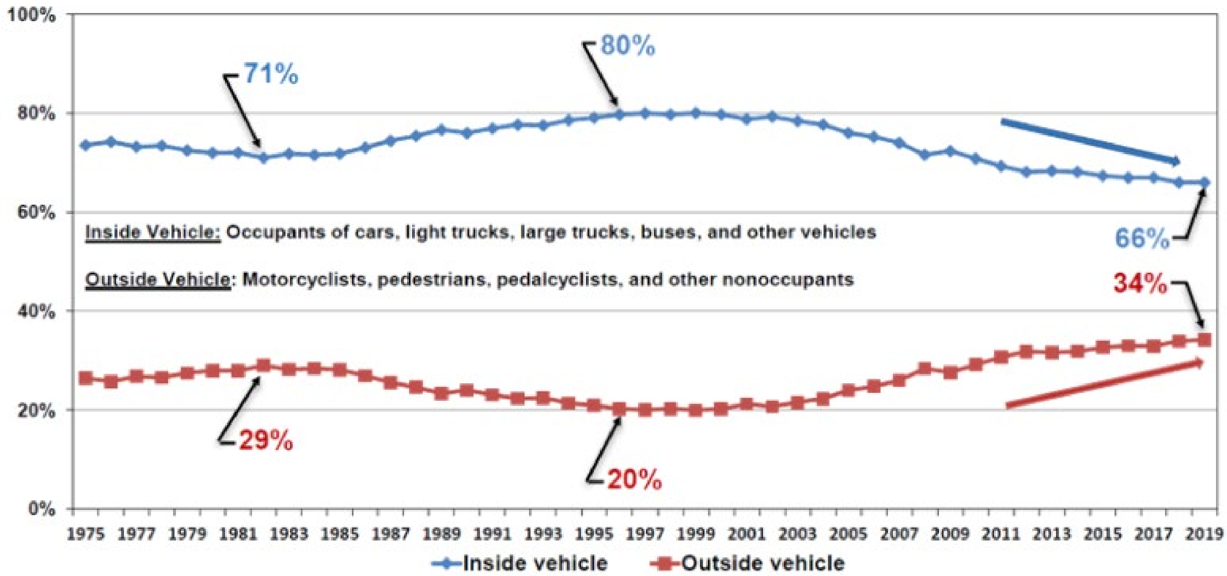


(Source: National Highway Traffic Safety Administration and National Road Safety Strategy, 2022)

Figure 2. Changes in Total Traffic Fatalities and Pedestrian Fatalities From 2010 to 2020

Since the mid-1990s a rising share of total traffic fatalities has involved people outside of vehicles compared to those inside of vehicles. Figure 3 shows this trend of rising deaths among pedestrians, bicyclists, and other vulnerable road users. This trend is intuitive as motor vehicles continue to be safer for those who drive and ride inside them. Advances in crash prevention technologies, safety equipment installed inside vehicles, and other vehicle design measures naturally lead to improvements in driver and passenger safety outcomes. However, those improvements have not been shown to reduce deaths among the pedestrians, bicyclists, and others who are struck by these motor vehicles. In fact, larger vehicles like trucks and SUVs, which account for a higher share of the overall vehicle fleet in recent years, are increasingly involved in fatal crashes with pedestrians than they were 10 years ago (Hu & Cicchino, 2018).

Despite the imbalance of these safety mechanisms, there is some promise in the ability of these technological advances to benefit the well-being of pedestrians and bicyclists. The *Discussion Guide for Automated and Connected Vehicles, Pedestrians, and Bicyclists* (Sandt & Owens, 2017) outlines 10 "problems" that current versions of automated vehicle detection systems present to pedestrians and bicyclists. If properly addressed and incorporated into vehicle safety standards, the solutions to these problems could play an instrumental role in addressing many current deficiencies in vehicle technologies and enhance safety for vulnerable road users.



(Source: NHTSA)

Figure 3. Proportion of Traffic Fatalities Occurring Among People Inside (Blue Line) and Outside (Red Line) of Motor Vehicles (1975 to 2019)

The study team found the southern and southwestern regions of the United States (often referred to as the "Sun Belt") to experience the highest rates of pedestrian deaths as a share of population (Schneider, 2020). Urban areas tend to experience the highest concentration of these deaths largely due to higher rates of walking compared to other types of trips.

Research also shows that pedestrian deaths and injuries are inequitably distributed across all populations. These deaths and injuries disproportionately affect Black, Hispanic, American Indian, and Alaska Native communities that have higher rates of pedestrian deaths than other groups. An examination of the U.S. roadway corridors experiencing the highest concentration of pedestrian deaths found that 75 percent of these "hot spot" areas border lower-income neighborhoods (Schneider et al., 2021).

A great deal of research has attempted to identify the key factors that contribute to higher risk for pedestrian death and injury. The vast body of this work has focused on location-specific, behavioral, and temporal factors that increase the likelihood of pedestrian crashes involving motor vehicles. The report *Systemic Pedestrian Safety Analysis* (Thomas et al., 2018) summarized a large volume of literature on risk factors known to contribute to crashes involving pedestrians.

- high volumes of motor vehicles
- high volumes of pedestrians
- pedestrian exposure to traffic for a long time or distance (e.g., long crossing distances)
- numerous conflict points between road users
- lack of separation between pedestrians and motor vehicles
- high motor vehicle speeds

- dark or unlit roadways
- long distances between crossing opportunities

A common challenge for many communities is understanding where to focus their efforts and resources. Facing limited budgets, staff capacity, and other constraints, agencies want to ensure their investments will make the greatest difference. For this reason, it may be useful for communities to understand their own vulnerabilities, those factors that may increase the likelihood of a pedestrian death or injury. The study team attempted to analyze a wide range of community factors and develop a common set of predictors for pedestrian safety outcomes. By comparing successful communities and their peers, the study team sought to isolate characteristics and factors that would predict success for pedestrian safety outcomes. The study team outlines its efforts to examine factors related to policies, land use and development, and socio-demographic factors in Appendix A.

Due to limitations in sample size and data availability, the study team identified a small number of factors predictive of pedestrian safety outcomes. The three measures that were strong predictors of success (decrease rates of pedestrian deaths) were all related to the distribution and density of both development and populations within a community. One variable is an index of land use diversity and travel mode called Regional Centrality Index – Auto, which measures "the relative centrality of a block group compared to other block groups within the same metropolitan region, as measured by travel time to working-age population via automobile" (Ramsey & Bell, 2014). In other words, the index assesses the ease of travel by motor vehicle between different areas of a community. In the context of this study, lower regional centrality index values mean that it is more difficult or requires more time to travel by automobile, which is more predictive of pedestrian safety success.

This relationship is intuitive given the auto-oriented nature of the street network and development in many U.S. cities, which can be hostile to pedestrians and feature many of the risk factors associated with pedestrian injuries and deaths. Such communities that deprioritize fast and easy travel by automobile may have land use and street design features that create safer and more comfortable walking environments. While this regional metric may minimize the pedestrian-friendliness of the built environment at a granular level, the index highlights an important relationship with land uses and transportation networks that are inherently more supportive of non-automobile travel.

The other variables found to be predictive of pedestrian safety success relate to the mixed density of certain employment sectors. These measures were percentage of service center employment, percentage of office employment, and percentage of entertainment employment. Communities with a more diverse mix of employment across these sectors were more likely to have pedestrian safety successes. While these measures are less clear in their direct connection to pedestrian safety, the positive correlation likely reflects a mix of both land uses and traffic generation that may suggest transportation layouts and arrangements that either improve or inhibit the flow of automobile travel.

These findings can support actions by local communities and especially regional agencies (e.g., metropolitan planning organizations, [MPOs]) as they develop strategic transportation and land use plans. These efforts can help communities identify core areas for growth and guide future development and transportation networks in support of community needs. Making decisions to plan future land use and transportation systems in support of transit, bicycling, and walking as opposed to prioritizing motor vehicle travel could result in long-term pedestrian safety benefits.

The study team also explored the degree to which the adoption of a certain type of plan or policy or the presence of a pedestrian safety program played a significant role in safety outcomes. The study team was unable to document a strong connection between these types of initiatives and reduction in pedestrian deaths. This finding does not mean those programs, plans, and initiatives had less impact; the assumption is that the analysis was unable to prove a strong relationship. In many smaller and medium-sized communities, it is important to note that pedestrian deaths are rare events. To improve the relevance and applicability of statistical power, communities are encouraged to replicate the study team's methods using crash data or another pedestrian injury data source (e.g., EMS data). A larger data sample would increase the potential to uncover additional relationships between hypothesized factors and pedestrian safety outcomes.

The next section presents the study team's insights from discussions with successful communities that set them apart from their peers: the strategies they are actively implementing to address and reverse rising rates of pedestrian deaths and injuries.

Strategies for Improving Pedestrian Safety

The study team conducted a thorough review of policies, plans, and programs implemented or currently under implementation by both successful and comparison communities[4] to further examine pedestrian safety strategies and interventions and their impact on pedestrian safety outcomes across the sample. All at once, the study team engaged representatives from 6 successful communities and 12 comparison communities to better understand the processes, practices, partnerships, and structures of pedestrian safety provisions in given communities as well as the strategies, countermeasures, and characteristics that inform a community's approach to improving pedestrian safety. The following strategies are put together from those discussions with community representatives as well as from the systematic review of their polices, plans, and programs. The strategies fall into various categories and reflect practices that may be contributing to the declining incidence rates of pedestrian deaths and injuries in communities around the country. Using the information below, other cities and municipalities can adopt and tailor these approaches to fit the local context and needs of their communities. Table 3 shows each category of strategies that details the frequency at which a given strategy was observed in a particular group of communities. These strategies are classified in one of three categories, common, uncommon, and rare, as described on page 1. Overall, the study team found successful communities were more likely to use these strategies than the comparison communities, indicating that these can be effective at improving pedestrian safety.

Table 3. Community Engagement Strategies

Strategy	Comparison Communities	Successful Communities
Connect with community members using social media or other online tools	Common	Common
Coordinate pedestrian safety messaging through a communications group	Uncommon	Common
Engage law enforcement for community engagement	Rare	Uncommon

Strategy 1: Connect With Community Members Using Social Media or Other Online Tools

Both successful and comparison communities commonly employ the use of social media platforms like Facebook, Twitter, Instagram, and YouTube, and run advertisements on these platforms and local online radio stations to encourage community participation in the planning process of pedestrian safety initiatives. Additionally, these cities are leveraging social media and other virtual means to solicit or react to feedback on traffic and pedestrian safety concerns throughout their communities. The communities also use virtual platforms to conduct surveys that gather feedback from pedestrians and motorists. Successful communities welcome public feedback to address issues in real-time as input directly from community residents remains one of the primary ways cities become aware of transportation-related issues. Virtual town hall

[4] Refer to Table A-8 in Appendix A for a full list of cities included in the document review.

meetings have been conducted as well, providing opportunities for people who are otherwise unable to attend meetings in person to participate in the planning and decision-making process. The study team found these opportunities have increased community engagement in the transportation planning process by both sets of communities in the study.

For example, the Washington, DC, its Department of Transportation used social media to increase public awareness of its “moveDC” planning process and encourage participation in community surveys among its residents. DC residents gave additional public feedback through interactive maps on the moveDC website that displayed draft transit, bicycle, and freight networks. This strategy has a large range of applicability since many city, county, State, and Federal agencies already use social media for press releases and other purposes. Communities could also consider engaging with their residents digitally during different phases of the planning process. This strategy may be particularly beneficial during the early data collection and existing condition review phases to ensure that community safety concerns are part of the planning process from the outset. Another phase where social media engagement may be helpful is during the design of specific countermeasures and facilities. Connecting with community members virtually is a low-to-no-cost strategy that many communities already use. As a result, interested cities have several proven models to reference in forming successful digital strategies. Additionally, transportation agencies have published information and resources to support communities as they establish virtual social media strategies. The Michigan Department of Transportation, for example, published a guidebook, *Virtual Public Involvement Benefits and Barriers: A Practical Guide to VPI Tools* (2021), containing best practices concerning virtual public engagement, , to support local and statewide activities related to public engagement. The guidebook provides recommended steps for selecting and carrying out virtual public involvement activities to support a variety of pedestrian safety project types.

Strategy 2: Coordinate Pedestrian Safety Messaging Through a Communications Group

Successful communities often have communications groups or affiliated organizations that explicitly support community engagement through pedestrian safety messaging. These groups are responsible for informing residents about transportation-related changes or initiatives happening in their cities. These groups can also talk with local media and coordinate narratives following high-profile crashes or important upgrades to the community road and sidewalk system. These groups also use social media plus traditional means to notify communities when public events or public meetings are taking place. While some comparison communities organized their pedestrian safety messaging through formal office, the study team found this to be uncommon for the cities in the study sample.

Communication teams usually organize themselves outside of traffic engineering and public works and embed their functions across different departments. Hollywood, Florida, for example, uses a communications group outside of its traffic engineering department for public engagement efforts to coordinate its social media campaigns around pedestrian safety. Outside the city government, transportation leaders can also leverage local community organizations with the drafting and distribution of pedestrian safety messaging. WalkArlington, for example, is an organization that works alongside Arlington County, Virginia, to expand walking-oriented programs and engage community members around promoting active transportation.[5] Its team specializes in marketing, outreach, and public engagement strategies, providing an asset to the county and its pedestrian-oriented programs.

This communications strategy has wide application at the local, State, and Federal levels and offers proven value at any stage of planning and project development. The cost of hiring a communications team may challenge some municipalities, but additional funding avenues exist that may be worth exploring. In the absence of designated public relations or communications groups, communities may be able to rely on other channels of public information services through other departments (e.g., law enforcement, the mayor's office, or public broadcasting channels).

Source: www.pedbikeimages.org/Dan Burden

Figure 4. West Savannah Neighborhood Planning Coordination Meeting

Strategy 3: Engage Law Enforcement for Community Engagement

Many successful communities in the sample engage law enforcement departments to connect with residents outside traditional settings of public transportation policing. Through a proactive partnership the police departments promote public safety through the lens of pedestrian and bicyclist safety. Instead of standard law enforcement operations whereby local officers address roadway safety issues on the job in uniform, they are engaged by these communities to play active roles in supporting community engagement efforts by educating residents in public forums

---

[5] For more information of WalkArlington, please visit: www.walkarlington.com/

about common roadway and pedestrian concerns and safety topics. This strategy could be particularly beneficial for children who are still developing safety habits while walking or bicycling. Communities in the comparison group, by contrast, rarely used their police departments for community engagement. Nevertheless, the comparison communities that chose to engage law enforcement for community engagement used similar forms of outreach as their counterparts in successful communities. For example, one community in the study allows its law enforcement department to give presentations on bicycle safety at local schools. As a result, the officers provide flyers and bicycle helmets and empower the residents by allowing them to translate their new knowledge into action. For example, Dare County, North Carolina uses its law enforcement department to better accommodate the community's seasonal tourists and residents. During tourism season law enforcement distributes traffic and road material to local employers, asking them to post and share messaging about road safety tips and best practices in the community. Additionally, law enforcement offices place highly visible signage at major entry points into high-traffic areas with similar messaging (Blank et al., 2020).

Communities can use law enforcement for public engagement at any stage of project planning, including stages that lie outside formal planning initiatives (although the ease and cost of doing so will vary). The ease of implementation for this strategy will depend heavily on the availability of law enforcement officers to contribute to transportation safety outside of speed control and enforcement. However, almost every municipality has officers who are tapped into pressing traffic issues, officers who could ultimately provide support to achieving safety goals through engagement with residents outside of traffic stops. Transportation officials and professionals should keep their law enforcement apprised of planning initiatives, safety goals, best practices (as they evolve over time), and programs that may ultimately strain staff capacity in smaller communities. The costs of implementing this strategy mostly depends on the level of engagement and any additional pay law enforcement officers would receive for their time. Efforts that involve law enforcement and resources should receive careful planning and must consider the history and cultural nuances of community relations. Considerations for over-policing and perceptions of law enforcement presence, for example, should inform the decision about whether to enlist law enforcement agencies in pedestrian safety initiatives.

Countermeasures

Table 4. Countermeasure Strategies

Strategy	Comparison Communities	Successful Communities
Deploy context-appropriate pedestrian and bicycle facilities	Common	Common
Develop adequate buffers and circulation networks for pedestrians and bicyclists	Uncommon	Common
Develop regular sidewalk and street maintenance and upgrade programs	Uncommon	Common
Engage law enforcement for speed control and education	Uncommon	Common

Strategy	Comparison Communities	Successful Communities
Facilitate behavioral change through positive reinforcement	Rare	Uncommon
Reduce interaction between motorists and pedestrians	Rare	Common

Strategy 1: Deploy Context-Appropriate Pedestrian and Bicycle Facilities

Communities seeking to reduce pedestrian and bicycle deaths can deploy innovative countermeasures to address the underlying causes. They can also upgrade their existing pedestrian and bicycle facilities when and where possible. Both successful and comparison communities employ ranges of these countermeasures precisely because they recognize the importance of flexibility in addressing and improving pedestrian safety. Indeed, transportation officials acknowledge that contextual features specific to their communities drive the countermeasures they can implement. The resulting interventions are by their nature localized in application, but they offer wide applicability to communities with similar contextual features. The commonly voiced concerns regarding local context include special population needs, acceptance to the local community and elected officials, and other built environment factors such as the availability of space on streets or the presence of adjacent jurisdictions with conflicting priorities.

Furthermore, communities across the sample noted their work to modernize their policies and development standards aligned more with current best practices over the older, less pedestrian-friendly policies that many cities adopted during the late 20th century. Some of these revisions have allowed for the development of a range of effective interventions including, the creation of high-visibility continental crosswalks; the revisiting of warrants for mid-block crossings and crosswalks; the addition of intersection signage; and the implementation of traffic-calming medians, HAWK beacons,[6] audible push and recall buttons, raised crosswalks, Mr. Walker statues,[7] and other such facilities. Table 5 details some of the provided contextual reasons for pedestrian facilities and features over others. The cost of implementing such a strategy will largely depend on the countermeasure chosen and other contextual factors such as the costs to build there. Most interventions will only be applicable at the local level, and community leaders typically outline their priorities through transportation plans and policies such as Complete Streets. San Francisco's Better Streets Plan, for example, is a citywide strategy that aims to change roadway design to support all modes of travel, particularly bicycling, walking, and transit use.[8] The plan shares information about specific design changes and countermeasures that promote active transportation.

---

[6] A HAWK (High-intensity Activated crossWalK) is a traffic control device that stops road traffic and allows pedestrians to cross safely.

[7] For more information on Springfield's Mr. Walker statues, please visit: www.springfieldmo.gov/3529/About-SGF-Yields

[8] For more information on San Francisco's Better Streets Plan, please visit: www.sfbetterstreets.org

Table 5. Contextual Drivers for Countermeasures

Facility Type	Contextual Driver
Audible push and recall buttons	Low-visibility or blind populations who need audio cues for crossings
Flashing speed limit signs	High speed travel corridor with unsignalized and uncontrolled crossing locations
Pedestrian signals	Leadership preference for full pedestrian signals instead of HAWK signals or rectangular beacons
Speed tables	Jurisdictional issues preventing the installation of pedestrian signals to address midblock crossing fatalities

Strategy 2: Develop Adequate Buffers and Circulation Networks for Pedestrians and Bicyclists

Several successful communities benefited from implementing additional buffers between pedestrians, bicyclists, and motorists, as well as establishing formal circulation networks for pedestrians and cyclists to navigate the city. Successful communities are creating buffers between motorists and bicyclists, especially as traffic volumes and speeds increase. They are also improving bicycle facilities to provide greater connectivity and prioritize safety for non-motorized users. Other actions include reducing the number of access points to adjacent roads to reduce conflict points between road users; providing adequate on-site motorized and non-motorized circulation; and offering adequate off-street parking relative to existing and planned commercial and multi-family residential development. Some communities in the comparison group are adopting similar tactics to create buffers and circulation networks, but to a lesser degree than successful communities.

Safety improvements of this nature tended to overlap with other transportation-related projects that are not specifically pedestrian-oriented. For example, one representative from a community in the study commented that it treats protected bike lanes and bus priority lanes as traffic-calming tools on arterial roads. As such improvements create buffers for pedestrians to "potential exposure [to vehicles]" as they attempt to use sidewalks or cross busy streets, the cities are then able to approach their pedestrian safety goals through indirect means. Another example that reflects this kind of prioritization in planning and policy is Portland's PedPDX, a citywide pedestrian safety plan that focuses on establishing a pedestrian priority network to support safe and convenient travel by foot.[9]

[9] For more information on Portland's pedestrian safety plan, please visit: www.portland.gov/transportation/planning/pedpdx

Source: www.pedbikeimages.org/Dan Burden

Figure 5. Multimodal Waterfront Path

Strategy 3: Develop Regular Sidewalk and Street Maintenance and Upgrade Programs

Successful communities have often established street maintenance and facility upgrade programs that occur at regular intervals of time to ensure the long-term health and sustainability of the pedestrian network. Comparison communities, by contrast, employed proactive or standing maintenance and upgrade programs to a significantly lesser degree. This resulted in reactive deployment of new sidewalks and streets in response to resident requests and created preconditions for new development. Communities seeking to improve their countermeasure implementation could adopt a systematized approach to upgrading pedestrian facilities and modernizing traffic signals, controllers, network, and management technology systems. This approach would still allow cities to react efficiently to both resident concerns and unanticipated issues while attempting to preempt future challenges. Carrying out some form of a regular maintenance and upgrade program (e.g., installing more visible crosswalks during annual roadway resurfacing) usually invites a higher cost for implementation. However, communities may find these costs preferable compared to retrofitting or a complete redesign of the pavement. Cities may also be able to couple this program with other types of safety improvements. One community in the study also used its annual signal re-timing exercise as an opportunity to update its pedestrian and bicycle infrastructure. Additionally, Ithaca, New York, has an unusual model for funding and prioritizing sidewalk maintenance and upgrades as well as creating designated funds that support investment in sidewalk replacements and repairs for the lowest-income areas of the city.[10]

Source: www.pedbikeimages.org/Kristen Langford

Figure 6. An Intersection in a Residential Setting Accommodating All Road Users

Strategy 4: Engage Law Enforcement for Speed Control and Education

Several successful communities benefited from working with law enforcement to connect with local schools on safety education campaigns and participate in specific speed control scenarios at problematic intersections. For example, communities with Safe Routes to School programs have successfully coordinated with their law enforcement agencies to provide additional enforcement along school routes, particularly regarding speeding and the passing of stopped school buses. Targeted enforcement programs have been fruitful in improving pedestrian safety outcomes in successful communities. The study team found that HVE activities in high-fatality areas and locations with vulnerable populations (e.g., children) increase compliance with measures such as posted speed limits and yielding rules, ultimately reducing unlawful and undesirable traffic behavior. A shared responsibility approach may offset the costs of pursuing these activities, but several communities have also been able to acquire grants to fund their short-term HVE projects. As mentioned, deployment of these measures and operations should follow careful planning and factor in the cultural nuances and history of community relations with law enforcement.

---

[10] For more information on Ithaca's sidewalk policy, please visit: www.cityofithaca.org/219/Sidewalk-Policy.

Although law enforcement inclusion was an uncommon strategy among the comparison communities, successful community representatives noted the importance of law enforcement to support countermeasure strategies, educational efforts, and project implementation.

Community representatives also suggested that cities should encourage multidisciplinary partnerships between transportation planners, law enforcement, and engineering leaders to enhance roadway design and train law enforcement agents on new roadway technologies. This collaboration provides an opportunity for knowledge exchange on policy updates and motor vehicle statutes and spawns debate on how they may apply in different scenarios throughout the community. These same officers can serve an instrumental role in providing bicycle and pedestrian education to children at schools through collaboration efforts with local area school districts. One community, for example, reported that its officers give out flyers with safety information along with bicycle helmets while educating children about the importance of bike safety.

This strategy has a range of applicability from the community to the regional level depending on local jurisdictional concerns for law enforcement. Community leaders can implement HVEs and other targeted enforcement activities on a short-to-medium-term basis; however, the educational component may benefit from both a long-range strategy and continual improvement alongside a proactive upgrading of technologies, laws, and standards.

Source: www.pedbikeimages.org/Dan Burden

Figure 7. Traffic Enforcement Stop in a School Zone

Strategy 5: Facilitate Behavioral Change Through Positive Reinforcement

Many successful communities developed ways to encourage safer behaviors from pedestrians, bicyclists, and motorists through community events and other feedback mechanisms. For example, one community deployed a resident-and-community-led campaign following an HVE operation that helped maintain yielding compliance by greeting motorists with friendly gestures and thanking them for yielding. This example highlights the importance of community initiative in the continued success of some of the strategies leaders are using to increase pedestrian and bicyclist safety. By using positive reinforcement methods, cities can also avoid many of the drawbacks typically associated with negatively focused traffic messaging such as those that rely on fear tactics and scaring road users into changing their behavior. While the study team saw evidence that a few comparison communities also used positive reinforcement to change driver and pedestrian behavior, this strategy was rarely used across the group.

Additionally, the study team found that positive reinforcement is effective in conjunction with other concurrent strategies. St Paul, Minnesota, for example, used a social-norms-oriented campaign to measure rates of yielding and then shared those rates with drivers to establish this practice as a "norm" in the community.[11] After the campaign, the data showed that yielding rates continued to rise after community leaders shared the results with the public. This strategy relies on a community enforcement of norms and thus has a limited applicability in its early stages. Additionally, this is a low-to-no-cost strategy to implement and requires minimum preparation with community groups.

[11] For more information of St. Paul's social norming campaign, see: https://usa.streetsblog.org/2018/10/18/want-drivers-to-yield-to-pedestrians-you-gotta-play-mind-games/.

Source: www.pedbikeimages.org/Mike Cynecki

Figure 8. Police Officer Distributing Helmets to Children

Strategy 6: Reduce Interaction Between Motorists and Pedestrians

One overarching theme that emerges from these strategies and the available data is the way cities prioritize the reduction of interaction between motorists and pedestrians. Cities have pursued this strategy by introducing leading pedestrian intervals; modifying intersection geometry and operations; changing parking rules at problematic intersections; and increasing yield distance requirements to increase motorist visibility of pedestrians, ultimately allowing pedestrians to establish a presence equal to motorists in a shared space. For some communities, this strategy also takes the form of filling in sidewalk gaps. Successful communities design and implement pedestrian facilities that are ADA-compliant to protect mobility-challenged pedestrians and other people with disabilities against additional hazards and exposure to traffic. The cost of implementing specific countermeasures for this strategy varies largely on the countermeasure and degree of need in a given community. Communities with minimal sidewalk coverage, for example, will have more ground to cover than others and those cities with stringent yielding and visibility requirements may find it more difficult to implement additional requirements and improve their outcomes without trying different methods.

This strategy has wide applicability at the local level through specific types of countermeasures and local policy action. For example, Washington, DC, is pursuing a "no turn on red" policy whereby vehicles are legally prohibited from turning at most intersections during red lights. This countermeasure follows a study that demonstrated the efficacy of this rule at intersections in reducing conflicts between pedestrians and motor traffic. Many communities also reported that "complete street" policies or approaches to transportation planning decrease the interaction between motorists, pedestrians, and bicyclists while also providing the optimal environment for safe and multimodal transportation options.

Source: www.pedbikeimages.org/Toole Design Group

Figure 9. High-Traffic Intersection Accommodating Different Road Users

Data Analysis Strategies

Table 6. Data Analysis Strategies

Strategy	Comparison Communities	Successful Communities
Develop staff capacity to identify, analyze, and respond to safety issues	Rare	Common
Engage law enforcement for data collection efforts	Rare	Uncommon
Use data-driven methods for targeting safety improvements	Common	Common

Strategy 1: Develop Staff Capacity to Identify, Analyze, and Respond to Safety Issues

Many successful communities have invested in opportunities to improve their staff's ability to identify, analyze, and respond to safety issues as they develop. Transportation planning staff are not experts on every issue related to pedestrian safety and the individual backgrounds of each staff member contributes significantly to the city's overall planning capacity. Continuing education and training opportunities for staff members will therefore strengthen a community's ability to effectively respond to both existing and future safety issues. Successful communities provide opportunities for staff to develop their data analysis skills to increase data literacy and facilitate the use of timely and relevant data. Among comparison communities, the study team rarely found educational and training programs in practice as part of a larger pedestrian safety strategy, chiefly due to a lack of resources. However, these development opportunities demonstrably result in an able and experienced staff that can use and combine key data into actionable measures that address safety issues. For example, some cities allocate funding in their budgets to support safety trainings for their staff. Other cities work with professional associations such as the National Association of City Transportation Officials or National Society of Professional Engineers to provide industry-specific safety trainings. Other cities encourage cross-departmental trainings (e.g., public works, and law enforcement staff) to help staff to better understand and analyze pedestrian incident data and reports.

Source: www.pedbikeimages.org/Dan Burden

Figure 10. City Planning Mapping Exercise

Strategy 2: Engage Law Enforcement for Data Collection Efforts

Several successful communities used law enforcement to participate in data collection exercises at specific locations. Law enforcement officers often target areas for enforcement based on available collected data and high-incidence locations. With these statistics they can identify corridors that have speeding concerns, high numbers of pedestrian-involved accidents, vulnerable populations, and other important metrics for transportation planning officials. In one successful community, for example, the public works department teams up with local law enforcement on crosswalk enforcement to collect data on vehicle yield rates. Comparison communities, by contrast, rarely employ similar strategies with law enforcement to actively collect data on drivers and pedestrians.

This strategy has a range of applicability from the community to the regional level depending on local jurisdictional concerns for law enforcement. The cost of implementing this strategy would largely depend on the type of data collection strategies the community prefers. An active data collection strategy involves law enforcement officers at specific locations where they collect specific types of information whereas a passive strategy relies on existing collection methods by law enforcement departments. For example, a targeted data collection campaign may require law enforcement members to receive compensation for overtime labor if the data collection responsibility falls outside their typical duties. However, transportation planning officials may also be able to access the data passively through their department's existing surveys or reports at little to no cost.

Strategy 3: Use Data-Driven Methods for Targeting Safety Improvements

Communities across the sample have benefited from using data-driven methods to identify which safety improvements deserve the most attention in their cities. While various methodologies exist, the study team found that both successful and comparison communities tend to use concrete measures (e.g., linear feet of improved sidewalks, fatal crashes along arterials, or average yield rate at an intersection), traffic studies, and feasibility studies to inform their policy responses as opposed to subjective measures or assessments. These measures enable community leaders to craft appropriate countermeasures required to address pedestrian safety problems at specific locations throughout the city. For example, many successful communities use GIS programming to provide maps that show the locations of sidewalks and traffic signals around the city. These also visually highlight the locations of pedestrian countdown signals, development zones, and pedestrian deficiencies. One additional benefit of this measure is the capability it offers communities to track their progress on pedestrian and traffic issues. While these examples represent the popular features of GIS programming, other communities use this technology to look at sidewalk failures and identify an estimated square footage of the sidewalk needing repairs and upgrades.

In other successful communities, leaders use transportation safety data (e.g., number of traffic-related fatalities per year, and annual percentage of vehicle collision) to guide resource allocation for priority areas such as locations with higher rates of fatalities and areas that require improvement for bicyclists and pedestrian safety. As part of its Vision Zero program, Seattle, Washington, for example, led a comprehensive safety analysis to identify areas of the city that pose the greatest risk for pedestrian and bicyclist crashes. As a result, city officials were able to make recommendations for improvements at these locations to prevent or minimize the incidence of future crashes.[12] Similarly, as part of its SafeAcross initiative, Springfield, Missouri, publishes crosswalk compliance study results on signage to train drivers to recognize crosswalks and yield for pedestrians.[13]

[12] For more information about Seattle's Vision Zero Program, please visit www.seattle.gov/documents/Departments/SDOT/VisionZero/SDOT_Bike%20and%20Ped%20Safety%20Analysis_Ph2_2420%280%29.pdf.

[13] For more information about Springfields' SafeAcross initiative, please visit https://safeacross.com/.

Organizational Structure Strategies

Table 7. Organizational Structure Strategies

Strategy	Comparison Communities	Successful Communities
Coordinate between city departments to capitalize on projects with safety components	Common	Common
Convene citizen and staff committees focused on pedestrian and bicyclist safety	Uncommon	Common
Devote staff to safety projects or establish safety roles and teams	Uncommon	Common

Strategy 1: Coordinate Between City Departments to Capitalize on Projects with Safety Components

Both successful and comparison communities are establishing relationships between city departments and relying on collaboration over competition to conduct joint projects with key safety initiatives and programs. This collaboration can result in opportunities to promote safety through non-transportation planning offices and staff communities can also supplement their own traffic planning staff capacity by relying on the pooled resources of several departments over a single one. For example, Escondido, CA's, traffic engineering department worked with its GIS office during an upgrade to its city's traffic signal communication network. As a result of this collaboration, the traffic engineering staff could broadcast and visualize information to the city's residents about the changes using ArcGIS dashboards, viewers, and story maps in a way they would otherwise be infeasible without the GIS office. This same city's traffic engineering staff stated that support from interdepartmental leadership and collaboration was invaluable in their ability to prioritize safety and pursue different opportunities.

In communities across the sample, city and county agencies work together to develop safety plans and policies to reduce traffic fatalities, solve school pedestrian problems, and provide transportation facilities to accommodate the needs of road users. In other communities, city departments work with Federal agencies like the NHTSA and MPOs to conduct studies aimed at improving pedestrian and bicyclist safety. San Francisco's Municipal Transportation Agency (SFMTA), for example, works with other area agencies, advocacy groups like WalkSF, and broad-based coalitions, a forward-thinking collaboration that has strengthened the city's approach to Vision Zero and ensured community-driven responses to road safety problems. Thanks to SFMTA's partnership with the San Francisco Department of Public Health, the city is directing safety improvements based on some of the best injury data in the country. This strategy has applicability across the local, regional, and State levels, but such measures require significant input from staff in terms of the requisite time, funding, and personnel commitments.

Source: www.pedbikeimages.org/Toole Design Group

Figure 11. Community Input Session

Strategy 2: Convene Citizen and Staff Committees Focused on Pedestrian and Bicyclist Safety

Successful communities commonly establish pedestrian and bicyclist safety citizen advisory boards or coordinate with advocacy groups as a part of their engagement strategy. These communities coordinate efforts with bicycle and pedestrian advocacy groups and as a result they leveraged these groups to arrange public meetings, produce flyers and other safety material, and accomplish an array of other safety-related tasks. Comparison communities, by contrast, generally lack these kinds of committees or advocacy groups. For the relatively few comparison communities that choose to employ this strategy, they use their committees for similar purposes as their successful counterparts.

Advocacy groups tend to consist of residents who have valuable insights to provide city leaders and officials as they plan and build their street and sidewalk networks. Additionally, advocates and leaders can coordinate city-level advisory boards as several communities in this study have done. These communities often establish advisory boards made up of city staff, residents within the community, or a mixture of the two to advise elected officials on pedestrian safety issues or coordinate community events with a safety component. Springfield, for example, has an action group that functions between a city committee and an advocacy group. The group's relationship with the city allows it to participate in sanctioned activism such as posting safety information flyers or engaging motorists while also giving the city access to a vital source of information.

This strategy has minimal costs beyond the time required of people serving on committees and boards. While these boards can form in any community, the makeup and nature of the board, committee, or organization will largely determine the extent of its mandate and capacity to affect positive change. An advisory board that consists of city officials may officially advise the mayor and other city leaders on pedestrian safety issues whereas an advisory board of residents may focus on hosting or organizing community events that help to educate the community about pedestrian safety. Any given community may benefit from several types of advisory boards or committees to approach safety issues from several angles. Ann Arbor, Michigan, for example, has numerous boards and advisory groups that help to steer the city's pedestrian safety activities. One such initiative was the Pedestrian Safety Access Task Force, whose input led to the development of the city's Crosswalk Design Guidelines. The Equitable Engagement Steering Committee provides input to improve the city's outreach efforts and input methods with respect to resident engagement.[14]

Source: www.pedbikeimages.org/Dan Burden

Figure 12. Community Engagement and Planning Exercise

[14] For more information on Ann Arbor's committees, please visit: www.a2gov.org/departments/engineering/pages/crosswalk-design-guidelines-project.aspx and www.a2gov.org/news/pages/article.aspx?i=813

Strategy 3: Devote Staff to Safety Projects or Establish Safety Roles and Teams

Many successful communities have benefited from establishing positions that specifically tackle walkability and pedestrian safety issues. Conversely, several of the comparison communities lack personnel who are dedicated to pedestrian safety outside their other road and transportation priorities. City leaders in other communities may demonstrate their priority for non-motorist safety in transportation planning by creating these kinds of positions. The roles of staff will depend largely on departmental capacity and available funding to hire traffic safety professionals. However, successful communities often have more than one staff member or fully fledged teams devoted to safety projects. Washington, DC, for example, has several roles that primarily work on pedestrian safety initiatives and mobility, including an active transportation manager, a Safe Routes To School team, and a trails team. Consider another example in Arlington County, where pedestrian and walkability initiatives have the support of a committed team of professionals who devote a large portion of their time to improving walking conditions for its residents. The team includes a pedestrian and bicycle planner, a WalkArlington program manager, an active transportation director, and an outreach and events coordinator.

Source: www.pedbikeimages.org/Toole Design Group

Figure 13. Public Engagement and Mapping Exercise

Project Funding Strategies

Table 8. Project Funding Strategies

Strategy	Comparison Communities	Successful Communities
Apply for grants and other available funding opportunities	Common	Common
Establish or identify a dedicated funding source for pedestrian-focused projects	Uncommon	Common

Strategy 1: Apply for Grants and Other Available Funding Opportunities

Transportation planning often requires more funding that exceeds the budgets of local governments. To help supplement funds for safety-focused projects, the study team found that many communities applied for various grant opportunities whenever possible. These communities receive mostly grant funding to implement these policies and projects from government agencies such as NHTSA, MPOs, State DOTs, and independent organizations. Grant-seeking and fundraising efforts vary based on community needs, but many cities take full advantage of different grant opportunities and devote a fair amount of staff time to grant writing and solicitation. Community leaders often use these funds and initiatives to replace worn floor tiles and road surfaces; increase safety awareness among motorists; promote pedestrian-friendly behavior amongst motorists; upgrade traffic signals; and provide other transit-oriented improvements. Many of these projects and improvements are difficult to initiate without grant funding as release of these funds are often conditional on new development. One example of available grant opportunities is the Safe Streets for All grant program, which is administered by the U.S. DOT and directs Federal funds to regional, local, and tribal safety initiatives, particularly those that support pedestrian safety and other vulnerable road users.[15] These opportunities are available at several levels, but individual communities may be ineligible to apply their grants outside their local context. Additionally, the cost of dedicating staff time and effort to grant writing may be a lower priority in certain communities.

[15] For information on the Safe Streets for All grant program, please visit: www.transportation.gov/grants/SS4A.

Source: www.pedbikeimages.org/Toole Design Group

Figure 14. Children Walking to School with a Parent

Strategy 2: Establish or Identify a Dedicated Funding Source for Pedestrian-Focused Projects

Many successful communities have at least one dedicated source of funding such as a sales or gas tax; this allows them to continually improve their pedestrian facilities and safety outcomes. Springfield, has a capital improvement fund dedicated solely to safety-related projects and a separate fund for maintaining its sidewalks and ramps. Comparison communities, by contrast, had fewer dedicated local funding sources to rely on for pedestrian-focused projects. However, both sets of communities sourced funds from the region or county outside the city itself. Sunrise benefits from a surtax that Broward County implements to support transportation improvements. MPOs also provide a funding source for cities to support multimodal regional travel. These funds are limited in their applicability if their eligibility mandates specific purposes (e.g., MPO funds must be dedicated to trails only). Communities can identify or establish consistent funding sources for an array of pedestrian-focused projects. Ultimately, these local funding sources reduce the city's dependency, which may have competing transportation planning priorities. Cities often identify these funding sources in their transportation planning documents and policies. As part of its statewide Pedestrian Safety Action Plan, New York State directed more than $100 million over 5 years specifically to support pedestrian safety projects and activities.[16]

---

[16] For more information on New York's Pedestrian Safety Action plan, please visit: www.ny.gov/programs/pedestrian-safety.

Project Prioritization and Support Strategies

Table 9. Project Prioritization and Support Strategies

Strategy	Comparison Communities	Successful Communities
Prioritize children, elders, and other vulnerable populations	Common	Common
Prioritize opportunities to improve non-motorized travel conditions	Uncommon	Common

Strategy 1: Prioritize Children, Elders, and Other Vulnerable Populations

Both successful and comparison communities have prioritized the safety of vulnerable residents by coordinating their efforts with schools and other community facilities that cater to those populations. For example, DC's Safe Routes to School program offers planning assistance to schools that are seeking to improve safety for students who bike and walk to school. Schools can develop a safety plan for this category of schools, install new ADA-compliant sidewalks, and provide bicyclist education to their students. This exposure to safety-focused education and best practices is particularly beneficial for young people as they form important lifelong habits. Additionally, communities can benefit from prioritizing the needs of its mobility-challenged population or other persons with disabilities who may have unique challenges in the built environment. A representative from Hollywood, FL, for example, stated that the backbone of its safety policy is ADA compliance and accessibility. This community also sets goals for compliance for all its sidewalk areas through an ADA transition plan.

This strategy is applicable for communities at the local level through municipal transportation planning officials. However, communities could work with regional or national organizations and other municipalities to help provide additional scale. These partnerships could enable communities to pursue new avenues for prioritizing vulnerable pedestrian populations. Philadelphia, for example, teamed up with Vision Zero for Youth to analyze data and target safety improvements in locations where children and young pedestrians may face greater risk of pedestrian crashes.[17] Costs for pursuing this strategy will largely depend on the needs of the prioritized population and the kinds of measures that would prove most effective.

[17] For more information on Philadelphia's Vision Zero partnership, please visit: www.pedbikeinfo.org/cms/downloads/PBIC_InfoBrief_VZYPhila.pdf.

Source: www.pedbikeimages.org/Dan Burden

Figure 15. Seniors Walking Across a Non-Signalized Intersection

Strategy 2: Prioritize Opportunities to Improve Non-Motorized Travel Conditions

Successful communities actively look for opportunities to repurpose highways to enhance connectivity for pedestrians and bicyclists as well as improve mobility and accessibility to jobs for people without access to vehicles. In several evaluations of successful communities' pedestrian and bicycle projects, the most heavily weighted factor was safety. Other ways communities prioritize pedestrian safety interventions involve the construction and widening of sidewalks, traffic circles, bike lanes, pedestrian facilities, and trails that connect to parks. These safety-centric decisions inevitably lead to a more pedestrian-friendly community.

Proactive and engaged community leaders serve as the major drivers and advocates of prioritizing and realizing safety improvements in their cities. As a result, residents, motorists, and pedestrians naturally attribute the safer outcomes and greater mobility to these leaders, ultimately improving community relations and mutual trust. Reflecting on this relationship, one city official credited the improvements in the community's road and pedestrian safety facilities and new safety-oriented projects with the close support between the city manager's office and elected city commissioners. Many other successful communities echoed a similar sentiment, including even communities that lacked robust safety policy goals as defined through programs like Vision Zero. The study team found other programs and strategies that city leaders have been using such as GIS programming to develop helpful apps with real-time information for pedestrians. SGY Yields, Springfield's pedestrian safety campaign, is another program that aims to foster increased awareness among motorists and pedestrians and encourage them to look out for one another.

Assessing Community Needs and Capabilities

After reviewing the strategies outlined here, many communities will likely identify some they are already pursuing and others that have yet to join their pedestrian safety programs. Each community is unique and should orient its activities based on local context and needs. Since each community is starting from a different place, the study team believes it can be useful to perform a self-assessment to determine how best to pursue the strategies included in this report. The following section, organized by the strategy areas, includes questions, and prompts that can help communities determine where to devote their resources as they work to improve pedestrian safety.

Community Engagement

Successful communities are using online tools and social media platforms to engage residents. They are also coordinating pedestrian safety messaging through a communications group and leveraging existing resources to interact with community members. Lastly, they are engaging law enforcement for community engagement efforts.

1. Describe your community's public engagement strategy around pedestrian safety. Has this strategy been successful in helping you identify community safety priorities? What are the deficiencies in your current approaches to community engagement?
2. Which of the following public engagement methods are you currently using? Which ones could you use for future outreach efforts? Add other examples of strategies you are (or could be) using.

	Using Now	**Could Be Using**
Public meetings	☐	☐
Workshops/charettes	☐	☐
Pop-up events	☐	☐
Phone or web surveys	☐	☐
Crowdsourcing platforms (e.g., SeeClickFix)	☐	☐
Ambassador programs	☐	☐
Virtual meetings and events	☐	☐
Active transportation-focused events (e.g., open streets)	☐	☐
Other:	☐	☐
Other:	☐	☐
Other:	☐	☐

3. Identify populations in your community that you can reach with tailored outreach and engagement initiatives. These may be populations who are overrepresented in crashes, especially those vulnerable to crash impacts or those traditionally underserved. Consider specific populations and their needs for meetings at certain times of day, in certain locations, and in different languages. Use some of the example populations as a starting point.

Description of population: People with disabilities
Specific needs for engagement/outreach: Community meetings and workshops should take place in locations that are easy to access. Audio visual presentations should accompany accessible materials that allow people with no or low vision, or those with hearing impairments, to participate.

Description of population: Children
Specific needs for engagement/outreach: Events and opportunities focused on schools, events, or other places where children spend a great deal of time. Safe Routes to School Programs that encourage walking/biking to school can offer opportunities for children to engage with these issues and identify opportunities to improve conditions. Age-appropriate messages and activities are instrumental in properly reaching different audiences within this group.

Description of population:
Specific needs for engagement/outreach:
Description of population:
Specific needs for engagement/outreach:
Description of population:
Specific needs for engagement/outreach:

Countermeasures

Successful communities are deploying context-appropriate pedestrian and bicycle facilities to address safety issues. They are developing adequate buffers and circulation networks for pedestrians and bicyclists to navigate their city and developing regular sidewalk and street maintenance programs to better accommodate travel. They are also engaging law enforcement for speed control and education where appropriate and facilitating motorist behavioral change through positive reinforcement. Successful communities are also reducing interaction between motorists and pedestrians to minimize potential conflicts.

- Using the checklist below, describe your community's use of the following design and countermeasure strategies using the three column options (Never Used, Sometimes Used, Often Used) (Zeeger et al., 2013). For more information about these countermeasures and how they work, please visit www.pedbikesafe.org/PEDSAFE/.

	Never Used	Sometimes Used	Often Used
Corridor/Segment			
Sidewalks	☐	☐	☐
Lane reduction/narrowing (e.g., Road Diet)	☐	☐	☐
Access management	☐	☐	☐
Raised medians	☐	☐	☐
Intersections			
Curb radius reduction	☐	☐	☐
Curb extensions	☐	☐	☐
Marked crosswalks	☐	☐	☐
Pedestrian signals	☐	☐	☐
Crossing islands	☐	☐	☐
Pedestrian detection	☐	☐	☐
Roundabouts	☐	☐	☐
Parking restrictions (e.g., "daylighting")	☐	☐	☐
Leading pedestrian interval	☐	☐	☐
Right-turn-on-red restrictions	☐	☐	☐
Left-turn phasing	☐	☐	☐
Raised crossings	☐	☐	☐
Raised intersections	☐	☐	☐
Uncontrolled crossings	☐	☐	☐
Marked crosswalks	☐	☐	☐
Advance stop/yield lines	☐	☐	☐
Median islands	☐	☐	☐
Rectangular rapid flashing beacons	☐	☐	☐
Pedestrian	☐	☐	☐

	Never Used	Sometimes Used	Often Used
In-street signs (R1-6)	☐	☐	☐
Raised crossings	☐	☐	☐
Traffic Calming			
Speed cushions/humps	☐	☐	☐
Mini traffic circles	☐	☐	☐
Chokers	☐	☐	☐
Chicanes	☐	☐	☐
Gateway treatments	☐	☐	☐
Traffic diverters or closures	☐	☐	☐
System-Wide			
Speed management	☐	☐	☐
Lighting and illumination	☐	☐	☐
Automated enforcement	☐	☐	☐
Other:	☐	☐	☐
Other:	☐	☐	☐
Other:	☐	☐	☐

Data Analysis

Successful communities provide ample opportunities for their staff to develop the capacity to identify, analyze, and respond to a range of safety issues. They are using law enforcement as a resource for data collection when appropriate and using data-driven methods to target safety improvements across the city.

1. Describe your most recent efforts to analyze community data to identify safety problems and priorities. What were the key findings? How did this analysis inform your current pedestrian safety initiatives?
2. Using the checklist below, identify the types of data you have available to use for analysis. For those you do not have, consider how they could be collected and used in safety analysis (Gelinne et al., 2017).

	Available	Could Be Collected
Crash Data		
Crash location	☐	☐
Contributing factors and crash types	☐	☐
Environmental and temporal factors	☐	☐
Hospital/health data	☐	☐
Emergency department visits	☐	☐
Severity and nature of injuries	☐	☐
Patient/victim characteristics	☐	☐
Behavioral/Observational Data		
Conflicts between road users	☐	☐
Motor vehicle speeds	☐	☐
Citations	☐	☐
Use of safety equipment (e.g., lights/reflectors)	☐	☐
Volume and Count Data		
Traffic volumes	☐	☐
Pedestrian counts or estimates	☐	☐
Pedestrian crossing counts	☐	☐
Roadway and Inventory Data		
Roadway characteristics	☐	☐
Pedestrian/bicycle facility inventories	☐	☐
Lighting	☐	☐
Parking location and type	☐	☐
Intersection characteristics	☐	☐
Speed limits	☐	☐
Land Use Data		
Land use type	☐	☐
Density and mix of land uses	☐	☐
Building volume/density	☐	☐
Socio-Demographic and Population Data		
U.S. Census Data	☐	☐
American Community Survey	☐	☐
National Household Travel Survey	☐	☐
Transit Data (if applicable)		
Route location and frequency	☐	☐
Stop or station locations and features	☐	☐
Ridership (boarding and alighting)	☐	☐

	Available	Could Be Collected
Number of buses/trains	☐	☐
National transit database	☐	☐

Organizational Structure

Transportation planning staff in successful communities coordinate project planning with other city departments to capitalize on different project opportunities with a safety component. These communities have found success with establishing citizen and staff committees of varying configurations to prioritize pedestrian and bicyclist safety in planning and project development.

1. Using the checklist below as a starting point, identify the agencies, departments, divisions, and organizations in the community that are involved in pedestrian safety initiatives. Using the three columns on the right, indicate how often these agencies coordinate and get involved in these initiatives. Consider how these organizations do (or do not) coordinate regularly on pedestrian safety activities. What opportunities exist to enhance or improve coordination?

	Never	Sometimes	Always
Planning Department	☐	☐	☐
Engineering/Public Works	☐	☐	☐
Transit Agency	☐	☐	☐
Mayor's Office	☐	☐	☐
City/Town Council	☐	☐	☐
Law Enforcement	☐	☐	☐
Public Health Department	☐	☐	☐
Hospitals/Trauma Centers	☐	☐	☐
Pedestrian or Bicyclist Advocacy Organizations	☐	☐	☐
Aging or Disability-Focused Organizations	☐	☐	☐
Other:	☐	☐	☐
Other:	☐	☐	☐
Other:	☐	☐	☐

2. Using the table below, list the resident-led advisory boards, commissions, or task forces that advise the community on issues related to pedestrian safety.

Board/Commission:
Chair/Point of Contact:
Mission and Description of Work:
Board/Commission Name:
Chair/Point of Contact:
Mission and Description of Work:
Board/Commission Name:
Chair/Point of Contact:
Mission and Description of Work:
Board/Commission Name:
Chair/Point of Contact:
Mission and Description of Work:

3. Identify people in various departments that work on pedestrian safety issues. Identify their title, department, and the number of hours per year they devote to pedestrian safety or walkability issues specifically using the table below:

Person:
Position:
Department:
Hours/Year:
Person:
Position:
Department:
Hours/Year:
Person:
Position:
Department:
Hours/Year:
Person:
Position:
Department:
Hours/Year:
Person:
Position:
Department:
Hours/Year:
Person:
Position:
Department:
Hours/Year:

Total Staff Hours per Year Devoted to Pedestrian Safety Issues: _______________

Project Funding

Successful communities apply for grants and other funding opportunities to finance safety projects. These communities are also establishing dedicated funding sources for pedestrian-focused projects whenever possible.

1. Using the table below, identify funding sources currently in use to support pedestrian safety projects and initiatives. Estimate the amount that is available on an annual basis from these sources.

Funding Source:
Description of Projects Supported (or Restrictions):
Amount Available (Annually):
Funding Source:
Description of Projects Supported (or Restrictions):
Amount Available (Annually):
Funding Source:
Description of Projects Supported (or Restrictions):
Amount Available (Annually):
Funding Source:
Description of Projects Supported (or Restrictions):
Amount Available (Annually):
Funding Source:
Description of Projects Supported (or Restrictions):
Amount Available (Annually):

2. What additional funding sources might be available to the community through grant programs, private donors, foundation funding, or other sources? Are there opportunities to collaborate and share funding with other departments on pedestrian safety initiatives?

Conclusion

Pedestrian safety remains a growing concern and high priority for communities across the United States. After a decade of annual increases in the number of people killed while walking, these trends are not only troubling, but they have garnered the attention of transportation professionals from small towns and local communities to big cities and the U.S. DOT. For those following this issue closely, one thing is clear: Something must be done. What is less clear for community leaders, however, are the "right-fit" policy responses and best ways to mobilize resources to improve safety outcomes.

As city leaders and transportation officials look for solutions, a natural temptation may be to focus on areas where the problem seems most pronounced and to attempt to understand what is going wrong. Many other efforts have drawn attention to the locations—particularly cities and States—where the highest share of pedestrian deaths occur every year. Training programs and funding sources are then devoted to redirecting resources to those places where pedestrians appear to face the greatest risk of death or injury.

Another strategy involves the opposite end of the spectrum by looking for success cases. Which communities around the country have succeeded in protecting pedestrians by making walking trips safer? Despite remarkable similarities among peer communities, many cities have seen reductions in pedestrian deaths while others across the nation have experienced rising pedestrian deaths. By identifying these successful communities and examining their programs and best practices, the study team believes it is possible to isolate and share strategies that may prove effective in improving pedestrian safety elsewhere.

This report shares a collection of strategies across different policy responses that can serve as a model and an inspiration to cities and towns striving to make their streets safer for pedestrians. These strategies are intended to be practical and realistic steps that any community can incorporate into its transportation safety programs. They encompass community engagement activities, data collection and analysis methods, countermeasures and design changes, funding ideas for transportation projects, organizational structures, and various methods for supporting and prioritizing safety projects.

The study team recognizes these strategies may serve some communities better than others. It is also likely that some communities are currently implementing any of these strategies today. The study team set out to define and describe the strategies and provide examples of how community leaders are implementing them to achieve better pedestrian safety outcomes. This report also offers an important self-assessment framework, providing an invaluable tool for community and transportation leaders to assess their current capabilities and needs. The objective insights gleaned from this exercise enable community leaders to reorient their safety programs and mobilize resources to align with these strategies. Pedestrian safety in U.S. communities is a complex and dynamic public issue, and the study team recognizes that solutions and policy responses take time, staff, and financial resources. For this reason, leaders and advocates are encouraged to exercise due diligence and take a long-term approach as they look at their existing policies and practices and begin to formulate their strategies for improving pedestrian safety in their communities.

References

Blank, K., Sandt, L. & O'Brien, S. W. (2020). *The role of law enforcement in supporting pedestrian and bicyclist safety: An idea book* (Report Number DOT HS 812 852). National Highway Traffic Safety Administration. https://rosap.ntl.bts.gov/view/dot/49827

Centers for Disease Control and Prevention. (2022, June 6). *Suppression of rates and counts.* [Web page]. www.cdc.gov/cancer/uscs/technical_notes/stat_methods/suppression.htm

Federal Highway Administration (2022). *Moving to a complete streets design model: A report to congress on opportunities and challenges.* https://highways.dot.gov/sites/fhwa.dot.gov/files/2022-03/Complete%20Streets%20Report%20to%20Congress.pdf

Fridman, L., Rothman, L., Howard, A. W., Hagel, B. E., & Macarthur, C. (2021). Methodological considerations in MVC epidemiological research. *Injury Prevention, 27*(2), 155–160. https://doi.org/10.1136/injuryprev-2020-043987

Gelinne, D., Thomas, L., Lang, K., Zegeer, C., & Goughnour, E. (2017). How to Develop a Pedestrian and Bicycle Safety Action Plan. FHWA-SA-17-050. Federal Highway Administration.

Hu, W., & Cicchino, J. B. (2018). *An examination of the increases in pedestrian motor vehicle crash fatalities during 2009–16.* Insurance Institute for Highway Safety Highway Loss Data Institute. www.drivesmartva.org/wp-content/uploads/2018/10/Wen-HU-IIHS-Pedestrian-fatality-trend-study_6th-Distracted-Driving-Summit.pdf

Injury Epidemiology and Surveillance Subcommittee. (2020, February 28). *Nonfatal unintentional motor vehicle traffic-related (MVT) emergency department visits* (ICD-10-CM Injury Surveillance Toolkit). Council of State and Territorial Epidemiologists. https://resources.cste.org/ICD-10-CM/Gen%20Injury%20Indicators/Nonfatal%20Unintentional%20Motor%20Vehicle%20Traffic-related%20(MVT)%20Emergency%20Department%20Visits-UPDATE-2-28-20.pdf

Mertens, W., Recker, J., Kohlborn, T., & Kummer, T. (2016) A Framework for the Study of Positive Deviance in Organizations, *Deviant Behavior*, *37*(11), 1288–1307, https://doi.org/10.1080/01639625.2016.1174519

Michigan Department of Transportation. (2021). *Virtual public involvement benefits and barriers: A practical guide to VPI tools*. www.michigan.gov/-/media/Project/Websites/MDOT/News-and-Outreach/Public-Involvement/Guide-Virtual-Public-Involvement.pdf?rev=825951f16632433589b73160f86a4a6f

National Center for Health Statistics. (2015, November 6). *ICD - ICD-10-CM - International Classification of Diseases (ICD-10-CM/PCS) Transition Background*. Centers for Disease Control and Prevention. www.cdc.gov/nchs/icd/icd10cm_pcs_background.htm

National Highway Traffic Safety Administration (2022). [Untitled web page]. https://www-fars.nhtsa.dot.gov/Main/index.aspx

NHTSA. (2022, October). *National pedestrian safety month 2022 resource guide*. www.trafficsafetymarketing.gov/sites/tsm.gov/files/2022-09/THE%20ABSOLUTE%20FINAL%20Pedestrian%20Toolkit%20Layout_20220901.pdf

NEMSIS Technical Assistance Center. (2021). NEMSIS Public Release Research Data Set V3.4.0 2020 User Manual. University of Utah School of Medicine. https://nemsis.org/wp-content/uploads/2021/05/2020-NEMSIS-RDS-340-User-Manual_v3-FINAL.pdf

NEMSIS Technical Assistance Center. (2022). *2019 data report*. University of Utah School of Medicine. https://nemsis.org/wp-content/uploads/2022/05/NEMSIS-Annual-Public-Data-Report-2019.pdf

Ramsey, K., & Bell, A. (2014). Smart Location Database: Version 2.0 User Guide. US EPA Office of Sustainable Communities. https://edg.epa.gov/EPADataCommons/public/OP/SLD/SLD_userguide.pdf

Sandt, L., & Owens, J. M. (2017). *Discussion guide for automated and connected vehicles, pedestrians, and bicyclists.* Pedestrian and Bicycle Information Center. Schneider, R. J. (2020). United States pedestrian fatality trends, 1977 to 2016. *Transportation Research Record: The Journal of the Transportation Research Board*. https://doi.org/10.1177/0361198120933636

Schneider, R. J., Sanders, R., Proulx, F., & Moayyed, H. (2021). United States fatal pedestrian crash hot spot locations and characteristics. *Journal of Transport and Land Use, 14*(1), 1–23. https://doi.org/10.5198/jtlu.2021.1825

Thomas, L., Sandt, L., Zegeer, Kumfer, W., Lang, K., Lan, B., Horowitz, Z. Butsick, A., Toole, J., & Schneider, R. J. (2018). *Systemic pedestrian safety analysis* (NCHRP Research Report 893). Transportation Research Board.

United States Department of Transportation. (January 2022). *National road safety strategy* [Web page and portal]. www.transportation.gov/NRSS

Zegeer, C. V., Nabors, D., & Lagerwey, P. (2013). *Pedestrian safety guide and countermeasure selection system* [Web page and portal]. Federal Highway Administration. http://www.pedbikesafe.org/pedsafe

Appendix A. Selecting Sites for Comparison

Introduction

The objective of this analysis was to identify a pool of communities to serve as control and comparison sites in the assessment of various approaches to pedestrian safety. The study team used several analysis steps to narrow hundreds of potential communities down to a select few that positively deviate from their peers in terms of pedestrian safety outcomes.

For this analysis, the study team classified 346 cities into 4 groupings for the purpose of identifying communities that have demonstrated more favorable pedestrian fatality trends ("positive deviants") than the U.S. average over the last 12 years (after adjusting for certain salient factors). The results of this analysis served as a guide for subsequent assessment of the communities, in which the study team performed a qualitative and quantitative assessment, respectively, of positive deviant communities and control communities (e.g., communities from different clusters other than the positive deviant cluster, but with similar characteristics regarding population size and socio-demographics).

Data Collection

The study team began this task by collecting data from the 500 Cities Project City Health Dashboard for the 350 cities with the largest populations. The study team omitted 4 cities from the original list of 350 cities. These cities were omitted because the team were unable to locate the city in FARS (i.e., Spokane Valley, Washington, and Jurupa Valley, California) or the city was missing data for a key variable for all years (i.e., Arlington, Virginia, and Ventura, California). The study team extracted relevant population data from the U.S. Census Bureau to supplement the City Health Dashboard variables. The study team also interpolated data for certain years when there were missing entries and developed new variables to account for changes in traffic fatality trends. In total, the study team collected and developed 49 variables for use in the Step 1 analysis. The data dictionary for these variables is available in Table A-1.

Table A-1. Data Dictionary of Variables for Step 1 Analysis

Position	Variable name	Description	Class	Type	Values
1	City	U.S. city	Text	Free text	Free text
2	ST	U.S. State abbreviation	Text	Free text	Free text
3	State	U.S. State (full name)	Text	Free text	Free text
4	Year	Data year	Categorical	Nominal	2008–2019
5	FIPS	Federal Information Processing System (FIPS) codes for geographic areas	Text	Nominal	
6	Geo_ID	Geographic identifiers: numeric codes that uniquely identify all administrative/legal and statistical geographic areas for which the Census Bureau tabulates data	Text	Nominal	

Position	Variable name	Description	Class	Type	Values
7	Region	NHTSA geographic Region	Categorical	Nominal	1–10
8	Ped_Dths	Number of traffic-related pedestrian fatalities per year	Numeric	Continuous	0-∞
9	Ped_4_Yr_Avg	Average number of pedestrian fatalities per 4-year period (2008–2011; 2012–2015; 2016–2019)	Numeric	Continuous	0-∞
10	Ped_12_Yr_Avg	Average number of pedestrian fatalities per 12-year period (2008–2019)	Numeric	Continuous	0-∞
11	Difference	The 12-year pedestrian fatality average minus the pedestrian fatality average for the first 4-year period (2008–2011)	Numeric	Continuous	0-∞
12	Trend	If the 12-year average is greater than 1.1 points (the average difference in the number of pedestrian fatalities across the 12-year span), then the pedestrian fatality trend is "1=increasing;" if it is less than or equal to 1.1 points and greater than or equal to 0 points, then the trend is "2=stable;" if the trend is less than 0 points, then the trend is "3=decreasing."	Categorical	1=increasing 2=stable 3=decreasing	1–3
13	MVC_Dths	Average number of MVC fatalities per 4-year period (2008–2011; 2012–2015; 2016–2019)	Numeric	Continuous	0-∞
14	MVC_4_Yr_Avg	Average number of MVC fatalities per 4-year period (2008–2011; 2012–2015; 2016–2019)	Numeric	Continuous	0-∞
15	MVC_12_Yr_Avg	Average number of MVC fatalities per 12-year period (2008–2019)	Numeric	Continuous	0-∞
16	Fatality_Ratio	Number of pedestrian fatalities divided by total	Numeric	Continuous	0-∞

Position	Variable name	Description	Class	Type	Values
		number of MVC fatalities for 4-year period (2008–2011; 2012–2015; 2016–2019)			
17	No_Vehicle	Percentage of households without vehicle (2008–2019)	Numeric	Continuous	0–100
18	Walkability_Index	Neighborhood amenities accessible by walking as calculated by Walk Score (Index) (2019)	Numeric	Continuous	0–100
19	Pop	Total population (2008–2019)	Numeric	Continuous	0-∞
20	Pop_Den	Population density per square mile (2008–2019)	Numeric	Continuous	0-∞
21	Female_Pop	Percentage of female population in total population (2008–2019)	Numeric	Continuous	0–100
22	Under_18_Pop	Percentage of population aged under 18 years (2008–2019)	Numeric	Continuous	0–100
23	65_Up_Pop	Percentage of population aged 65 years and over (2008–2019)	Numeric	Continuous	0–100
24	Med_Age	Median age (2008–2019)	Numeric	Continuous	0-∞
25	Black_Pop	Percentage of population that is Black or African American (2008–2019)	Numeric	Continuous	0–100
26	Amer_In_Pop	Percentage of population that is American Indian or Alaska Native (2008–2019)	Numeric	Continuous	0–100
27	Asian_Pop	Percentage of population that is Asian (2008–2019)	Numeric	Continuous	0–100
28	Pac_Is_Pop	Percentage of population that is Native Hawaiian or Pacific Islander (2008–2019)	Numeric	Continuous	0–100
29	Other_Race_Pop	Percentage of population that is some other race (2008–2019)	Numeric	Continuous	0–100
30	Multi_Race_Pop	Percentage of population that is two or more races (2008–2019)	Numeric	Continuous	0–100

Position	Variable name	Description	Class	Type	Values
31	Hispanic_Pop	Percentage of population that is Hispanic/Latinx (2008–2019)	Numeric	Continuous	0–100
32	White_Pop	Percentage of population that is White, not Hispanic (2008–2019)	Numeric	Continuous	0–100
33	Foreign_Born	Percent of population that is foreign born (2008-2019)	Numeric	Continuous	0–100
34	Property_Value	Median house value for all owner-occupied housing units (2008–2019)	Numeric	Continuous	0-∞
35	Rent	Median gross rent (2008–2019)	Numeric	Continuous	0-∞
36	Households	Number of households (2008–2019)	Numeric	Continuous	0-∞
37	HH_Size	Average household size (2008–2019)	Numeric	Continuous	0-∞
38	Education	Educational attainment for population 25 years and over: Percentage of population that graduated high school (includes equivalency) or higher degree (2008–2019)	Numeric	Continuous	0–100
39	College	Educational attainment for population 25 years and over: Percentage of population with bachelor's degree or higher degree (2008–2019)	Numeric	Continuous	0–100
40	Unemployment	Unemployment rate for civilian population in labor force 16 years and over (2008–2019)	Numeric	Continuous	0–100
41	Veteran	Population with veteran status for civilian population 18 years and over (2008–2019)	Numeric	Continuous	0-∞
42	Insurance	Percentage of population with health insurance coverage (2008–2019)	Numeric	Continuous	0–100
43	Labor	Percentage of population in labor force for	Numeric	Continuous	0–100

Position	Variable name	Description	Class	Type	Values
		population 16 years and over (2008–2019)			
44	Commute	Average commute to work (in minutes) (2010–2019)	Numeric	Continuous	0-∞
45	HH_Income	Median household income (In 201X inflation adjusted dollars) (2008–2019)	Numeric	Continuous	0-∞
46	Per_Capita_Income	Per capita income (In 201X inflation adjusted dollars) (2008–2019)	Numeric	Continuous	0-∞
47	Poverty	Ratio of income in 201X to poverty level (summarized); percentage of population for whom poverty status is determined (2008–2019)	Numeric	Continuous	0–100
48	ESL	Percentage of population 5 years and over that speaks other languages at home (2010–2019)	Numeric	Continuous	0–100
49	Disability	Percentage of civilian noninstitutionalized population under 65 years with a disability (2012–2019)	Numeric	Continuous	0–100

Cluster Analysis

To identify a potential cluster, or a group of cities with similar properties, that may contain potential positive deviant cities, the study team used a statistical grouping method called k-means clustering. K-means clustering involves hypothesizing that there exists within your dataset some number *k* clusters of entities (in this case, cities) with similar properties (e.g., the statistical distance, sometimes calculated as the Euclidean Distance in Equation 1, is minimal). The model then tests whether a statistically significant number of clusters *k* can in fact be found based on the specified variables.

$$Euclidean\ Distance = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \tag{1}$$

Given that the study team are unaware of how many ways the data can be clustered at the outset, the team tested different hypothesized numbers of clusters (specified by k=n) and explanatory variables that may be used to fit the clusters in sequential simulations. This process allowed the study team to determine if the hypothesized number of clusters is correct. For this analysis, the study team hypothesized that four distinct clusters (shown in Table A-2) exist within the city data and tested relevant traffic fatality data to determine if k=4 data allowed the model to converge with a reasonable fit. It is the study team's hypothesis that the positive deviant cities can be found in the cluster belonging to cities with high or rising levels of active transportation and low or stable pedestrian fatality trends.

Table A-2. Hypothesized Clusters in the Data

	High or Rising Pedestrian Fatality Trends	**Low or Falling Pedestrian Fatality Trends**
High or Rising Levels of Active Transportation	Potentially successful [a]	Successful
Low or Falling Levels of Active Transportation	Unsuccessful	Potentially successful [b]

Notes:

[a] Investigate any community with high or rising levels of active transportation (walking and transit, in particular), even if their pedestrian fatality trends are also high or rising.

[b] Investigate any community with low or falling pedestrian fatality trends, even if its levels of active transportation are low or falling.

To determine if the data contain the four hypothesized distinct clusters, the study team assessed several different parameters in the k-means clustering simulations, including the following:

- Convergence: Using the specified variables, did the data converge into k clusters?
- Pseudo F Statistic: A statistic to compare between different k-values, with larger values indicating a better fit.
- Approximate Expected All-Over R-Squared: A statistic that indicates a general fit to the selected variable set, with larger values indicating a better fit.
- Cubic Clustering Criterion: A statistic indicating appropriate clustering within the data, with large positive values indicating a viable clustering fit.

First, the study team tested for multicollinearity within the traffic fatality variables; the R-Squared and Cubic Clustering Criterion cannot be used to assess fit if the variables used to generate the clusters are highly correlated. For this analysis, the study team used a threshold of r=0.6 to indicate highly correlated variables and excluded any above this threshold. For the cluster analysis, the team retained Fatality_Ratio, increase (a binary variable equal to 1 when Trend equals 1), decrease (a binary variable equal to 1 when Trend equals 3), and difference. The statistics for these variables as captured in the k-means clustering are available in Table A-3.

Table A-3. Fit Statistics for the Variables Used in Cluster Analysis

Statistics for Variables				
Variable	**Total STD**	**Within STD**	**R-Square**	**RSQ/(1-RSQ)**
Fatality Ratio	1.00000	0.98078	0.038760	0.040323
Increase	1.00000	0	1.000000	
Decrease	1.00000	0.95673	0.085327	0.093286
Difference	1.00000	0.43759	0.808657	4.226208
OVER-ALL	1.00000	0.71916	0.483186	0.934932

For the k=4 simulation, the model converged, the Pseudo F Statistic equaled 1292.70, the Approximate Expected All-Over R-Squared equaled 0.45310, and the Cubic Clustering Criterion equaled 11.516. Altogether, the variables indicate that the hypothesis regarding four distinct clusters based on traffic fatality data cannot be rejected. This indicates that k=4 clusters are appropriate based on the study's analyses.

Logistic Regression

After the completion of the cluster analysis, the study team examined the data and determined that Cluster 1 likely contained the positive deviant cities as all cities in this cluster had negative pedestrian fatality trends. A full list of the Cluster 1 cities is available in Table A-4.

Table A-4. U.S. Cities Identified as Being Possible Positive Deviants, as Determined Through K-Means Clustering

Number	U.S. City	U.S. State
1	Allentown	PA
2	Athens	GA
3	Boca Raton	FL
4	Boulder	CO
5	Buffalo	NY
6	Cape Coral	FL
7	Clarksville	TN
8	Clovis	CA
9	College Station	TX
10	Coral Springs	FL
11	Corona	CA
12	El Monte	CA
13	Elgin	IL
14	Elizabeth	NJ
15	Escondido	CA
16	Eugene	OR
17	Fargo	ND
18	Hampton	VA
19	High Point	NC
20	Hollywood	FL
21	Honolulu	HI
22	Inglewood	CA
23	Joliet	IL

Number	**U.S. City**	**U.S. State**
24	Lafayette	LA
25	Laredo	TX
26	Lawrence	KS
27	Lee's Summit	MO
28	Livonia	MI
29	Longmont	CO
30	Lowell	MA
31	Lynn	MA
32	McKinney	TX
33	New Bedford	MA
34	Orem	UT
35	Overland Park	KS
36	Pembroke Pines	FL
37	Plano	TX
38	Providence	RI
39	Provo	UT
40	Renton	WA
41	Rio Rancho	NM
42	Roseville	CA
43	San Mateo	CA
44	Sandy Springs	GA
45	Santa Clara	CA
46	Santa Maria	CA
47	South Gate	CA
48	Springfield	MO
49	St. Paul	MN
50	Sugar Land	TX
51	Sunrise	FL
52	Temecula	CA
53	Virginia Beach	VA
54	Washington	DC
55	West Jordan	UT

Number	U.S. City	U.S. State
56	Wichita Falls	TX
57	Yuma	AZ

To determine whether a distinct group of positive deviant cities exists within this cluster, the study team then built a logistic regression model using all the variables in Table A-1 as explanatory variables and a binary variable indicating whether the city was in Cluster 1 (1) or not (0) as the dependent variable. Logistic regression is useful for calculating the log odds that a specific variable increases the likelihood of the response variable being in one category or another. In this case, statistically significant ($p<0.05$) variables can increase or decrease the log odds of a city being in Cluster 1 or not. The generic version of the logistic regression model to be developed by this process is shown in Equation 2.

$$\log \frac{\Pr\,(Y=Cluster\ 1)}{\Pr\,(Y=Other\ Clusters)} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots \beta_n X_n \qquad (2)$$

where:
Pr(Y=Cluster 1) is the probability that a city is in Cluster 1
Pr(Y=Other Clusters) is the probability that a city is in a different cluster α is the intercept
β_n is the partial slope coefficient for variable X_n
X_n is the estimate for the value of variable n

To identify statistically significant variables, the study team used backward elimination, removing variables one-by-one until only those that met the $p<0.05$ criteria and provided an improved model fit—indicated by a lower Akaike information criterion (AIC) than that of the initial model—remained in the variable list. The final model had an AIC value of 479.633 and no missing observations. The final variable set, coefficient estimates, confidence intervals, and p-values are available in Table A-5. Specific definitions for each of these variables are available in Table A-1.

Table A-5. Final Variable Set for Cluster Logistic Regression Model

Parameter	Categorical Level	Cluster Bin	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	n.a.	1	1	2.3143	12.0118	0.0371	0.8472
Ped_12_Yr_Avg	n.a.	1	1	1.6531	0.5453	9.1912	0.0024
MVC_12_Yr_Avg	n.a.	1	1	-1.5244	0.1890	65.0776	<.0001
No_Vehicle	n.a.	1	1	-0.2466	0.0596	17.1141	<.0001
Walkability_Index	n.a.	1	1	0.0499	0.0224	4.9610	0.0259
Female_Pop	n.a.	1	1	-0.5561	0.1707	10.6156	0.0011
Pop_65_Up	n.a.	1	1	-1.1528	0.1559	54.6454	<.0001
Med_Age	n.a.	1	1	0.5885	0.0996	34.9452	<.0001
Black_Pop	n.a.	1	1	0.3771	0.0598	39.7222	<.0001

Parameter	Categorical Level	Cluster Bin	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Amer_In_Pop	n.a.	1	1	-0.6220	0.2465	6.3690	0.0116
Pac_Is_Pop	n.a.	1	1	3.4577	0.3716	86.5843	<.0001
Other_Race_Pop	n.a.	1	1	0.2800	0.0500	31.3589	<.0001
Multi_Race_Pop	n.a.	1	1	0.2979	0.1463	4.1451	0.0418
Hispanic_Pop	n.a.	1	1	0.1717	0.0369	21.6124	<.0001
White_Pop	n.a.	1	1	0.5121	0.0687	55.4790	<.0001
Foreign_Born	n.a.	1	1	0.3276	0.0731	20.0712	<.0001
Property_Value	n.a.	1	1	-0.00002	3.089E-6	43.0213	<.0001
Rent	n.a.	1	1	0.00935	0.00162	33.1621	<.0001
Households	n.a.	1	1	0.000036	0.000012	8.3047	0.0040
HH_Size	n.a.	1	1	3.9911	1.4411	7.6700	0.0056
College	n.a.	1	1	-0.1274	0.0343	13.8110	0.0002
HH_Income	n.a.	1	1	-0.00018	0.000044	15.8098	<.0001
Commute	n.a.	1	1	-0.2955	0.0478	38.2508	<.0001
Per_Capita_Income	n.a.	1	1	0.000353	0.000096	13.5076	0.0002
ESL	n.a.	1	1	0.1131	0.0538	4.4136	0.0357
Disability	n.a.	1	1	0.3582	0.1077	11.0634	0.0009
Difference	n.a.	1	1	-33.5433	2.7686	146.7865	<.0001
Labor	n.a.	1	1	-0.6739	0.0849	63.0753	<.0001
Region	1	1	1	0.9415	1.7591	0.2864	0.5925
Region	2	1	1	-16.1630	2.1853	54.7058	<.0001
Region	3	1	1	9.8732	1.3602	52.6868	<.0001
Region	4	1	1	0.0751	0.9059	0.0069	0.9340
Region	5	1	1	-5.7818	1.0744	28.9586	<.0001
Region	7	1	1	-0.9718	1.0757	0.8162	0.3663
Region	8	1	1	-2.9961	1.0716	7.8177	0.0052
Region	9	1	1	-2.4384	0.8524	8.1831	0.0042
Region	10	1	1	-9.5302	1.4222	44.9051	<.0001
Insurance	n.a.	1	1	0.1775	0.0542	10.7207	0.0011

Deviant Identification

After the completion of the logistic regression model, the study team took the completed equation and reapplied it to the full city dataset to generate a set of predictions regarding which cities likely fit completely into Cluster 1. Based on the model parameters, only 22 cities fit fully into Cluster 1. Table A-6 displays the total list of U.S. cities identified as being probably positive deviants. The study team hypothesized approximately 20 cities would fit the criteria of positive deviance. As a result, this list of 22 cities likely includes the study team's target cities. Due to the project timeline and resources available, however, the team decided to further decrease the number of cities for analysis in Step 2.

Table A-6. U.S. Cities Identified as Being Probable Positive Deviants, as Determined Through K-Means Clustering

Number	U.S. City	U.S. State
1	Boulder	CO
2	El Monte	CA
3	Elizabeth	NJ
4	Escondido	CA
5	Fargo	ND
6	Hollywood	FL
7	Joliet	IL
8	Lafayette	LA
9	Laredo	TX
10	Lee's Summit	MO
11	McKinney	TX
12	New Bedford	MA
13	Orem	UT
14	Pembroke Pines	FL
15	Provo	UT
16	Sandy Springs	GA
17	Santa Clara	CA
18	Santa Maria	CA
19	South Gate	CA
20	Springfield	MO
21	Sunrise	FL
22	Washington	DC

Table A-7 displays the list of 22 positive deviant cities, their respective States and NHTSA geographic regions, and the values and Z-scores for the variables Walkability, Property_Value, Black_Pop, Education, Poverty, and ESL. The study team selected these specific variables to target a geographically and socio-demographically diverse group of cities. Ultimately, it is the purpose of the Step 1 analysis and the ensuing qualitative and quantitative analyses in Steps 2 and 3 to identify the factors that have resulted in these cities performing better than their peers regarding pedestrian fatality trends over the last 12 years. The cities that were selected for participation in the Qualitative analysis are highlighted and bolded in Table A-7.

The final task was to recommend four comparison cities for each positively deviant city for the qualitative analysis. To accomplish this task, the study team ran a k-means clustering model using the pedestrian fatality measures and the variables Walkability_Index, Property_Value, Black_Pop, Education, Poverty, Region, and ESL. The study team avoided matching on the entire covariate dataset to prevent overmatching deviant and "control" cities. For each deviant, starting in alphabetical order, the study team selected the four cities with the shortest distance from the centroid of the cluster. If a control city had already been matched with a deviant, it was ineligible for matching with other deviant cities. Table A-8 displays the results of the matching process. For all positive deviant and control cities, the study team abstracted information from relevant documents (e.g., city pedestrian safety action plans, transit plans, and zoning laws) and contacted each city regarding its power distribution and process, regulatory environment, built environment, land use, and community investment and disinvestment.

Table A-7. Values and Z-Scores for the U.S. Cities Identified as Being Probable Positive Deviants

#	U.S. City	U.S. State	NHTSA Region	Values						Z-scores					
				Walkability_ Index	Property_ Value	Black_Pop	Education	Poverty	ESL	Walkability_ Index	Property_ Value	Black_Pop	Education	Poverty	ESL
1	Boulder	CO	8	56.6	$700,000	1.2	96.9	20.4	15.3	0.92	2.89	-0.92	1.52	0.47	-0.71
2	El Monte	CA	9	61.7	$454,900	0.6	58.9	19.5	84.0	1.26	1.32	-0.96	-3.36	0.35	2.95
3	Elizabeth	NJ	2	80.6	$282,700	19.5	73.4	17.6	75.5	2.53	0.22	0.20	-1.50	0.08	2.49
4	**Escondido**	**CA**	**9**	**43.5**	**$335,900**	**2.4**	**72.2**	**19.8**	**47.4**	**0.04**	**0.56**	**-0.84**	**-1.66**	**0.38**	**1.00**
5	**Fargo**	**ND**	**8**	**43.9**	**$212,100**	**7.0**	**94.3**	**13.2**	**9.2**	**0.07**	**-0.24**	**-0.56**	**1.17**	**-0.54**	**-1.03**
6	**Hollywood**	**FL**	**4**	**53.8**	**$254,000**	**18.2**	**87.4**	**12.7**	**50.3**	**0.73**	**0.03**	**0.12**	**0.29**	**-0.62**	**1.16**
7	**Joliet**	**IL**	**5**	**34.8**	**$181,100**	**17.1**	**84.2**	**10.9**	**28.7**	**-0.54**	**-0.44**	**0.05**	**-0.11**	**-0.87**	**0.01**
8	**Lafayette**	**LA**	**6**	**31.3**	**$195,400**	**30.9**	**89.5**	**19.7**	**9.3**	**-0.78**	**-0.34**	**0.89**	**0.57**	**0.37**	**-1.03**
9	Laredo	TX	6	43.3	$129,900	0.5	68.6	26.7	89.6	0.03	-0.76	-0.96	-2.12	1.36	3.25
10	Lee's Summit	MO	7	22.4	$200,300	7.9	96.6	5.5	5.7	-1.37	-0.31	-0.51	1.47	-1.62	-1.22
11	**McKinney**	**TX**	**6**	**26.5**	**$228,500**	**11.3**	**91.9**	**7.0**	**20.4**	**-1.10**	**-0.13**	**-0.30**	**0.87**	**-1.42**	**-0.43**
12	**New Bedford**	**MA**	**1**	**65.6**	**$226,900**	**7.0**	**76.4**	**20.3**	**36.8**	**1.52**	**-0.14**	**-0.57**	**-1.12**	**0.45**	**0.44**
13	**Orem**	**UT**	**8**	**43.2**	**$207,400**	**1.0**	**91.4**	**16.9**	**19.1**	**0.02**	**-0.27**	**-0.93**	**0.81**	**-0.03**	**-0.51**
14	Pembroke Pines	FL	4	31.8	$275,900	21.7	83.7	6.5	48.7	-0.74	0.17	0.34	-0.19	-1.49	1.07
15	Provo	UT	8	46.6	$247,100	0.8	92.4	25.9	21.6	0.25	-0.01	-0.94	0.93	1.25	-0.37
16	Sandy Springs	GA	4	26.9	$471,800	18.6	94.6	7.6	24.3	-1.07	1.43	0.14	1.22	-1.34	-0.23
17	Santa Clara	CA	9	58.0	$1,034,000	3.0	92.8	6.7	54.0	1.01	5.04	-0.81	0.98	-1.46	1.35
18	Santa Maria	CA	9	46.9	$297,200	1.3	59.3	18.6	64.4	0.27	0.31	-0.91	-3.31	0.23	1.90
19	South Gate	CA	9	69.6	$351,000	0.9	54.4	19.3	88.7	1.79	0.66	-0.93	-3.94	0.32	3.20
20	**Springfield**	**MO**	**7**	**38.2**	**$118,100**	**4.4**	**90.5**	**22.9**	**5.6**	**-0.31**	**-0.84**	**-0.72**	**0.68**	**0.83**	**-1.22**
21	**Sunrise**	**FL**	**4**	**36.9**	**$205,100**	**35.2**	**87.8**	**12.3**	**42.2**	**-0.40**	**-0.28**	**1.16**	**0.34**	**-0.68**	**0.73**
22	**Washington**	**DC**	**3**	**75.9**	**$601,500**	**46.3**	**90.9**	**16.2**	**17.2**	**2.21**	**2.26**	**1.84**	**0.75**	**-0.11**	**-0.61**
Mean value for 346 cities				42.9	$248,935	16.2	85.1	17.0	28.6						
Standard deviation for 346 cities				14.9	$155,814	16.4	7.8	7.1	18.8						

Table A-8. Positively Deviant U.S. Cities and Their Matches

#	Deviant/Match	U.S. City	U.S. State	NHTSA Region	Distance	2019 Total Population	2019 Population Density
1	**Deviant**	**El Monte**	**CA**	**9**	**23.63**	**115,517**	**12,080.39**
	Matches	Port St. Lucie	FL	4	23.70	189,396	1,588.86
		Paterson	NJ	2	23.78	145,710	17,319.19
		Inglewood	CA	9	23.79	109,613	12,087.92
		Santa Clara	CA	9	24.03	127,721	7,007.80
2	**Deviant**	**Escondido**	**CA**	**9**	**10.47**	**151,300**	**4,054.74**
	Matches	Roanoke	VA	3	10.46	99,229	2,333.64
		Coral Springs	FL	4	10.46	132,568	5,797.99
		Aurora	IL	5	10.42	199,927	4,441.95
		South Bend	IN	5	10.42	102,037	2,431.63
3	**Deviant**	**Fargo**	**ND**	**8**	**12.09**	**121,889**	**2,450.36**
	Matches	Chico	CA	9	12.08	94,529	2,824.92
		Meridian	ID	10	12.08	101,905	2,999.98
		Killeen	TX	6	12.10	145,686	2,670.94
		Ontario	CA	9	12.07	176,760	3,537.82
4	**Deviant**	**Hollywood**	**FL**	**4**	**20.59**	**152,511**	**5,592.80**
	Matches	Pearland	TX	6	20.61	122,078	2,534.85
		Fontana	CA	9	20.53	210,759	4,893.23
		Palm Bay	FL	4	20.67	111,997	1,145.06
		Victorville	CA	9	20.68	121,902	1,655.85
5	**Deviant**	**Joliet**	**IL**	**5**	**9.24**	**147,826**	**2,304.31**
	Matches	Vancouver	WA	10	9.23	180,556	3,704.18
		Salt Lake City	UT	8	9.22	197,756	1,786.44
		Baton Rouge	LA	6	9.22	224,149	2,592.84
		Milwaukee	WI	5	9.27	594,548	6,181.38
6	**Deviant**	**Lafayette**	**LA**	**6**	**5.39**	**126,666**	**2,282.45**
	Matches	Pompano Beach	FL	4	5.42	110,062	4,582.48
		Tallahassee	FL	4	5.33	191,279	1,903.77
		Norman	OK	6	5.28	122,837	686.90
		Mesquite	TX	6	5.28	143,456	3,035.99

#	Deviant/Match	U.S. City	U.S. State	NHTSA Region	Distance	2019 Total Population	2019 Population Density
7	**Deviant**	**McKinney**	**TX**	**6**	**12.97**	**182,055**	**2,719.69**
	Matches	Waco	TX	6	12.98	135,858	1,528.97
		Evansville	IN	5	12.94	118,588	2,506.20
		Fayetteville	NC	3	12.93	210,432	1,423.31
		Worcester	MA	1	12.88	185,143	4,955.64
8	**Deviant**	**New Bedford**	**MA**	**1**	**12.06**	**95,239**	**4,761.97**
	Matches	High Point	NC	3	12.04	111,714	1,995.46
		Rockford	IL	5	12.01	147,070	2,284.45
		Alexandria	VA	3	12.13	157,613	10,553.83
		Temecula	CA	9	11.96	113,381	3,042.35
9	**Deviant**	**Orem**	**UT**	**8**	**11.95**	**96,725**	**5,234.98**
	Matches	Lancaster	CA	9	11.94	159,028	1,686.74
		Albany	NY	2	11.96	97,478	4,554.44
		Gresham	OR	10	11.92	110,494	4,731.70
		Chandler	AZ	9	11.86	252,692	3,880.19
10	**Deviant**	**Springfield**	**MO**	**7**	**9.53**	**167,051**	**2,027.52**
	Matches	Little Rock	AR	7	9.50	197,958	1,649.76
		Concord	CA	9	9.48	129,183	4,227.77
		Clovis	CA	9	9.64	109,160	4,295.99
		Davenport	IA	7	9.42	102,169	1,607.97
11	**Deviant**	**Sunrise**	**FL**	**4**	**7.72**	**94,060**	**5,812.13**
	Matches	Tuscaloosa	AL	4	7.71	99,390	1,606.99
		Springfield	IL	5	7.71	115,888	1,901.57
		Lowell	MA	1	7.73	111,306	8,180.04
		Athens	GA	4	7.83	124,719	1,072.12
12	**Deviant**	**Washington**	**DC**	**3**	**15.93**	**692,683**	**11,330.28**
	Matches	Lee's Summit	MO	7	16.02	97,275	1,524.24
		Brockton	MA	1	15.84	95,594	4,481.12
		Roswell	GA	4	15.83	94,498	2,320.75
		San Jose	CA	9	16.14	1,027,690	5,779.77

Appendix B. Factors Associated With Safety Outcomes Among Positive Deviant communities

Introduction

The objective of this analysis was: (1): Analyze National Emergency Medical Services Information System data to compare the incidence of pedestrian injuries among positively deviant communities with their matches identified in Tasks Three and Four of this project; and (2) Expand upon the multivariable logistic regression analyses performed in Appendix A to identify additional factors associated with safety outcomes among the positively deviant communities (as compared to their matches).

Analysis of NEMSIS Data

Background

While motor vehicle crash injury surveillance studies often use mortality data sources such as FARS—as these data sources are often the only ones available at the population-level—deaths represent the apex of the injury pyramid in terms of the total Burden of injury (Fridman et al., 2021). Pedestrian fatalities are relatively rare events, with 4,000 to 6,500 fatalities observed each year across the entire United States (NHTSA, 2022). Outside of many metropolitan centers, many communities have annual pedestrian fatality counts of less than five per year, resulting in unstable annual rates and precluding the examination of annual temporal trends and necessitating the collapsing across 3, 5, or 10 years of data (Centers for Disease Control and Prevention, 2022). Therefore, morbidity data sources such as emergency department visits, hospitalizations, and EMS data are important for tracking pedestrian safety trends.

The study team analyzed EMS activations for the positively deviant communities identified in Steps Three and Four of this project to identify differences in pedestrian morbidity across the two types of communities. As a reminder, the study team identified positive deviant communities as those communities with low, stable, or falling pedestrian fatality trends using a statistical grouping method called k-means clustering. While the study team initially identified 22 communities that met the study criteria, the team ultimately selected 12 positively deviant communities due to resource constraints. For these communities the study team used U.S. Census variables such as "Property Value" and "Percent Black Population" to ensure a diverse array of communities were selected for further analysis. For each positively deviant community, the study team selected four "match" communities.

Methods

The study team obtained information on EMS activations by NEMSIS, a NHTSA-funded program that collects, processes, and analyzes EMS data from the U.S. States and Territories for the purpose of improving patient care and pre-hospital outcomes (NEMSIS Technical Assistance Center, 2021). The study team selected data for the calendar years 2017 to 2020 for all positively deviant cities and their matches. The study team did not examine data pre-2017 because there were two major transitions during 2015 and 2016: (1) the transition from the 9th Revision of the International Classification of Diseases Clinical Modification (ICD-9-CM) to the 10th Revision (ICD-10-CM), the U.S.'s system for classifying diseases, injuries, health encounters, and procedures, and (2) the transition from NEMSIS Version 2 to Version 3 (National Center for Health Statistics, 2015; NEMSIS Technical Assistance Center, 2021). The study team defined pedestrian and motor vehicle crash injuries as EMS activations containing an ICD-10-CM external cause of injury code for a motor vehicle traffic-related injury (Table B-1) (Injury Epidemiology and Surveillance Subcommittee, 2020).

To compare pedestrian morbidity outcomes across the positively deviant and match cities, the study team calculated population-based rates per 100,000 for both EMS activations and deaths as reported by NEMSIS and FARS, respectively, using U.S. Census data as population denominators. The study team also calculated the ratio of pedestrian injuries to total motor vehicle crash injuries and the ratio of pedestrian injuries to deaths among the positively deviant and match communities.

It is worth noting that unlike FARS data and many hospital and emergency department discharge data sources, NEMSIS data are **not** population-based. NEMSIS only collects data from participating EMS agencies. While NEMSIS coverage has increased in recent years, with all 50 States participating as of 2020, the study team cannot confirm that data from all positively deviant cities and their matches are included in the study's results; the primary reason for this lies in the fact that the data was dichotomized into deviant and match cities before release to maintain the anonymity of the data. Additionally, there are known issues with data gaps and data quality in NEMSIS with variable quality across reporting EMS agencies (NEMSIS Technical Assistance Center, 2021). The primary responsibility of individual EMS agencies lies in responding and transporting patients quickly and safely to definitive care. While important, data quality naturally becomes a secondary responsibility. It is not uncommon for EMS responses to have descriptions and coding in a variety of ways. Furthermore, the unit of analysis lies at the event level rather than the patient level. An injured patient can appear several times in the dataset as the person could have been involved in more than one crash over the 4-year period. Several agencies may also respond to the same event, resulting in the possibility of duplicate records. Given this context, the term "injuries" will be used throughout this memo for simplicity and does not always represent an entirely accurate characterization (NEMSIS Technical Assistance Center, 2022).

Table B-1. ICD-10-CM Codes for Unintentional Motor Vehicle Traffic-Related Injuries

ICG-10-CM Code	Injury Mechanism
V02.1, V02.9, V03.1, V03.9, V04.1, V04.9, V09.2, V09.3	MVT Pedestrian
V12-V14 (.3-.9), V19.4-V19.6, V19.9	MVT Pedal cycle
V20-V28 (.3-.9), V29.4-V29.9	MVT Motorcycle
V30-V79 (.4-.9), V83-V86 (.0-.3), V87.0-V87.8, V89.2	MVT Occupant
V80.3-V80.5, V81.1, V82.1	MVT Other

Results

Table displays the results of the NEMSIS data. The study team found that the positively deviant cities had five times the morbidity rate of the match cities. However, the team believes that the low rate observed among the match cities is inaccurate. For one reason, the study team identified a larger number of pedestrian fatalities than injuries among the match cities during the years 2017–2020. While this is not impossible, it is unlikely. For this reason, as well as NEMSIS's stated limitations regarding data collection and quality, the study team are unable to draw any definitive conclusions from the NEMSIS data (NEMSIS Technical Assistance Center, 2021). Nevertheless, the study team found that the positively deviant cities had a lower fatality rate and a lower ratio of pedestrian fatalities to total motor vehicle crash fatalities than the match cities during the period 2017–2020. This finding is encouraging as the team had not included the 2020 FARS data in the initial analysis.

*Table B-2. Comparison of Injuries and Fatalities Related to Pedestrian and Motor Vehicle Crashes Across Positively Deviant and Match Communities, 2017–2020**

	EMS Activations (NEMSIS)					**Fatalities (FARS)**					**Ped Fatalities/Ped Injuries**
Category	**Ped Injuries**		**MVC Injuries**		**Ped/MVC Injuries**	**Ped Fatalities**		**MVC Fatalities**		**Ped Fatalities/MVC Fatalities**	
	No.	**Rate**	**No.**	**Rate**		**No.**	**Rate**	**No.**	**Rate**		
Positive Deviant City	711	33.37	13,932	653.87	0.051	145	6.81	535	25.11	0.271	0.20
Match City	644	5.88	13,510	123.25	0.048	1,095	10.00	3,720	33.94	0.294	1.70
Total	1,355	10.35	27,442	250.35	0.049	1,240	9.47	4,255	32.50	0.291	0.92

*All reported rates are per 100,000 population (U.S. Census).

Characteristics of Positively Deviant Communities

Background

In this analysis, the study team aggregated and analyzed new data from the U.S. Environmental Protection Agency (EPA)—the Smart Location Database and the NAVSTREETS database—to answer two questions.

- Are there additional data points that may be significant predictors of positive pedestrian safety outcomes among positive deviant cities as compared to "match" cities (e.g., cities with outwardly similar characteristics [as identified in Task 3], but worse pedestrian safety outcomes)?
- Can the analysis of these data points identify any critical aspects of practice in the positively deviant cities that correspond to better pedestrian safety outcomes?

To answer these questions, the study team developed a new binary logistic regression model using "deviant" as the dependent binary variable and following a similar procedure from the Task 3 analysis.

After 61 different model iterations, the study team settled on a logistic regression model with 4 statistically significant ($p<0.05$) independent variables. This model used a sample of 60 cities (12 deviants and 48 matches) and had a chi-square likelihood ratio of 21.6116 ($p=0.0002$) and a Wald value of 9.3127 ($p=0.0537$), indicating a generally good fit with some variance remaining in the model. A larger sample likely would have provided a better fit.

Table B-3 shows the model results. The four statistically significant variables are E5_Svc, E8_off, DIC5_ENT, and D5CRI. The sign of the estimate indicates whether the variable increased the log odds of the city being either a deviant (+) or a match (-). Table B-4 shows odds ratio estimates. Note the intercept for this model was not statistically significant.

Table B-3. Analysis of Maximum Likelihood Estimates

Parameter	PDCat	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	Deviant	1	-0.9861	0.6347	2.4139	0.1203
E5_Svc	Deviant	1	-0.00008	0.000029	6.7631	0.0093
E8_off	Deviant	1	0.000304	0.000101	9.1143	0.0025
D1C5_ENT	Deviant	1	-0.0928	0.0355	6.8110	0.0091
D5CRI	Deviant	1	0.0423	0.0177	5.7156	0.0168

The first three variables in the model likely indicate exposure measures. The concentration of service employment (E5_Svc) and entertainment employment (D15C_ENT) decreases the log odds of a city being a deviant, while the concentration of office employment increases the log odds of a city being a deviant. It is hard to glean guidance from these variables as they likely relate to trip attraction and generation but fail to provide sufficient specificity for pedestrians.

The fourth variable, however, may indicate a more tangible aspect of positively deviant cities. That variable, D5CRI, is a measure of the regional centrality index of census block groups for automobile access. The lower the score, the less accessible by automobile census blocks. Interestingly, this variable increases the log odds of a city being a deviant. A possible explanation for this could be that census blocks that are less accessible by automobile are likely to be safer for pedestrians. Therefore, cities may consider vehicular accessibility when intending to improve pedestrian safety. In the absence of additional research into this variable, however, the research team is unable to draw further conclusions.

Table B-4. Odds Ration Estimates

Effect	**PDCat**	**Point Estimate**	**95% Wald Confidence Limits**	
E5_Svc	Deviant	1.000	1.000	1.000
E8_off	Deviant	1.000	1.000	1.001
D1C5_ENT	Deviant	0.911	0.850	0.977
D5CRI	Deviant	1.043	1.008	1.080

DOT HS 813 463
July 2023

U.S. Department
of Transportation

National Highway
Traffic Safety
Administration

NHTSA

15927-061623-v2