2018 CITY OF MINNEAPOLIS

VISION ZERO CRASH STUDY

COMPLETED BY:

Minneapolis
City of Lakes

PREPARED BY:

Kimley»Horn

VISION ZERO
MINNEAPOLIS

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EXECUTIVE SUMMARY

On September 20, 2017 the City Council passed a Vision Zero resolution with the commitment to eliminate fatalities and severe injuries that are a result of crashes on Minneapolis streets by 2027. The Vision Zero Crash Study identifies trends, contributing factors, and characteristics of bicycle and vehicle crashes in Minneapolis over the past 10 years. This study builds on the Pedestrian Crash Study completed in 2017 and will inform upcoming efforts to achieve the Vision Zero goal.

Minneapolis Streets are Safer than Most Cities, but Crashes Increased in Recent Years

- **AN AVERAGE OF 95 PEOPLE PER YEAR WERE KILLED OR SEVERELY INJURED IN TRAFFIC CRASHES** on city streets from 2007 to 2015. Traffic deaths per capita in Minneapolis is lower than most peer cities, the state, and country, but higher than St. Paul, Hennepin County as a whole, and the metro area.
- **BICYCLING IS GETTING SAFER.** Bicycle crashes have generally declined even as biking has increased. The ratio of bicycle commuters to bicycle crashes was about 3.5 times better in 2013-2017 than it was in 1993-1997. A bicyclist was killed or severely injured every 24 days on average and there was a reported bicycle crash every 36 hours.
- **VEHICLE CRASHES HAVE INCREASED, BUT FATAL AND SEVERE INJURY CRASHES HAVE DECLINED.** There were 11 percent more vehicle crashes on average from 2013-2015 than from 2007-2012, but 14 percent fewer people were killed or severely injured on average from 2013-2015 than the earlier period. A motorist was killed or severely injured in a crash every seven days on average.
- **PEDESTRIAN CRASHES HAVE INCREASED RECENTLY.** Pedestrian crashes declined more than 40 percent from an average of 414 from 1993-1997 to 235 from 2008-2012. However, pedestrian crashes have increased again since 2015. A pedestrian was killed or severely injured every 13 days on average.

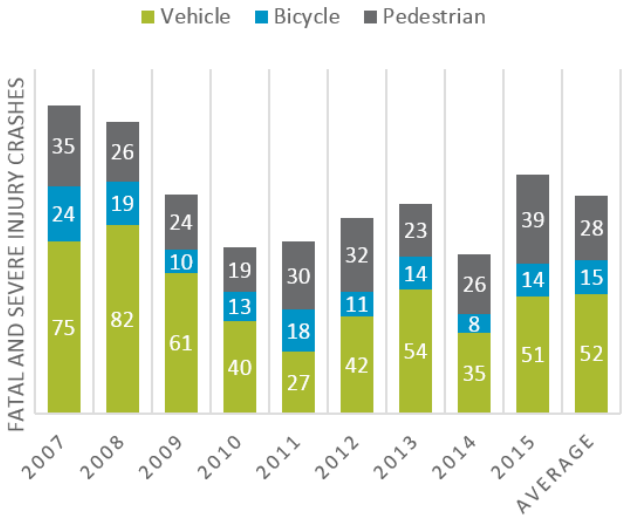


Figure ES-1. Number of Fatal and Severe Injury Crashes (2007-2015)

Source for Crash Data: Vision Zero 10-Year Dataset

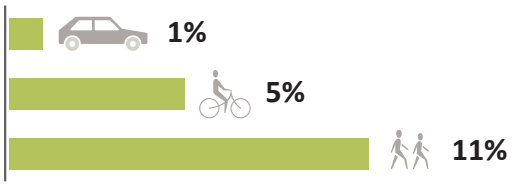


Figure ES-2. Percent of Crashes Resulting in Severe Injury or Death by Mode (2007-2016)

Crash Causes

- Motorists had a contributing factor in 70 percent of bicycle crashes while bicyclists had a contributing factor in 45 percent of crashes.
- The most common vehicle contributing factors were failing to yield the right of way and disregarding a traffic control device.
- The most common bicycle contributing factors were entering the crosswalk from an unexpected direction, disregarding traffic control devices, and failing to yield the right of way.

Where Crashes are Occurring

36% OF VEHICLE, PEDESTRIAN AND BICYCLE CRASHES OCCUR ON 2% OF STREETS THAT CARRY 10% OF TRAFFIC.

- They are most concentrated in areas with more residents with **LOW INCOME**.
- More than 80 percent of all crashes happened at intersections. More than 50 percent of crashes happened at **INTERSECTIONS WITH TRAFFIC SIGNALS**, though they are only 12 percent of intersections.
- Generally, streets with **HIGHER SPEED LIMITS** had more crashes per mile.
- Both one-way and two-way **STREETS WITH FEWER VEHICLE LANES** had fewer bicycle and vehicle crashes per mile.
- Bicycle crashes between 2014-2016 overwhelmingly occurred on **STREETS WITHOUT ANY BICYCLE FACILITY**.
- Bicycle crashes per mile per year increased as **VEHICLE VOLUME** increased.
- **PHYSICAL SEPARATION** of bicycles resulted in fewer crashes per mile: shared on-street facilities had more bicycle crashes per mile than on-street facility types that have designated space for bicycles.

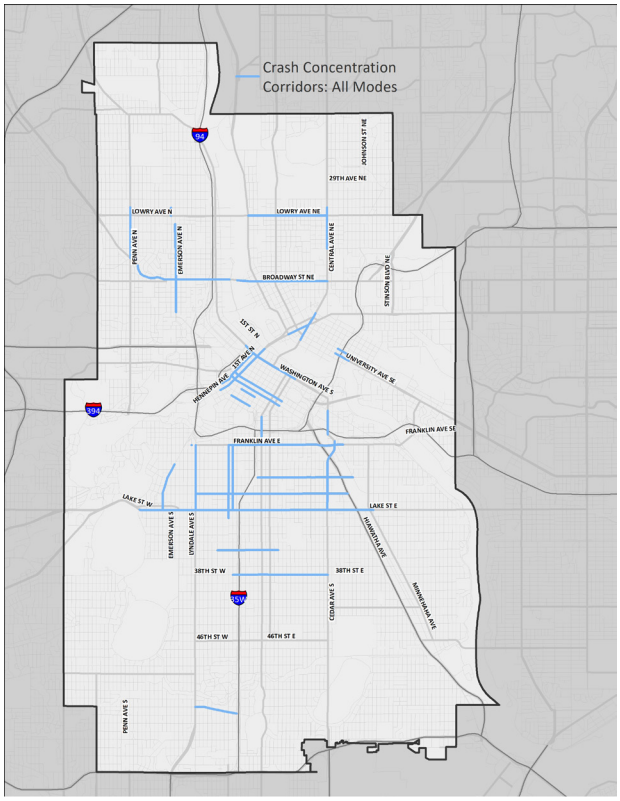


Figure ES-3. Crash Concentration Corridors for All Modes

Source for Bicycle and Vehicle Crash Data: Vision Zero 10-Year Dataset, Source for Pedestrian Crash Data: Pedestrian Crash Study 10-Year Dataset

Who is Involved in Crashes

- **ADULTS OVER 65** were the least likely adults to be killed or severely injured in a vehicle or bicycle crash and the most likely to be killed in a pedestrian crash.
- **MEN** were significantly over-represented in bicycle crashes.
- **AMERICAN INDIANS WERE MOST DISPROPORTIONATELY IMPACTED** by traffic deaths as they are about one percent of the Minneapolis population, but were nine percent of fatal bicycle and pedestrian and eight percent of fatal vehicle crashes in the studied period.

Safety Improvement Strategies

This study uses data to demonstrate crash trends over time. Specific action items in response to the trends identified in this study will be created in the upcoming Vision Zero Action Plan. The six E's of safety are the components of a systematic approach to improve safety that will be addressed in the Action Plan: engineering, education, enforcement, encouragement, evaluation, and equity.

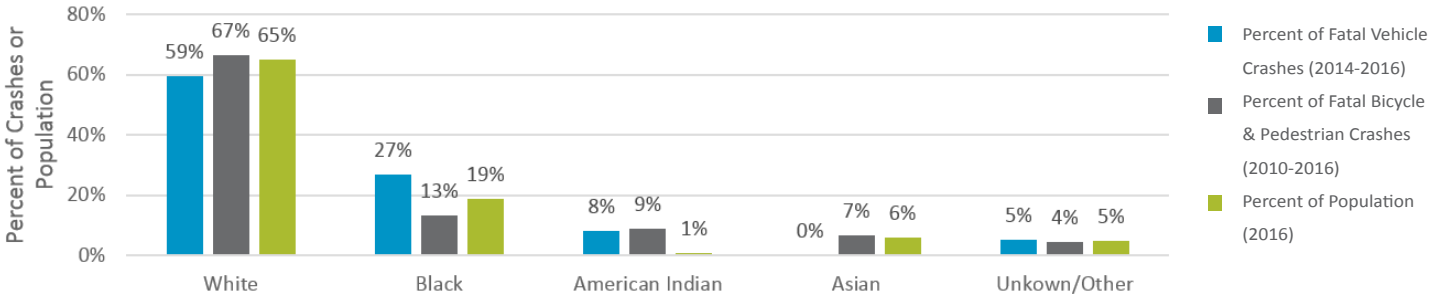


Figure ES-4. Fatal Bicycle and Pedestrian and Vehicle Crashes (2010-2016) by Race

Source for Crash and Race Data: Fatality Analysis Reporting System (FARS)

1. INTRODUCTION

The City of Minneapolis is committed to safe travel on its streets for all users. On September 20, 2017 the City Council passed a resolution that provides for a Vision Zero policy to eliminate fatalities and severe injuries that are a result of crashes on Minneapolis streets by 2027. Minneapolis has a history of prioritizing safety and has completed the following plans and studies and established the following policies over the past 10 years:

- The **Pedestrian Crash Study** completed in 2017 identified trends in pedestrian crashes throughout the city.
- Minneapolis Public Schools and the City of Minneapolis are national leaders in **Safe Routes to School** programs. A 2017 **Strategic Action Plan** lays the course for future action to increase educational opportunities and equitable bicycle/walk access for youth across the city.
- The **Complete Streets Policy** passed in 2016 and prioritizes public right-of-way use for walking, followed by those bicycling and using transit, above people driving motor vehicles.
- The City identified over 50 miles of protected bikeways through the **2013 Climate Action Plan** and a 2015 update to the **Bicycle Master Plan**. Most of the 15 miles of Tier 1 corridors are now complete, and many of the 29 miles of Tier 2 corridors are under construction.
- Completed in 2013, **Understanding Bicyclist-Motorist Crashes in Minneapolis**, identified key factors in bicyclist-motorist crashes in the city.
- The **Bicycle Master Plan** completed in 2011 (part of Access Minneapolis) sets several goals and objectives to create a citywide network of safe and accessible bicycle routes – including on and off-street bicycle facilities.
- The **Pedestrian Master Plan** completed in 2009 (part of Access Minneapolis) sets goals to improve pedestrian safety.

> "A commitment to Vision Zero is a commitment to life and equitable opportunity for people in the City of Minneapolis"
> **- Vision Zero Resolution (2017)**

Purpose

The Vision Zero Crash Study identifies trends, contributing factors, and characteristics of bicycle and vehicle crashes in the City of Minneapolis over the past 10 years, to inform the creation of the Vision Zero Action Plan. This study was initiated to better understand where, how, and why vehicle and bicycle crashes are occurring in Minneapolis. With the completion of the Pedestrian Crash Study in 2017, the City of Minneapolis uncovered many trends and priorities related to pedestrian crashes that could be used to reduce fatal and severe injury crashes for pedestrians. This Vision Zero Crash Study is intended to be a parallel study but with a focus on bicycle and vehicle crashes. Paired together, both these studies provide foundational knowledge for the city's Vision Zero Action Plan (in development 2018 – 2019), which will guide policy and next steps to achieve zero traffic-related deaths and severe injuries by 2027.

This data-driven approach will be used in street planning and programming to improve safety on the city's streets. The results of this analysis are intended to be used in both reactive and proactive ways – to reduce crashes that are happening in concentrated areas and identify other areas where crashes could happen in the future based on similar conditions.

Crash Trends by Mode Over Time

Statewide

Across all modes, crashes in Minnesota have been on the rise since 2012. Statewide, crashes are dominated by vehicle-vehicle crashes. Over 70,000 vehicle crashes, 800 pedestrian crashes, and 700 bicycle crashes occur in the state of Minnesota annually.[1]

Minneapolis

These statewide trends are reflected in Minneapolis: the total number of crashes has been increasing since 2012, and there are many more vehicle crashes than other modal crashes (**Figure 1-2**). Bicycle crashes in Minneapolis have decreased over the study period and pedestrian crashes have stayed relatively constant.

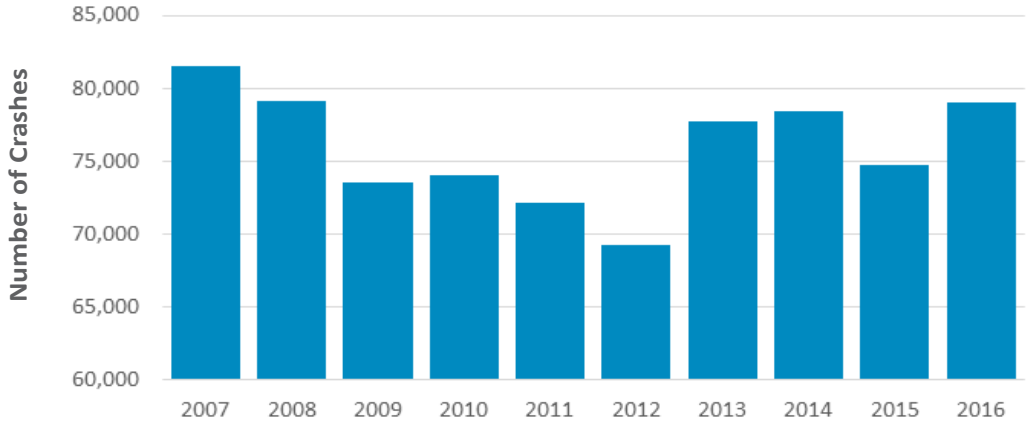


Figure 1-1. Total Vehicle Crashes in Minnesota (2007-2016)

Source: Minnesota Department of Public Safety, 2016 Crash Facts, Preliminary Summary of Minnesota Motor Vehicle Crash Facts (https://dps.mn.gov/divisions/ots/reports-statistics/Documents/crash-facts-summary-2016.pdf).

Other Figure 1-1 Notes: Vehicle crashes are not available for 2016. Freeway crashes were excluded from the study and from this figure. Parked vehicle crashes were included in this figure only; these crashes are excluded from all other crash trends in the report.

[1] Minnesota Department of Public Safety, Minnesota Motor Vehicle Crash Facts 2015

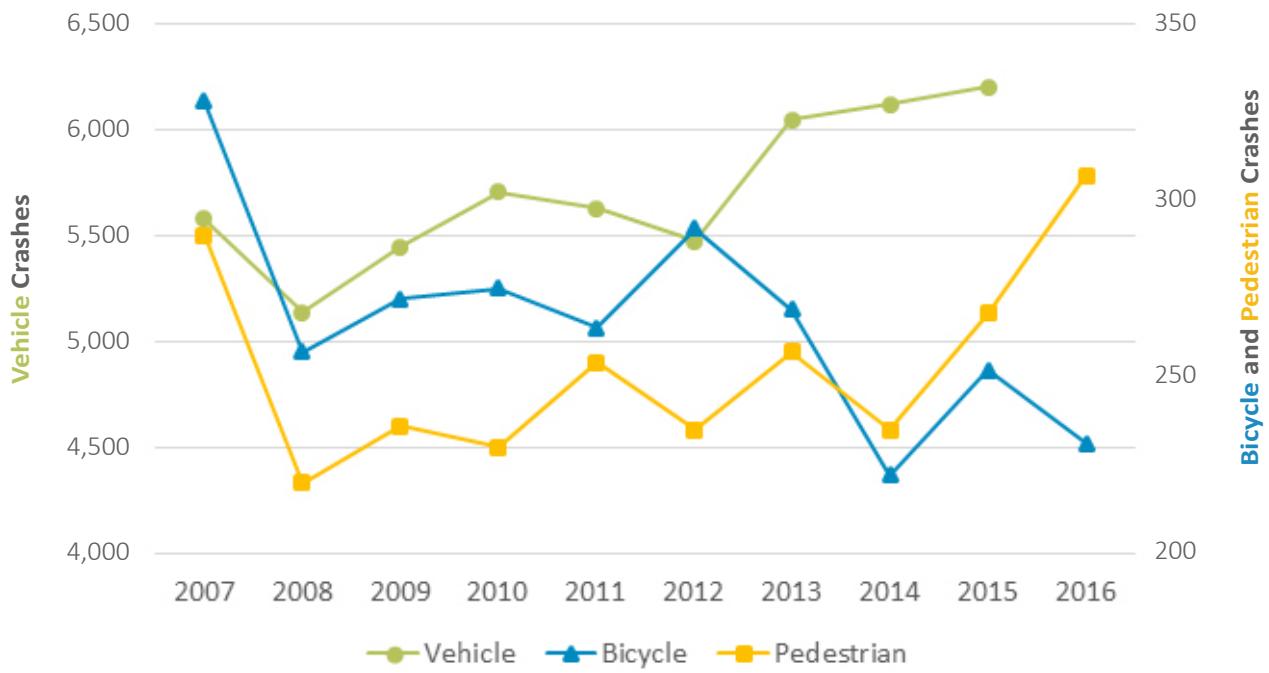


Figure 1-2. Minneapolis Crashes Over Time (2007-2016)

Source: City of Minneapolis crash database supplemented with fatal and severe injury (Type A) crashes from the Minnesota Department of Transportation Crash Mapping and Analysis Tool (MnCMAT).

Using this Report

This study is an informational document that presents bicycle and vehicle crash trends citywide. The results provide the city with valuable data on where, how, and why crashes happen.

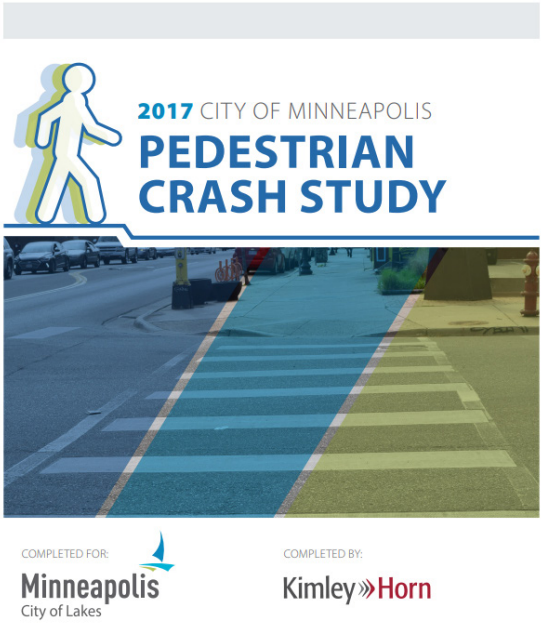
There is a growing trend across the United States to focus on systemic safety improvements at locations that may not have had any fatal or severe injury crashes. Rather, cities focus on preventing crashes from occurring in the future based on characteristics typical of high crash locations. The results of this study can be used to identify crash causes and contributing factors and implement design, policy, and other countermeasures to reduce bicycle and vehicle crashes.

This Vision Zero Crash Study comprises the following sections:

- **Chapter 2** provides an overview of national and local trends in bicycle and vehicle crashes and in other cities Vision Zero crash studies.
- **Chapter 3** discusses the data sources used in the analysis.
- **Chapter 4** presents the approach and methodology used for the bicycle and vehicle crash analysis of this study.
- **Chapter 5** presents the results of the analysis. These results include details on when and where crashes are occurring and how those crashes correlate with street and intersection characteristics, environmental factors, demographics, and other crash influences.
- **Chapter 6** presents recommended next steps for continued safety improvements.

2. BICYCLE AND VEHICLE SAFETY IN CONTEXT

To understand the overarching trend of recent bicycle and vehicle crashes in Minneapolis, several national, state, and city-level studies and reports regarding bicycle and vehicle crashes were reviewed. The main takeaways of these reports are provided in this chapter to give background and context for the Minneapolis bicycle and vehicle safety crash analysis. More detailed descriptions of these studies can be found in **Appendix A.**



Similar data regarding pedestrian crash context was analyzed through the 2017 City of Minneapolis Pedestrian Crash Study.

Bicycle and Vehicular Fatality Trends

National Fatality Trends

From 1975 to 2016, vehicle crash fatalities across the United States have decreased by 23 percent and bicyclist fatalities have decreased by 16 percent. This overall decrease in both vehicle and bicyclist crash fatalities reversed to show a slight national increase within the past decade and dramatic increases in 2015 and 2016. Note that 2016 injury data is not included in the graph because new tracking methodology is not comparable to earlier years.

- In 2016, 840 people bicycling in the United States were killed, representing a 1.3 percent increase from 2015 bicyclist fatalities (**Figure 2-1**). An additional 60,000 were injured in crashes involving vehicles.[1]
- A total of 25,096 individuals (not including motorcyclists) were involved in a fatal vehicle crash in 2016– a five percent increase from 2015.[2] (**Figure 2-2**)
- Sixty-seven (67) percent of crash fatalities in 2016 involved passenger vehicles, 14 percent involved motorcyclists, 16 percent involved pedestrians, two percent involved bicyclists, and the remaining one percent are categorized as "other/unknown" by the National Highway Traffic Safety Administration.[3]
- Minnesota, in comparison with other states, tied with Massachusetts and Rhode Island for the lowest ratio of deaths per 100 million vehicle miles traveled (0.66) in 2016.

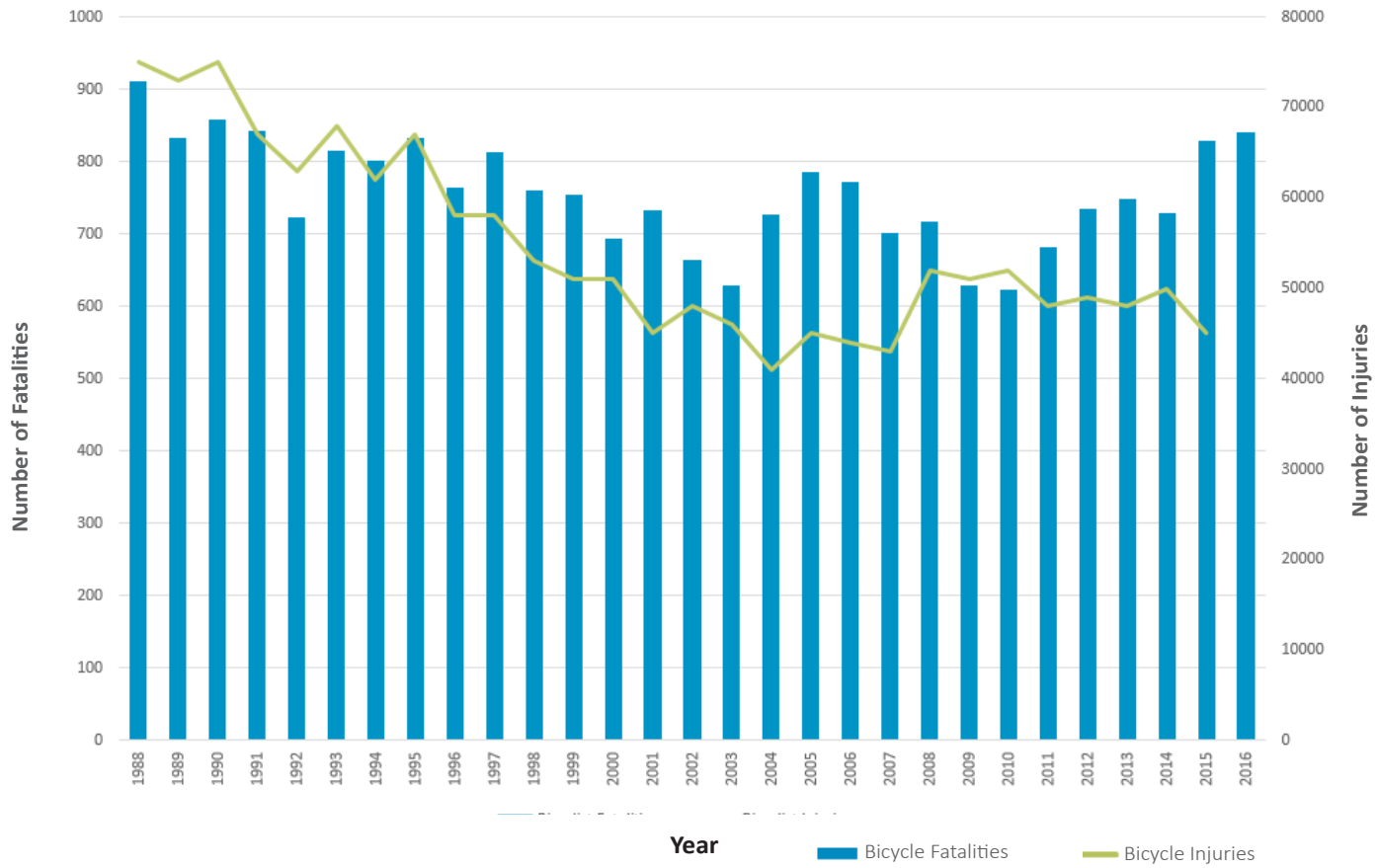


Figure 2-1. Number of Bicycle Crash Fatalities and Injuries, 1988 - 2016

Source: FARS 1975-2015 Final, 2016 ARF; NASS GES 1988-2015; CRSS 2016

[1] Insurance Institute for Highway Safety, & Highway Loss Data Institute. (2017, December). Highway safety topics. Retrieved from http://www.iihs.org/iihs/topics#fatalityfacts

[2] National Highway Traffic Safety Administration. (2018). Fatality Analysis Reporting System (FARS) Encyclopedia. Retrieved from https://www-fars.nhtsa.dot.gov/Main/index.aspx

[3] Ibid.

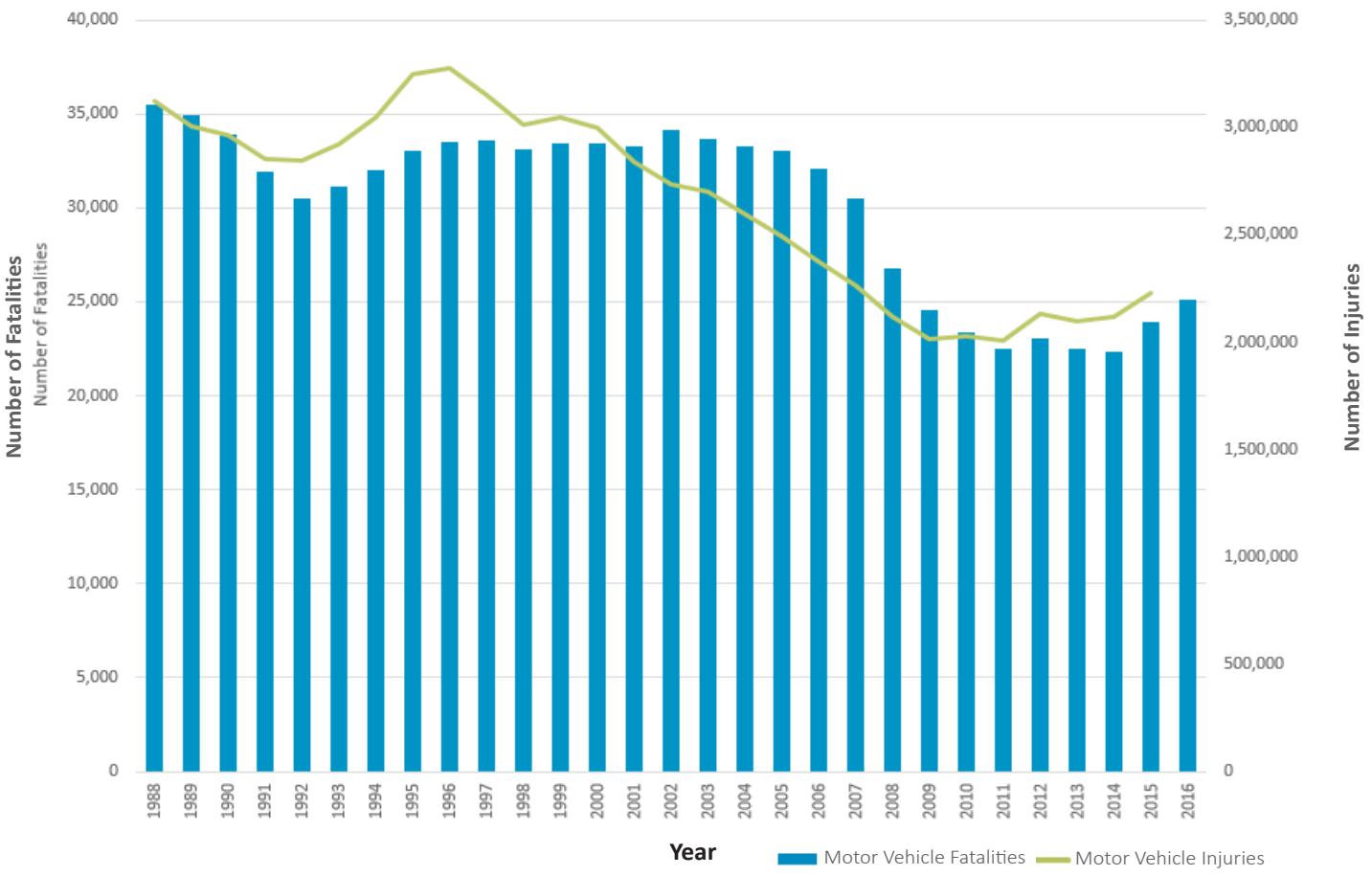


Figure 2-2. Number of Vehicle Crash Fatalities and Injuries, 1988 - 2016

Source: FARS 1975-2015 Final, 2016 ARF; NASS GES 1988-2015; CRSS 2016

National Trends in Crash Factors

A review of various Vision Zero Action Plans across the nation showed some commonalities in factors that cause fatal and severe injury crashes.

Speeding

National data and Vision Zero Action Plans reviewed across the United States identified speeding as a factor in crashes resulting in fatalities and severe injuries. In an impact with a vehicle driving 20 mph, the likelihood of a fatality or severe injury is 13 percent, but at 40 mph that likelihood jumps to 73 percent (**Figure 2-3**).[4]

- Nationally, 27 percent of traffic fatalities involved speeding in 2016. [5]
- Speeding was a factor in 53 percent of fatalities in Denver in 2015.[6]
- In Portland, crash data from 2004 to 2013 showed that speeding was an influential factor in 47 percent of all deadly crashes.[7]

Figure 2-3. Likelihood of Fatality or Severe Injury if Hit by a Vehicle Traveling at Various Speeds
Source: Denver Vision Zero Action Plan, 2017

Impaired Driving

Impaired driving includes instances when the driver of a vehicle is under the influence of alcohol, drugs, or driving while drowsy. A drug is defined as any substance that can impair driving, such as illegal drugs, legal non-medicinal drugs, prescription medications, or over-the-counter medicines. Though it is illegal to operate a vehicle with a blood alcohol concentration (BAC) of 0.08 g/dL or higher, 10,497 individuals nationwide were killed in 2016 in crashes involving alcohol-impaired driving.[8]

- In 2016, 22 percent of the total number of bicyclist crash fatalities in the United States involved a bicyclist with a BAC of 0.08g/dL or higher.[9]
- About 28 percent of all fatal vehicle crashes involved alcohol-impaired driving, with 55 percent of those crashes occurring between midnight and 3 a.m.[10]
- The Governors Highway Safety Association found that in 2015, drugs were a factor in 43 percent of fatal and serious injuries among drivers in the U.S.
- Lack of sleep was found to be a factor in a 2018 report, by the AAA Foundation for Traffic Safety, which showed that drivers who sleep four to five hours daily have 5.4 times the crash rate of drivers who sleep seven or more hours daily.[11]

[4] City of Denver. (2017, July). Denver Vision Zero Action Plan. Retrieved from https://www.denvergov.org/content/dam/denvergov/Portals/705/documents/visionzero/Denver-Vision-Zero-Action-Plan-draft-July2017.pdf. Data from: Brian C. Tefft. (2013). Impact speed and a pedestrian's risk of severe injury or death.
[5] National Highway Traffic Safety Administration. (2018, May). Traffic Safety Facts 2016. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812554
[6] Ibid.
[7] Portland Bureau of Transportation. (2016, December). What is Vision Zero? Retrieved from https://www.portlandoregon.gov/transportation/71733#Speed
[8] National Highway Traffic Safety Administration, & US Department of Transportation. (2017, October). Alcohol-Impaired Driving. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812450
[9] National Highway Traffic Safety Administration. (2018, May). Traffic Safety Facts: Bicyclists and Other Cyclists. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812507
[10] National Highway Traffic Safety Administration. (2018, May). Traffic Safety Facts 2016. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812554
[11] AAA Foundation for Traffic Safety. (2018, March). 2017 Traffic Safety Culture Index. Retrieved from https://aaafoundation.org/wp-content/uploads/2018/03/TSCI-2017-Report.pdf

Inattentive Driving

Distracted driving in 2016, whether texting, operating a GPS device, looking for street signs, or talking on the phone while driving, caused nine percent of all crash fatalities.[12] The actual percentage of fatalities caused by inattentive driving is likely higher due to a variety of challenges in being able to identify distracted driving. If a crash results in a fatality, law enforcement must rely on the crash investigation to report if distracted driving was a factor leading up to the crash. This process can be further complicated if there are no witnesses to corroborate findings.

- Of the nine percent of crash fatalities in 2016 caused by distracted driving, about 14 percent of crashes were attributed to cellphone use.
- In the City of Denver, distracted driving was a contributing factor in 14 percent of crash fatalities and severe injuries in 2016.
- In 2016, over 20 percent of crashes in North Carolina involved a distracted driver.
- Seattle saw a 300 percent increase in instances of distracted driving from 2011 to 2015, which contributed to 30 percent of total crashes in the city.[13]

Failure to Yield to Pedestrians and Bicyclists

Another common underlying factor in crash fatalities and severe injuries is the driver's failure to yield to people walking and bicycling.

- In Seattle, more than 200 traffic collisions and 10 percent of pedestrian fatalities resulted from vehicle drivers' failure to yield.[14]
- Fifty-three percent of crash fatalities in Philadelphia are due to aggressive driving, which include speeding and failure to yield.
- Fifty-one percent of crashes resulting in a fatality in Portland between 2004 and 2013 were caused by dangerous behaviors, defined as not yielding the right-of-way, improper lane changes, running red lights, and wrong-way driving on a one-way street.

[12] National Center for Statistics and Analysis. (2018, April). Distracted driving 2016. (Traffic Safety Facts Research Note. Report No. DOT HS 812 517). Washington, DC: National Highway Traffic Safety Administration.
[13] Seattle Department of Transportation. (2017). Vision Zero 2017 Progress Report. Retrieved from http://www.seattle.gov/Documents/Departments/beSuperSafe/VZ_2017_Progress_Report.pdf
[14] Ibid.

National Demographic Trends in Fatal Bicycle and Vehicular Crashes

Across the United States, demographic trends for people who drive vehicles and those who ride bicycles help identify risks for vehicle and bicycle crashes, which in turn help policymakers and urban planners proactively create safer environments for all individuals travelling in the public right of way.

- In 2015, 34 percent of individuals age 3 and older rode a bicycle.[15]
- Men are more likely to ride a bicycle, but they are also more likely to be involved in a crash.
- Individuals between the ages of 21 and 24 are the most likely age group to be involved in a fatal vehicle crash, while individuals between the ages of 55 and 64 are the most likely age group to be involved in a fatal bicycle crash.
- Low-income households make up about 17 percent of the total U.S population, but only 13 percent of all U.S. bicycling trips.

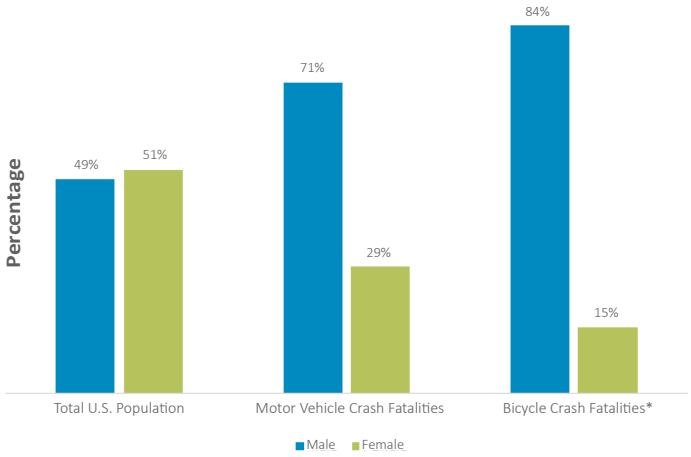


Figure 2-4. Percentages of Total U.S Population, Vehicle Crash Fatalities, and Bicycle Crash Fatalities by Gender, 2016

Total may not sum to 100 percent due to rounding.
Source: FARS 1975-2015 Final, 2016 ARF; NASS GES 1988-2015; CRSS 2016

Gender

Figure 2-4 compares the 2016 total population of men and women in the United States alongside the 2016 crash fatalities categorized by gender. Though the U.S. population is about 50 percent men and 50 percent women, men made up approximately 76 percent of national bicycling trips in 2016.[16] This higher representation of men who use bicycling as a mode of transportation is also reflected in the higher percentage of men involved in bicycle crash fatalities (84 percent). Men, on average, drive vehicles more miles than women, and are more likely to exhibit risky driving behaviors than women, such as not using seat belts, driving under the influence, and speeding. In 2016, men were involved in 71 percent of all vehicle crash fatalities.[17]

Age

Figure 2-5 shows the decreasing number of vehicle crash fatalities over time. This figure also shows that the fatality rates of individuals between the ages of 16 to 34, as well as adults over the age of 74, have the highest vehicle crash fatality rates. **Figure 2-6** depicts the overall trend of various age groups involved in a fatal bicycle crash. Bicyclists in the 45 to 64 age groups have the overall highest fatality rates per 100,000 population, and these fatality rates have been increasing for these age groups over time.

[15] Governors Highway Safety Association, & State Farm. (2017). A Right to the Road: Understanding & Addressing Bicyclist Safety. Retrieved from https://www.ghsa.org/sites/default/files/2017-09/2017BicyclistSafetyReport-FINAL.pdf

[6] Alliance for Biking and Walking, & Centers for Disease Control and Prevention. (2016). Bicycling and Walking in the United States: Benchmarking Report. Retrieved from https://www.aarp.org/content/dam/aarp/livable-communities/documents-2016/2016-WalkingBicyclingBenchmarkingReport.pdf

[7] Insurance Institute for Highway Safety. (2017, December). General Statistics: Gender. Retrieved from http://www.iihs.org/iihs/topics/t/general-statistics/fatalityfacts/gender

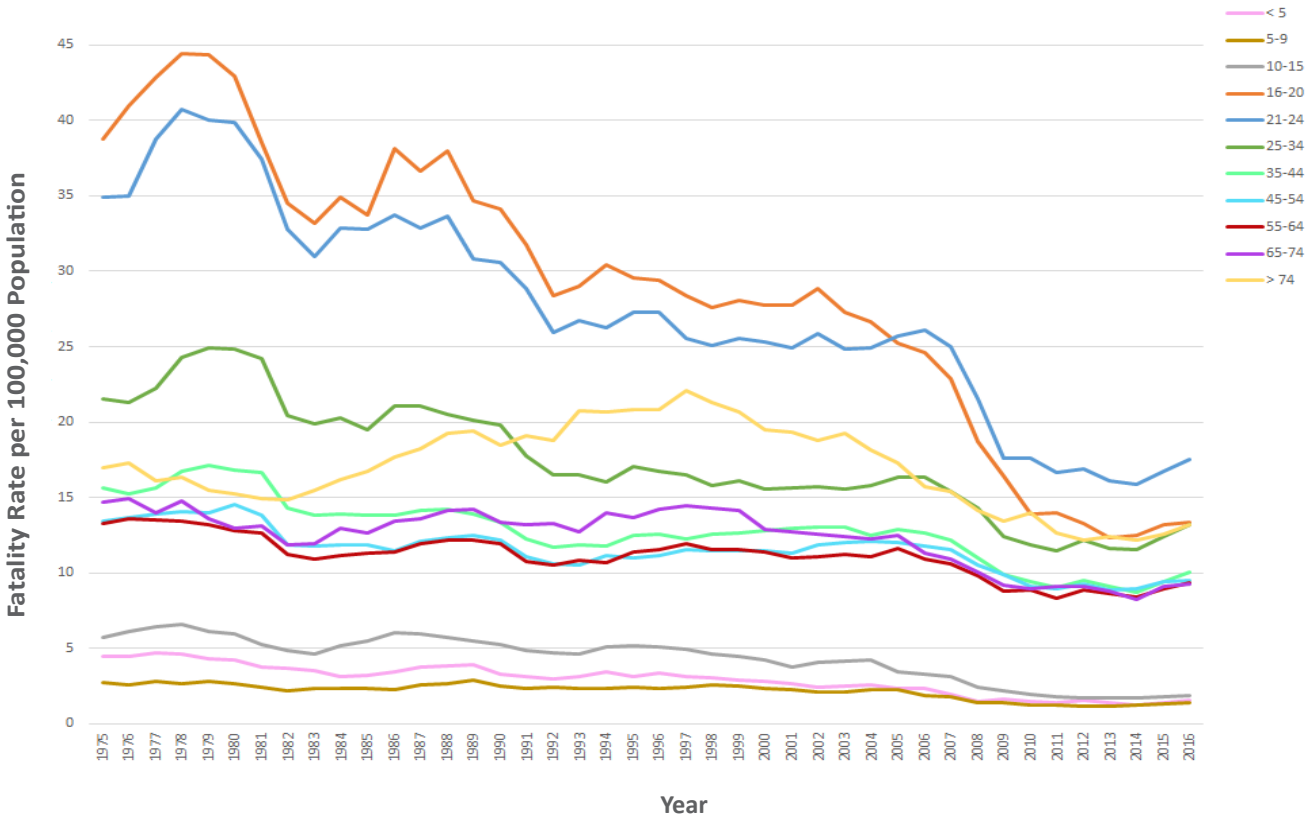


Figure 2-5. Vehicle Occupant and Motorcyclist Fatality Rates per Population of 100,000 by Age Group, 1975 - 2016

Source: FARS 1975-2015, 2016 ARF; U.S. Bureau of the Census

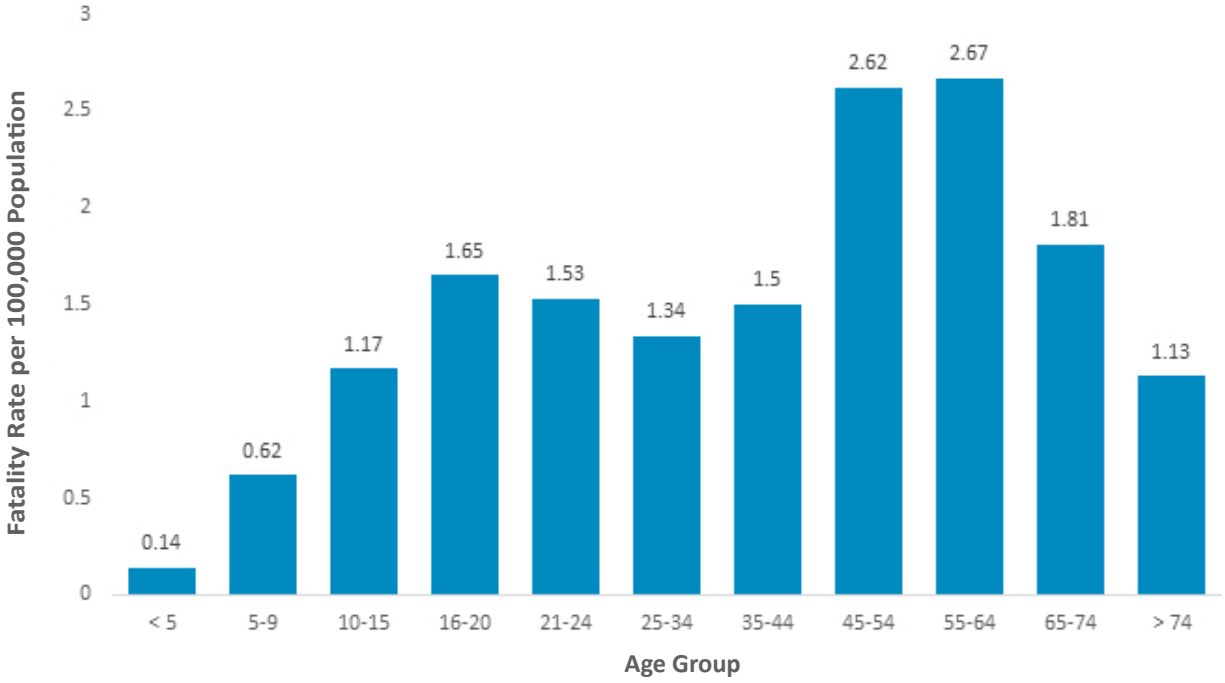


Figure 2-6. Combined Bicyclist Fatality Rates per Population of 100,000 by Age Group, 2010 - 2016

Source: FARS 2010-2016, 2016 ARF; U.S. Bureau of the Census

Income

The reasons for, as well as the perceptions of, bicycling are different for people of different socioeconomic status. In 2009, 13 percent of US biking trips are made by people in low-income households.[18] Generally, households with higher incomes have a greater percentage of trips taken for social or recreational purposes than households earning less than $20,000 per year (**Figure 2-7**).[19] Of low-income households, 47 percent of bicycling trips were reported for social or recreational purposes, compared to 68 percent of bicycling trips by the highest-income households.

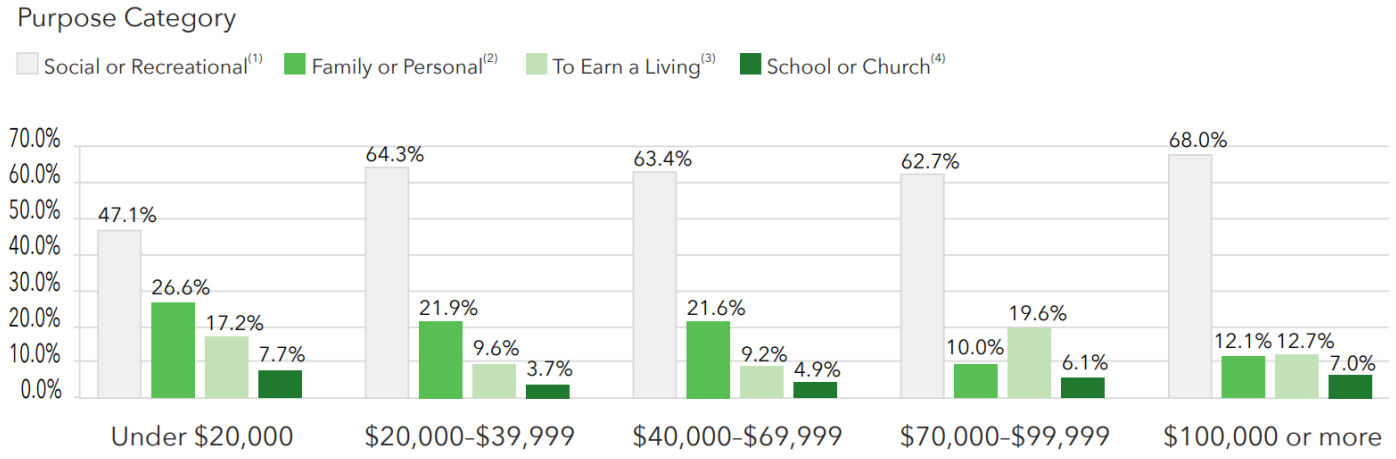


Figure 2-7. Biking Trips, by Income and Purpose, 2009

Source: NHTS 2009. Notes: Travel data disaggregated by respondent income and trip purpose may be unreliable due to small sample sizes. Percentages do not add up to 100% because "other" and unknown responses are omitted. (1) Combines the following NHTS response categories: "vacation," "visit friends/relatives," and "other social/recreational." (2) Combines the following NHTS response categories: "shopping," "medical/dental," and "other family/personal business." (3) Combines the following NHTS response categories: "to/from work" and "work-related business." (4) Represents the single NHTS response category "school/church."

[18] Alliance for Biking and Walking, & Centers for Disease Control and Prevention. (2016). Bicycling and Walking in the United States: Benchmarking Report. Retrieved from https://www.aarp.org/content/dam/aarp/livable-communities/documents-2016/2016-WalkingBicyclingBenchmarkingReport.pdf

[19] Ibid.

Crash Location Comparison

Rural Versus Urban

Vehicle crashes more often occur on rural roads. Fatalities result in crashes occuring at higher speeds. In 2016, about 19 percent of the United States population lived in rural areas, yet 51 percent of vehicle crash fatalities happened on rural roads.[20] Bicycle crash fatalities, on the other hand, occur more often on roads in urban areas (**Figure 2-8**).[21]

In major U.S. cities, it is common for a disproportionate number of both vehicle and bicycle crashes resulting in a fatality or severe injury to occur on a relatively small network. For example, in Los Angeles, crash data showed that two-thirds of all severe and fatal crashes happened on six percent of the city's streets.[22]

Crashes can happen between a bicyclist and a vehicle, two vehicles, a single vehicle and a fixed object, or any other combination involving vehicles, bicyclists, or pedestrians. **Figure 2-9** shows a breakdown of vehicle fatalities by road type and the number of vehicles involved in the crash. A greater percentage of fatal crashes that occur on roadways involve multiple vehicles, but fatal crashes that happen off roadways, on shoulders, in a median, or in another/unknown location, usually involve just one vehicle.

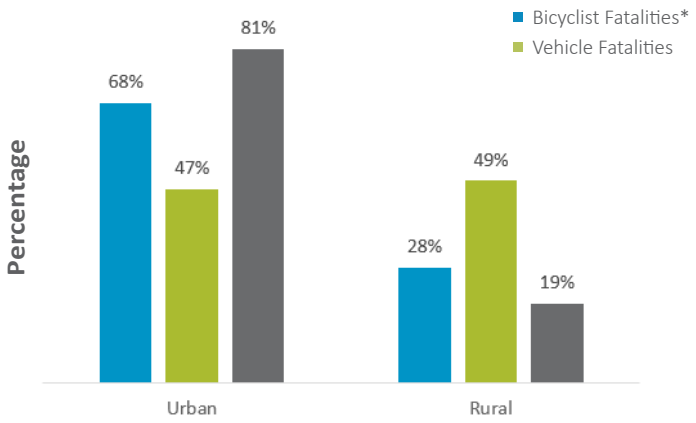


Figure 2-8. Percent of U.S Bicyclist and Vehicle Crash Fatalities by Land Use, 2016

Total bicyclist fatalities include "Other and/or Unknown" crash location land use.
Source: Insurance Institute for Highway Safety and FARS data, 2016

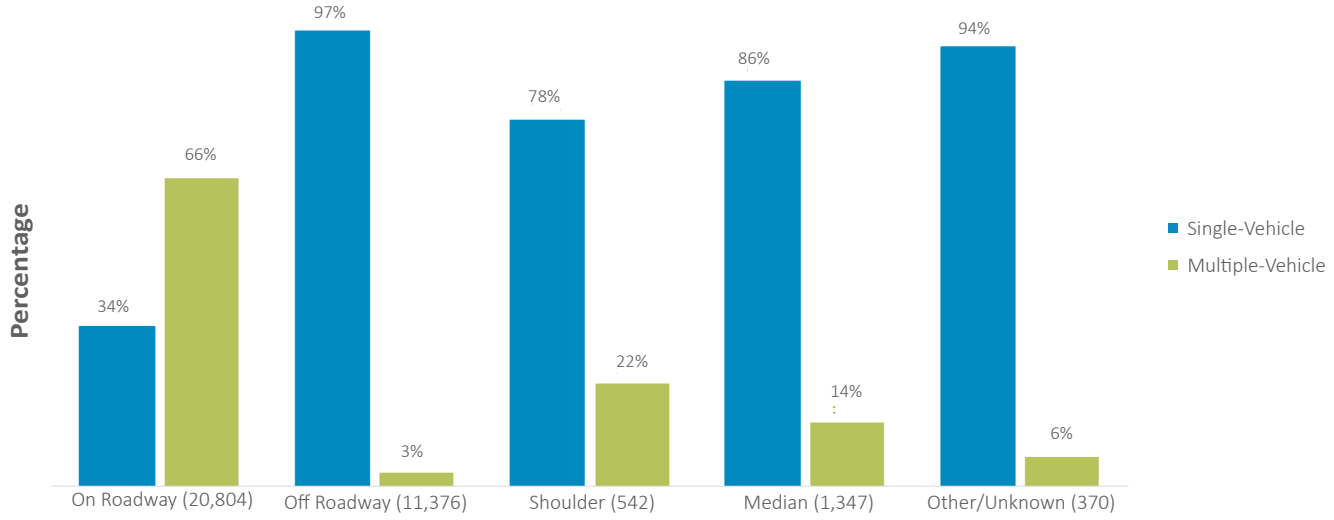


Figure 2-9. Percentage of Fatal Vehicle Crashes by Crash Type and Relation to Trafficway, 2016

Total number of fatal crashes found in parentheses.
Source: FARS 2016 ARF, CRSS 2016

[20] Insurance Institute for Highway Safety, & Highway Loss Data Institute. (2017, December). Urban/rural comparison. Retrieved from http://www.iihs.org/iihs/topics/t/roadway-and-environment/fatalityfacts/roadway-and-environment#Where-crashes-occur
[21] Ibid.
[22] Vision Zero Action Plan- 2017. (2017, January 26). Retrieved from https://view.joomag.com/vision-zero-action-plan-2017/0893807001485436685?short

Crash Characteristics

Many of the national reports on bicycle and vehicle fatalities pointed to crash trends across the nation. Below are some highlights from the National Highway Traffic Safety Administration using 2016 data.

Vehicle Crash Statistics[23]

- About 24 percent of drivers of passenger cars, pickup trucks, and SUVs did not use a safety restraint in a fatal crash, and about 44 percent of vehicle passenger occupants were not restrained during a fatal crash.
- Fifty-eight (58) percent of fatal crashes involved only one vehicle.
- Thirty-three (33) percent of crash fatalities happened between 3:00 and 9:00 p.m.
- Ninety-five (95) percent of vehicles involved in fatal crashes were passenger cars or light trucks.
- Forty (40) percent of vehicles involved in fatal crashes were passenger cars, 39 percent light trucks, 10 percent motorcycles, 8 percent large trucks, and 2 percent other (including buses).

Bicycle Crash Statistics[24]

- Bicyclist fatalities made up about two percent of all traffic crash fatalities in 2016 – slightly higher than the bicyclist fatalities from 2015.
- Most crashes happened in shared mode space outside of an intersection (58 percent). This includes crashes occuring in standard driving lanes, but not those in bicycle lanes, sidewalks, medians, shoulders, or parking lanes.
- **Figure 2-10** shows the percent distribution of crash fatalities, for both vehicles and bicyclists, during various times throughout a day.
- Ninety-five (95) percent of bicyclist crashes involved one vehicle.
- Pickup trucks, vans, and SUVs were the most frequent type of vehicle involved in a fatal bicyclist crash (42 percent). Passenger cars were involved in 37 percent of fatal bicyclist crashes, large trucks in 11 percent, and buses in 2 percent.

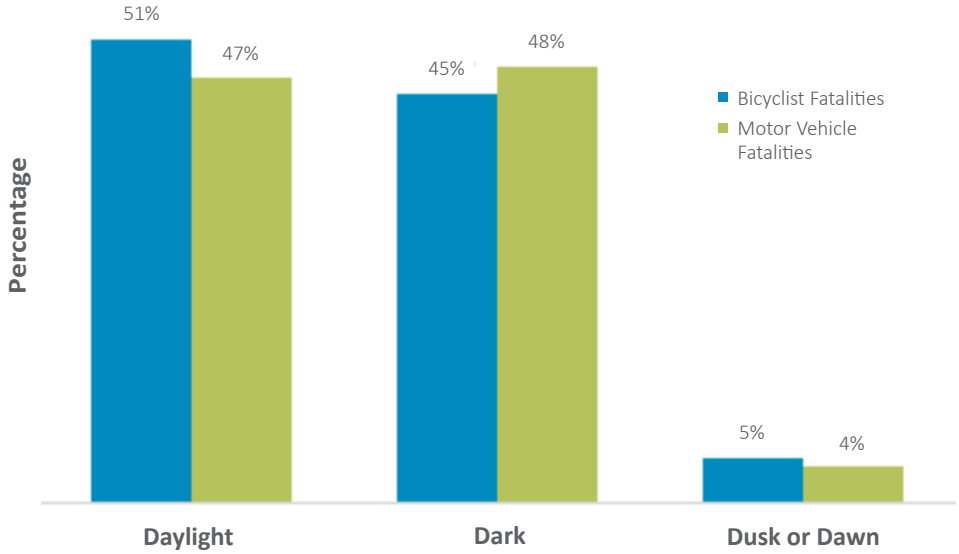


Figure 2-10. U.S Bicyclist and Vehicle Fatalities by Light Level, 2016 (Does not total 100% due to rounding).
Source for Crash Data: National Highway Traffic Safety Administration and FARS, 2016

[23] National Highway Traffic Safety Administration. (2018, May). Traffic Safety Facts 2016. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812554

[24] National Highway Traffic Safety Administration. (2018, May). Traffic Safety Facts: Bicyclists and Other Cyclists. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812507

3. UNDERSTANDING THE CRASH DATA

Where the Data Comes From

This study used bicycle and vehicle crash data supplied by City of Minneapolis Public Works, which consists of crashes reported by the Minneapolis Police Department (MPD). Supplemental data was also provided by Metro Transit to analyze bicycle-bus crashes and reported near misses. To create a complete dataset of all fatal and severe injury bicycle and vehicle crashes that occurred on streets in Minneapolis, additional data was sourced from the Minnesota Department of Transportation (MnDOT) via the Crash Mapping and Analysis Tool (MnCMAT). This data was needed to capture crashes reported by the Minnesota State Patrol, Hennepin County Sheriff Department, University of Minnesota Police, Metro Transit Police, or other law enforcement agencies.

This process of acquiring and compiling crash data is technically challenging. Minneapolis Public Works receives reports from MPD, but does not have direct access to the crash reporting system. Some MPD reports are not transmitted to Public Works due to ongoing investigations or other reporting delays. In addition, Minneapolis Public Works does not have any access to crash reports filed by other agencies such as the Minnesota State Patrol or Metro Transit Police.

While acquiring all the bicycle and vehicle crash reports and data from every reporting agency is a large effort, it is a vital task to produce a complete picture of those crashes occurring in Minneapolis. This process of compiling crashes from every reporting agency was conducted for fatal and severe injury crashes only because the trends of those crashes are the focus of the Vision Zero initiative. It was not feasible to do this for every vehicle and bicycle crash in this study due to the magnitude of data (that would constitute checking over 30,000 lines of data for duplicates).

The more comprehensive the dataset, the more robust and accurate the analysis will be.

A crash is not simply a line item in a database. It is the representation of complex and unique events which are experienced differently by all parties involved, including the victims, witnesses, responding law enforcement officers, and staff who input the data. Emotions, adrenaline, and personal perceptions are only some of the intangibles that are directly tied to this data. The results of this analysis must be interpreted with these limitations in mind.

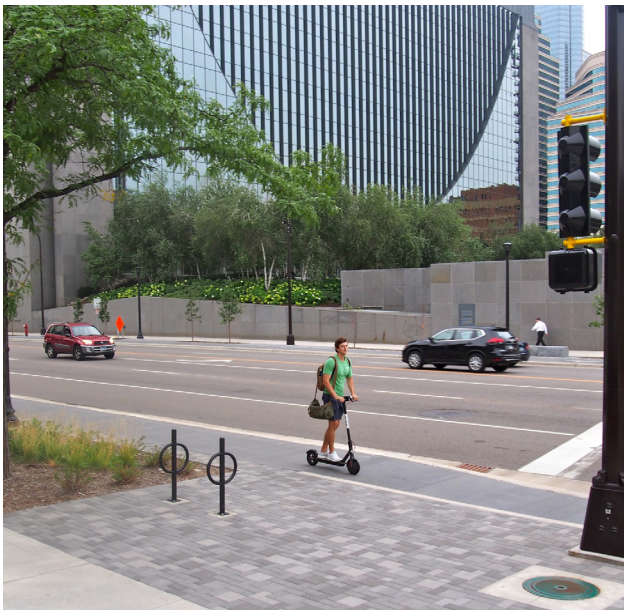
When a crash occurs, there is a process by which the numerous details and factors of the event are documented, organized, and recorded.

- Per Minnesota State Statute 169.09, an individual involved in a traffic crash that immediately results in property damage or bodily injury is required to remain at the scene of the crash until contact information is exchanged with all parties involved. The involved parties then have up to 72 hours to notify the relevant law enforcement official.
- If the law enforcement agency is notified at the time of the crash, an officer joins the involved parties at the scene of the crash, gathers all necessary details of the crash and completes a Minnesota Department of Public Safety (DPS) motor vehicle crash report (required for incidents involving at least $1,000 in property damage, injury or death). Attributes such as location, time, personal information, weather, and road surface conditions are recorded using a standardized coding system. A crash narrative and diagram are also included in the report.
- The Minneapolis Police Department sends copies of their DPS crash reports to the City's Public Works Department. The Traffic Division enters the crash data into an internal database tool, which is then used to monitor crash trends, identify locations for further study or improvements, and inform the design of capital improvement projects.
- The Minnesota DPS is the centralized reporting agency for all crashes that occur in Minnesota. Law enforcement officers are required to submit reports on crashes they investigate within 10 days. DPS also collects crash reports submitted by an individual involved in the crash.[1] The crash data from all law enforcement agencies and individuals are then aggregated and imported into the MnCMAT system, which is maintained by the Minnesota Department of Transportation. MnCMAT makes the crash data available to engineers and planners for study and analysis.
- The MnCMAT database has not been updated since 2015 due to changes in reporting. In addition, accuracy and reliability of the MnCMAT database is generally less than the Minneapolis crash database. Each crash report that is entered into the Minneapolis database is reviewed to correct errors or inconsistencies such as location of the crash or direction of movements. Crashes involving suicides, homicides, and those on private property are also removed. As a result, the Minneapolis crash database is the most reliable source of crash data for city streets and is the primary data source used in this analysis.

Limitations of the Data

The process and procedure of reporting and documenting crashes described above provides the best available source of crash data and information. However, the process has its limitations which arise from conflicting witness accounts, innate challenges of reducing complex events to a set of data codes, and the crash interpretation by law enforcement and engineering staff. To address many of these limitations, the Department of Public Safety created a new, universal crash reporting form starting in 2016. Incorporation of the information from this new form into the statewide database (MnCMAT) had not yet occurred at the time of the study; as such, the 2016 vehicle crash data was not available for this study. Bicycle crash data from 2016 was available for this study because copies of these reports are sent to Public Works directly from the Minneapolis Police Department.

Despite these limitations, the crash reports remain a valuable source of information on crash patterns and locations of crashes occurring over the last 10 years.



[1] https://dps.mn.gov/divisions/dvs/Pages/dvs-content-detail.aspx?pageID=489

Some of the crash attributes that may be reported with the least consistency:

- **Bicyclist position within intersection prior to the crash** – This data is largely dependent on the statements of the bicyclist(s) and the reporting officer's depiction in the crash report, and some crash reports are more robust than others in their description, while some reports are missing this information.
- **Driveway, alley, and mid-block crashes** – Crashes occurring at driveway entrances, alleys, or mid-block locations are included in the analysis, however the location information is known only as an estimate of distance from the center of the nearest intersection and may not reflect the precise location of the crash.
- **Contributing factors** – Factors that require the person at fault to admit wrong-doing are likely to go underreported. Distracted driving is particularly challenging without witnesses or a search warrant to access cell phone records.
- **Traffic control status** – The specific signal phase or operational status of the traffic control device at the time of the crash relies on the statements of those involved in the crash or witnesses, and is not directly observed by those completing the crash report. Therefore, in cases of conflicting statements, it is not always possible to determine who had the right-of-way at the time of the crash.

Unreported Crashes

In addition to data limitations of crashes that are reported, some number of vehicle crashes go unreported and crashes involving pedestrians and bicyclists may have a higher rate of underreporting. The reasons for not reporting a crash may be that property damage or injury was marginal, the individuals did not want to involve law enforcement, or that the parties involved were not aware that they are required to report the incident.

A recent study by researchers at UCLA and UC Berkeley compared online survey responses with police-reported crash data to understand how frequently these incidents go unreported. They found that a small percentage of the online self-reported crashes were automobile incidents; the self-reported responses were dominated by bicycle and pedestrian collisions. Study researchers concluded that people are less likely to report a crash using formal reporting sources if there are no injuries or they involve predominantly non-motorized transportation.[2]

Researchers in Brussels also found that unreported incidents occur in the same places as the police reported crashes.[3] Therefore, it is likely that while the total bicycle crash numbers presented and analyzed are likely lower than the true number that occurred, they are still significant for determining where to direct future Vision Zero resources.

Near Misses

Near misses, or when a collision is narrowly avoided, happen, but how common they are is challenging to determine. While these events can be tracked and analyzed at an intersection-level, they are nearly impossible to capture citywide. A 2010 study of users in Oxford, England found that bicyclists and pedestrians reported a near-miss type incident every five and a half miles, and motorists reported a near-miss every 42 miles.[4] However, the inability to consistently track these events means they are not included in the datasets of this study.

[2] https://safetrec.berkeley.edu/publications/investigating-underreporting-pedestrian-and-bicycle-crashes-and-around-university
[3] https://journals.openedition.org/cybergeo/28073
[4] Joshi, M., Senior, V., & Smith, G. (2001). A diary study of the risk perceptions of road users. Health, Risk & Society, 3(3), 261-279. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/13698570120079877

4. METHODOLOGY

Approach and Methods Used to Analyze Crash Data

Table 4-1 summarizes the approach and assumptions used in the Vision Zero Crash Study. While crashes are difficult to predict, this study compiled two distinct datasets to evaluate bicycle and vehicle crash trends in Minneapolis. This study used a similar approach and crash analysis years as the 2017 Minneapolis Pedestrian Crash Study for consistency. The two datasets were used to generate the crash trends presented in **Chapter 5**. The Vision Zero 10-year database provides a very large dataset for analyzing location and crash type trends of both bicycle and vehicle crashes. The Vision Zero 3-year database allows for more detailed analysis of the contributing factors and actions of drivers and bicyclists involved in bicycle crashes. Because the 10-year database captures many vehicle-specific characteristics of crashes, and because it would be impractical to read the tens of thousands of vehicle crash police reports for this study, the Vision Zero 3-year dataset does not include vehicle crash information.

[1] Minneapolis Pedestrian Crash Study, 2017

The 10-year vehicle and bicycle dataset and the 3-year bicycle dataset were used to generate the crash trends presented in Chapter 5.

Dataset	Vision Zero 10-Year Data		Vision Zero 3-Year Data
Description	The existing Minneapolis crash database was supplemented with fatal and severe injury crashes from MnCMAT.		The original police reports for each bicycle crash within the City of Minneapolis were reviewed, geolocated, and contributing factors coded to glean a higher level of detail related to circumstances of bicycle crashes.
Sample Size	**41,651** crashes, comprised of:		**728** bicycle crashes, comprised of: • 2 Fatal (K) • 28 Incapacitating Injury (A) • 251 Non-Incapacitating Injury (B) • 380 Possible Injury (C) • 60 No Apparent Injury (N) • 7 Unknown
	2,661 crashes with bicycles (17 of those are from MnCMAT)	38,990 vehicle crashes (128 of those are from MnCMAT)	
	14 Fatal (K) 117 Incapacitating Injury (A) 616 Non-Incapacitating Injury (B) 1,364 Possible Injury (C) 344 No Apparent Injury (N) 206 Unknown	51 Fatal (K) 416 Incapacitating Injury (A) 2,199 Non-Incapacitating Injury (B) 8,877 Possible Injury (C) 27,431 No Apparent Injury (N) 16 Unknown	
Years	Bicycle crashes: 10 years (2007-2016) Vehicle crashes: 9 years (2007-2015)		Bicycle crashes: 3 years (2014-2016)
Purpose	• Large sample size from which to analyze spatial relationships on a citywide scale and trends over time • Before/after analysis		• Higher level of confidence in accuracy of bicyclist location and actions • Better determines contributing factors in crashes • Includes more demographic information
Limitations	• Multiple sources inherently produce inconsistency in coding of data • Collision location is aggregated to within or outside an intersection based on distance from the center of the intersection; cannot be used for fine-grained location analysis at intersections		• Smaller sample size
Source Specifics	Several agencies provided line items for the 10-Year database: • City of Minneapolis: 2007-2016. • Metro Transit: 2007-2016 for bus-bicycle crashes. • MnCMAT: Severe (Fatal and Type A) crash data 2007-2015		Police Reports were compiled from 2014-2016 from the City of Minneapolis Police Department generate the 3-Year database.

Table 4-1. Vision Zero Datasets

Crash Analysis Exclusions

Some reported crashes have been excluded from this study because they are outside the public right-of-way (i.e., they occurred on private property) or because they are not related to City-owned public infrastructure or policy:

- Homicides or intentional injury crashes (this accounts for approximately one percent of crashes; in 2016 there were 31 of these crashes excluded from the Minneapolis database)
- Crashes occurring on private property (this accounts for approximately one percent of crashes; in 2016 there were 29 of these crashes excluded from the Minneapolis database)
- Crashes occurring in a parking lot (this accounts for approximately seven percent of crashes; in 2016 there were 183 of these crashes excluded from the Minneapolis database)
- Crashes on freeways or other right-of-way where pedestrians and bicycles are prohibited and City policies and programs are not applicable (this accounts for approximately four percent of vehicle crashes; there were on average 100 crashes per year from the MnCMAT database excluded from this study due to crash location on a freeway or on a freeway ramp more than 100 feet from an intersection)

Combined, these types of crashes represented ten to fourteen percent of the reports reviewed.

Infrastructure and Volume Datasets

The types of crash trends and factors analyzed were selected based on findings from other national studies and from Minneapolis' needs and priorities. The types of analyses that could be conducted were limited by what infrastructure data was readily available and how often the data is updated.

Unless otherwise noted, this study assumed that the most current infrastructure data available was applicable for the entire study period, which may cause an over-representation of features that were updated or changed within the study period. Thus, a bicycle crash that occurred at an intersection that has a feature today may not have had the feature when the crash occurred. This methodology pertains to the speed limit analysis, the travel lanes analysis, and the intersection control analysis. Because bicycle crashes are a focus of this study, the bicycle facility analysis did account for the year the bicycle facility was built.

This analysis generally did not account for volumes of pedestrians, bicyclists, or motorists citywide as a measure of exposure to potential crashes. While pedestrian, bicycle, and vehicle counts are taken every year by the City of Minneapolis, they are not taken on many streets where there are crashes (e.g., residential streets and parkways) and they are not taken on the same streets every year. Thus, although crash rates are typically used in crash studies to identify locations where high numbers of crashes occur relative to total users, this study does not include calculation of crash rates due to the lack of comprehensive data citywide.

5. FINDINGS IN MINNEAPOLIS BICYCLE AND VEHICLE CRASHES

In 2016 there were over 300 crashes involving pedestrians and over 230 crashes involving bicyclists on Minneapolis streets. In 2015 (the most recent year for which data is available) there were over 6,200 vehicle crashes in the city. The following analyses address the context, severity, demographics and causes of these bicycle and vehicle crashes. Additional pedestrian analysis is available in the 2017 Pedestrian Crash Study[1]. Comparisons between bicycles, pedestrian and vehicle crashes are made when approapriate.

When do Crashes Occur?

Vehicle crashes peak during the noon to 3PM period (**Figure 5-1**). Bicycle and pedestrian crashes follow a slightly later trend, peaking during the afternoon rush hours.

Fatal and severe injury crashes for both vehicles and bicyclists peak from 3PM to 6PM (**Figure 5-2**). Similar to overall crash frequencies, pedestrian fatal and severe injury crashes peak from 6PM to 9PM.

[1] http://www.minneapolismn.gov/pedestrian/data/WCMSP-206913

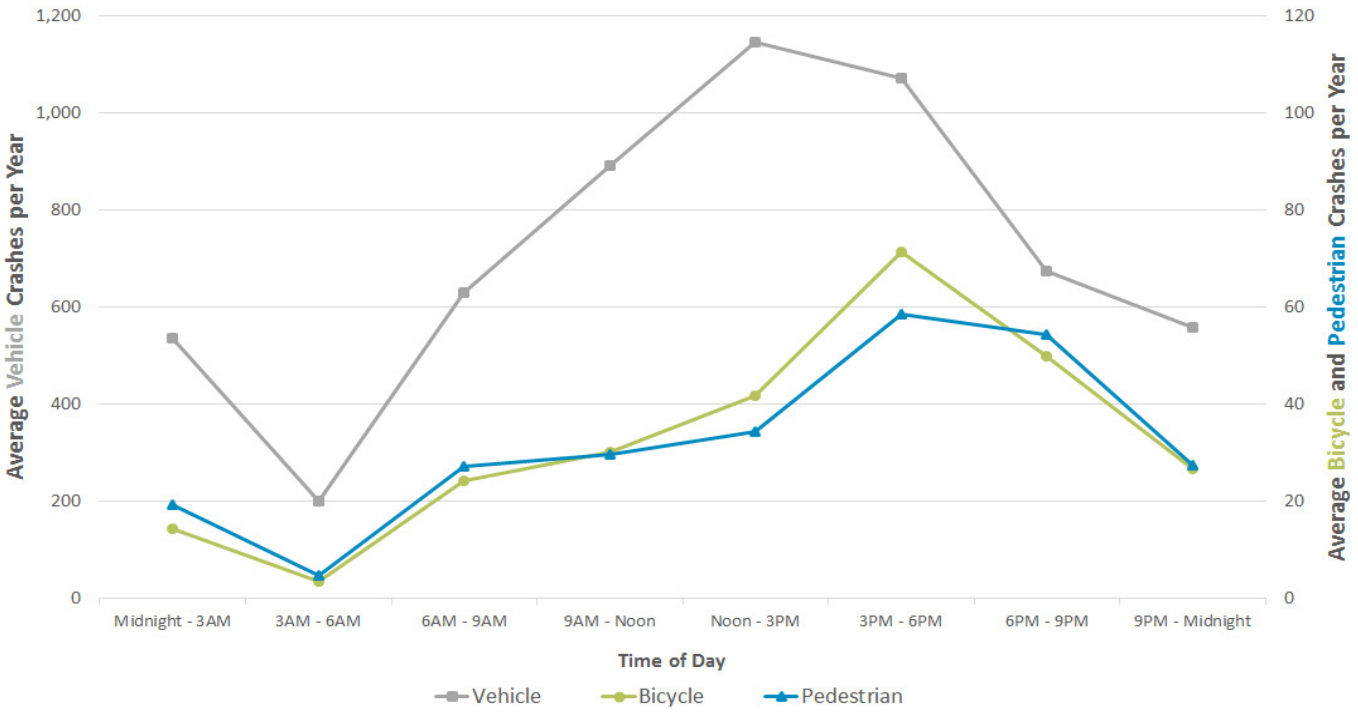


Figure 5-1. Average Crashes Per Year by Time of Day

Source for Crash Data: Vision Zero 10-Year Dataset

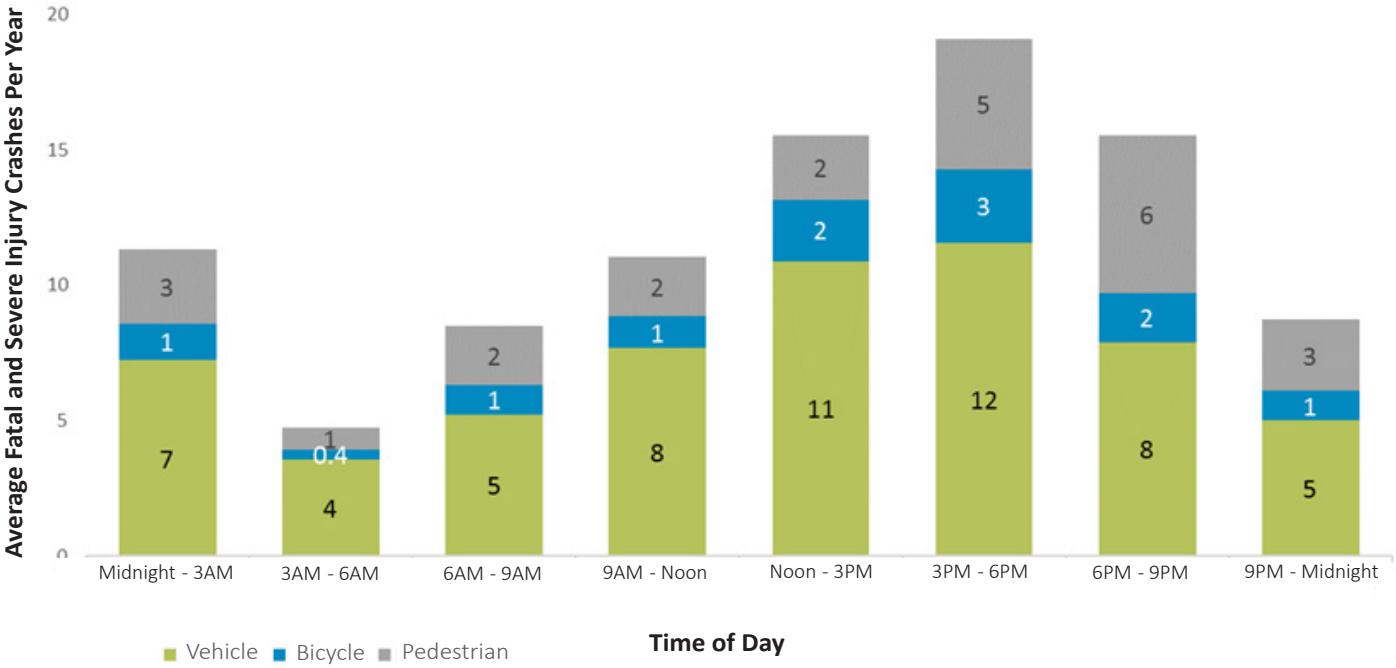


Figure 5-2. Average Annual Fatal and Severe Injury Crashes by Time of Day

Source for Crash Data: Vision Zero 10-Year Dataset

How Severe are the Crashes?

Fatal (Type K) and incapacitating injury crashes (Type A) are life-altering. Fatal crashes result in the death of a street user, and incapacitating injury crashes (Type A) result in severe injury of a street user and likely impair them with some sort of disability following the crash.

These two crash severity levels have been grouped together as "fatal and severe injury crashes" in this study, as they are in many other safety assessments. Fatal and severe injury crashes together are used as the state performance measure for traffic safety in Minnesota in the 2014 Strategic Highway Safety Plan (SHSP).

Combining fatal and severe injury incidents is standard practice in statistical crash analysis because these types of crashes typically have similar characteristics and the factors that result in a fatality rather than a severe injury can be minor or random. For instance, if the bicyclist's location had been different by a matter of feet, or if the automobile had been traveling one or two miles per hour slower, the outcome of the crash may have been different. Additionally, the grouping creates a larger sample size for analysis, which is more useful for identifying trends and patterns.

Figure 5-3 shows the numbers of fatal and severe injury crashes that have occurred from 2007 to 2015 within Minneapolis, excluding homicides and intentional injury crashes, private property crashes, crashes on freeways, and parking lot crashes as described in Chapter 4.

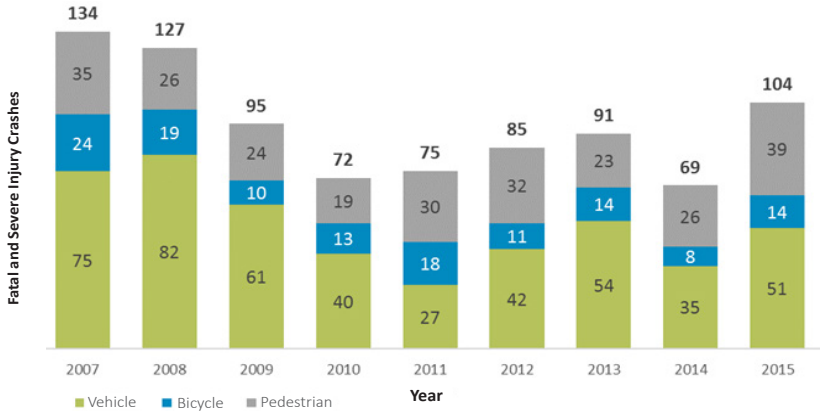


Figure 5-3. Number of Fatal and Severe Injury Crashes
Source for Crash Data: Vision Zero 10-Year Dataset

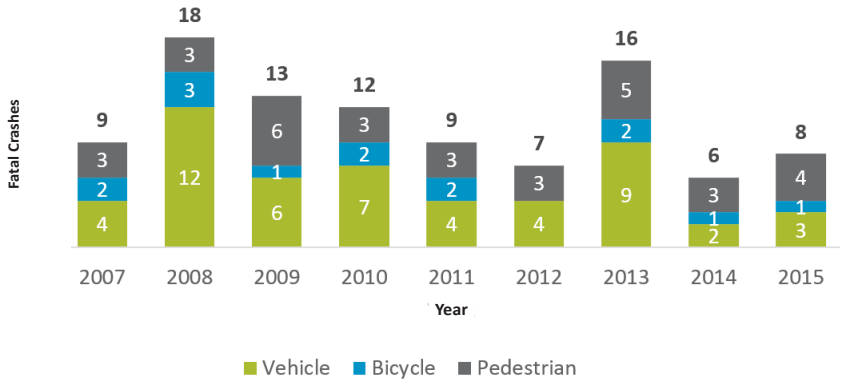


Figure 5-3.1. Number of Fatal Crashes
Source for Crash Data: Vision Zero 10-Year Dataset

Figure 5-4 shows the percentage of crashes in Minneapolis that result in fatal or severe injuries by mode. Non-motorized crashes have much higher percentages of fatal and severe injuries than vehicle crashes, reflecting the fact that users are more vulnerable and any type of crash is more likely to result in an injury. Ten percent of pedestrian crashes and four percent of bicycle crashes result in a fatal or severe injury, while only one percent of vehicle crashes result in a fatal or severe injury.

Although only one percent of vehicle crashes result in a fatality or severe injury, the larger number of vehicle crashes means that fatal and severe injury vehicle crashes represent the highest number of fatal and severe injury crashes overall. **Figure 5-5** shows the percentages of all fatal and severe injury crashes by year and by mode.

- Fatal and severe injury **vehicle** crashes have generally accounted for 50-60 percent of all fatal and severe injury crashes, trending downward overall with the exception of 2011-2013.
- The distribution of fatal and severe injury **bicycle** crashes has remained relatively constant over the last 10 years, accounting for 10-20 percent of all fatal and severe injury crashes.
- For pedestrians, the distribution of fatal and severe injury has accounted for 20-40 percent of all fatal and severe injury crashes, with that number generally trending upward through the study period.

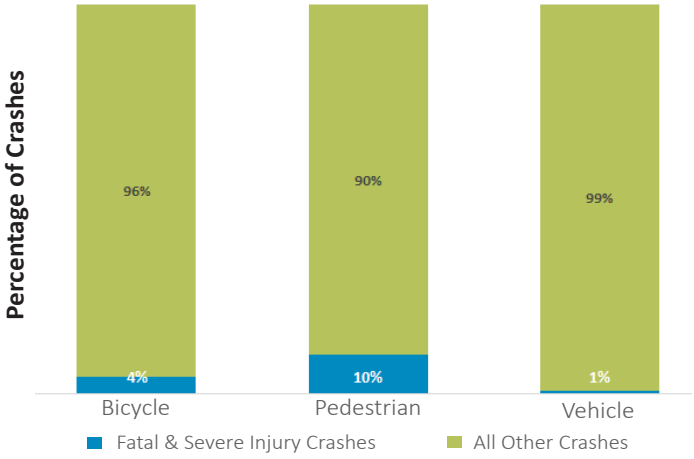


Figure 5-4. Percentage of Fatal and Severe Injury Crashes

Source for Crash Data: Vision Zero 10-Year Dataset, excludes supplemental MnCMAT crashes

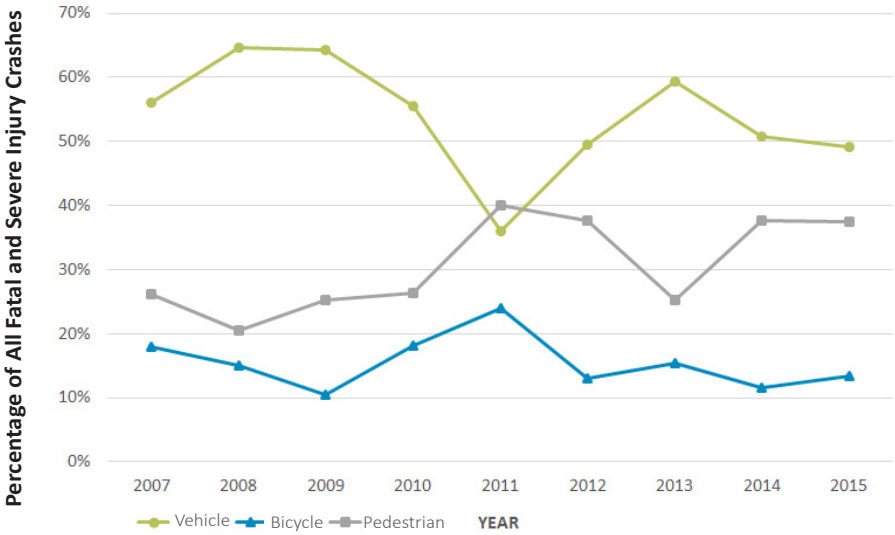


Figure 5-5. Distribution of Fatal and Severe Injury Crashes between Modes

Source for Crash Data: Vision Zero 10-Year Dataset

Motorcycle Crash Severity

There were nearly 800 motorcycle crashes over the study period, representing one percent of the vehicle crashes. Nine percent of all motorcycle crashes resulted in a fatality or severe injury compared to one percent of all vehicle crashes that resulted in a fatality or severe injury. Although motorcycles are classified as a vehicle, motorcycle riders are more vulnerable than drivers of an automobile.

Sport Utility Vehicle (SUV) Crash Severity Trends

Although the City of Minneapolis database does not track sport utility vehicle crashes separately from other vehicle types, the MnCMAT database does contain a more detailed categorization of motor vehicle types. According to the MnCMAT data, in 2007 passenger cars accounted for 44 percent of the vehicles in fatal and severe injury crashes. In 2015, that percentage had dropped to 35 percent. Over that same timeframe, SUVs rose five percentage points from 10 percent of the vehicles in fatal and severe injury crashes to 15 percent of the vehicles in those crashes – a trend that reflects an increasing presence of SUV sales in the U.S. auto market. **Table 5-1** shows the distribution of vehicle types involved in fatal and severe injury crashes by year in Minneapolis.

Street Users	2007	2008	2009	2010	2011	2012	2013	2014	2015	Percent Change Over Time
Passenger Car	44%	49%	43%	45%	36%	35%	42%	39%	35%	-9%
Pickup Truck	8%	6%	6%	6%	5%	3%	2%	5%	5%	-3%
Sport Utility Vehicle	10%	11%	17%	11%	12%	13%	14%	15%	15%	5%
Minivan	7%	5%	4%	5%	6%	9%	7%	6%	7%	0%
Recreation and Farm Equipment	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Professional Drivers	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus	2%	1%	3%	4%	2%	1%	2%	3%	1%	-1%
Motorcycle	4%	3%	5%	4%	5%	7%	9%	8%	7%	2%
Motorscooter	1%	1%	2%	2%	1%	0%	0%	1%	0%	0%
Heavy Truck or Semi	1%	3%	3%	2%	4%	1%	2%	4%	2%	0%
Pedestrian	12%	11%	10%	14%	18%	20%	13%	15%	18%	6%
Bicyclist	8%	7%	5%	8%	10%	6%	8%	4%	6%	-1%
Other or Unknown	2%	3%	3%	1%	3%	2%	1%	2%	3%	1%

Table 5-1. Street Users Involved in Fatal and Severe Injury Crashes by Year in Minneapolis

Source: MnDOT Crash Mapping and Analysis Tool (MnCMAT)

Who is Involved?

Passenger vehicles and freight vehicles are grouped together in the crash database as vehicles. These users make up the largest percentage of user types involved in crashes on Minneapolis streets. All other types each make up three percent or less of users in crashes. **Figure 5-6** shows the distribution of street users involved in crashes.

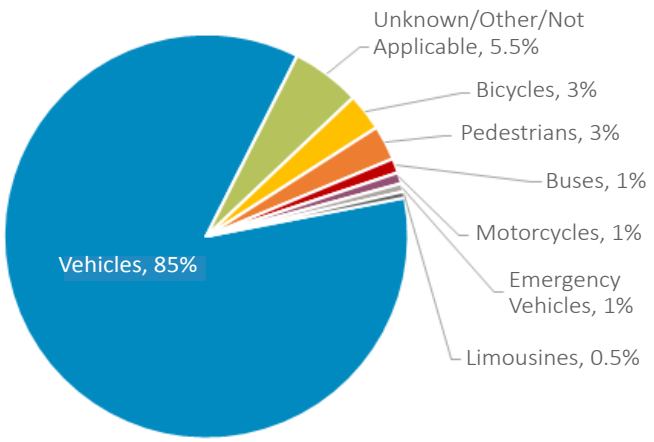


Figure 5-6. Users Involved in Crashes in Minneapolis
Source for Crash Data: Vision Zero 10-Year Dataset

Key takeaways for analyzing who is involved in crashes include:

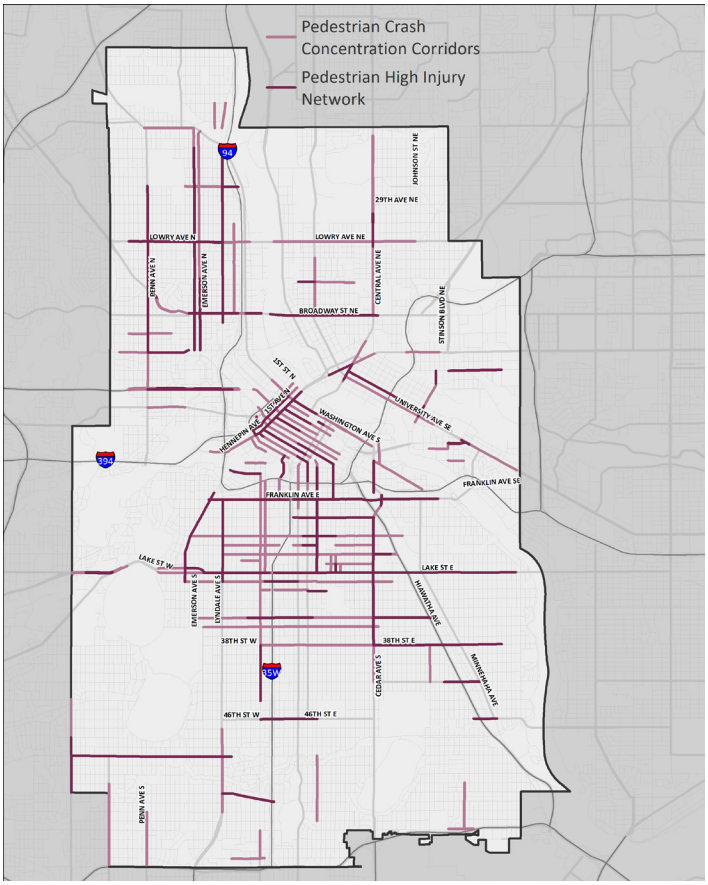
- "Vehicles" (which includes typical passenger vehicles and freight vehicles) make up 85 percent of the vehicle types identified in crashes.
- Bicycles make up three percent of the vehicle types identified in crashes.
- Pedestrians make up three percent of the vehicle types identified in crashes.
- Buses, motorcycles, and emergency vehicles each make up one percent of vehicle types identified in crashes.
- The other possible vehicle types in the Minneapolis crash database are Unknown, Other, Limousine, or Not Applicable. Together they account for six percent of crashes.

Street Characteristics

Crash Concentration Corridors and High Injury Networks

Although crashes have occurred in all parts of the city over the past 10 years, the majority of crashes are concentrated on a small number of streets. This study identifies the streets where crashes occur most frequently as **Crash Concentration Corridors.** Streets where crashes are more likely to result in severe injury or death are identified as part of the **High Injury Network.** Because crashes in Minneapolis are most common at intersections, there is no minimum or maximum length of corridor for selection. As such, the shorter corridors are largely due to one or two adjacent intersections with a history of crashes.

In 2017 the City of Minneapolis used this approach in the Pedestrian Crash Study. The Pedestrian Crash Concentration Corridors and the Pedestrian High Injury Network from that study are shown in **Figure 5-7**. The following analysis of bicycle and vehicle crashes utilized the same process for each mode respectively, as well as for all combined crashes. Identifying these corridors by mode provides insight into locations with a history of crashes for each user group, and locations with a history of all crash types.



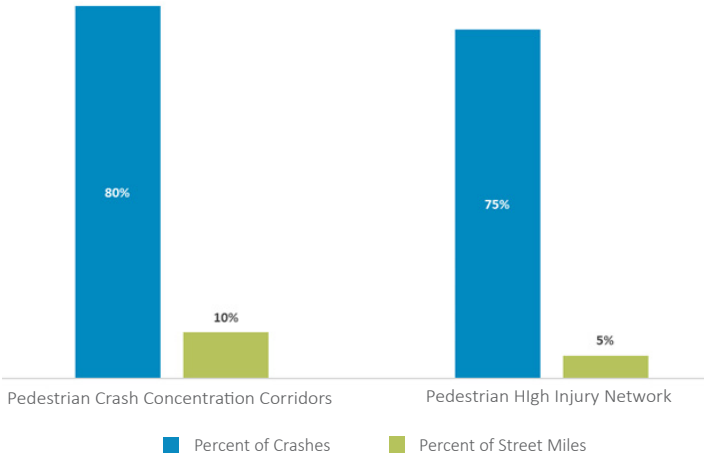


Figure 5-7. Pedestrian Crash Concentration Corridors and High Injury Network

Source for Pedestrian Crash Data: Pedestrian Crash Study (2017) 10-Year Dataset

Vehicle Crash Concentration Corridors

Most streets in the city have experienced at least one vehicle crash over the study period. However, crashes are generally concentrated on the major traffic corridors in the city. Sixty-two (62) percent of all vehicle crashes occurred on six percent of the streets in the city. These six percent of streets, in this study called the **Vehicle Crash Concentration Corridors**, are highlighted in purple in **Figure 5-8**. These streets are characterized by closely spaced intersections and high volumes of vehicle traffic. These corridors encompass an estimated 28 percent of the vehicle miles traveled on city streets.

Vehicle High Injury Network

Fatal and severe injury vehicle crashes are also concentrated. Nearly two-thirds (63 percent) of all fatal and severe injury vehicle crashes occurred on four percent of the streets in the city. While there are fewer of these types of crashes, concentrations at the busiest intersections and corridors are still somewhat apparent. Streets containing these intersections are shown in purple and labeled as the **Vehicle High Injury Network** on **Figure 5-9**. These corridors encompass an estimated 18 percent of the vehicle miles traveled on city streets.

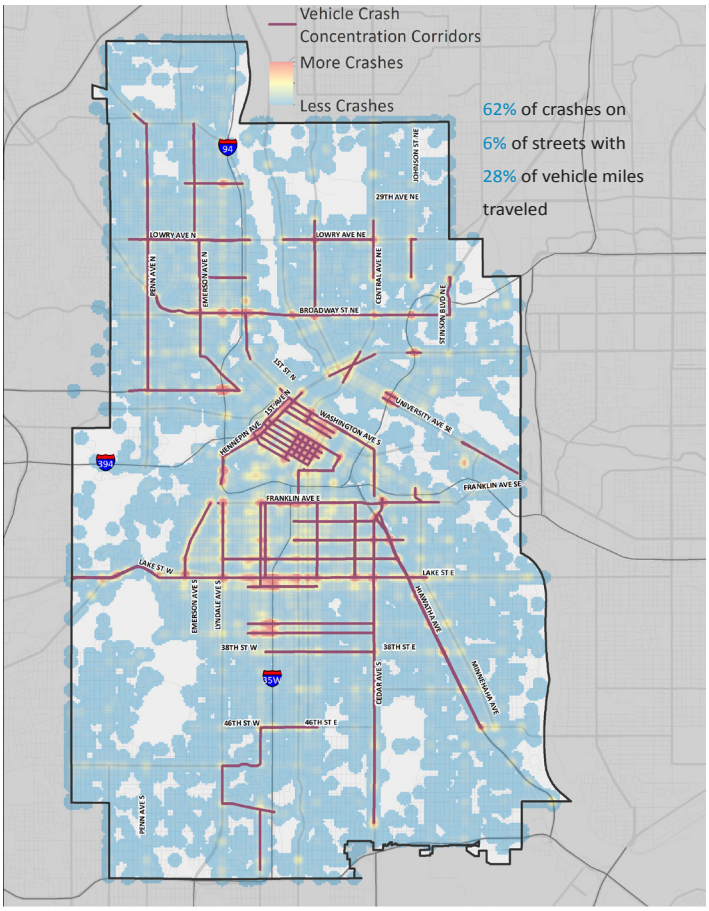


Figure 5-8. Vehicle Crash Concentration Corridors

Source for Vehicle Crash Data: Vision Zero 10-Year Dataset

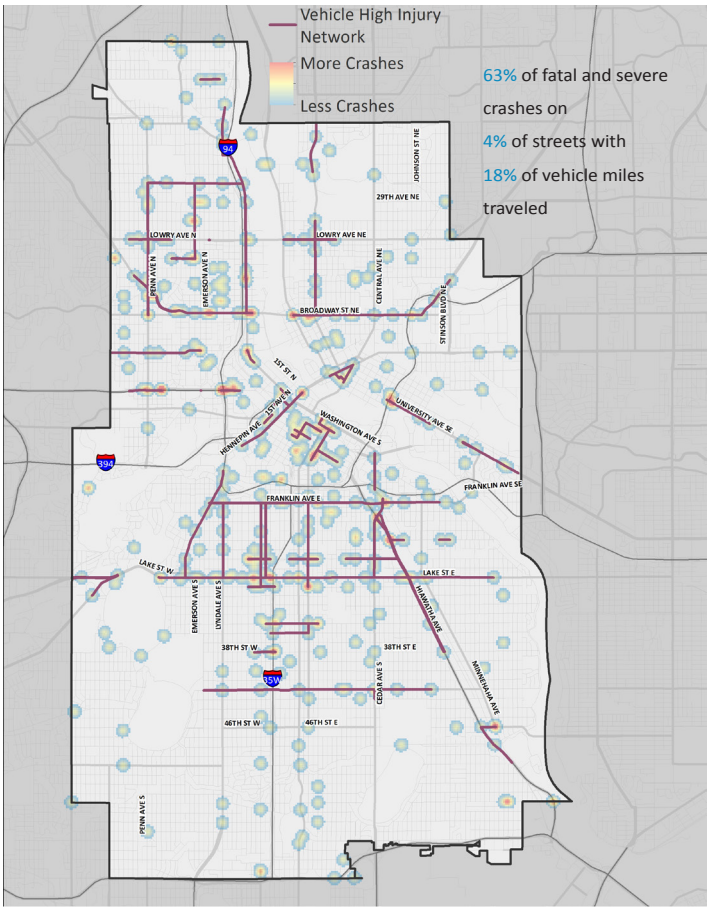


Figure 5-9. Vehicle High Injury Network

Source for Vehicle Crash Data: Vision Zero 10-Year Dataset

Bicycle Crash Concentration Corridors

There are hundreds of miles of streets in the city that have not experienced a bicycle crash over the study period, and there are many locations throughout the city that have experienced a single bicycle crash. The pattern of crashes is focused around some key intersections, which led to identifying corridors with multiple key intersections. The map below shows the identified **Bicycle Crash Concentration Corridors**, which represent 53 percent of bicycle crashes and four percent of streets in the city. The Bicycle Crash Concentration Corridors are highlighted in blue on **Figure 5-10**. These corridors encompass an estimated 13 percent of the vehicle miles traveled on city streets.

Bicycle High Injury Network

There have been relatively few severe injury and fatal bicycle crashes in the city over the study period. The crashes that have occurred are concentrated at a few intersections. Eighty-one (81) percent of the fatal and severe injury bicycle crashes occurred on the three percent of street miles that connect these intersections together. These three percent of streets encompass an estimated 10 percent of the vehicle miles traveled on city streets. These streets are called the **Bicycle High Injury Network** and are highlighted in blue on **Figure 5-11**.

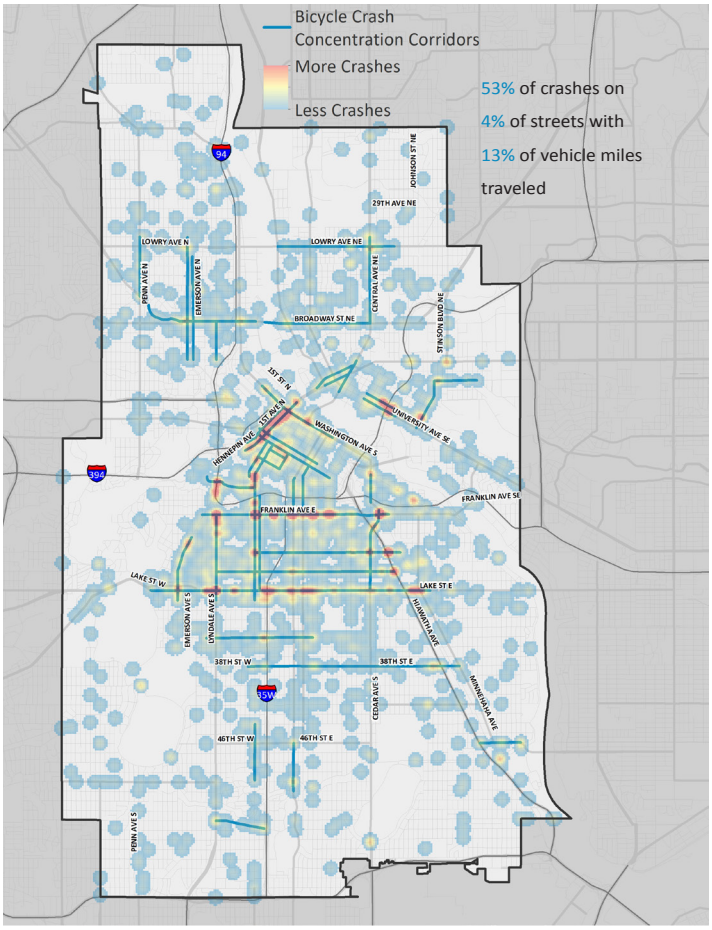


Figure 5-10. Bicycle Crash Concentration Corridors

Source for Crash Data: Vision Zero 10-Year Dataset

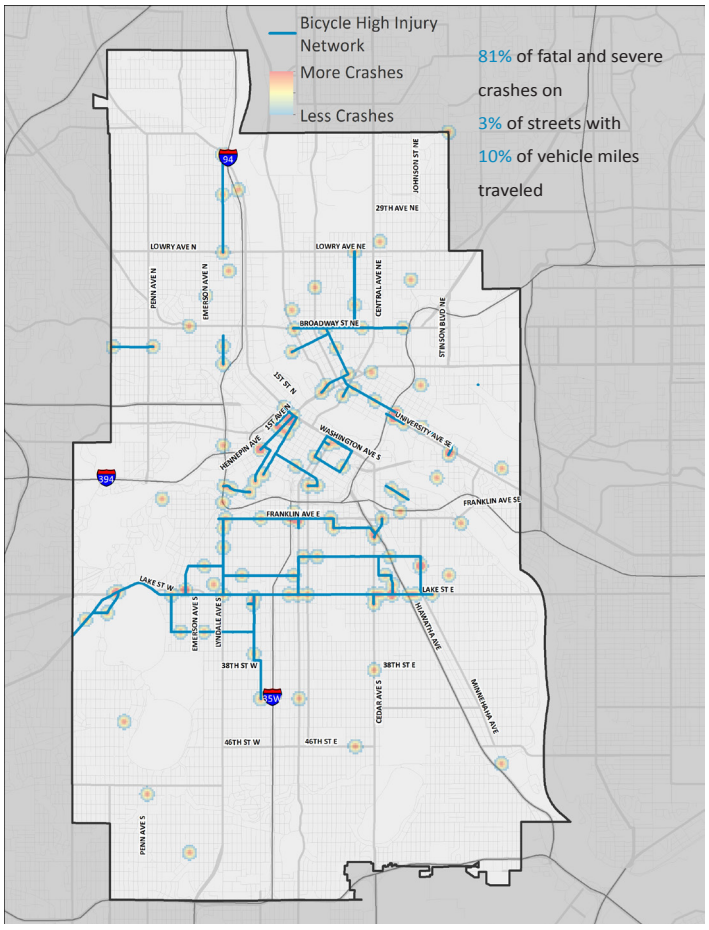


Figure 5-11. Bicycle High Injury Network

Source for Bicycle Crash Data: Vision Zero 10-Year Dataset

Crash Concentration Corridors: All Modes

Certain corridors were identified as having crash concentrations that were common among all modes. The streets shown in **Figure 5-12** show the **Crash Concentrator Corridors** for all the modes. The longest contiguous stretches of streets include Lake Street, Franklin Avenue, West Broadway Avenue, 28th Street and Broadway Street NE. In total, these corridors account for 36 percent of all crashes and 10 percent of all vehicle miles traveled on just over two percent of streets.

The crash percentages and vehicle miles traveled are much lower on the combined crash concentration corridor than the modal specific corridors because of the sheer number of vehicle crashes that occur throughout the city (and outside of these corridors). However, the 36 percent of crashes that happened on this network represents **15,000 crashes over ten years,** which translates to 125 crashes per month or approximately four per day.

High Injury Network: All Modes

Certain corridors were common for fatal and severe injury crashes across all modes. The streets shown in **Figure 5-13** are on the **High Injury Network** of all the modes. These streets have had a trend of fatal and severe injury crashes in every mode: pedestrian, bicycle, and vehicle. Fifteen percent of fatal and severe injury crashes across all modes occurs on these less than one percent of roads, representing four percent of vehicle miles traveled on city streets. These corridors include stretches of Lake Street, Franklin Avenue, Lyndale Avenue, Hennepin Avenue and Broadway Street NE.

Again, the percentages of total crashes and vehicle miles traveled are much lower on the combined high injury network than the modal specific networks because of the sheer number of vehicle crashes that occur throughout the city (and outside of these corridors). Despite that lower percentage, **140 fatal and severe injury crashes happened over ten years on the eight miles of road that is the combined high injury network.**

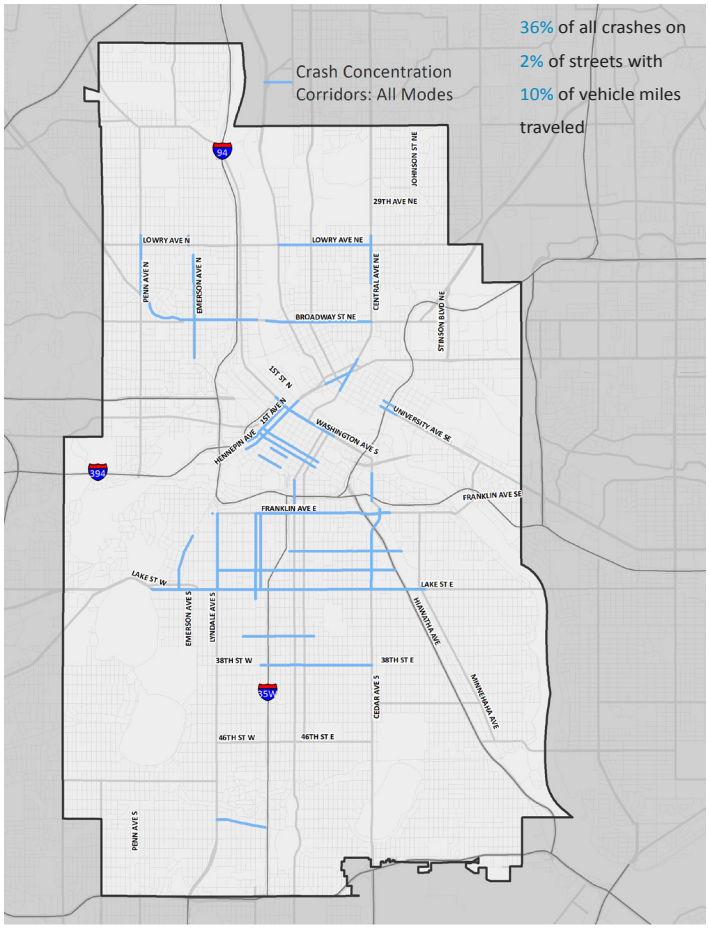


Figure 5-12. Combined Crash Concentration Corridors

Source for Bicyle and Vehicle Crash Data: Vision Zero 10-Year Dataset
Source for Pedestrian Crash Data: Pedestrian Crash Study 10-Year Dataset

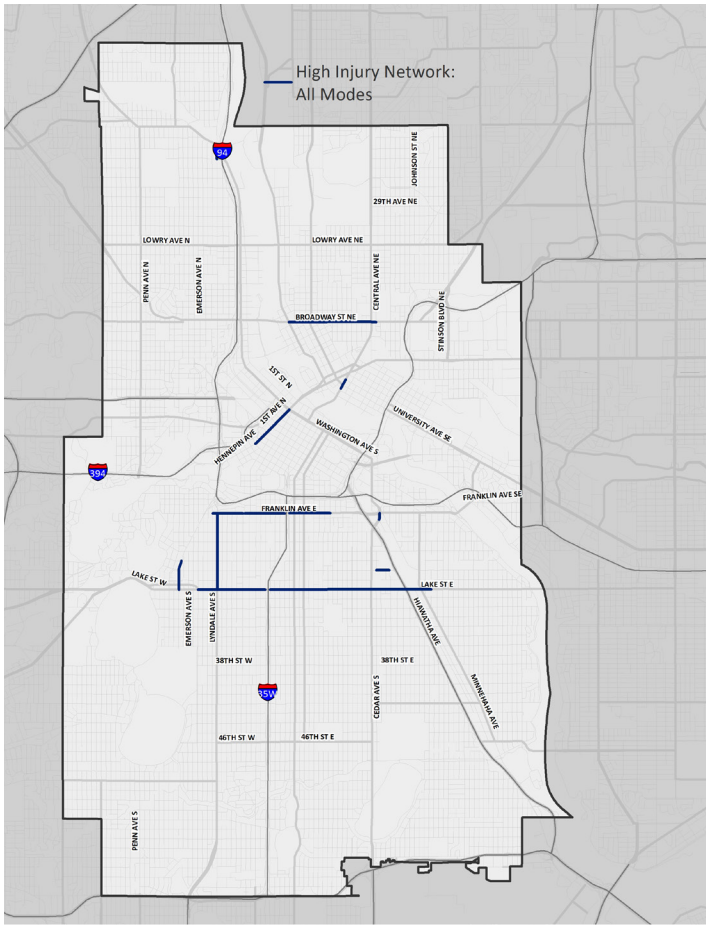


Figure 5-13. Combined High Injury Network

Though many of these corridors are among Minneapolis' more heavily traveled streets, the percent of crashes that occur on them is much larger than the percent of traffic these streets carry.

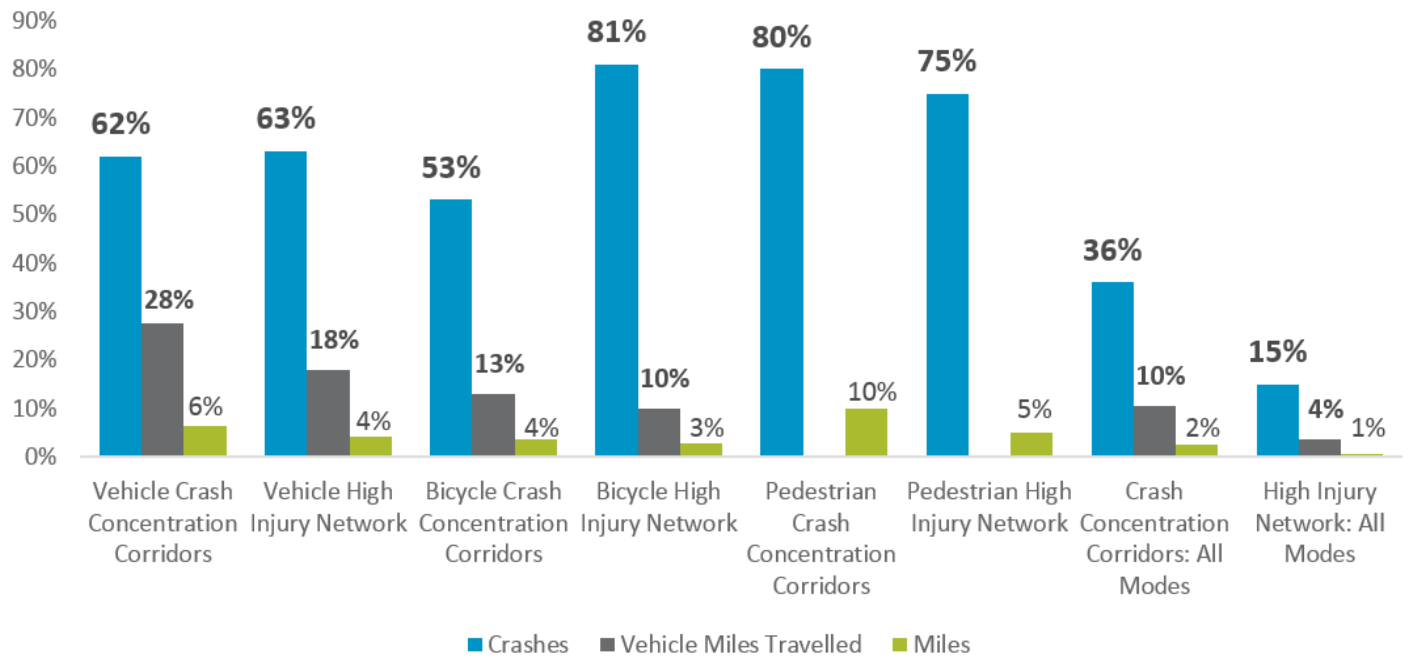


Figure 5-14. Crash Concentration Corridors and High Injury Network Statistics

Source for Vehicle & Bicycle Crash Data: Vision Zero 10-Year Dataset

Source for Pedestrian Crash Data: Pedestrian Crash Study 10-Year Dataset

Source for Street Mileage and Vehicle Miles Traveled: City of Minneapols 20 Year Street Funding Plan

Every mode has a stake in this network: the one percent of streets on the High Injury Network (All Modes) have had trends of fatal and severe injury crashes for pedestrians, bicyclists, and vehicles.

Approach to Identifying Crash Over- and Under-Representation

Bicycle and vehicle crashes occur on different types of streets throughout the city. Similar to the Pedestrian Crash Study, a systematic safety approach is used in the Vision Zero Crash Study to analyze the frequency of crashes compared to the frequency of infrastructure characteristics or features. This approach is used to identify features that are significantly over-represented in bicycle or vehicle crashes. An over-representation suggests that that feature could be a contributing factor in crashes. The features analyzed in this study include bicycle lanes, speed limit, and vehicle lanes. The systematic analysis has two benefits:

1. Identify locations with a history of crashes
2. Identify locations that have similar characteristics where crashes have not yet occurred.

Figure 5-15 shows an example feature that is equally represented in infrastructure prevalence and bicycle/vehicle crashes. This indicates that the feature is likely not a contributing factor to the crash type and therefore would not be a focus area for improvements. The two charts in **Figure 5-16** show an example feature that is over-represented in that crash type compared to infrastructure prevalence. This suggests that the feature is potentially a contributing factor to those crashes and would be a focus area for improvements, even at locations where crashes have not occurred.

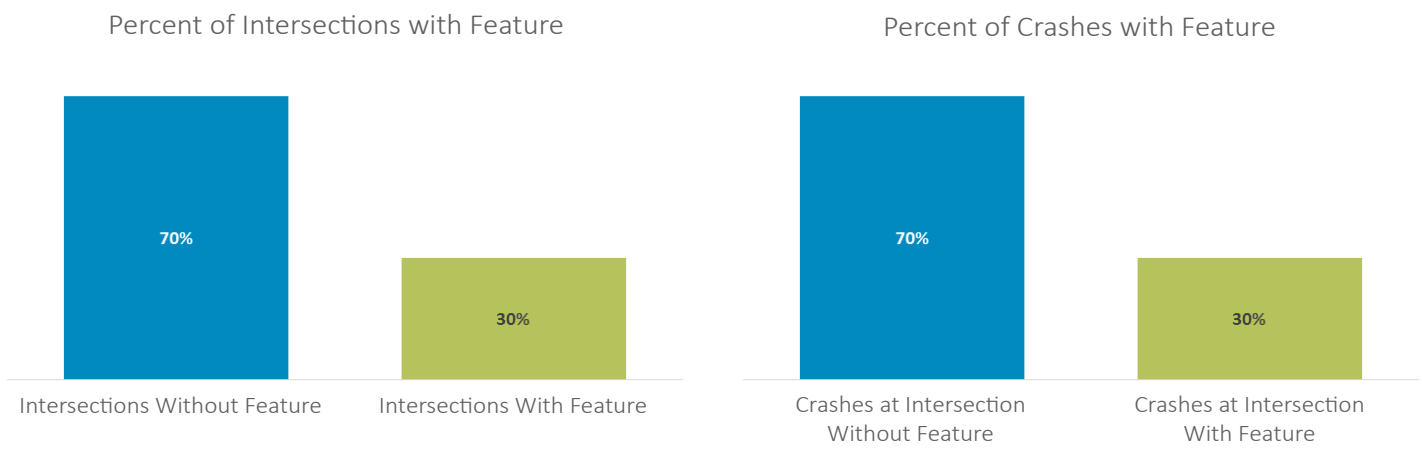


Figure 5-15. Example of Feature that is Not Over-Represented in Crashes

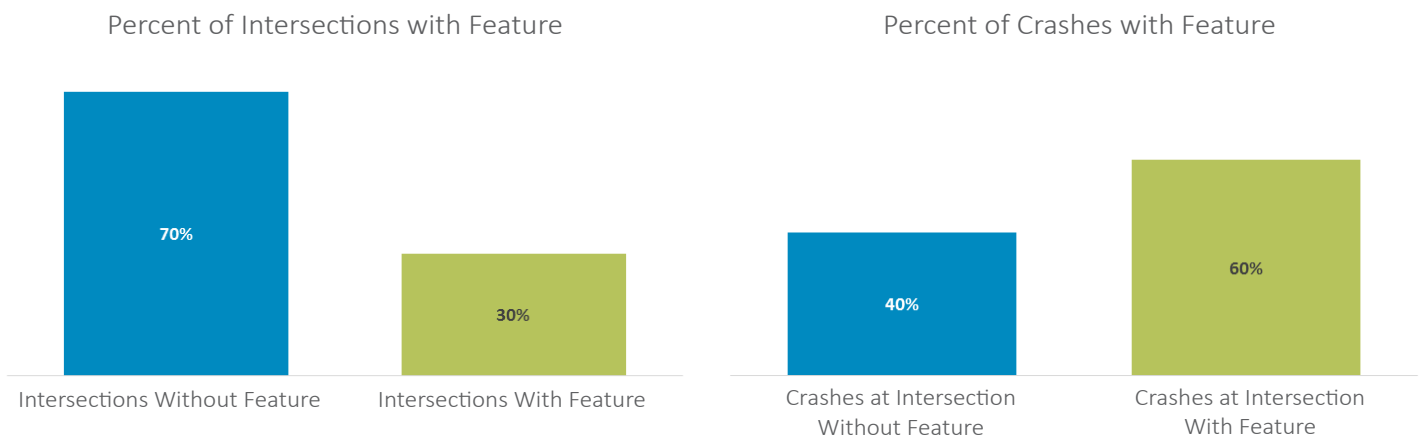


Figure 5-16. Example of Feature that is Over-Represented in Crashes

Street Infrastructure

Bicycle Infrastructure Types

There are many types of bicycle infrastructure in Minneapolis. The "**Understanding Bicycle Markings in Minneapolis**[2]" guide summarizes bicycle facility types that exist in Minneapolis and how people bicycling and driving should interact with them. The Vision Zero Crash Study grouped the types of bicycle infrastructure into four categories based on space allocated to people bicycling in the street and the level of visual and physical separation between the bicyclist and the motor vehicle. Additionally, the aggregation to a few categories was necessary to create sufficient sample sizes of both crash and infrastructure mileage to be able to draw conclusions. **Figure 5-17** identifies where these bicycle infrastructure types are found throughout the city.

- **Shared on-street facilities** refer to bicycle facilities that have no dedicated space allocated to people bicycling in the street. These facilities include bicycle boulevards, advisory bicycle lanes, signed bike routes, routes with shared use markings, and shared bus and bike lanes.

The photos above show examples of a bicycle boulevard and an advisory bicycle lane.

- **On-street bicycle lanes** have designated space for people bicycling within the street right-of-way and are adjacent to vehicle traffic.

As shown in the example photos below, these facilities include bicycle lanes that may or may not have green markings.

[2] The "Understanding Bicycle Markings in Minneapolis" Retrieved from http://www.minneapolismn.gov/www/groups/public/@publicworks/documents/images/wcms1p-083551.pdf

- **Separated on-street bicycle lanes** have designated space for people bicycling within the street right-of-way and have a striped buffer area or a combination of striping and bollards to protect the bicycle lane from vehicle traffic.

These facilities include buffered on-street bicycle lanes and bollard protected on-street bicycle lanes, which are shown in the example photos above. Curb-protected on-street bicycle lanes are also included in this category of facilities.

- **Off-street lanes and trails** have designated space for people bicycling that are behind the curb. The bicycle facilities have curb, median, grass, or concrete walls separating bicycles from vehicles.

These facilities include separated use bicycle/pedestrian bridges, trails, and separated use sidepaths.

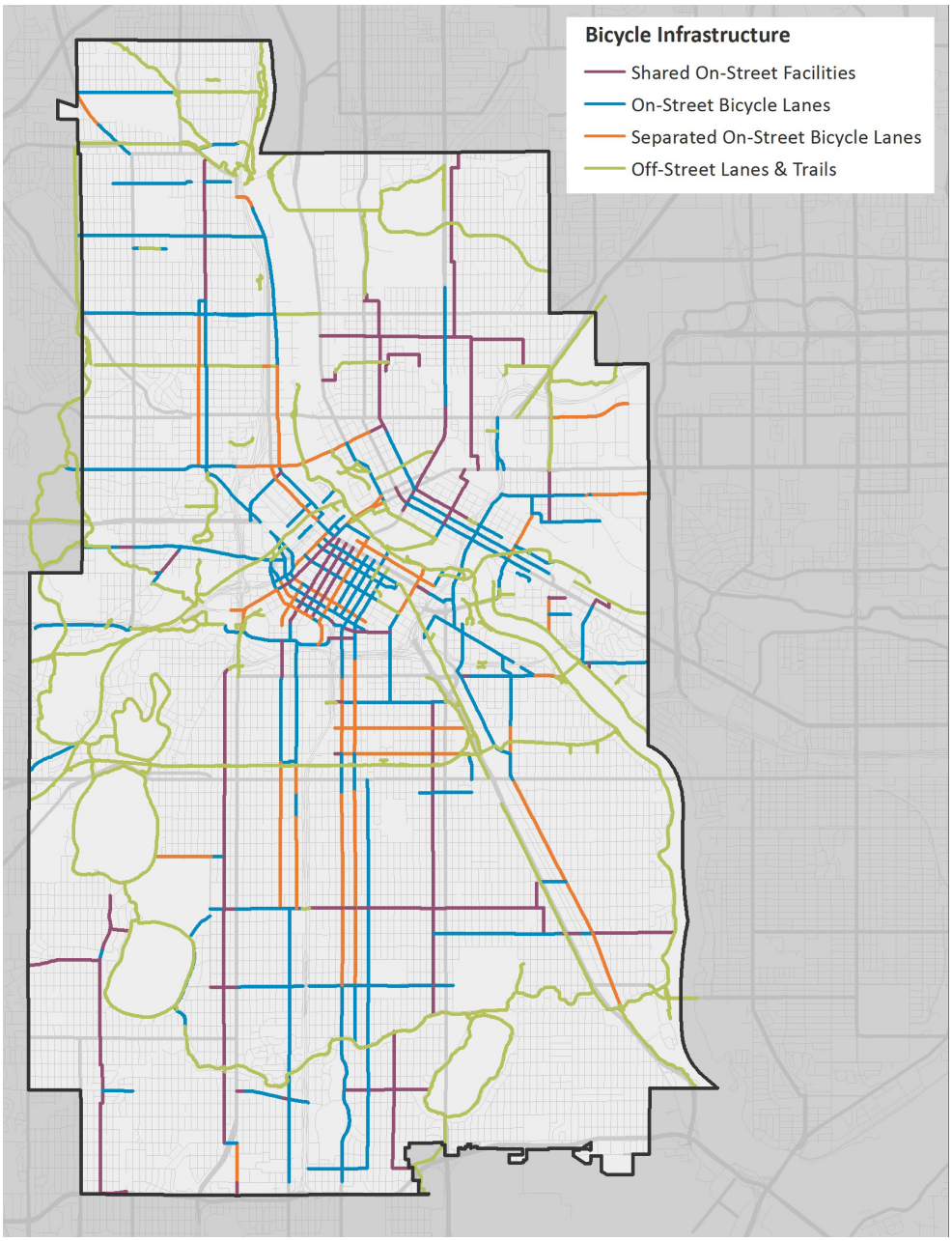


Figure 5-17. Bicycle Infrastructure in Minneapolis (2016)

Source for Bicycle Infrastructure: City of Minneapolis Bikeway Network maintained by Transportation Planinng and Programming Division of Public Works.

Growth in Bicycle Infrastructure

The City of Minneapolis has almost doubled the miles of bicycle facilities over the 10-year study period, including both on- and off-street facilities. Separated on-street bicycle lanes have had the greatest growth rate in recent years, increasing from three miles in 2011 to 28 miles in 2016 (**Figure 5-18**).

This increase in bicycle infrastructure likely had an effect on bicycle traffic numbers as well. However, without annual bicycle counts at the same location, this statement cannot be quantified.

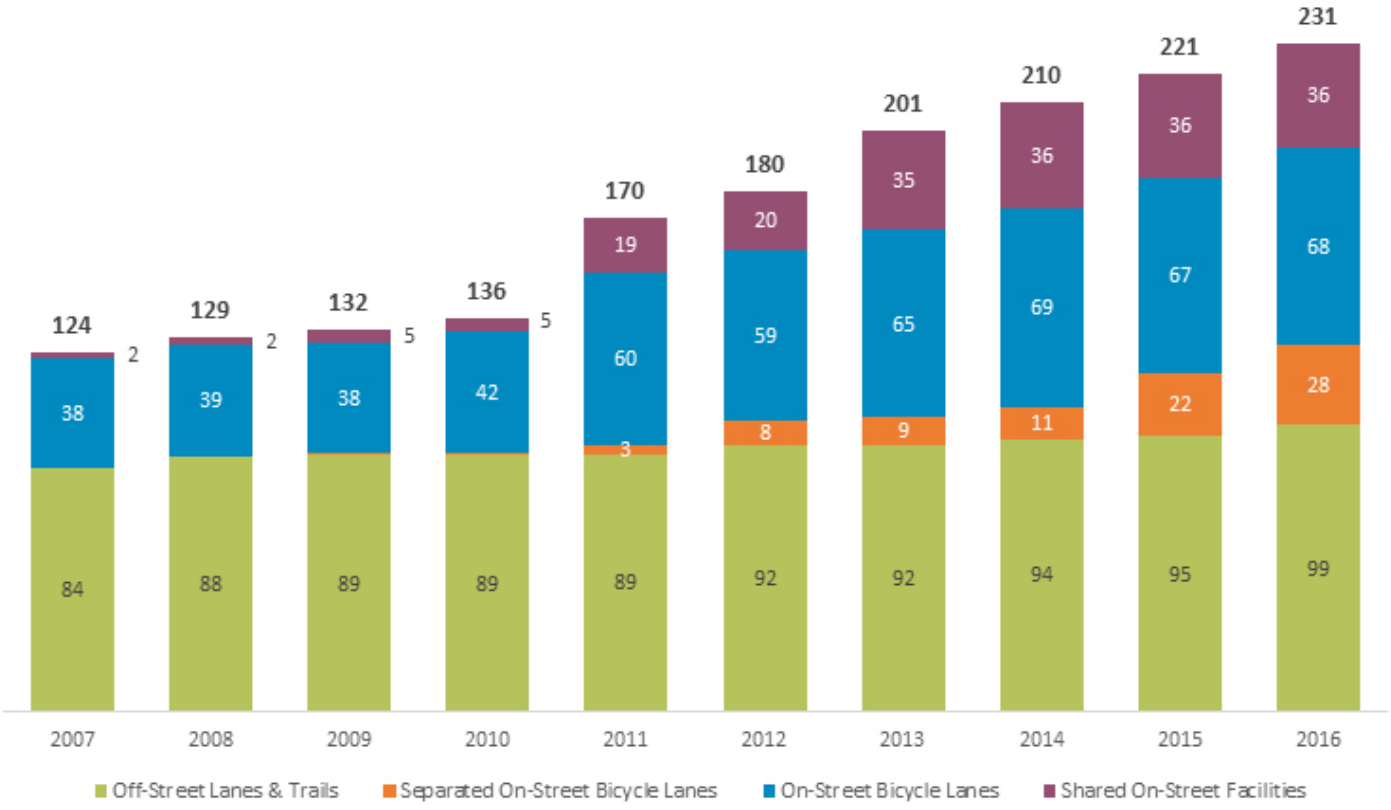


Figure 5-18. Miles of Minneapolis Bicycle Facilities by Year

Source for Bicycle Facility Mileage: City of Minneapolis Bikeway Network maintained by Transportation Planinng and Programming Division of Public Works.

Bicycle Crashes by Bicycle Facility Type

The bicycle crashes that occurred in Minneapolis between 2014-2016 overwhelmingly occurred on streets without any bicycle facility (**Figure 5-19**).

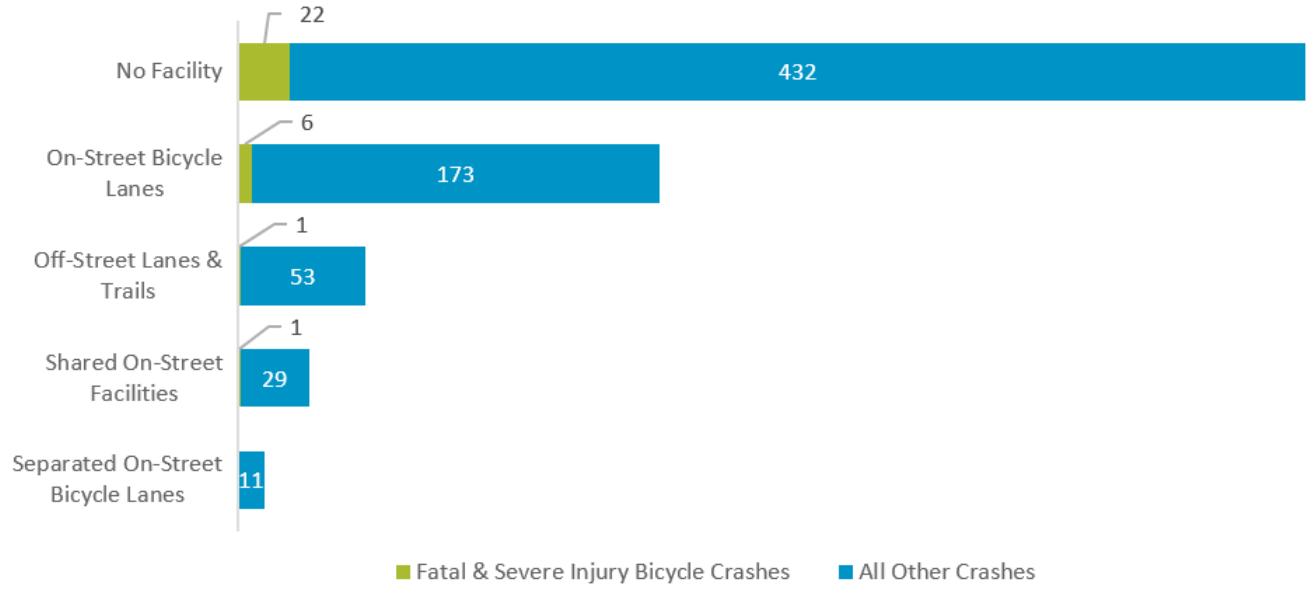


Figure 5-19. Bicycle Crashes by Bicycle Facility Type

Source for Crash Data: Vision Zero 3-Year Dataset

Ideally this finding would be compared against the bicycle activity citywide to determine if the prevalence of crashes on streets without facilities is over- or under-represented compared to the prevalence of trips on those streets. However, that analysis cannot be done comprehensively because nearly 80% of streets in the City of Minneapolis have not had bicycle counts taken and therefore do not have estimated daily bicycle traffic counts. Twenty percent (20%) of streets do have an estimated daily bicycle traffic count; half of those count locations have been on streets without bicycle facilities, and half of the count locations have been on streets with bicycle facilities **(Figure 5-20)**. Despite that even distribution, only 39% of the daily bicycle traffic observed has been on streets that do not have a bicycle facility. In other words, despite having more of the traffic count locations, streets without bicycle facilities have less bicycle traffic than streets with bicycle facilities. A next step of this analysis would be to compare the distribution of crashes on streets with counts against the traffic on those streets to see if there is any over- or under- representation based on facility type, corrected for activity.

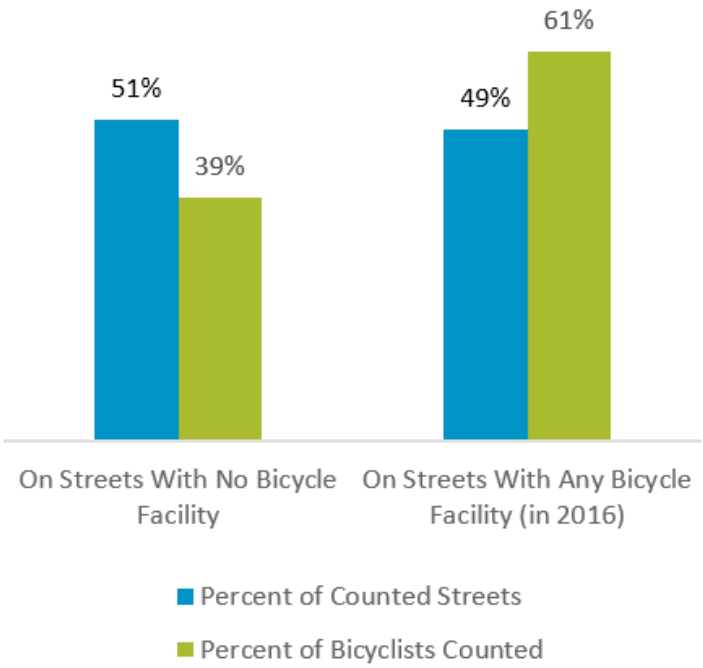


Figure 5-20: Bicycle Traffic Count Prevalence by Presence of Bicycle Facility Type

Bicycle Crash Frequency by Facility Type and Volume

Calculation of crash rates for bicycle facilities is very difficult because most street segments do not have bicycle user counts and many do not have vehicle user counts. However, additional analysis was conducted that classified each street segment based on both the type of bicycle facility and the vehicle activity (based on approximate vehicle volume). Because vehicle volumes are not available on all street segments, streets were grouped into ranges:

- Low Volume Streets – Average Daily Traffic (ADT) less than 5,000 vehicles per day
- Medium Volume Streets – ADT between 5,000 and 10,000 vehicles per day
- Higher Volume Streets – ADT between 10,000 and 20,000 vehicles per day

The following combinations of vehicle activity and bicycle facilities had fewer than one mile; these facility combinations were excluded from this analysis because the sample size was too small to draw conclusions.

- Off-Street Lanes and Trails on Low Volume Streets
- Off-Street Lanes and Trails on Higher Volume Streets
- Any bicycle facility type on streets with more than 20,000 vehicles per day

Across all facility types, bicycle crashes per mile per year increased as vehicle volume increased (**Figure 5-21**). Key findings of this analysis include:

- As volume increases, there is a demonstrable benefit to designating on-street space for bicycles separate from vehicles. Shared on-street facilities on streets with medium and higher vehicle volumes have much higher numbers of bicycle crashes per mile than those same facilities on streets with lower vehicle volumes.
- Across all categories of vehicle volumes, physical separation of bicycles results in fewer crashes per mile.
    - On medium and higher volume streets, shared on-street facilities have much higher bicycle crashes per mile than other on-street facility types that have designated space for bicycles.
    - In every volume category, separated on-street bicycle lanes have lower bicycle crashes per mile than on-street bicycle lanes.
- Off-Street Lanes and Trails have the lowest crashes per mile of any volume and facility category.

As volume increases, there is a demonstrable benefit to designating on-street space for bicycles separate from vehicles.

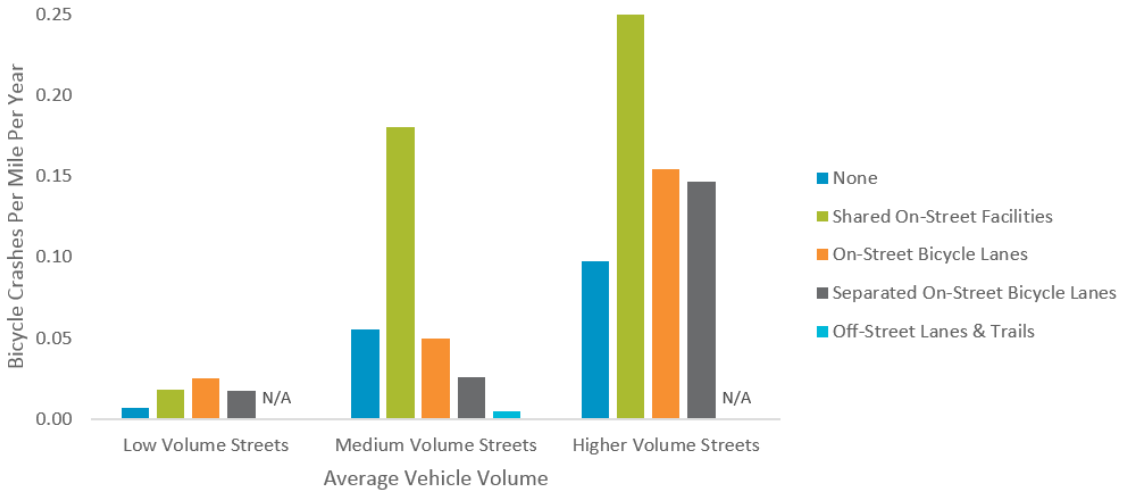


Figure 5-21. Bicycle Crashes per Mile per Year by Bicycle Facility Type and Vehicle Volume

Source for Crash Data: Vision Zero 10-Year Dataset; Source for Traffic Volume Data: City of Minneapolis

Types of Separated On-Street Bicycle Lanes

Separated on-street bicycle lanes can be broken into bollard-protected on-street bicycle lanes and buffered on-street bicycles lanes. Buffered means there is a striped area separating the bicycle lane from the vehicle lane, but there is no physical infrastructure. There are relatively few miles of either subcategory citywide. There were no curb-protected on-street bicycle lanes during the study period.

- In 2011, there were three miles of buffered on-street bicycle lanes and a half-mile of protected on-street bicycle lanes.
- In 2016, there were nineteen miles of buffered on-street bicycle lanes compared with nine miles of bollard-protected bicycle lanes.

Since 2011 when the first bollard-protected on-street bicycle facility was constructed, buffered on-street bicycle lanes have had fewer bicycle crashes per mile per year than bollard-protected on-street bicycle lanes (**Figure 5-22**). However, this is likely due to the relatively few miles and fewer years of data for bollard-protected on-street bicycle lanes. Crashes on these types of facilities, as well as curb-protected on-street bicycle lanes, will need to continue to be evaluated as the city has a larger sample size of data and drivers and bicyclists gain experience with these facilities.

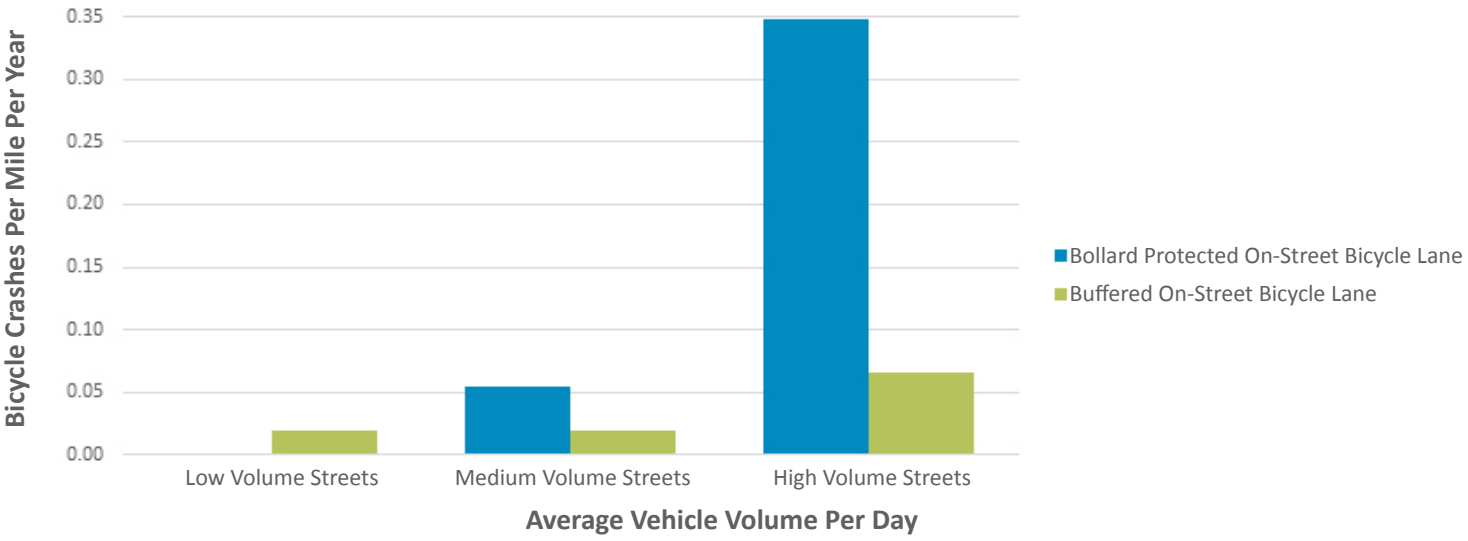


Figure 5-22: Bicycle Crashes by Separated On-Street Bicycle Facility Type and Vehicle Volume

Source for Crash Data: Vision Zero 10-Year Dataset
Source for Traffic Volume Data: City of Minneapolis

Bicycle Facility Type and Intersection Treatments

This analysis considers the type of bicycle facility leading up to intersections (along corridors), but does not incorporate the fact that intersection treatments vary within the same facility type. Over 90 percent of bicycle crashes on bicycle facilities happened at intersections, indicating the need to further focus on intersection design where trails, off-street lanes, and protected on-street facilities interact with vehicle traffic. These crash data confirm that traffic signals alone do not function as safety devices, and their effectiveness could be strengthened by broader intersection design considerations.

Speed Limit

The vast majority of fatal and severe injury crashes for all modes occur on streets with a 30 mile per hour (mph) speed limit because this is the most predominant speed limit on streets in Minneapolis (**Figure 5-23**). Bicycle crashes are under-represented on streets with a 25 mph speed limit and over-represented on those with a 35 mph speed limit, compared to the percentage of street miles in the city. Vehicle crashes are similarly under-represented on streets with lower speed limits and over-represented on streets with 35 mph or higher speed limits.

For bicycle crashes, the proportion of fatal and severe injury crashes increases as speed limit increases (**Figure 5-24**). While only 0.4 percent of bicycle crashes on 25 mph streets resulted in a fatality or severe injury, that figure rises to five percent of crashes at 30 mph, six percent at 35 mph, and declining to four percent at 40-50 mph.

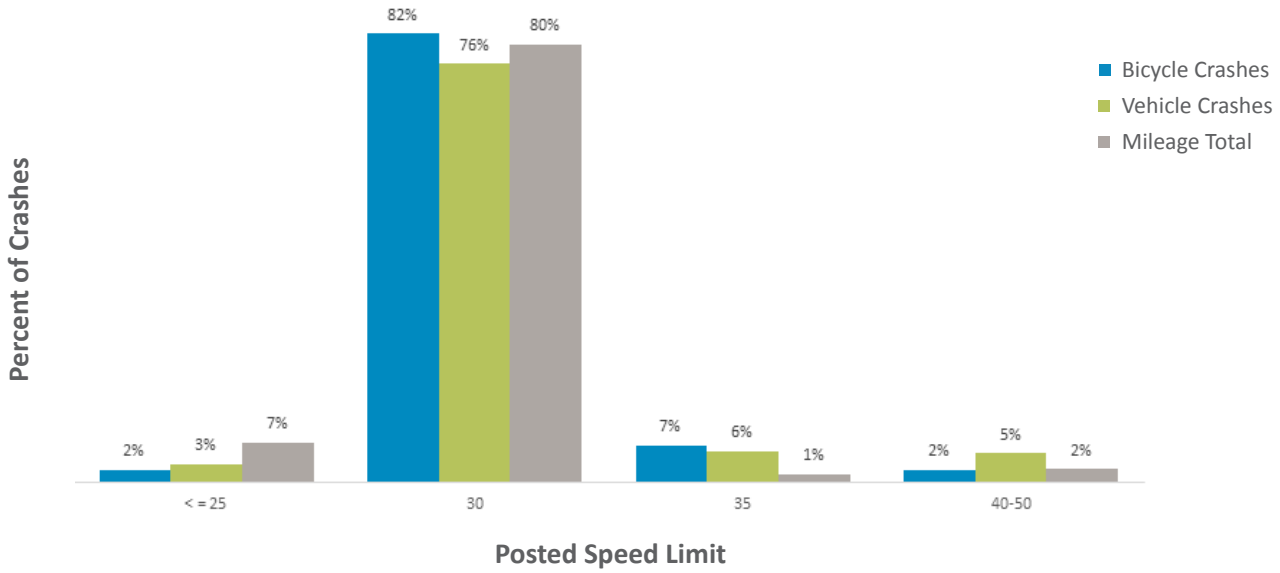
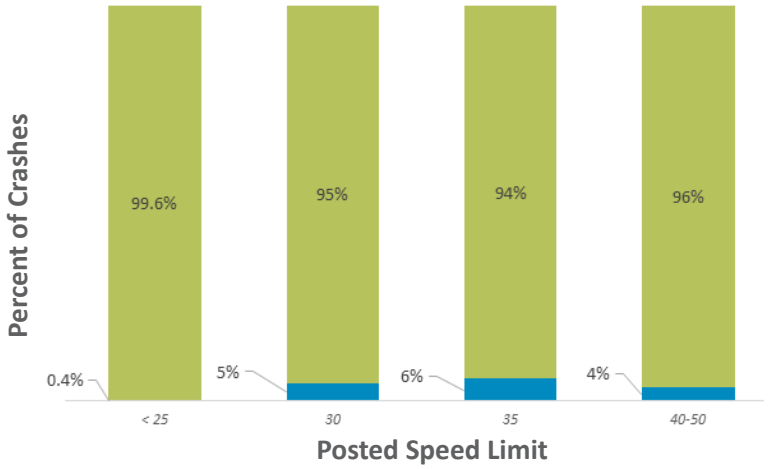


Figure 5-23. Bicycle and Vehicle Crashes by Speed Limit

Source for Crash Data: Vision Zero 10-Year Dataset
Source for Facility Mileage Data: City of Minneapolis



For bicyclists, crashes are more likely to result in fatality or severe injury as posted speed limit increases.

Figure 5-24. Percentage of Bicycle Fatal and Severe Injury Crashes by Speed Limit

Source for Bicycle Crash Data: Vision Zero 10-Year Dataset, excluding the supplemental fatal and severe injury crashes from MnCMAT

Number of Travel Lanes

The number of vehicle lanes on a street relates to traffic volume: as traffic volume increases there is more exposure and potential for conflict. One-way streets with one, two, and three vehicle travel lanes and two-way streets with two and four vehicle travel lanes comprise the majority of the street network in Minneapolis. The crash analysis found that both one-way and two-way streets with fewer vehicle lanes result in fewer bicycle and vehicle crashes per mile (**Figure 5-25** & **Figure 5-26**).

Although two-way streets with three, five, and six lanes were considered in this analysis, these lane configurations make up a very small percentage of total mileage and therefore the sample size was too small to be conclusive.

One-way and two-way streets with fewer vehicle lanes result in fewer bicycle and vehicle crashes per mile.

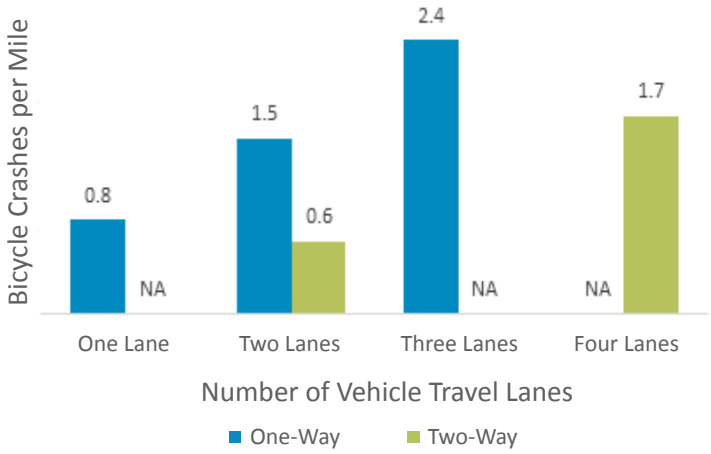


Figure 5-25. Bicycle Crashes and Number of Vehicle Travel Lanes

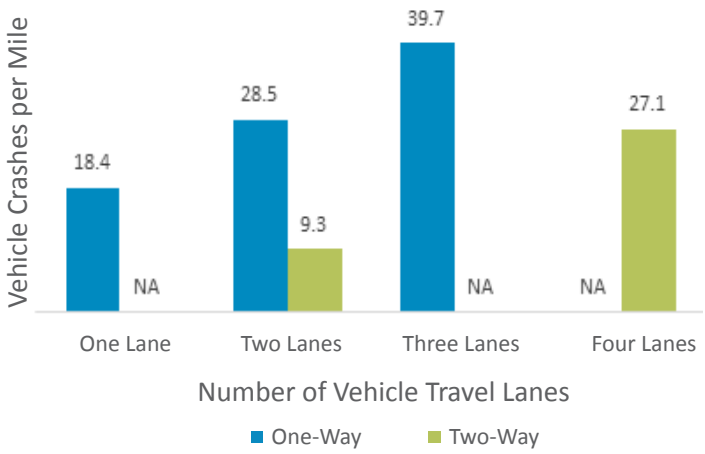


Figure 5-26. Vehicle Crashes and Number of Vehicle Travel Lanes

Source for Crash Data: Vision Zero 10-Year Dataset ; Source for Vehicle Travel Lane Data: City of Minneapolis

Bicycle-Bus Crashes

There is an average of 10 bicycle-bus crashes per year in Minneapolis. **Figure 5-27** shows the history of bicycle-bus crashes over time.

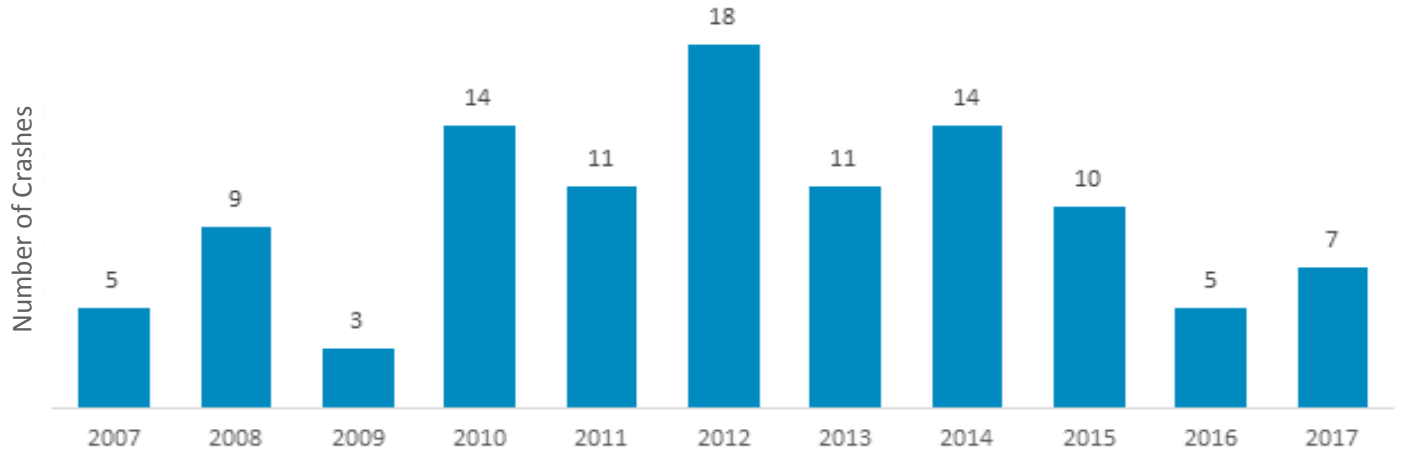


Figure 5-27. Bicycle-Bus Crashes by Year

Source for Bicycle Crash Data: Vision Zero 10-Year Dataset supplemented with crashes from Metro Transit

Many of the bicycle-bus crashes are concentrated along a few corridors, and the locations of these crashes are shown in **Figure 5-28**. These corridors all have different types of transit service and bicycle facilities.

- West Lake Street in Uptown: Three transit routes and no bicycle infrastructure.
- Hennepin Avenue in downtown: Eight transit routes and shared on-street bicycle facility.
- 4th Street S in downtown: Three transit routes in contra-flow transit lane and on-street bicycle lane.

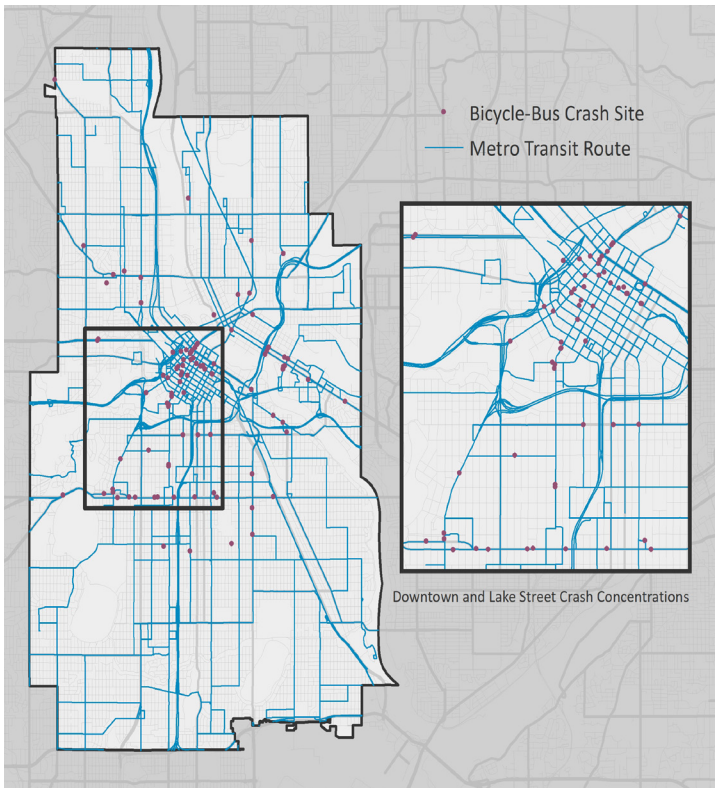


Figure 5-28. Locations of Bus-Bicycle Crashes

Source for Bicycle Crash Data: Vision Zero 10-Year Dataset supplemented with crashes from Metro Transit
Source for Metro Transit Route Data: Metropolitan Council (through MetroGIS.org)

Intersection Characteristics

Intersection Overview

In Minneapolis, 80 percent of all bicycle crashes and nearly 90 percent of vehicle crashes happened at intersections (**Figure 5-29**).

Only 12 percent of intersections are controlled by signals, but 48 percent of bicycle crashes in Minneapolis happened at signalized intersections. Stop signs are underrepresented in crashes; only 32 percent of bicycle crashes happened at stop signs which are the control type of 72% of the intersections. Vehicle crashes follow a similar trend, with 57 percent of all crashes at signalized intersections and 32 percent at intersections with a stop sign.

This correlation between crash location and traffic signals is a function of activity; locations with traffic signals are where the majority of activity and travel occurs in the city. In Minneapolis, streets with 5,000 daily vehicles or more are typically corridors with traffic signals. An analysis of these streets found that 80 percent of the vehicle miles travelled in the city are on streets with more than 5,000 average daily vehicles (where signals are typically found).

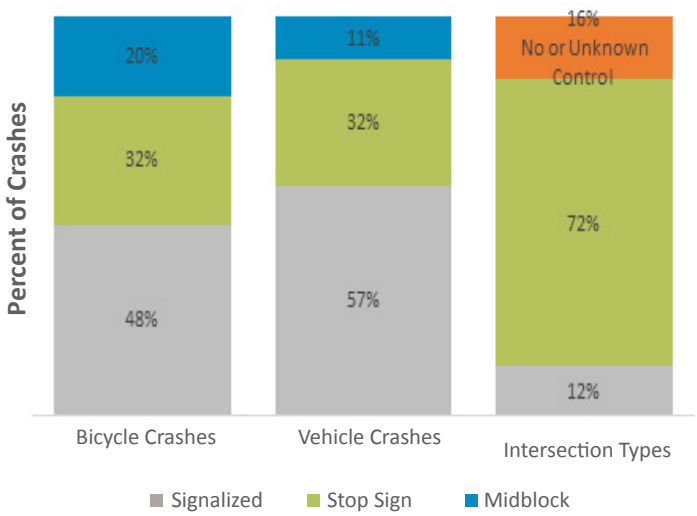


Figure 5-29. Bicycle and Vehicle Crashes and Intersection Control Type

Source for Crash Data: Vision Zero 10-Year Dataset

Although the vast majority of crashes happen at intersections, fatal and severe injury crashes of all modes are more likely to be a at a mid-block location than crashes that result in lesser severity levels (**Figure 5-30**). The graph refers to the following crash categorizations:

- Fatal crashes result in the death of a street user
- Type A crashes (sometimes referred to as incapacitating injury crashes) result in severe and life-altering injury.
- Type B crashes (sometimes referred to as a non-incapacitating injury crashes) result in an injury that is not immediately life threatening, such as a fracture or broken arm.
- Type C crashes (sometimes referred to as possible injury crashes) result in a minor injury or a potential future injury, such as whiplash, bruising, or minor cuts or scrapes.

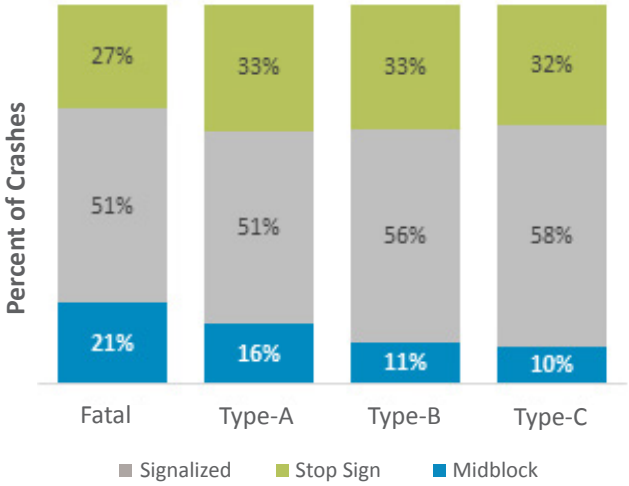


Figure 5-30. Location of Crashes and Crash Severity (All Modes)

Source for Crash Data: Vision Zero 10-Year Dataset

Mid-block Bicycle Crashes

The more detailed analysis of bicycle crashes that occurred away from intersections showed that bicycle crashes occur most frequently at a mid-block driveway, in the travel lane, or are curbside related such as with an opening car door (**Figure 5-31**).

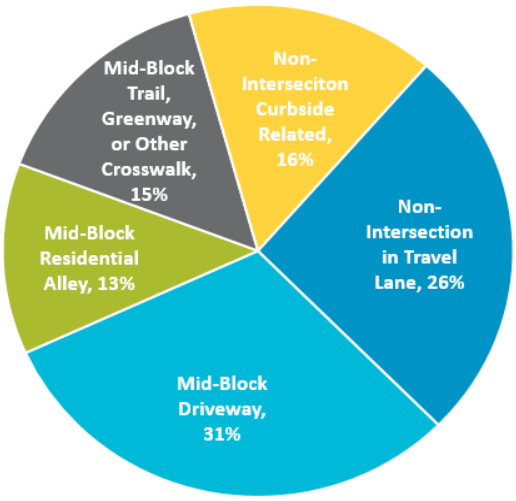


Figure 5-31. Non-Intersection Bicycle Crash Locations
Source for Crash Data: Vision Zero 3-Year Dataset

Bicycle Crashes at Intersections

When bicycle crashes occur at an intersection, approximately half are at intersections with no bicycle facility (**Figure 5-32**). Bicyclists on trails and sidewalks are more likely to be involved in a crash at the intersection compared with on-street bicycle facilities.

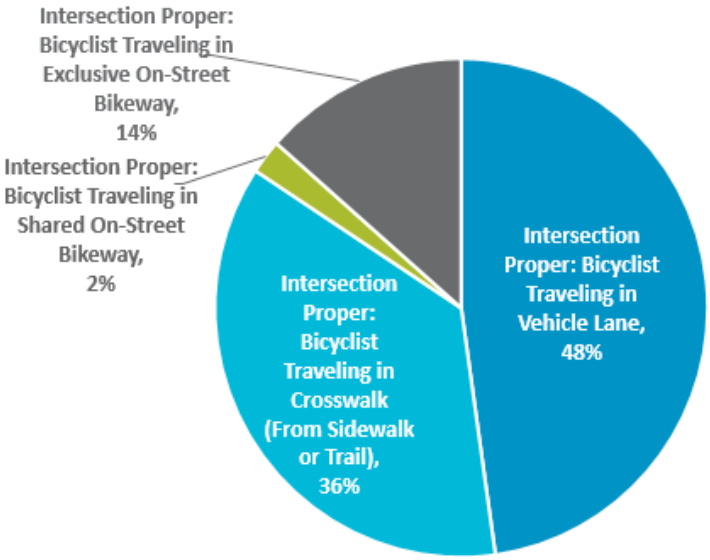


Figure 5-32. Bicycle Crashes at Intersections
Source for Crash Data: Vision Zero 3-Year Dataset

Priority Intersections

The number of crashes at intersections tends to be a function of exposure – the volume of pedestrian, bicycle, and vehicle traffic traveling through the intersection. Vehicle, bicycle, and pedestrian volumes are not available for many streets in Minneapolis, therefore crash rates were not calculated as part of this study.[3] However, intersections that consistently have a high total number of crashes should be considered for further study. Regardless of entering vehicle volume, a high number of crashes offers the largest opportunity to reduce the number of crashes.

[3] To account for exposure, an intersection crash rate is calculated as the number of crashes per million entering vehicles (MEV). While the number of crashes per million entering vehicles and bicycles would be an ideal measure of exposure, daily bicycle volumes are not available for most streets and daily vehicle volumes are not available for many streets; therefore, entering volume and crash rates were not utilized in this study.

Intersections with the Most Bicycle Crashes

Table 5-2 shows the intersections with the most bicycle crashes over ten years. Many of the intersections that have the most bicycle crashes also have significant percentages of fatal and severe injury bicycle crashes.

Rank	Street On	Cross Street	Total Bicycle Crashes	% Fatal and Severe Injury Crashes	Intersection Control	Intersection Jurisdictions
1	26th St E	Hiawatha Av S	18	6%	Signalized	City, State
2	Franklin Av W	Nicollet Av S	15	7%	Signalized	County, City
3	Lake St W	Lyndale Av S	15	7%	Signalized	County
4	3rd St N	Hennepin Av S	14	14%	Signalized	City
5	Franklin Av E	Chicago Av S	14	0%	Signalized	County, City
6	Franklin Av E	Cedar Av S	13	8%	Signalized	County
7	7th St N	Hennepin Av S	12	0%	Signalized	City
8	Franklin Av E	3rd Av S	12	0%	Signalized	County, City
9	Franklin Av E	Portland Av S	12	0%	Signalized	County
10	28th St E	Hiawatha Av S	11	0%	Signalized	City, State
11	Grant St W	Nicollet Mall S	11	0%	Signalized	City
12	Groveland Terrace W	Hennepin Av S	10	0%	Signalized	City
13	Lake St E	Snelling Av S	10	10%	Signalized	County, City
14	Vineland Place W	Lyndale Av S	10	10%	Signalized	City
15	26th St W	Nicollet Av S	9	0%	Signalized	City
16	Franklin Av W	Lyndale Av S	9	0%	Signalized	County, City
17	4th St SE	8th Av SE	8	0%	Stop-Controlled	State, City
18	5th St SE	15th Av SE	8	0%	Signalized	City
19	8th St N	Hennepin Av S	8	0%	Signalized	City
20	Franklin Av E	11th Av S	8	0%	Signalized	County, City
21	Franklin Av E	Park Av S	8	0%	Signalized	County
22	Lake St W	Bryant Av S	8	0%	Signalized	County, City
23	University Av SE	10th Av SE	8	25%	Signalized	County, City
24	Washington Av N	Hennepin Av S	8	13%	Signalized	County, City

Table 5-2 Intersections with the Most Bicycle Crashes
Source for Crash Data: Vision Zero 10-Year Dataset

Intersections with the Most Vehicle Crashes

Table 5-3 shows the intersections with the most vehicle crashes from 2007 to 2015.

Rank	Street On	Cross Street	Total Vehicle Crashes	% Fatal and Severe Injury Crashes	Intersection Control	Jurisdictional Responsibility
1	Olson Memorial Hwy N	West Lyndale Av N	206	1%	Signalized	State
2	26th St E	Hiawatha Av S	166	2%	Signalized	City, State
3	West Broadway Av N	Washington Av N	163	0%	Signalized	County
4	Lake St E	Cedar Av S	162	0%	Signalized	County
5	Olson Memorial Hwy N	East Lyndale Av N	159	2%	Signalized	State, City
6	35th St E	Stevens Av S	145	0%	Signalized	City
7	Vineland Place W	Lyndale Av S	143	1%	Signalized	City
8	Lowry Av NE	University Av NE	131	0%	Signalized	County, State
9	9th St S	4th Av S	129	1%	Signalized	City
10	Broadway St NE	University Av NE	129	1%	Signalized	County, State
11	Franklin Av W	Lyndale Av S	125	1%	Signalized	County
12	Lake St W	Lyndale Av S	123	0%	Signalized	County
13	West Broadway Av N	Lyndale Av N	115	0%	Signalized	County
14	Broadway St NE	Johnson St NE	111	2%	Signalized	County, City
15	Franklin Av E	Cedar Av S	106	1%	Signalized	County
16	Franklin Av E	3rd Av S	101	0%	Signalized	County, City
17	Franklin Av E	5th Av S	101	0%	Signalized	County, City
18	Franklin Av E	Portland Av S	101	0%	Signalized	County
19	Lake St E	Chicago Av S	99	0%	Signalized	County, City
20	Washington Av S	3rd Av S	99	0%	Signalized	County, State, City
21	31st St E	2nd Av S	98	1%	Signalized	City
22	Lake St E	Portland Av S	97	2%	Signalized	County
23	Lake St E	2nd Av S	96	0%	Signalized	County, City
24	Hennepin Av E	Johnson St NE	95	0%	Signalized	County, City
25	22nd St W	Lyndale Av S	94	0%	Signalized	City, County

Table 5-3 Intersections with the Most Vehicle Crashes
Source for Crash Data: Vision Zero 10-Year Dataset

Green Pavement Markings

Green pavement markings are visible indications of bicycle movements at or through intersections, and highlight potential conflict areas. Their purpose is to highlight bicycle-vehicle interaction or mixing areas and make vehicle drivers more aware of bicyclists at intersections.

The Vision Zero Crash Study identified ten intersections across the City that were treated with green pavement markings during the study period. The intersections were selected based on the date of green marking implementation and the ability to conduct before/after analysis. **Table 5-4** displays the selected intersections with the year the green markings were implemented highlighted in green. Crashes per year decreased after installation of green pavement markings in four of the ten intersections. The treatment appears to have had the greatest effect at larger street crossings, such as at the Olson Memorial Highway/7th Street N and Hennepin Avenue S/Oak Grove St W intersections.

Further citywide analysis should be conducted once additional green pavement marking installations have occurred and crash data after implementation is available. This preliminary analysis shows a small increase in crashes after installation, which could be due in part to the overall volume of bicyclists increasing. Further analysis should account for the volume of bicycle and vehicular traffic that is a major factor in crash incidence. Installation of green pavement markings at the intersections with the most bicycle crashes (shown in **Table 5-2**) will enable a more robust before and after analysis because of the larger crash sample sizes.

Intersection	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total	Crashes/Year Before Installation	Crashes/Year After Installation
Franklin Ave E & 11th Ave S (On-Street Lane)	1			1		4	1		1	2	1	11	0.88	1.50
Lowry Ave N (On-Street Lane) & Freemont Ave N (Protected On-Street Lane)	1				2				1		1	5	0.38	0.50
15th Ave SE (On-Street Lane) & 5th St SE			2			1	3	1	1	1	1	10	0.50	1.33
15th Ave SE (On-Street Lane) & 4th St SE (On-Street Lane)				1	1					1		3	0.25	0.17
University Ave (On-Street Lane) & 15th Ave SE (On-Street Lane)								1			1	2	0.00	0.33
Johnson St NE (On-Street Lane) & Broadway St NE	1										1	2	0.25	0.17
Olson Memorial Hwy/N 6th Ave & 7th St N (On-Street Lane)	1	1										2	0.50	0.00
Olson Memorial Hwy/N 6th Ave & Oak Lake Ave/Border Ave (On-Street Lane)			2	1					1	1	2	7	0.50	1.00
Lyndale/Hennepin Ave S (Off-Street Trail) & Groveland Ave W			1	2	3	1	1		2	2	1	13	0.75	1.17
Hennepin Ave S (Off-Street Trail) & Oak Grove St W (On-Street Lane)	1	2	1	2	2		1	1	1			11	1.50	0.50
Total	5	3	6	7	8	6	6	3	7	7	8	66	5.50	6.67

Table 5-4 Bicycle Crashes at Intersections Before and After Green Treatment

Source for Crash Data: Vision Zero 10-Year Dataset; Source for Green Pavement Marking Installation: City of Minneapolis

Demographics

Several national studies have shown that bicycle crashes correlate with demographics. While the 10-Year crash database does not include race or gender, the police reports used for the detailed three-year analysis include gender and age for both bicyclists and drivers. Self-identified or personal demographic information such as race and income are not captured on crash reports, but census block data and Fatality Accident Reporting System (FARS) data can be used to review these factors relative to crash trends.

Age

Bicycle crashes include higher proportions of young people than vehicle crashes. Bicyclists aged 18 to 24 were most over-represented in non-fatal or severe injury crashes, and bicyclists aged 25 to 34 were most over-represented in fatal and severe injury crashes (**Figure 5-33**). Adults over 65 were the least likely adults to be killed or severely injured in a vehicle or bicycle crash and the most likely to be killed in a pedestrian crash.

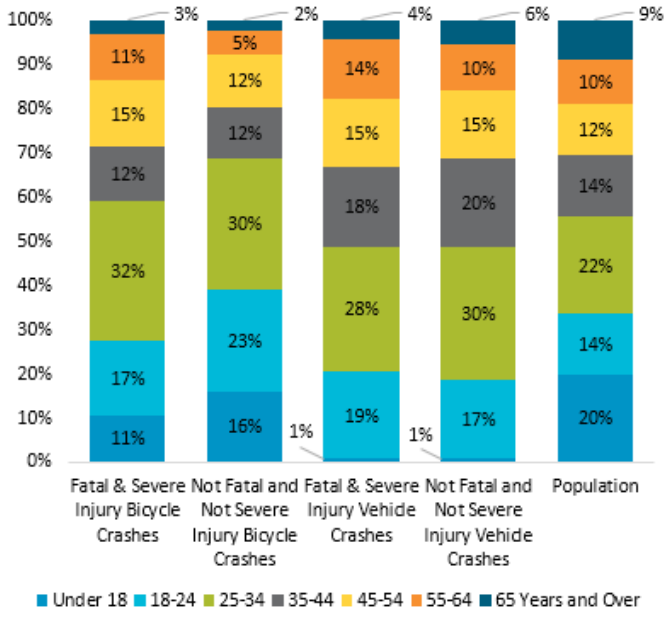


Figure 5-33. Bicycle and Vehicle Crashes by Age

Source for Crash Data: Vision Zero 10-Year Dataset

Source for Demographic Data: 2015 American Community Survey 5-Year Estimates

Gender

Men are significantly over-represented as the bicyclist in bicycle/motor vehicle crashes (**Figure 5-34**).

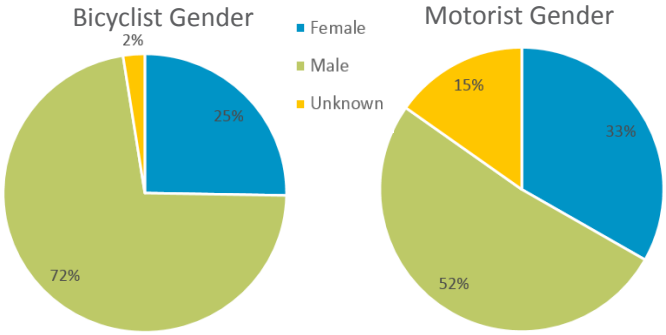


Figure 5-34. Bicycle and Vehicle Crashes by Gender

Source for Crash Data: Vision Zero 3-Year Dataset

Race & Ethnicity

Minneapolis Police Department crash reports do not include race or ethnicity. However, race is available for fatal crashes from the Fatality Analysis Reporting System (FARS), which is maintained by the National Highway Traffic Safety Administration (NHTSA). FARS is a nationwide dataset gathered from police accident reports, medical service reports, and state administrative records. There were 45 fatal pedestrian and bicycle crashes in Minneapolis from 2010-2016 in the FARS database. There were an additional 106 fatal vehicle crashes from 2014-2016.

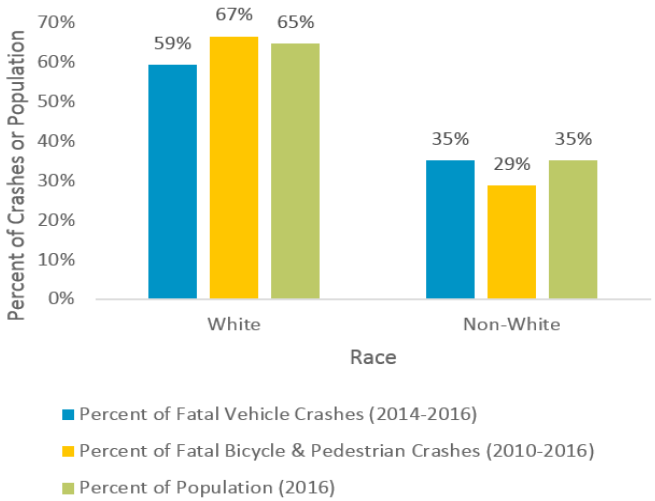


Figure 5-35. Fatal Bicycle and Pedestrian and Vehicle Crashes (2010-2016) by Race

Note: Percentages may not add to 100% because in some crashes the race of involved people was not reported.

Source for Crash and Race Data: Fatality Analysis Reporting System (FARS)

Residents of the City of Minneapolis in 2016 were just under two-thirds white and just over one-third non-white. People of color are very slightly under-represented in fatal bicycle and pedestrian crashes in Minneapolis, with two-thirds of victims being white and one-third of victims being non-white (**Figure 5-35**). People of color and white people are equally represented in fatal vehicle crashes compared to their percentage of the population.

Crash Causes

There are many factors that contribute to crashes. This report provides trends on those factors by crash groups and by mode. The crash groups and contributing factors for vehicles are pulled from the 10-Year Vision Zero database. For bicycle crashes, the crash groups, crash types within those groups, and contributing factors are extracted from information in the 3 years of police reports. Trends in crash groups by mode are described first. Then, the contributing factors within each of the most common crash groups are presented. For bicycle crashes, contributing factors for the most common crash types and pre-crash maneuvers of bicyclists and motorists were evaluated.

Crash Groups

Bicycle Crash Groups

The most common types of bicycle crashes can be categorized as either the motorist or the bicycle failing to yield at an intersection or other designed conflict points such as a driveway or alley. Motorists failing to yield the right of way at an intersection represents three times more crashes than bicyclists failing to yield at an intersection (**Figure 5-36**).

Other bicycle crash groups include:

- Motorist Improper Travel Lane Use: Motorist improperly using the travel lane, striking the bicyclist when passing or as a rear-end
- Bicyclist Improper Travel Lane Use: Bicyclist improperly using the travel lane, striking the motorist when passing or as a rear-end
- Curbside Related: Bicycle collision due to parking, transit operations, or other temporary curb uses
- Lost Control/Error: Bicyclist or motorist loses control and strikes other user

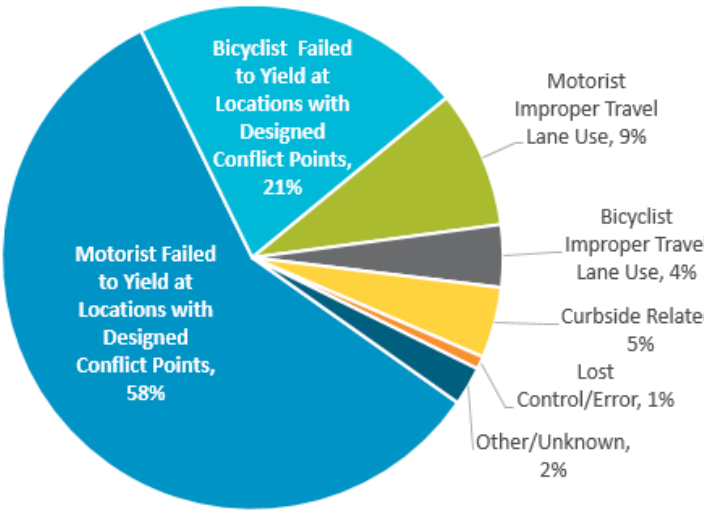


Figure 5-36. Bicycle Crash Groups
Source for Crash Data: Vision Zero 3-Year Dataset

Bicycle Crash Types

Each bicycle crash group can be more finely broken into crash types.

Motorist Failure to Yield

Figure 5-37 shows the distribution of crash types when the motorist failed to yield the right of way. When the motorist failed to yield at a designed conflict point, the most common crash types are motorist right turn crashes (32% of bicycle crashes), motorist left turn crashes (31% of bicycle crashes), and right angle crashes with both motorist and bicyclist traveling straight (26% of bicycle crashes).

The motorist right turn crashes were split relatively evenly between the bicycle travelling perpendicular to the motorist and the bicycle travelling in parallel with the motorist. **Table 5-5** details several Motorist Right-Turn crash scenarios:

- When the bicyclist was travelling perpendicular to the motorist prior to the turn, the bicycle was in the crosswalk 80% of the time and in the cross-traffic travel lane the other 20% of the time.
- When the bicyclist was travelling in parallel with the motorist prior to the turn, the bicyclist was in the crosswalk nearly half of the time and in the travel lane or bicycle facility the other half of the time.

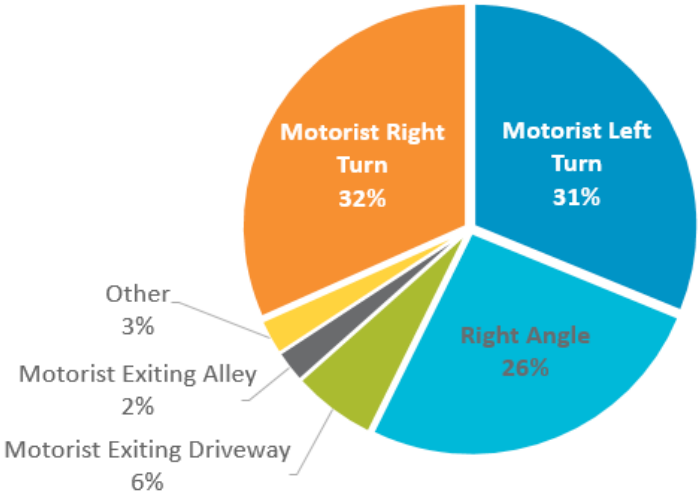


Figure 5-37. Bicycle Crash Types: Motorist Failed to Yield at Locations with Designed Conflict Points
Source for Crash Data: Vision Zero 3-Year Dataset

- The subset of these crashes when the bicyclist is in the travel lane are called Right Hooks. Right Hooks are when the motorist and bicyclist are travelling in parallel (in the same direction) and the right turning vehicle turns across the path of an on-street through moving bicyclist. Right Hooks can occur at signalized and unsignalized intersections, and they appear to be about as common at each intersection type. Right Hooks represent eight percent of all Motorist Right-Turn bicycle crashes.

Intersection Control	Bicycle Pre-Crash Location	Vehicle & Bicycle Travelling in Parallel	Vehicle & Bicycle Travelling Perpendicular
Signalized	Crosswalk	18	38
	Bike Facility	9	0
	General Purpose Travel Lane	10	6
Unsignalized	Crosswalk	10	22
	Bike Facility	6	0
	General Purpose Travel Lane	7	6
Subtotal by Travel Path		60	72
Total (includes 3 unknown travel paths)		135	

Table 5-5 Motorist Right-Turn Crash Scenarios

Bicyclist Failure to Yield

Roughly two-thirds of the crashes when the bicyclist failed to yield at a designed conflict point were right angle crashes (**Figure 5-38**).

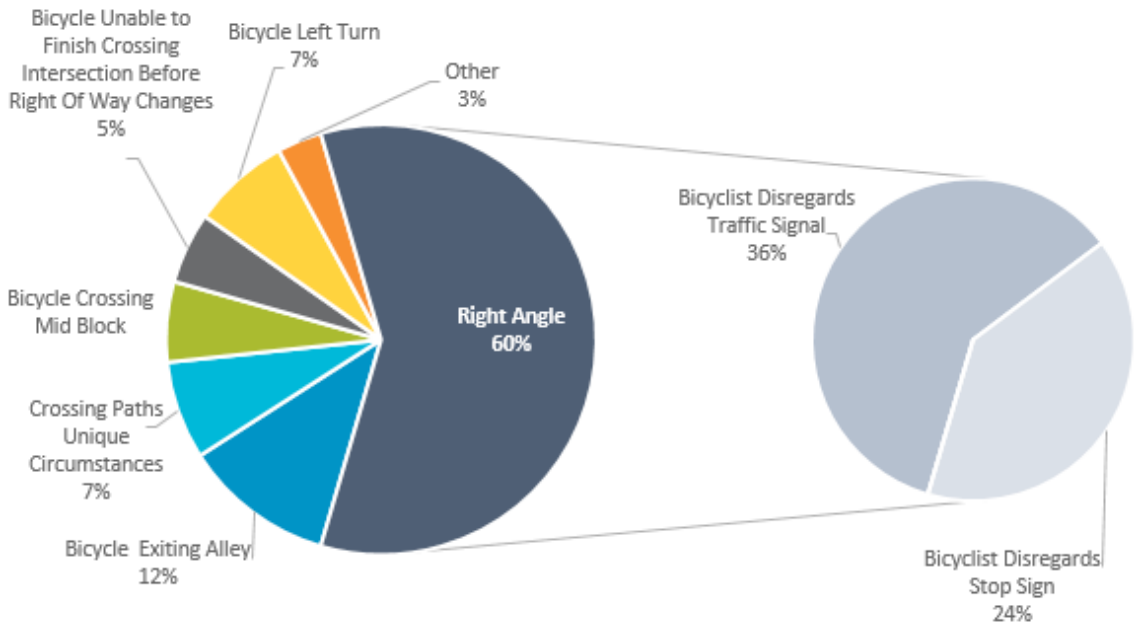


Figure 5-38. Bicycle Crash Types: Bicyclist Failed to Yield at Locations with Designed Conflict Points
Source for Crash Data: Vision Zero 3-Year Dataset

Mid-block or Non-Intersection Related

Bicycle crashes at non-intersection locations were relatively evenly distributed between several crash types (**Figure 5-39**). Motorist overtaking, passing, or dooring were the most common non-intersection bicycle crash types.

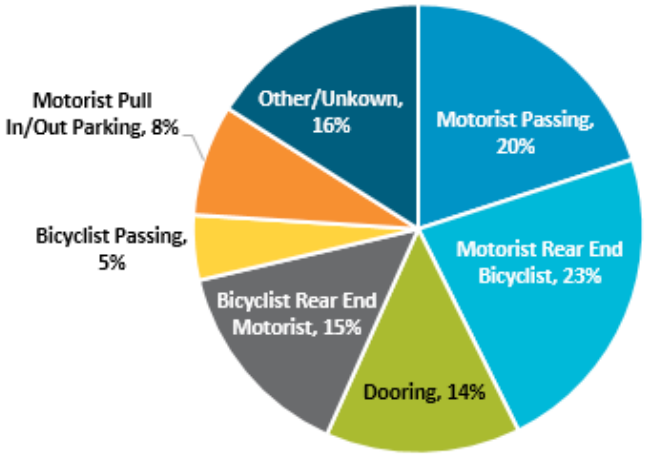


Figure 5-39. Bicycle Crash Types: Crash Groups Unrelated to Intersections
Source for Crash Data: Vision Zero 3-Year Dataset

Bicycle Crash Type Severity

Some types of bicycle crashes are more likely to result in a death or severe injury. Right angle crashes are the most common crash type in fatal and severe injury bicycle crashes (**Figure 5-40**).

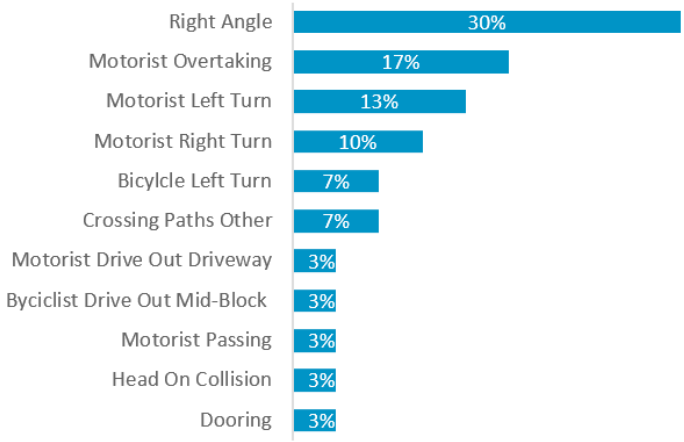


Figure 5-40. Bicycle Crash Types in Fatal and Severe Injury Bicycle Crashes

Source for Crash Data: Vision Zero 3-Year Dataset

Bicycle Crash Contributing Factors

Bicyclists do not have a clear contributing factor in more than half of bicycle crashes (**Figure 5-41**). The distribution of contributing factors remained constant when considering all bicycle crashes or when considering only fatal and severe injury bicycle crashes.

However, the most common vehicle contributing factors are different for fatal and severe injury versus all bicycle crashes. The most common contributing factors in all bicycle crashes were failing to yield the right of way and improper passing.

In Fatal and Severe injury bicycle crashes, the most common vehicle contributing factors were failing to yield the right of way and chemical impairment (**Figure 5-42**). Disregarding a traffic control device, improper passing, and door open were the other notable vehicle contributing factors to fatal and severe injury bicycle crashes.

Situational circumstances were tracked as potential contributing factors in bicycle crashes. These factors included whether there was a lack of lighting at the crash location, whether seasonal visibility impacts played a role, or whether the bicyclist was wearing a headlamp, safety vest, and/or helmet. However, the vast majority of crashes did not indicate whether these factors were or were not present, so usage rates, and how these items effect crash outcomes cannot be determined because the sample size is likely not truly representative. For example, while 22 crashes indicated that a bicyclist was not wearing visibility gear and 4 crashes did indicate that the bicycle was wearing visibly gear, over 600 crashes were silent on the bicyclists attire. Additionally, rarely did police reports indicate whether the bicyclist was wearing a helmet.

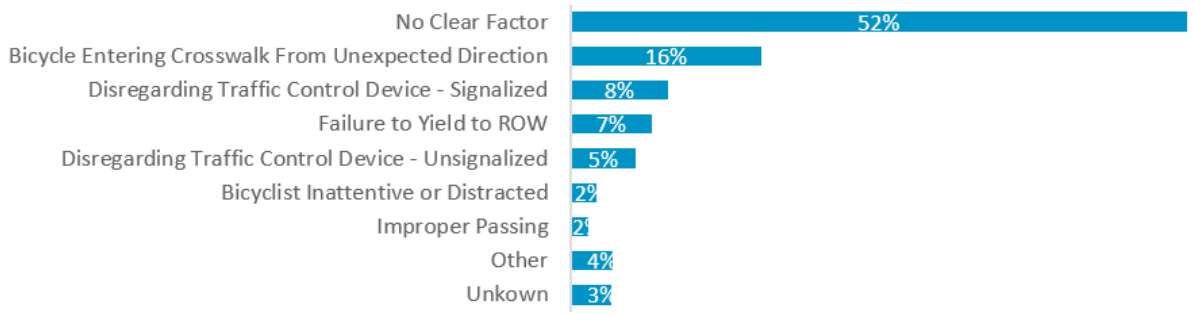


Figure 5-41: Bicyclist Contributing Factors in Bicycle Crashes
Source for Crash Data: Vision Zero 3-Year Dataset

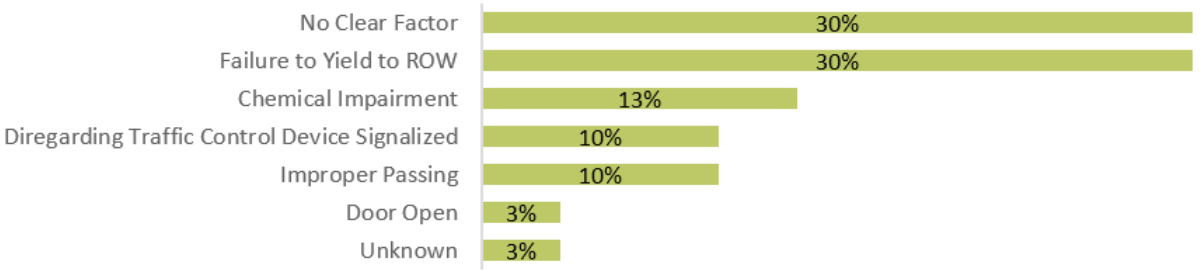


Figure 5-42: Vehicle Contributing Factors in Fatal & Severe Injury Bicycle Crashes
Source for Crash Data: Vision Zero 3-Year Dataset

Vehicle Crash Types

The most common crash groups for vehicles are right angle crashes, rear end crashes, and side-swipe crashes (**Figure 5-43**). Some types of crashes result in higher percentages of fatalities and severe injuries. Right angle crashes, fixed object crashes, and rear end crashes make up the largest percentages of fatal and severe injury crashes. Side swipe crashes, while common, do not represent a significant percentage of fatal and severe injury crashes.

Collision Type	Right Angle	Rear End	Side Swipe	Fixed Object	Left Turn	Head On	Right Turn	Other
Non-Fatal and Non-Severe Injury Vehicle Crashes	31%	26%	15%	12%	9%	3%	2%	3%
Fatal and Severe Injury Vehicle Crashes	34%	16%	7%	20%	11%	3%	1%	8%

Figure 5-43. Vehicle Crash Groups: Crashes by Collision Type
Source for Crash Data: Vision Zero 10-Year Dataset

Contributing Factors

Examples of contributing factors include failing to yield the right of way, motorist inattentive or distracted, chemical impairment, or disregarding a traffic control device.

- Some examples of failing to yield the right-of-way include:
  - A left-turning vehicle misjudges the gap in oncoming through traffic, chooses a gap that is too small, or overlooks the oncoming traffic.
  - A right-turning vehicle crosses the path of a through bicyclist traveling in the same direction.
- Some examples of disregarding a traffic control device include:
  - A vehicle or a bicyclist proceeds through a stop-controlled intersection without stopping, or without coming to a full stop.
  - A vehicle proceeds into a signalized intersection after the signal indication has turned red.

In bicycle crashes resulting in fatalities or severe injuries, bicyclists had at least one contributing factor 53 percent of the time, while that figure was 48 percent for motorists. In many crashes, both the bicyclist and the motorist had a contributing factor.

Source for Crash Data: Vision Zero 10-Year Dataset

Bicycle Contributing Factors in Fatal and Severe Injury Crashes

The most frequently-occurring known contributing factors in fatal and severe injury bicycle crashes are failing to yield right-of-way (16 percent) and disregarding a traffic control device (10 percent). Also influential were non-motorist errors (six percent), distracted driving (five percent), and improper lane use (five percent). In 40 percent of fatal and severe injury bicycle crashes, either the bicyclist or the motorist had no clear factor contributing to the crash.

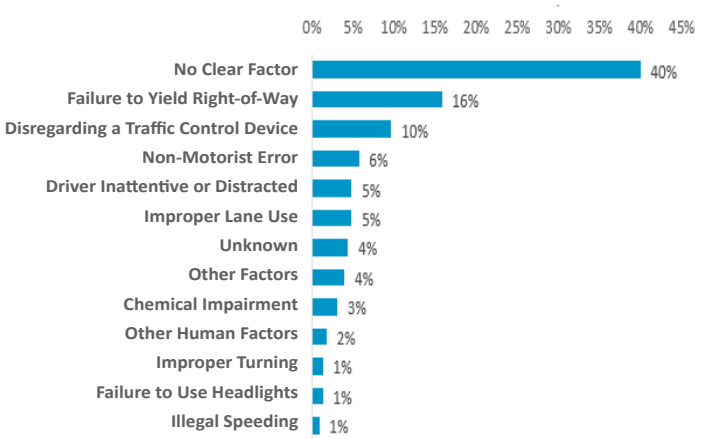


Figure 5-44. Bicycle Crash Contributing Factors: Fatal and Severe Injury Crashes
Source for Bicycle Crash Data: Vision Zero 10-Year Dataset

Vehicle Contributing Factors in Fatal and Severe Injury Crashes

For **right angle vehicle crashes** resulting in a fatality or severe injury, 32 percent resulted from disregarding a traffic control device. Other leading contributing factors were failing to yield the right-of-way (11 percent) and chemical impairment (three percent).

- Disregarding a traffic control device: Vehicle ignoring stop sign altogether or proceeding through signalized intersection during a red phase.
- Failing to yield the right-of-way: After stopping at a stop sign, the vehicle proceeds into intersection out of turn. Alternatively, a vehicle misjudges a gap in traffic and strikes an oncoming vehicle during a permissive left-turn movement.
- Chemical impairment: The vehicle operator was driving under the influence of drugs or alcohols and made a poor judgement call or movement which resulted in a crash.

For **fixed object vehicle crashes** resulting in a fatality or severe injury, the main contributing factors included illegal speeding (15 percent), distracted driving (six percent), chemical impairment (five percent) and improper lane use (five percent). In nearly 50 percent of fixed-object crashes, a contributing factor was unknown, not assigned, or unclear.

For **rear end vehicle crashes** resulting in a fatality or severe injury, the main contributing factors included following too close (14 percent), driver inattentive or distracted (12 percent), illegal speeding (8 percent), and chemical impairment (7 percent).

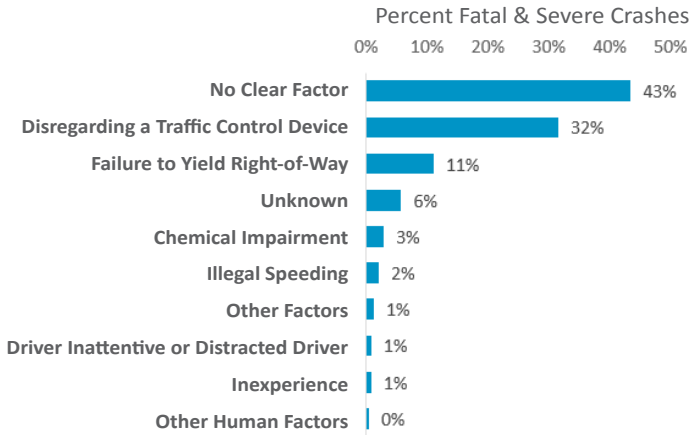


Figure 5-45. Right Angle Vehicle Crash Contributing Factors: Fatal and Severe Injury Crashes

Source for Crash Data: Vision Zero 10-Year Dataset

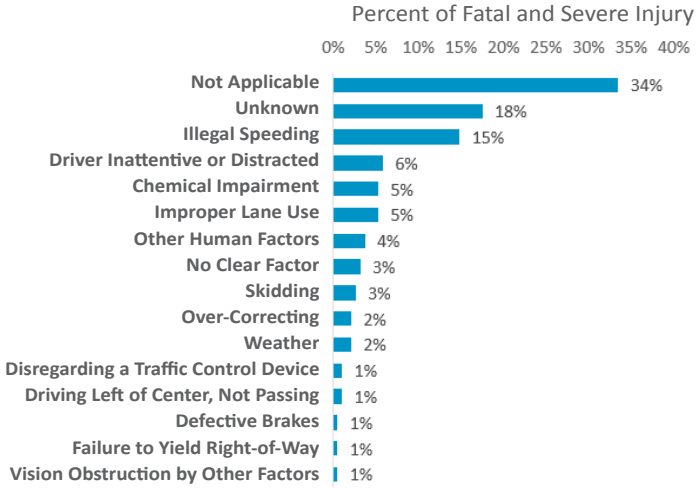


Figure 5-46. Fixed Object Vehicle Crash Contributing Factors: Fatal and Severe Injury Crashes

Source for Crash Data: Vision Zero 10-Year Dataset

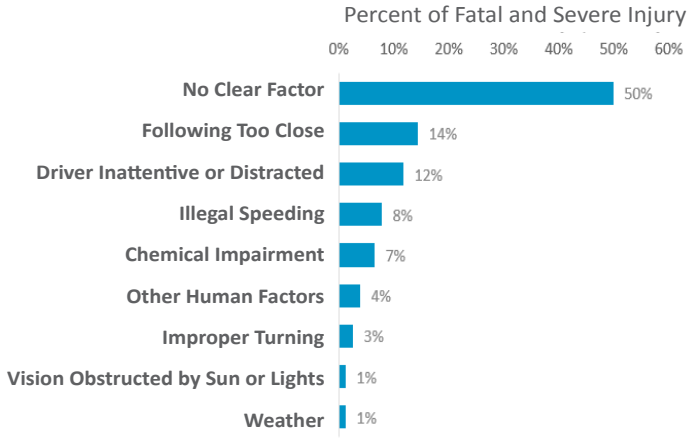


Figure 5-47. Rear End Vehicle Crash Contributing Factors: Fatal and Severe Injury Crashes

Source for Crash Data: Vision Zero 10-Year Dataset

Fault in Bicycle Crashes

Assigning fault to crashes requires judgement and consideration of the unique circumstances of each crash. This study considered fault in bicycle crashes by reading police reports and assigning fault based on contributing factors, right-of-way, and other actions and circumstances present.

Bicyclist Pre-Crash Maneuvers

When Motorist is at Fault

When the motorist was at fault in crashes, there was no clear pattern in the bicyclist's maneuver before the crash.

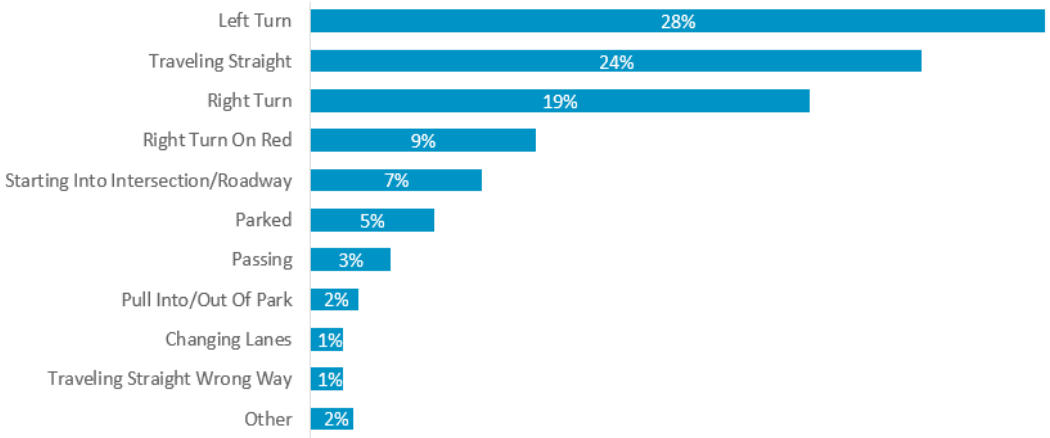


Figure 5-48. Bicycle Pre-Crash Maneuver When Motorist at Fault
Source for Crash Data: Vision Zero 3-Year Dataset

When Bicyclist is at Fault

When the bicyclist was at fault in crashes, the bicyclist was primarily traveling straight.

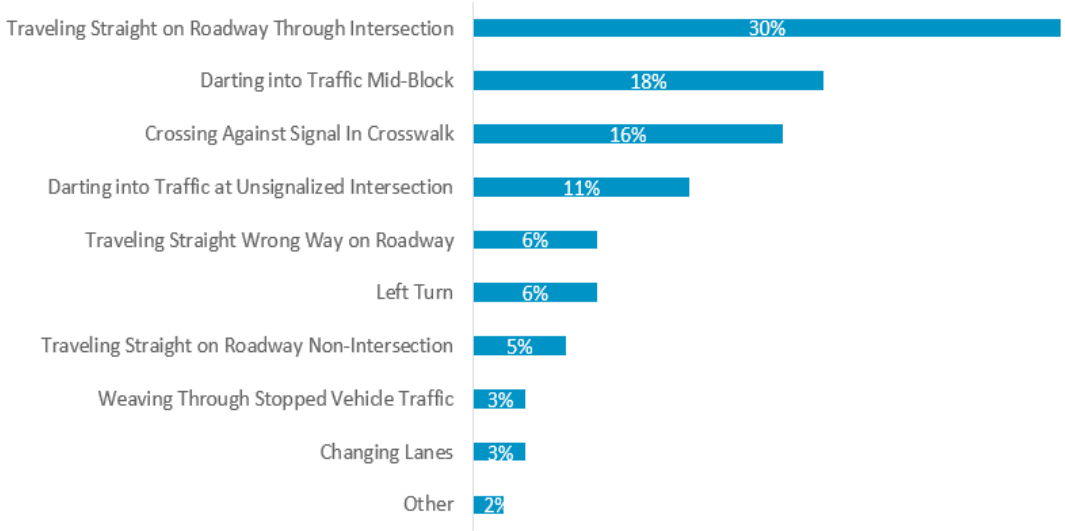


Figure 5-49. Bicycle Pre-Crash Maneuver When Bicyclist at Fault
Source for Bicycle Crash Data: Vision Zero 3-Year Dataset

6. SAFETY IMPROVEMENT STRATEGIES

The Six E's of Safety

The six E's of safety – Engineering, Education, Enforcement, Encouragement, Evaluation, and Equity – are the components of a systematic approach to improve safety. The following sections summarize key strategies for each of the E's relative to the bicycle and vehicular travel modes, but all practices should be implemented with equity considerations to ensure that they do not disproportionately impact people of color and people with low incomes. Pedestrian specific improvement strategies can be found in the 2017 Pedestrian Crash Study[1]. The following strategies are based on findings from the study of Minneapolis crashes and from trends documented in national studies.

Next steps for reducing the crash trends found in this study and in the Pedestrian Crash Study will be documented in the Vision Zero Action Plan.

[1] http://www.minneapolismn.gov/pedestrian/data/WCMSP-206913

Engineering

Context-specific street and intersection design is one of the tools that Minneapolis and other agencies will need to employ to reduce the number of crashes. The tools below could be implemented as demonstration projects to try out new infrastructure designs or test their effectiveness before committing resources to a permanent infrastructure change.

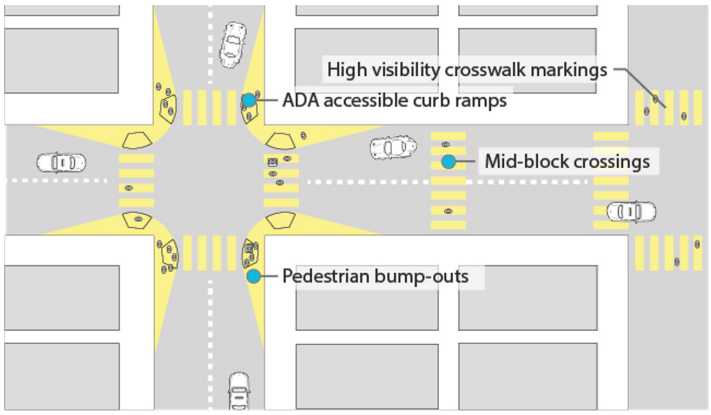


Figure 6-1. Curb Bump Out at Intersection
Source: City of Minneapolis Asset Management and Municipal Funding Presentation dated July 11, 2018

Intersection Treatments

The following intersection treatments could be considered to reduce crashes at intersections with a history of crashes. Selection of an improvement strategy should be data-driven and use proven methods, and implementation of the design will need to be context specific.

- **Intersection Radii** – Smaller corner radii reduce vehicle turning speeds and shorten intersection crossing distances and exposure for all modes. The Access Minneapolis Design Guidelines for Streets and Sidewalks, Chapter 5.8.1 Curb Return or Corner Radii notes that the typical curb radius should be 10-15 feet where high pedestrian volumes are present, where bicycle and/or parking lanes create additional space, and where the width of the receiving intersection approach can accommodate a turning passenger vehicle without encroachment into the opposing lane. The National Association of City Transportation Officials (NACTO) supports reducing corner radii to improve safety, noting that many cities use corner radii as small as two feet. The presence of school buses and larger commercial vehicles calls for creative solutions that still protect the pedestrian realm.
- **Left Turn Treatments** – Bicycle signal heads and bicycle friendly phasing are treatments that can be used to facilitate left-turn movements for bicycles. For vehicles, left-turn lanes that allow for protected or protected-permissive left-turn phases reduce conflict points and the "back-pressure" that exists during solely permissive left-turn phases.
- **Right Turn Treatments –** Use of green pavement markings and other delineation, such as yield triangle pavement markings where vehicles need to yield to bicycles, can be used to highlight bicycle/vehicle conflict areas and reduce right-hook crashes.
- **Protect More Vulnerable Modes** – Features like refuge islands and curb bump-outs reduce the exposure of people walking and bicycling within the street. Traffic signals with leading pedestrian or bicycle intervals put those modes in the street first – making them more visible and giving them right-of-way.
- **Protected Intersections** – Protected intersections are intersections with physical separations between automobiles and bicycles at the same grade (**Figure 6-2**). Four common features of protected intersections that make them unique from traditional intersections are: a corner refuge island, a forward stop bar for bicyclists, a setback bike and pedestrian crossing, and bicycle friendly signal phasing[2]. Combined, these features create better visibility, reduce conflict points, create time for users to react to potential conflicts, make bicycle waiting spaces more comfortable, and help drivers be more aware of bicyclists (particularly right-turning vehicles).
- **Reduce Mid-block Conflict** – Focus on improving access management along roadways where alleys and driveways create higher risk for bicyclists and pedestrians.

[2] http://www.protectedintersection.com/wp-content/uploads/2014/02/Falbo_ProtectedIntersection_Transcript1.pdf

Make Routes Visible and Predictable

- **Visibility of Bicycle Routes** – Bicycle signage or markings on the street, on-street and protected bicycle lanes, and green pavement markings at key intersections alert motorists that bicyclists are present. These visible bicycle markings create more predictability of where bicycles are expected. Additionally, the markings provide designated space for bicyclists.
- **Physically Protected Bikeways** – When pursuing citywide protected bikeway goals, implement more substantial solutions when possible. Bikeways physically protected by curbs, bollards, or other means separate automobiles from bicycles and give motorists a better sense of where bicyclists will be riding.

Safety and Advanced Mobility

This crash study assessed actual crashes against existing infrastructure. However, the way people travel through the city and the scope of public infrastructure is changing. The following topics could create great opportunities for crash prevention. The Transportation Action Plan will expand upon these topics:

- **New Mobility Patterns:** How people travel about the city is ever-changing. Shared mobility programs, shifting mode shares, and autonomous or connected trips could alter what safety improvements have the most impact.
- **Smart City Infrastructure:** Cutting edge technology, such as smart street light, variable notifications, and smart travel lanes could help reduce human error and implement the traditional safety strategies. More robust travel data gathered through smart city infrastructure could be used to more fully understand crash patterns and prevention strategies.

Reduce Motorist Speed

- **Reducing Speed** – Lower vehicle speeds have a lesser chance of a crash resulting in a fatality or severe injury. Reducing regulatory speed limits, while desirable, should also be paired with design changes to maximize changes in driver behavior.
- **Reducing Travel Lanes** – Fewer vehicle lanes encourage appropriate travel speeds, helping to reduce the severity of crashes and resulting injuries.
- **Lower Travel Speed through Design** – A lower design speed will better reflect the operational speed of bicyclists instead of motorists. Lower design speeds have been shown to reduce speeding occurrences and create an environment more conducive to walking, on-street parking, and navigating through intersections. Written in 2008, Chapter 4 of the Access Minneapolis Design Guidelines for Streets and Sidewalks notes target operational speeds by corridor type. An update to this material, which includes operational speeds on streets with and without bicycle infrastructure, should be a product of the upcoming Vision Zero Action Plan and/or Transportation Action Plan.

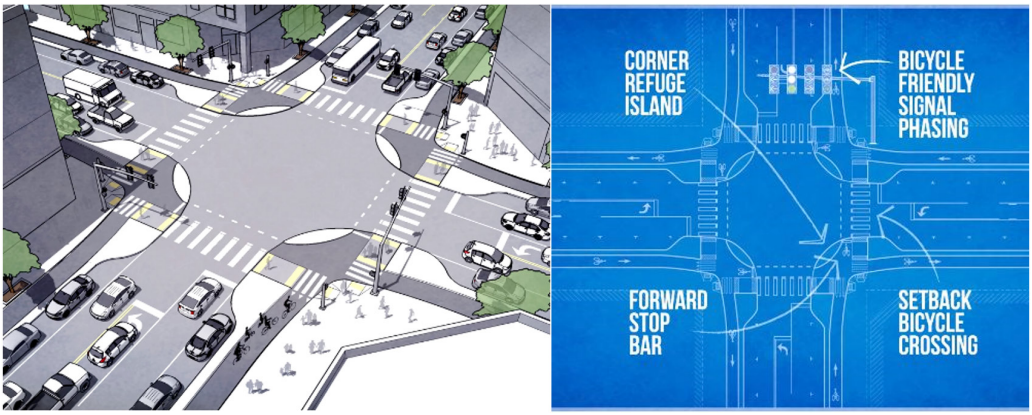


Figure 6-2. Protected Intersection Sketches
Source: http://www.protectedintersection.com/

Education

Educating frequent users of the streets, including transit operators and truck drivers as well as the general public, of safety best practices and the rules of the road can help prevent crashes before they happen.

- **Distracted Driving** – Education campaigns should address driver inattention and failure to yield, which are frequent contributing factors to all crashes[3].
- **Incapacitated Driving** – A renewed effort on educating the public on the repercussions from driving under the influence of drugs or alcohol could contribute to future crash prevention. This strategy is most effective when paired with additional enforcement.
- **Rules of the Road** – Education campaigns on how to share the road should be expanded so that all road users act in a more informed, responsible, and predictable way.
- **Biking and Walking Safety Education in Schools** – Programs like Safe Routes to School can be used to teach children lifelong safe bicycling practices, especially when they may not have access to a bicycle at home or be familiar with designated bicycle infrastructure.
- **Educate Professional Drivers** – Truck and transit drivers are held to high safety standards and receive regular training. Many organizations for these professionals have already utilized a curriculum developed by the City, Minneapolis Public Schools, the Minnesota Truckers Association and the Bicycle Alliance of Minnesota. Continued engagement with these groups could reduce the number of bicycle-bus crashes and conflicts with large or fleet vehicles.
- **Coordination with Transit Operators and Users** – Transit operators should be aware of the overall crash hotspots and trends so they can help encourage safety best practices for their riders.

[3] Public Health Reports "Fatalities of pedestrians, bicycle riders, and motorists due to distracted driving motor vehicle crashes in the U.S., 2005-2010" available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3804087/.

Enforcement

Targeted traffic enforcement coordinated with education and communications can reduce crashes. Any enforcement practices should be implemented with equity considerations to ensure that they do not inequitably impact people of color and people with low incomes.

- **Targeted Enforcement** – Disregarding traffic control device and failure to yield are the primary contributing factors of right-angle crashes in Minneapolis. Targeted enforcement at high-crash intersections can help draw attention to the issue and reduce hazardous driving behaviors.
    - **Overhead Traffic Signal Installations to Reduce Need for Enforcement** – Increasing signal visibility through the installation of overhead traffic signal indications reduces the instances of disregarding traffic control devices. Adding blue enforcement lights reduces the number of officers needed to catch drivers running red lights from two to one, freeing up officers for other enforcement efforts.
    - **Consider Automated Enforcement** – Cities that have installed automated enforcement devices such as red-light safety cameras and mobile speed cameras have seen significant reductions in dangerous traffic violations and resulting crashes[4].
- **Ticketing Crashes with Vulnerable Users** – The City should consider larger citations for motorists responsible for crashes involving vulnerable users, as these crashes are more likely to result in a fatal or severe injury crash.

- **Enforcement as Education** – Prosecutors in the City of Minneapolis may offer defendants charged with certain criminal offenses, such as some traffic offenses, the opportunity to have the charge(s) dismissed by participating in a diversion program. The Traffic Education Diversion Program teaches better driving habits and understanding of driving laws to offenders charged with moving violations. Program requirements include an online training course and exam. The course can be used as an opportunity to educate all parties on the rules of the road.
- **Distracted Driving Enforcement** – In Minnesota, it is illegal for drivers to read/compose/send text messages and emails, or access the Internet using a wireless device while the vehicle is in motion or a part of traffic — including stopped in traffic or at a traffic signal. While the law does not apply to devices that are permanently affixed to the vehicle or global positioning or navigation systems, drivers are responsible for remaining vigilant and attentive while using the street. Enforcing this rule consistently is challenging but necessary to reduce crashes where distracted driving was a contributing factor.
- **Speeding** – Enforcing speed limits may reduce the number and severity of both bicycle and vehicle crashes.

[4] https://www1.nyc.gov/assets/visionzero/downloads/pdf/vision-zero-year-4-report.pdf; https://www.computer.org/csdl/proceedings/big-data/2016/9005/00/07841099.pdf

Encouragement

Encouraging diverse conversations about safety and expanding walking, biking, and transit can make implementation of the other E's more feasible.

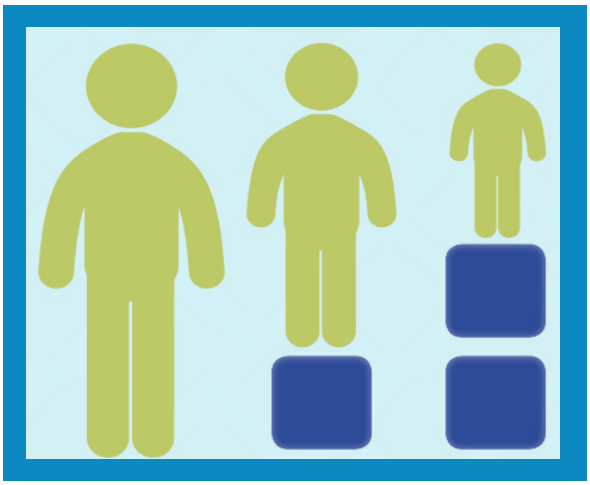
- **Design for "Interested but Concerned" Users** – Many individuals who are hesitant to ride a bicycle are encouraged by the perceived safety of infrastructure. To attract a wider demographic of users, design infrastructure that will be welcoming for all residents, whether they are 8 or 80 years old. Couple these protected and visible designs with engagement and education at public events to encourage new users of all ages to give bicycling a try.
- **Public Realm** – Creating inviting spaces in the public right-of-way or with adjacent property owners enhances both the pedestrian and bicyclist experience. Additionally, adding visual interest and activity can contribute to traffic calming.
- **Land Use and Zoning** – Bicycling, especially for shorter neighborhood trips, is encouraged by bicycle-friendly land use policies such as mixed-use zoning, adequate bicycle parking, and employment centers connected to bicycle facilities. Pedestrians and transit users would also benefit from mixed-use zoning and dense connected employment centers. As identified in the Pedestrian Crash Study, there is strength in numbers for non-motorized users: a higher percentage of non-motorized users makes that mode more apparent to vehicles and each individual trip less risky for that one vulnerable user.

Evaluation

Progress should be tracked through a defined evaluation process. Continuous evaluation will help drive the need for implementation of more and better safety practices through the city.

- **Before/After** – Continue to monitor the impact of different intersection and corridor treatments with before/after studies. While the street network remained relatively constant through the course of this study, much of the bicycle infrastructure was installed during the study period. More robust conclusions can be made when the "after installation" period and prevalence of a facility type city-wide is sufficient to provide a large sample size.
- **Monitoring** – Tracking bicycle and vehicle volume and crash data by mode over time will allow the city to identify and address evolving trends and needs. While bicycle and pedestrian count data exists at a handful of key intersections throughout the city, more consistent and thorough data is needed to track trends citywide over time. This should also include a set of comparative untreated sites to account for other factors, such as technology or citywide mode shifts.
    - Including demographic data across these metrics is crucial to gaining a more holistic sense of the City's needs and where the most improvement can be made by user group. If not taken citywide, counts should be taken in a diverse set of areas through the city.

Equity



Supporting improvements in low-income communities and in communities of color is one part of equity in safety. Equity considerations should be included throughout the other E's to understand and address obstacles, create access, and ensure safe and equitable outcomes. Ensuring efficient and equitable access to emergency medical services regardless of crash location will need to be considered alongside other improvements. The following communities should be considered in particular as they have historically been underrepresented in evaluating transportation trends and impacts:

- **ACP50s** – When designing and prioritizing improvements, special consideration should be given to areas of concentrated poverty with high populations of people of color (ACP50s), as these areas have historically had disproportionate numbers of crashes.
- **Children** – Children and young people are overrepresented in bicycle crashes. Street design, and particularly bicycle infrastructure design, should accommodate all users from all age ranges. Additionally, incorporating bike education into school curriculum would further empower youth to safely participate in active transportation.
- **Low Vehicle Access** – When designing and prioritizing improvements, special consideration should be given to areas with low vehicle access and high rates of walking, bicycling, and taking transit. Infrastructure should accommodate these travel patterns and encourage the non-motorized trips through design.

What's Next

This Vision Zero Crash Study documents the trends in bicycle and vehicle crashes in the City of Minneapolis. The Pedestrian Crash Study documented the trends in pedestrian crashes in the City of Minneapolis. The studies inform where and what types of crashes are occurring on city streets, and this information can be used to identify improvements to existing infrastructure such that crashes can be prevented in the future. **Specific action items in response to the trends identified in this study will be created in the upcoming Vision Zero Action Plan.** This Vision Zero Action Plan will be a collaborative effort that combines the data presented in this study with public and internal city feedback to create measurable and specific next steps for the City of Minneapolis to eliminate fatal and severe injury crashes.

APPENDIX A. NATIONAL BICYCLE AND VEHICLE CRASH STUDY REVIEW

This chapter is a review of bicycle and vehicle crash trends in Minnesota and across the United States. This review relies on information from published federal, state, and local crash and safety studies and Vision Zero Action Plans. Crash trends, current research, and best practices are taken from these Vision Zero Action Plans and applied to the Minneapolis Vision Zero Crash Study.

Studies and Plans Considered

Fourteen studies and action plans were reviewed to inform the Vision Zero Crash Study. The national-level reviews provide the crash statistics involving bicyclists and vehicle operators, as well as causes and characteristics of crashes resulting in a fatality or severe injury. The city-level reports summarize crash trends, and how Vision Zero campaigns are working towards implementing various tactics to reduce the number of fatal and severe crashes. This Appendix provides a summary of the original reports, findings, and offers some insight to the purpose, methodologies, and best practices across the nation to help reduce the number of crash fatalities and severe injuries. The reports reviewed are summarized in **Table A-1**.

Report Title	Year	Author/Agency	Geographic Scope
Highway Safety Topics	2017	Insurance Institute for Highway Safety/Highway Loss Data Institute	National
2016 Traffic Safety Facts	2017	National Highway Traffic Safety Administration	National
Traffic Safety Facts Annual Report Tables: Fatality Analysis Reporting System (FARS) Encyclopedia	2018	National Highway Traffic Safety Administration	National
A Right to the Road: Understanding & Addressing Bicyclist Safety	2017	Governors Highway Safety Association/State Farm	National
Urban Street Design Guide	2013	National Association of City Transportation Officials	National
Denver Vision Zero Action Plan	2017	City of Denver	City
Vision Zero Boston 2016 Review	2017	City of Boston	City
North Carolina Vision Zero	2018	North Carolina Department of Transportation	City
Vision Zero Action Plan	2017	Portland Bureau of Transportation	City
Vision Zero 2017 Progress Report	2017	Seattle Department of Transportation	City
2016-2018 Vision Zero Action Plan	2016	Austin City Council	City
Vision Zero Three-Year Action Plan	2017	City of Philadelphia	City
Vision Zero Los Angeles: Action Plan and Progress Report	2018	Los Angeles Department of Transportation	City

Table A-1. Reports Reviewed for the City of Minneapolis Vision Zero Crash Study

National Studies

Highway Safety Topics

- Author: Insurance Institute for Highway Safety (IIHS) & Highway Loss Data Institute (HLDI)
- Year Published: 2017

The IIHS and HLDI are both nonprofit, educational organizations that focus on providing resources and data that call attention to fatal vehicle crashes across the United States. The Highway Safety Topics website offers a range of highway safety related issues, research, and statistics on demographics impacted by crashes and geographic locations of types of crashes across the United States. For this study, the Fatality Facts section was referenced for detailed information regarding annual crash trends, state by state comparisons, and a variety of data related to bicyclist and vehicle crashes.

- In 2016, speeding was a factor in 27 percent of vehicle crash fatalities, and speeding has continued to be a factor in more than a quarter of fatal vehicle crashes since 2007.
- At all ages for both vehicle and bicycle crash fatalities, male had higher per capita crash fatality rates than females in 2016.
- While bicyclists had a higher percentage of fatal crashes in urban areas (71 percent), motorists had slightly higher fatality rates in rural areas (51 percent).

The information presented in the Highway Safety Topics are based on data analysis of the Fatality Analysis Reporting System (FARS), operated by the U.S. Department of Transportation (USDOT).

2016 Traffic Safety Facts

- Author: National Highway Traffic Safety Administration (NHTSA)
- Year Published: 2018

The NHTSA published a series 2016 Traffic Safety Facts in the form of various factsheets that are specialized to an area of traffic-related crashes. These factsheets provide a snapshot of annual vehicle crash trend crashes, as well as a breakdown of the demographics of those affected by various types of crashes in 2016. In the present national crash study review, the following Traffic Safety Facts documents were considered:

- 2016 Fatal Motor Vehicle Crashes: Overview
  - Vehicle miles traveled (VMT) in the United States increased by 2.2 percent, and raised the fatality rate to 1.18 fatalities per 100 million VMT – a 2.6 percent increase from 2015.
- 2016 State Traffic Data
- Alcohol-Impaired Driving, 2016 Data
  - Drunk-driving fatalities increased by 3.5 percent since 2015.
- Rural/Urban Comparison of Traffic Fatalities, 2016 Data
- Speeding, 2016 Data
  - Speeding-related deaths increased from 2015 by four percent.
- Bicyclists and Other Cyclists, 2016 Data
  - Bicyclist fatalities are at the highest number since 1991.
- Figure A-1 is a graphic from a Traffic Safety Facts series that shows a 5.6 percent increase in overall traffic fatalities, and then further breaks down whether the individual involved was a vehicle operator or passenger, a pedestrian, or a bicyclist.

Urban Street Design Guide

- Author: National Association of City Transportation Officials
- Year Published: 2013

The Urban Street Design Guide is a visual resource that helps identify a variety of urban street treatments for prioritizing those walking, bicycling, and taking transit. In doing so, the Guide also provides visuals for intuitively reducing traffic speeds and adding designs and colors to the streets to increase awareness of surroundings where there are pedestrians and bicyclists. The guide offers treatment streets, intersections, and design elements that can be implemented as proven to reduce traffic crashes and fatalities.

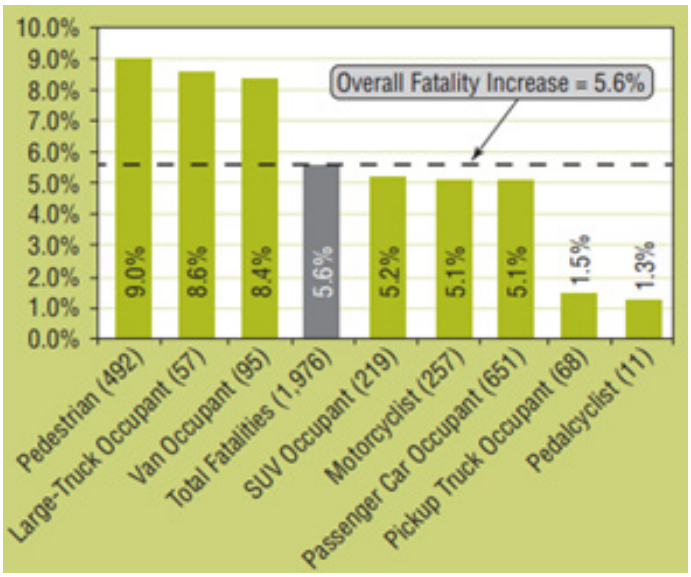


Figure A-1: Percentage Change in Fatalities by Occupant/ Nonoccupant, 2015-2016

Figure originally from the 2016 Fatal Motor Vehicle Crashes: Overview, NHTSA

A Right to the Road: Understanding & Addressing Bicyclist Safety

- Author: Governors Highway Safety Association and State Farm (GHSA)
- Year Published: 2017

The GHSA and State Farm created a report that examines data about bicyclist ridership and crash demographics. The report also raises awareness regarding existing funding opportunities for increasing bicycle-friendly infrastructure, and informs the audience about the "Three E" approach to bicycle safety: engineering, enforcement, and education. The authors touch on various ways to educate both vehicle operators and bicyclists on safe operating techniques, tips for being more aware of their surroundings, and the rules for right-of-way. This report also addresses the growing Vision Zero Network in cities across the United States and highlights case studies and best practices implemented by local governments, which include several resources used to educate community members and leaders on how to create safer environments for bicycling.

Local Plans and Studies

A variety of Vision Zero cities, policies, and best practices were reviewed to inform Chapter 2: Bicycle and Vehicle Safety in Context. Below are figures and summaries of trends seen across the Vision Zero Network or cities, and some of the best practices that came from cities across the United States.

Vision Zero programs bring a public health perspective when looking at effects of traffic fatalities. Human health and safety are compromised when people walking or bicycling are fatally and seriously injured from traffic crashes that could have been prevented with proven street design treatments and educational campaigns. The Vision Zero documents reviewed, whether an Action Plan or Progress Report, identified similar areas of most-needed improvement: **speeding, impaired or distracted driving**, and other dangerous driving behaviors, such as failure to yield the right-of-way.

Each city, including Minneapolis, also found that there was a very small percentage of all streets that accounted for most of vehicle and bicyclist crashes. These areas are referred to as "High Injury Networks." This disproportionate amount of crashes in condensed locations indicate that street design may play a crucial role. The built environment can impact subconscious behavior of people traveling in public streets, so designing these spaces purposefully and with design elements aimed at reducing driver speed and giving bicyclists safer roads to travel, for example, can be tools reduce the number of fatal and severe crashes. Many of the street design treatments that have been implemented to change the behavior of people walking, bicycling, and driving to reduce the overall number of crashes in these High Injury Networks.

Findings

Bicycle and Vehicle Fatalities

COMMENTARY ON REASONS FOR FINDINGS

Bicyclist crash-related data shows that from 2014 to 2015 the number of bicyclists injured slightly decreased. The actual number of injured bicyclists may, in fact, be higher. Reports looking at hospital records show that only a small percentage of bicycle crashes are reported to the police. Most reported crashes happen on public roadways where there was a severe injury or when at least one of the vehicles had to be towed away. Because many bicyclists do not cause enough damage for a vehicle to require towing, crashes involving bicyclists largely go unreported.[1]

NATIONAL TRENDS

After years of steady decline in bicycle fatalities, the trend reversed in 2010. For vehicles, crashes have been on a downward trend since 1999. The incidence for a crash was higher for vehicles in rural areas, while the crash incidence was higher for bicyclists in urban areas. **Figure A-2** shows this increase in national "outside vehicle" crashes (involving pedestrians, bicyclists, and motorcyclists), and contrasts it with the overall decrease in "inside vehicle" crashes (involving vehicle drivers and passengers).

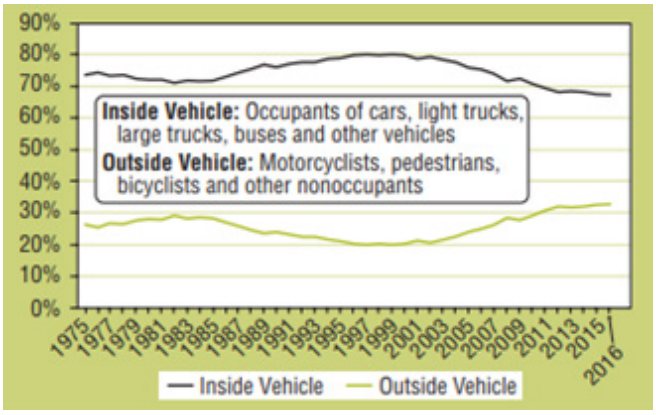


Figure A-2: Proportion of Fatalities Inside/Outside Vehicle, 1975-2016

Figure originally from the 2016 Fatal Motor Vehicle Crashes: Overview, NHTSA

Nationally, the fatality rates per 100 million Vehicle Miles Traveled (VMT) increased three percent from 2015 to 2016.

- Of the overall increase in crash fatalities, 54 percent of those fatalities were vehicle occupants.
- Vehicle crash fatalities increased by five percent (1,075 fatalities) from 2015 to 2016, resulting in the highest vehicle fatality count since 2008.
- Bicyclist fatalities increased by 1.3 percent (11 fatalities from 2015 to 2016, also resulting in the highest bicyclist fatality count since 1991.

[1] Governors Highway Safety Association, & State Farm. (2017). A Right to the Road: Understanding & Addressing Bicyclist Safety. Retrieved from https://www.ghsa.org/sites/default/files/2017-09/2017BicyclistSafetyReport-FINAL.pdf

STATE TRENDS

Minnesota consistently performs well compared to the rest of the United States in providing safe and accessible bicycle infrastructure, as well as low vehicle crash rates per every 100,000 people in the state's population. While the United States traffic crash fatality rate in 2016 was 1.18 deaths for every 100 million VMT, the traffic crash fatality rate for Minnesota was 0.67 deaths for every 100 million VMT.

According to the annual Minnesota Motor Vehicle Crash Facts by the Office of Traffic Safety, traffic crashes increased by six percent between 2015 and 2016, but traffic crash fatalities decreased almost five percent within the same time frame.[2]

Figure A-3 shows number of traffic fatalities that occurred in Minnesota from 1997 to 2016. The Office of Traffic Safety attributes the following to the improving safety conditions throughout the state:

- Traffic safety laws
- Better enforcement
- Education and outreach
- Engineering
- Emergency medical and trauma response

In 2016, there were a total of seven bicyclist crash fatalities – making up two percent of the total traffic crash fatalities in Minnesota. This percent of bicycle crash fatalities remained unchanged from 2015.

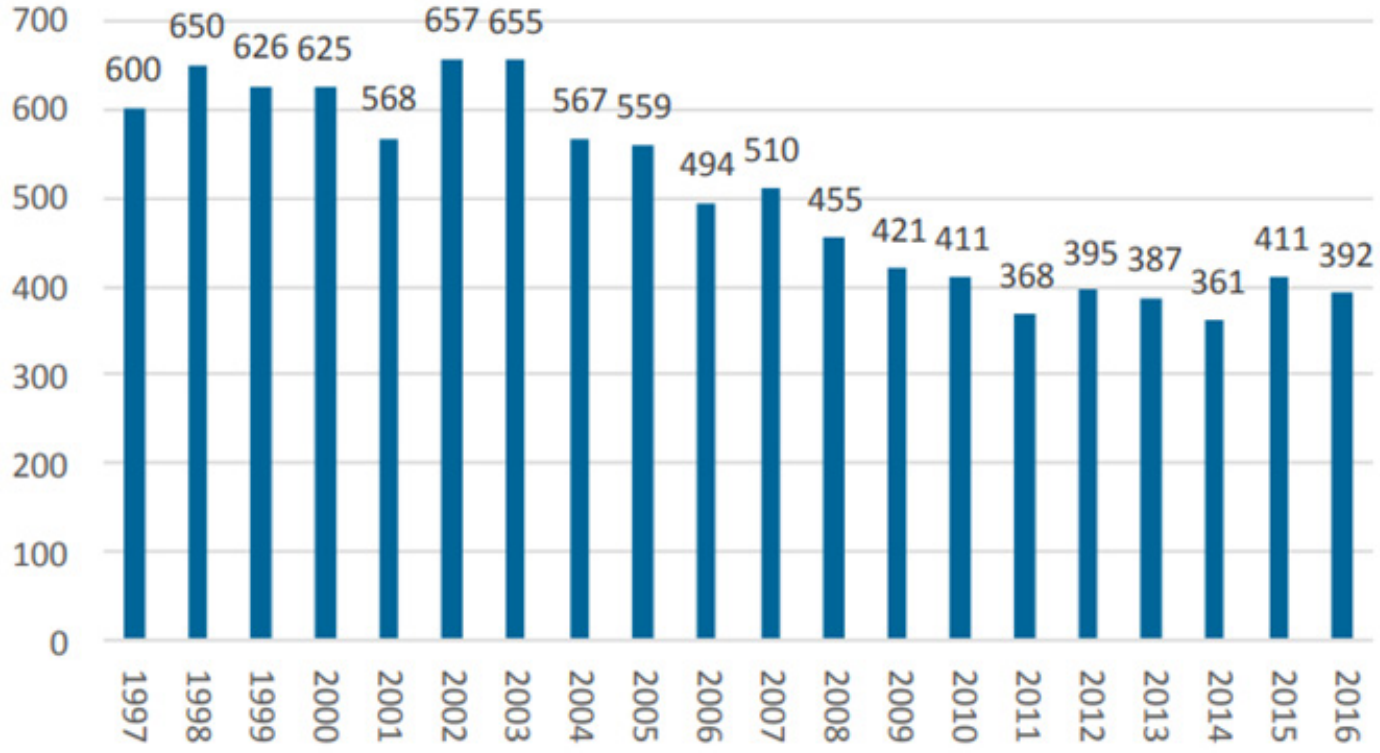


Figure A-3: Traffic Fatalities in Minnesota, 1997 - 2016
Figure originally from the 2016 Minnesota Motor Vehicle Crash Facts

[2] Minnesota Department of Public Safety. (2016). Overview of Traffic Crashes in Minnesota. Retrieved from https://dps.mn.gov/divisions/ots/reports-statistics/Documents/crash-facts-summary-2016.pdf

VISION ZERO CITY TRENDS

NEW YORK CITY

Since the city started integrating Vision Zero tactics into the public right-of-way in 2013, pedestrian, bicyclist, and vehicle occupant fatalities have continued to decrease annually. This goes against the national crash fatality that increased by 13 percent between 2013 and 2016 – New York City's traffic crash fatalities decreased by 28 percent during the same period.[3]

Speeding was a leading factor in New York City traffic fatalities, more than impaired and distracted driving combined. In 2014, State Legislature approved the citywide speed limit to be lowered from 30 mph to 25 mph. At the same time, New York City began to roll out a pilot for automated speed enforcement program around 20 schools. The program was expanded to 140 school zones, and from 2014 to 2016, speeding during school hours in the monitored zones dropped by 63 percent.

DENVER

High Injury Networks (HIN) are corridors where high numbers of people have been killed and severely injured in traffic crashes. HINs have been identified in many cities with a Vision Zero program. The City of Denver found that 50 percent of crashes resulting in fatalities and severe injuries from 2011 to 2015 were occurring on just five percent of the city street miles. Coupling this information with Communities of Concern – areas of lower socioeconomic status, lower education levels, and higher concentrations of seniors – helped city leaders focus on prioritizing Vision Zero projects in areas with the highest need.[4]

LOS ANGELES

Los Angeles' Vision Zero plan includes a Safety Toolkit that the L.A. Department of Transportation utilizes to create safer streets.[5] The Toolkit includes techniques like curb extensions, speed feedback signs, pedestrian refuge islands, and protected left turn signals. Each technique has an assessment for cost (low, medium, high), timeframe (short, medium, long), and effectiveness (low, medium, and high). The toolkit also provides an estimate for improvement after installment:

- Curb extensions reduce crashes by 30 percent
- Refuge islands reduce crashes at intersections by 46 percent
- Speed feedback signs reduce traffic speed by an average of five mph
- Protected left-turns reduce left-turn crashes by 99 percent

AUSTIN

One of the main Vision Zero strategies for eliminating all traffic fatalities includes looking at the impact of fatalities and crash severity on certain populations. The City of Austin found that people experiencing homelessness are more likely to live along high-roads, making them more vulnerable to fatal crashes. Between 2013 and 2014, 14 percent of deaths in the homeless population were caused by vehicle crashes. The City of Austin plans on focusing on the needs of diverse and vulnerable populations to ensure that they are involved in the planning, implementation, and evaluation of Vision Zero designs.

[3] Szekely, P. (2018, January 08). New York City traffic deaths fall to record low under safety program. Retrieved from https://www.reuters.com/article/us-new-york-traffic/new-york-city-traffic-deaths-fall-to-record-low-under-safety-program-idUSKBN1EX2D6

[4] Ferrier, K. (2018, March 08). HIN for the WIN. Retrieved from https://visionzeronetwork.org/hin-for-the-win/

[5] Los Angeles Department of Transportation. (n.d.). Safety Toolkit. Retrieved from http://visionzero.lacity.org/safety-toolkit/

Demographics

The following subsections identify trends on bicycle and vehicle crash statistics at a national level.

Age

Bicyclists

- The average age of crash fatalities has slightly increased over time, from 20 years old in 1989 to 45 years old in 2015.[6]
- Regardless of the average age of bicyclist crash fatalities, children under the age of 14 and seniors are the most vulnerable population when bicycling.
- **Figure A-4** shows the distribution of bicyclist crash fatalities in the United States from 1975 to 2015 by age group.

Vehicle Occupants

- Those in the 24 – 34 age group had the highest number of vehicle crash fatalities from 2010 to 2016 (**Figure A-5**).
- Much of the increased vehicle crash fatalities in seniors stems from the higher risk of injuries, rather than a higher tendency of being involved in crashes.[7]
- Since 1975, the rate of crash fatalities for children under the age of 13 has decreased by 55 percent, possibly a result of new laws requiring children to be properly restrained and seated in rear seats.[8]

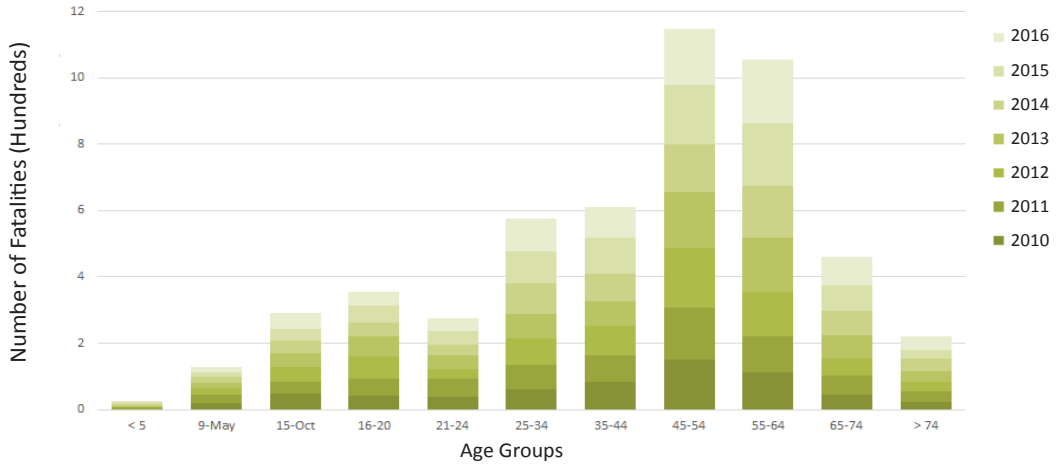


Figure A-4: U.S Bicyclist Fatalities by Age Group, 2010 – 2016

Sources: FARS 2016 ARF, CRSS 2016 and FARS 2010-2015

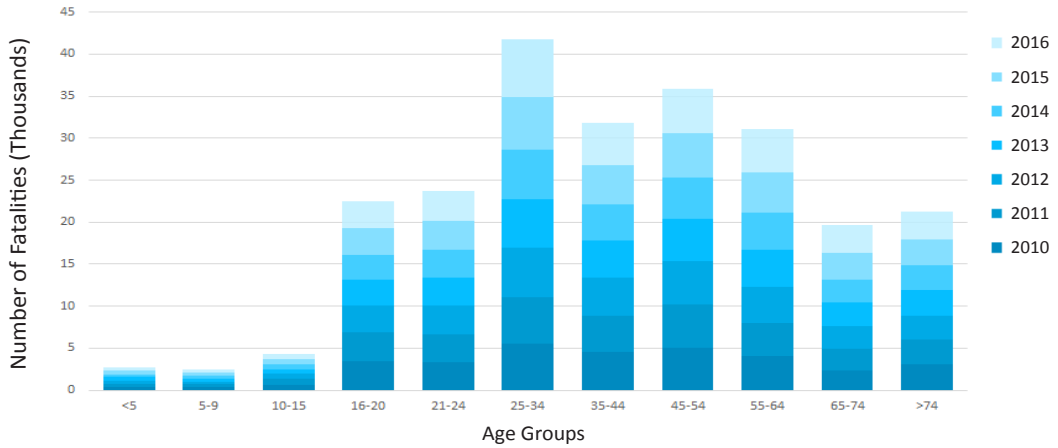


Figure A-5: U.S Vehicle Fatalities by Age Group, 2010 – 2016

Sources: FARS 2016 ARF, CRSS 2016 and FARS 2010-2015

[6] Governors Highway Safety Association, & State Farm. (2017). A Right to the Road: Understanding & Addressing Bicyclist Safety. Retrieved from https://www.ghsa.org/sites/default/files/2017-09/2017BicyclistSafetyReport-FINAL.pdf

[7] Insurance Institute for Highway Safety. (2017, December). Older drivers. Retrieved from http://www.iihs.org/iihs/topics/t/older-drivers/fatalityfacts/older-people/2016

[8] Insurance Institute for Highway Safety. (2017, December). Child Safety. Retrieved from http://www.iihs.org/iihs/topics/t/child-safety/fatalityfacts/child-safety/2016

Gender

- Male bicyclists are four times more likely to be injured and six times more likely to be fatally injured than female bicyclists.
- In 2016, 84 percent of all national bicycle crash fatalities were male.
- Male drivers also make up the vehicle crash fatality victims than females. Seventy-one (71) percent of victims in vehicle crash fatalities in 2016 were males.[9]
- **Figure A-6** shows the gender distribution of vehicle crash fatalities from 1975 to 2016.

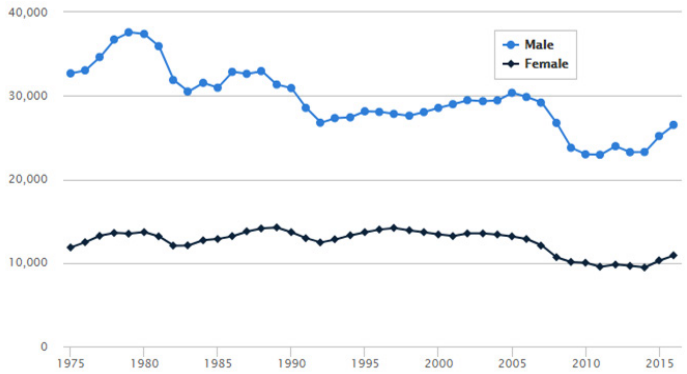


Figure A-6: Motor vehicle crash deaths by gender, 1975-2016

Figure originally from the Insurance Institute for Highway Safety and FARS data

People of Color

Vision Zero reports in cities like Portland, OR and Austin, TX show that communities of color and of lower socioeconomic status are disproportionately affected in crashes resulting in fatalities or severe injuries.

- According to the League of American Bicyclists, Black and Hispanic bicyclists are 30 percent and 23 percent, respectively, more likely to suffer a fatal injury from a crash than White bicyclists.[10]
- Many of the High Injury Networks identified in Austin, TX fall within areas where rates of poverty are higher.[11]

Figure A-7 shows the traffic fatality distribution by race and ethnicity in 2015.[12]

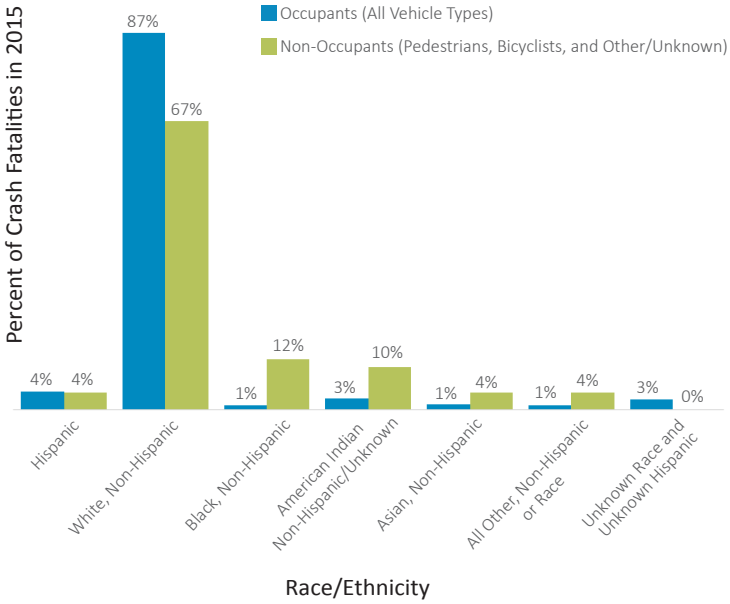


Figure A-7: Minnesota Fatalities by Person Type and Race/Hispanic Origin, 2015

Source: FARS 2015 Final

[9] Insurance Institute for Highway Safety, & Highway Loss Data Institute. (2018). Distracted Driving. Retrieved from http://www.iihs.org/iihs/topics/t/general-statistics/fatalityfacts/gender

[10] Governors Highway Safety Association, & State Farm. (2017). A Right to the Road: Understanding & Addressing Bicyclist Safety. Retrieved from https://www.ghsa.org/sites/default/files/2017-09/2017BicyclistSafetyReport-FINAL.pdf

[11] Austin City Council. (2016, May 19). 2016-2018 Action Plan. Retrieved from https://austintexas.gov/sites/default/files/files/Imagine_Austin/VisionZero/ActionPlan_5.19.16adoption.pdf

[12] National Highway Traffic Safety Administration. (2016). Traffic Safety Performance (Core Outcome) Measures for Minnesota. Retrieved from https://cdan.nhtsa.gov/SASStoredProcess/guest

Bicycle and Vehicle Crash Characteristics

Location

URBAN VS. RURAL

Vehicle crashes occur at a slightly higher rate in rural areas compared to urban areas (2.4 times higher in rural areas).[13]

Crashes involving bicyclists, on the other hand, happen more in urban areas than in rural areas; in 2015, 70 percent of all bicycle crash fatalities occurred in urban areas.[14]

INTERSECTIONS

- Thirty-six percent of bicyclist fatalities in 2016 happened at intersections
- A common cause was the failure to yield from either the motorist or the bicyclist.[15]
- Intersections that do not meet at a right angle make it more difficult for drivers to see bicyclists approaching.

Timing of Crashes

TIME OF YEAR

Figure A-8 shows the percent of all vehicle crash fatalities during the months of 2016. January had the lowest percentage of crash fatalities and October had the highest.

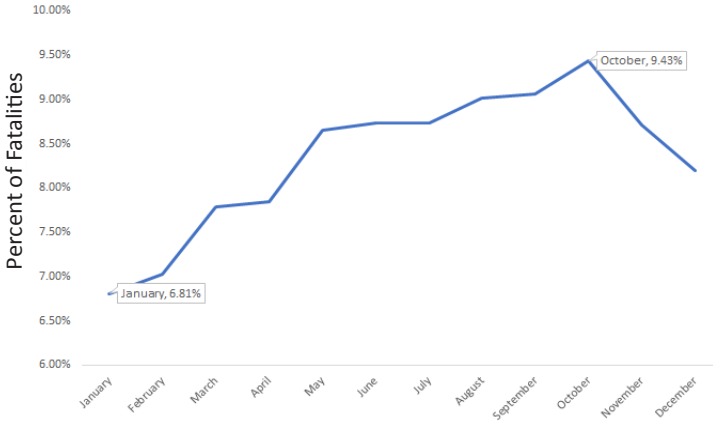


Figure A-8: Crashes and Crash Rates by Month and Crash Severity, 2016

Source: Sources: FARS 2016 ARF, CRSS 2016

TIME OF DAY

In 2016, 33 percent of vehicle crashes occurred between 3 p.m. and 9 p.m. Fatal crashes for bicyclists were evenly distributed between daytime and nighttime hours; forty-one (41) percent of bicyclist fatalities occurred between 6 p.m. and midnight. **Figure A-9** shows the percentage of crash fatalities by time of day.

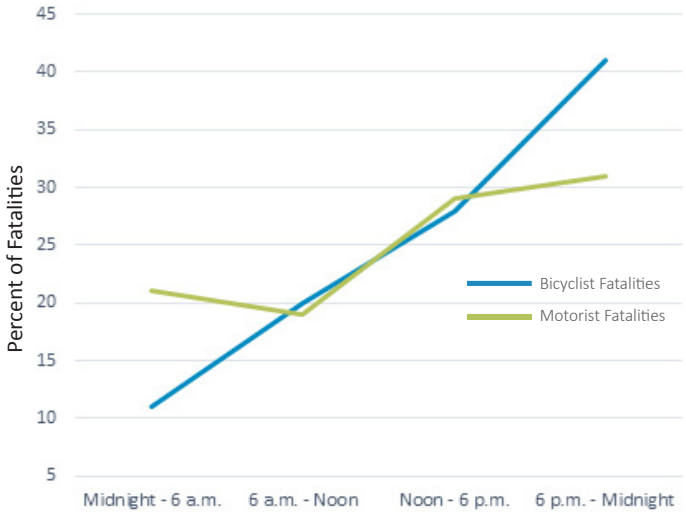


Figure A-9: Bicyclist and Motorist Crash Fatality by Time of Day in 2016

Source: Insurance Institute for Highway Safety and FARS data

[13] Insurance Institute for Highway Safety, & Highway Loss Data Institute. (2018). Distracted Driving. Retrieved from http://www.iihs.org/iihs/topics/t/roadway-and-environment/fatalityfacts/roadway-and-environment/2016#Where-crashes-occur
[14] Ibid.
[15] Governors Highway Safety Association, & State Farm. (2017). A Right to the Road: Understanding & Addressing Bicyclist Safety. Retrieved from https://www.ghsa.org/sites/default/files/2017-09/2017BicyclistSafetyReport-FINAL.pdf

Crash Causes

SPEED

In 2015, 27 percent of all vehicle fatalities and 14 percent of crashes resulting in a serious injury were a result of exceeding the posted speed limit.[16] Incremental increases in the speed of a vehicle can exponentially increase the likelihood of a crash resulting in a fatality or serious injury. At 40 mph, a pedestrian is eight times more likely to die than a pedestrian involved in a crash with a vehicle going 20 mph.[17]

IMPAIRED DRIVING

Impaired driving can mean that the operator of a vehicle or motorcycle is under the influence of alcohol, drugs, or is driving while drowsy. In 2016, 28 percent of all vehicle crash fatalities across the United States resulted from alcohol-impaired driving, and the most frequently recorded BAC for drivers involved in these crashes was 0.16 g/dL – double that of the legal limit. Compared to this national average of fatal crashes involving alcohol, Montana and North Dakota both ranked among the states with highest incidence of alcohol-impaired-driving fatalities (45 percent), and Mississippi and Utah ranked among the lowest (19 percent). Though national alcohol-impaired-driving crashes have decreased by 20 percent since 2007, it increased by 1.7 percent from 2015 to 2016.[18] Using FARS data for Minnesota, the alcohol-impaired driving fatalities dropped from 117 to 93 from 2015 to 2016. **Figure A-10** shows the percentage of alcohol-impaired driving fatalities at a national level compared to the percentage of alcohol-impaired crash fatalities in Minnesota from 2012 to 2016.

There are various drugs, whether illicit or prescription, that can impact one's ability to operator a vehicle. Depending on the type, drugs can slow reaction time, increase reckless driving behaviors, or cause drowsiness. In 2015, 43 percent of fatally-injured drivers were under the influence of drugs during the crash.

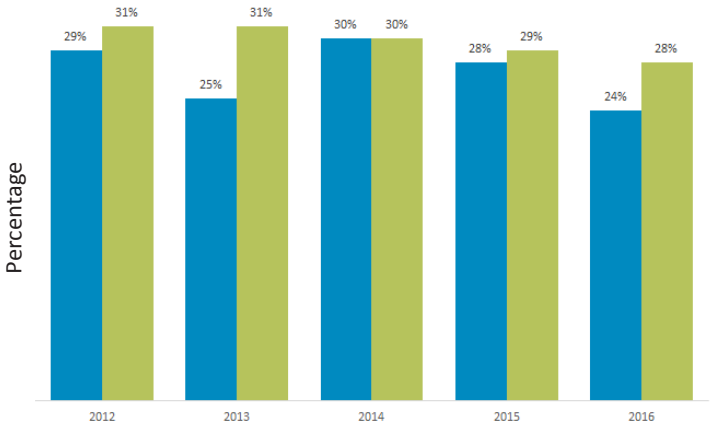


Figure A-10: Percent of Alcohol-Impaired Driving Fatalities across the United States and within Minnesota, 2012 - 2016

Source: FARS data 2012 – 2015 Final and FARS 2016 ARF

DISTRACTED DRIVING

Distracting activities include texting, talking on the phone, eating, or manipulating a GPS device, stereo, or entertainment system. In 2016, distracted driving resulted in 3,477 fatalities and injured an additional 391,000 in crashes across the United States.[19] Reseach is emerging around the effectiveness of different measures to reduce distracted driving, but more analysis is needed. Sixteen state governments and the District of Columbia have laws that ban use of all hand-held devices while driving, and 47 states and the District of Columbia ban texting while driving.[20] **Figure A-11** shows a map of the United States and each state's law regarding banning hand-held devices while driving.

[16] Insurance Institute for Highway Safety, & Highway Loss Data Institute. (2017, December). Speed. Retrieved from http://www.iihs.org/iihs/topics/t/speed/qanda#speed--speed-and-speed-limits
[17] Portland Bureau of Transportation. (2016, December). What is Vision Zero? Retrieved from https://www.portlandoregon.gov/transportation/71733#Speed
[18] North Carolina Department of Transportation. (2018). Safety Focus Areas. Retrieved from https://ncvisionzero.org/safety-focus-areas/drinking-driving/
[19] National Highway Traffic Safety Administration. (2018, April 23). Distracted Driving. Retrieved from https://www.nhtsa.gov/risky-driving/distracted-driving
[20] Insurance Institute for Highway Safety, & Highway Loss Data Institute. (2018). Distracted Driving. Retrieved June 19, 2018, from http://www.iihs.org/iihs/topics/t/distracted-driving/topicoverview

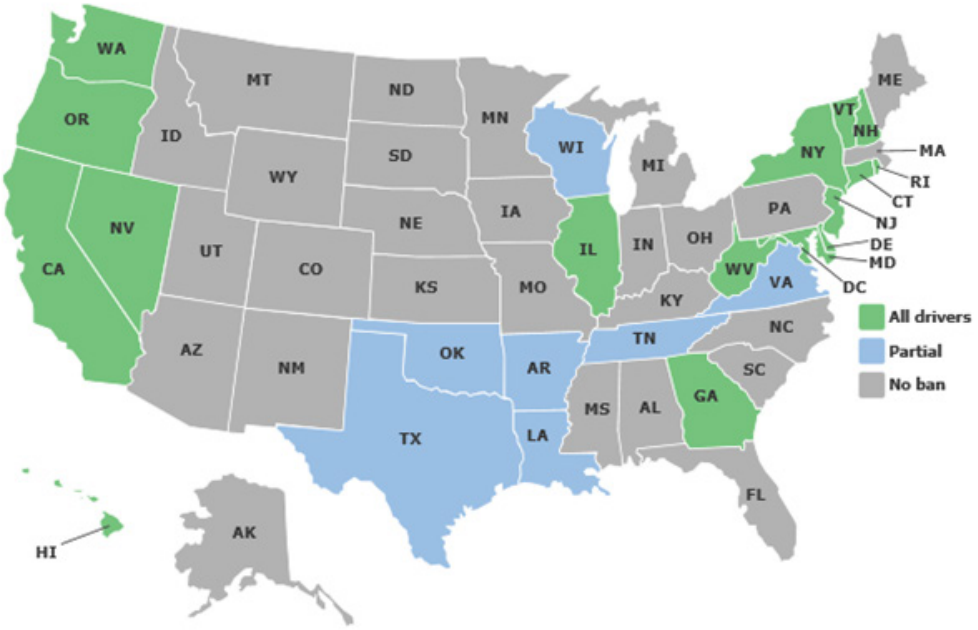


Figure A-11: Laws regarding usage of handheld devices in all 50 states and the District of Columbia. Partial bans vary in affecting holders of learner's permits, drivers younger than 18 years of age, or public transit operators.

Figure originally from the Insurance Institute for Highway Safety, 2018