Appendix C-1

Regional Pedestrian Safety Action Plan

Task 4: Crash Data Analysis and Trend Summary Memo

May 26, 2023

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METROPOLITAN COUNCIL

TOOLE DESIGN

Executive Summary

Approximately 800 recorded pedestrian crashes per year occurred between 2006 and 2019 in the seven-county Minneapolis-Saint Paul region. A retrospective analysis of these crashes was conducted to investigate where pedestrian crashes occur in specific geographic contexts for six key categories: Basic Crash Report Variables, Geographic Distribution, Land Use, Roadway Characteristics, Demographics, and Economics. Through this analysis, correlations were identified between fatal and serious injury pedestrian crashes and various factors including proximity to transit, functional classification, and areas where economically disadvantaged people, people with disabilities, and people of color live. These factors associated with higher pedestrian crash prevalence may be used by practitioners to identify the best locations for pedestrian countermeasure implementation, investment, and engagement in urbanized areas experiencing the majority of pedestrian crashes.

Introduction

The number of pedestrians killed each year on our roadways is increasing, despite the availability of proven safety countermeasures. Significant structural changes must occur across all facets of the roadway transportation industry in order to attain appreciable safety outcomes. As the Metropolitan Planning Organization (MPO) for the seven-county Twin Cities Metropolitan area, the Metropolitan Council (Council) is in a unique position to promote pedestrian safety through its position leading regional visioning and planning processes, monitoring long-range planning goals and ability to provide technical assistance to communities in the region. The Council has established a goal to support an industry framework that reduces the number of pedestrians killed or seriously injured in the region to zero. To address this goal from a policy and funding approach, the Council is developing the Pedestrian Safety Action Plan (PSAP) to ground existing pedestrian safety initiatives in a data- and evidence-driven systemic process. This technical memorandum documents the retrospective crash analysis component of the PSAP development.

How the region's streets are planned and designed has a significant impact on safety for all road users. A safe system approach to transportation network and facility design is grounded in the understanding that crashes and deaths are not inevitable, and that safe road system design can mitigate human error and save lives. A retrospective crash analysis plays an important role in supporting a safe systems framework. By examining patterns of crashes, including their risk factors and outcomes, the underlying nature of the safety deficiencies can be better identified.

The analysis is divided into six general categories which cover specific aspects of where pedestrian crashes occur: Basic Crash Report Variables, Geographic Distribution, Land Use, Roadway Characteristics, Demographics, and Economics. Any of these categories may result in different trends among pedestrian crashes.

The Basic Crash Report Variables section reviews factors such as crash severity in relation to type of vehicle involved and lighting conditions when the crash occurred. The factors analyzed in the Geographic Distribution section intend to identify crash occurrences with respect to broad regional boundaries. The Land Use attributes identify crash occurrences with respect to activities going on in the surrounding areas. Roadway Characteristics' attributes identify crash occurrences with respect to the physical and operational characteristics of the roadways. Finally, the attributes analyzed in the Demographic and Economic analyses explore the relationship between crash occurrences with respect to socio-economic factors.

Although this analysis uses the presently available crash data from 2016 through 2019, national as well as regional traffic crash and travel patterns changed significantly in 2020 and 2021. If and when these new traffic patterns stabilize, the crash trends may substantively differ to those observed in this analysis. While 2020-2021 data was unavailable for this analysis, the short- and long-term trends associated with these patterns are important to consider alongside the retrospective crash analysis results.

Crash Data Background

Crash data is created when police officers complete and file a report. The crash reports include information such as date, time, location, basic roadway information (intersection control), people involved (including age, injury status, etc.), vehicles involved (including type and size), and a narrative about what happened. The Minnesota Department of Public Safety (DPS) compiles these crash reports and shares them with the Minnesota Department of Transportation (MnDOT), who in turn makes additional revisions (e.g., correcting locations). Crash data has issues and limitations due to under-reporting, data incompleteness, inaccuracy (misclassification of key elements, missing/inaccurate descriptive attributes, bias, etc.), and small sample size. Pedestrian crashes are common in our system, but because they are geographically distributed, they are *statistically* rare. This can make analysis and planning to improve pedestrian safety difficult.

In 2016 the Minnesota Department of Public Safety changed officer reporting forms for crashes, updating the forms for more accurate description of injury severity. The injury severity scale used in crash reporting is the KABCO scale, which is used as a tool to classify crashes by injury severity where the severity of a crash is based on the greatest level of injury that occurs. The letters represent injury levels as follows[1]: K – involves a fatal injury, A – involves an incapacitating or life-altering injury, B – involves a non-incapacitating injury, C – possible injury, and O – involves no injury or is a property damage-only (PDO) crash. After the 2016 reporting form change, crashes that were once classified as moderate/possible injuries are now classified as more severe. Data are more complete and accurate and show more severe injuries from 2016 onward. Due to the changes, comparisons over time across the 2016 transition point cannot be made. Data pre-2016 are less complete and less accurate and pooling the pre- and post-transition data is problematic. However, not pooling the data results in even smaller sample sizes. Thus, this analysis focuses exclusively on the 2016-2019 data and where the sample of fatal and incapacitating injury (K plus A severities, sometimes referred to as “severe”, “serious injuries”, “severe injuries”, or “life-altering injuries”) crashes is too small, the data was expanded to include injury B crashes.

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[1] Federal Highway Administration. “Improving Safety on Rural Local and Tribal Roads – Safety Toolkit”. October 4, 2013. https://safety.fhwa.dot.gov/local_rural/training/fhwasa14072/sec4.cfm.

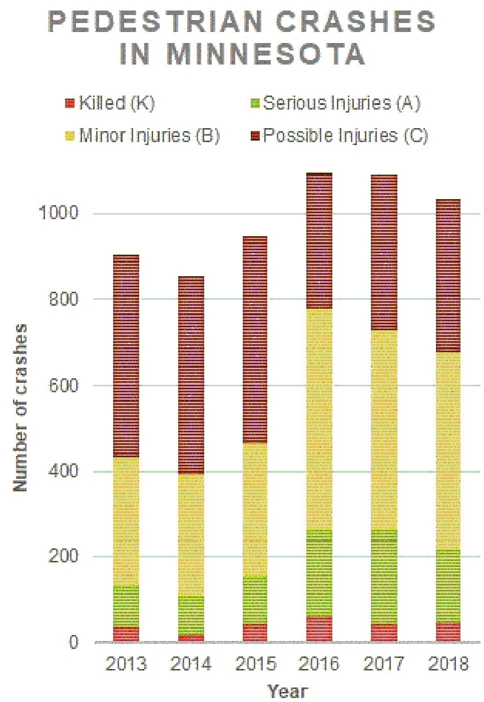


Figure 1. Pedestrian Crashes in Minnesota

Further processing of the crash data is necessary for the geographic analysis. The location of each crash is geocoded, and relevant fields are standardized. For example, there are over 30 values for “Pedestrian Pre-Crash Movement” which have been simplified into two values, “Crossing” and “Not Crossing”, for this analysis (see Crash Typology section). The data is also joined to external spatial datasets including U.S. Census/American Community Survey (ACS), roadway attributes, and land use attributes to provide a wider array and depth of data.

When conducting an analysis of motor vehicle crashes, the number of crashes is normalized by the number of vehicle trips or vehicle miles traveled. This controls for how many motorists were “exposed” to the risk of a crash occurring, and crash risk can be expressed as a rate (e.g., 1 crash per 1 million vehicles passing through an intersection or per 1 million miles driven). However, pedestrian volumes and mileage are not available systemwide. Therefore it is not possible to directly control for exposure in a way that is analogous to motor vehicle crash analysis. Nonetheless, geographic analysis factors associated with where pedestrians are killed or seriously injured while walking can still be identified without exposure data. This is a common issue for pedestrian safety studies nationwide and is not limited to the Twin Cities or Minnesota.

Sliding Window Analysis

A sliding windows analysis helps us understand crashes along a corridor and identify segments with the highest crash density. This analysis was done by determining the number and severity of crashes along a one-mile “window” on a roadway and shifting that window along the roadway 1/10 mile at a time. Two sets of maps were developed based on this analysis:

- **Pedestrian Fatalities and Incapacitating Injuries (Appendix A):** These maps depict the density of fatal, incapacitating, non-incapacitating, and possible injury pedestrian crashes per mile.
- **Pedestrian Weighted Crash Scores (Appendix B):** These maps depict the density of fatal, incapacitating, non-incapacitating, and possible injury pedestrian crashes per mile and weigh

the crashes by severity. Crashes were weighted by severity by multiplying the number of fatal and incapacitating injury crashes by three and non-incapacitating injury crashes by one (non-injury crashes are not reflected). Each segment is scored and the result visualizes the areas with the highest density of crashes for pedestrians.

Both sets include maps of the following areas:

- Anoka and adjacent counties (Sherburne and Wright within the MPO)
- Carver county
- Dakota county
- Hennepin county
- City of Minneapolis
- Ramsey county
- Scott County
- City of Saint Paul
- Washington County
- Metro (entire MPO area)

The results in both sets of maps are very similar, so the rest of this section focuses on the weighted crash score set of maps (available in Appendix B). Minneapolis' Vision Zero Action Plan High Injury Streets map is also included as Appendix B6. Many of the same corridors are identified on both the High Injury Streets map and Minneapolis' Pedestrian Weighted Crash Score map.

Crash Typology

Pedestrian crash types were categorized based on pedestrian pre-crash locations and motor vehicle pre-crash movements, loosely based on the Location Movement Classification Method developed by Schneider and Stefanich[2]. The motorist pre-crash movements used to define crash types are “going straight”, “turning left”, “turning right”, and “other”. The Task 5 systemic analysis is designed to study distinct crash types. Specific types of pedestrian crashes help link patterns of risk to appropriate countermeasures: for instance, installing crossing islands for where mid-block pedestrian crashes occur.

Table 1. Pedestrian Crash Typology

Recoded Pre-Crash Movement	Officer-Reported Pedestrian Pre-Crash Movement
Crossing	• Walk/Cycle Across Traffic (Crossing Roadway) • Coming From School Bus • Going to School Bus • Going to or from Public Transit
Not Crossing	• Adjacent to Roadway (e.g. Shoulder, Median) • Walk/Cycle Against Traffic • Walk/Cycle With Traffic • Walk/Cycle on Sidewalk • Going to or from School (K-12) • In Roadway - Other (Working, Playing, etc.) • Standing/Stopped • Working in Trafficway (EMS, Enforcement) • Working in Trafficway (Maintenance, Construction) • Working in Trafficway (Utility)
Other	• Other • Unknown • Multiple actions • Null actions

The two figures (see Appendix C) show the crashes divided into Intersection and Segment crash types. Intersection crash types are distributed among [Motor Vehicle] Turning (divided into Left Turn and Right Turn), Straight, and Other/Unknown movements, for all pedestrian movements combined. Segment crash types are distributed into [Motor Vehicle] Turning, Other/Unknown, and Pedestrian Movements, with Pedestrian Movements being divided into Pedestrian Crossing, Pedestrian Walking Along Road[3], Pedestrian in Road, and Unknown/Other. A majority of pedestrian crashes occurred at an intersection

[2] Schneider, R.J. and Stefanich, J. 2016. “Application of the Location—Movement Classification Method for Pedestrian and Bicycle Crash Typing”. Transportation Research Board. January 1, 2016. https://doi.org/10.3141%2F2601-09.

[3] Pedestrian Walking Along Road movement crashes are not included in the crash trees associated with Task 5; this is representative of mid-block segment crossing crashes and not mid-block non-segment/non-crossing crashes. This field is coded ambiguously in crash report data and is less reliable than other fields and other pedestrian actions.

with the motor vehicle moving straight (forward). Focusing on specific types of pedestrian crashes helps to identify and link patterns of risk to the appropriate countermeasures.

Retrospective Descriptive Analysis

The six categories for the retrospective pedestrian crash analysis are Basic Crash Report Variables, Geographic Distribution, Land Use, Roadway Characteristics, Demographic Characteristics, and Economic Characteristics.

Basic Crash Report Variables

Approximately 800 recorded pedestrian crashes per year occur over the four-year period. The number and rate of severe crashes declined slightly between 2016-2017 and 2018-2019, although the subtle differences may not be significant (see Figure 2).

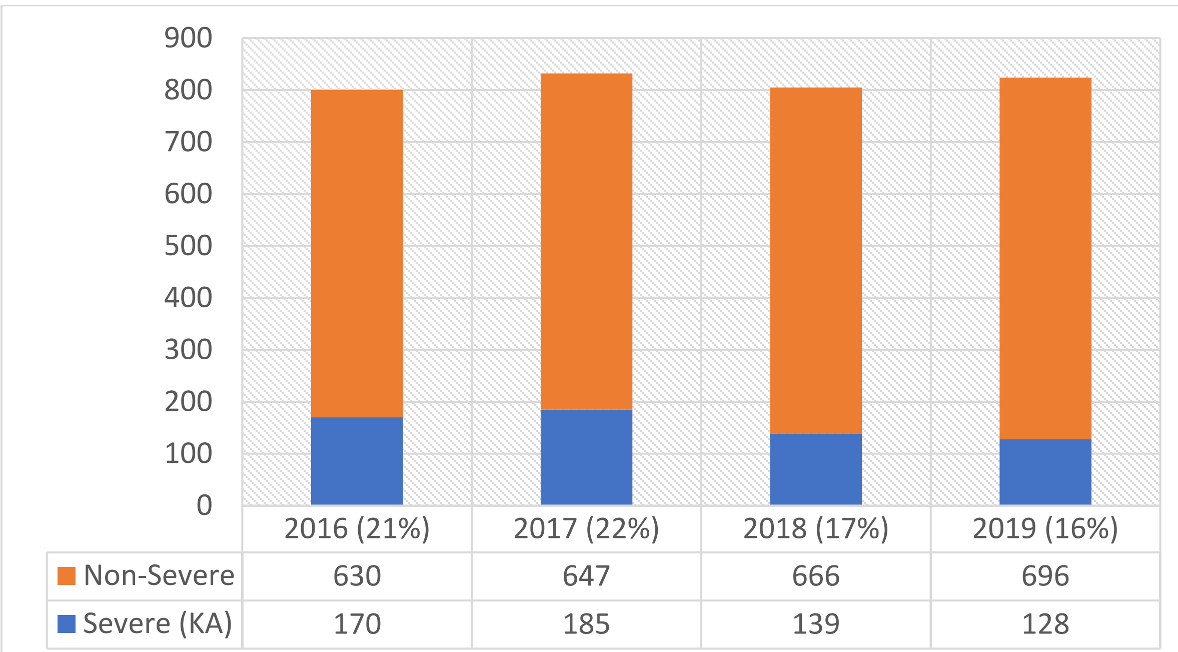
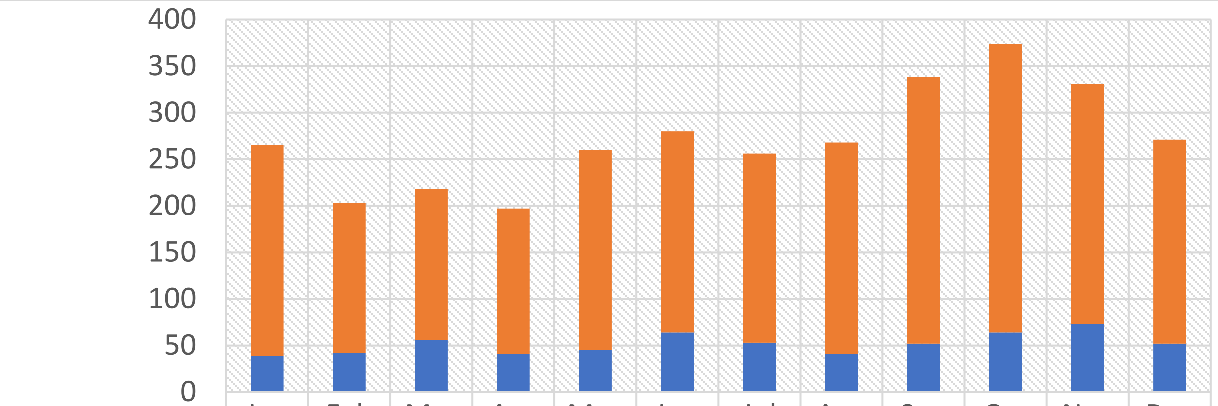


Figure 2. Pedestrian Crashes by Severity and Year

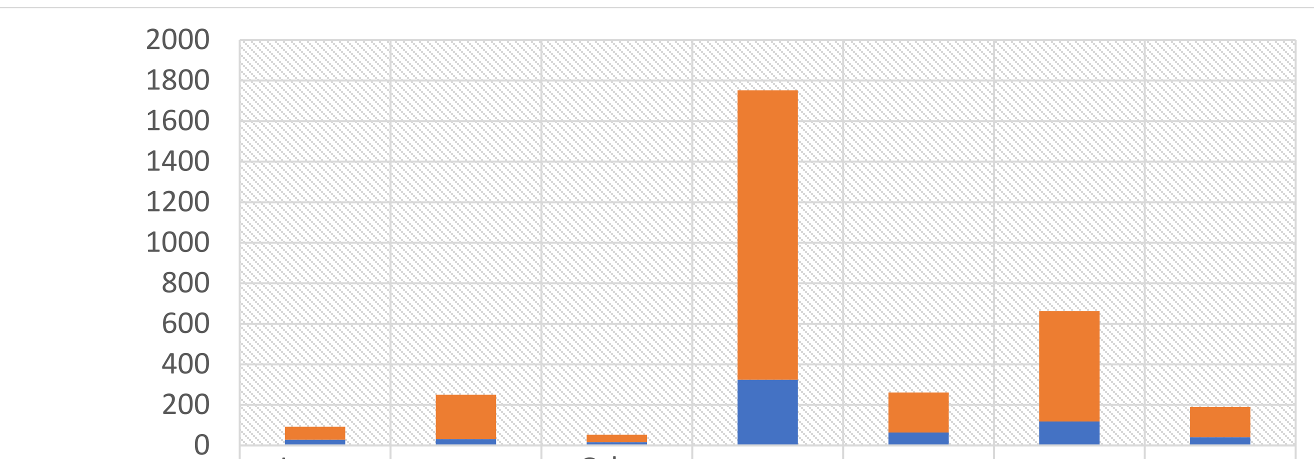
Crash patterns from 2016 in particular may vary in injury severity compared to later years due to adjustment to the new crash reporting system. Autumn months (September through November) have the highest number of pedestrian crashes and November has the largest number of severe crashes (73). March, July, and November represent the highest percentage of crashes that are severe (see Figure 3).



	Jan (15%)	Feb (21%)	Mar (26%)	Apr (21%)	May (17%)	Jun (23%)	Jul (21%)	Aug (15%)	Sep (15%)	Oct (17%)	Nov (22%)	Dec (19%)
Non-Severe	226	161	162	156	215	216	203	227	286	310	258	219
Severe (KA)	39	42	56	41	45	64	53	41	52	64	73	52

Figure 3. Pedestrian Crashes by Severity and Month

Crashes involving passenger cars and SUVs comprise three-fourths of all pedestrian crashes while those involving heavier vehicles (i.e., larger trucks/RVs/buses, smaller trucks/vans, pickup trucks) tend to have more severe outcomes. The “Other Vehicle” category includes other vulnerable road users, like motorcyclists, which may explain the high severity rate (see Figure 4).



	Large Truck/RV/ Bus (30%)	Missing (12%)	Other Vehicle (30%)	Passenger Car (18%)	Pickup (25%)	SUV (18%)	Van/Truck (22%)
Non-Severe	64	219	37	1428	197	545	149
Severe (KA)	28	31	16	324	64	118	41

Figure 4. Pedestrian Crashes by Severity and Heaviest Vehicle Type

Pedestrian crashes and their severity are significantly impacted by the lighting conditions. The crash data shows that 55 percent of pedestrian crashes happen in daylight and are the least likely to result in death or serious injury (16 percent) (see Figure 5). While the majority of crashes occur in daylight, these events are also related to the likelihood of pedestrians walking near streets during daylight hours. Nearly 90 percent of pedestrian crashes happen in either daylight or dark with streetlights on. This is strongly linked to when and where people are most likely to be out walking. Additionally, crashes in dark conditions with streetlights off or no streetlights are much more likely to result in death or serious injury than any other lighting condition. With the streetlights off, 40 percent of crashes in dark conditions result in death or serious injury, compared to only 23 percent with lights on. Crashes with unknown lighting conditions are not shown, as they account for less than 2 percent of all crashes. Overall, while most crashes occur in lit conditions, darkness is associated with severe outcomes. Thus, lighting may help reduce the severity of crashes. These patterns are consistent with national trends showing darkness and low light conditions contributing to pedestrian fatality rates. National research is underway to investigate further strategies for improving pedestrian safety in darkness.[4]

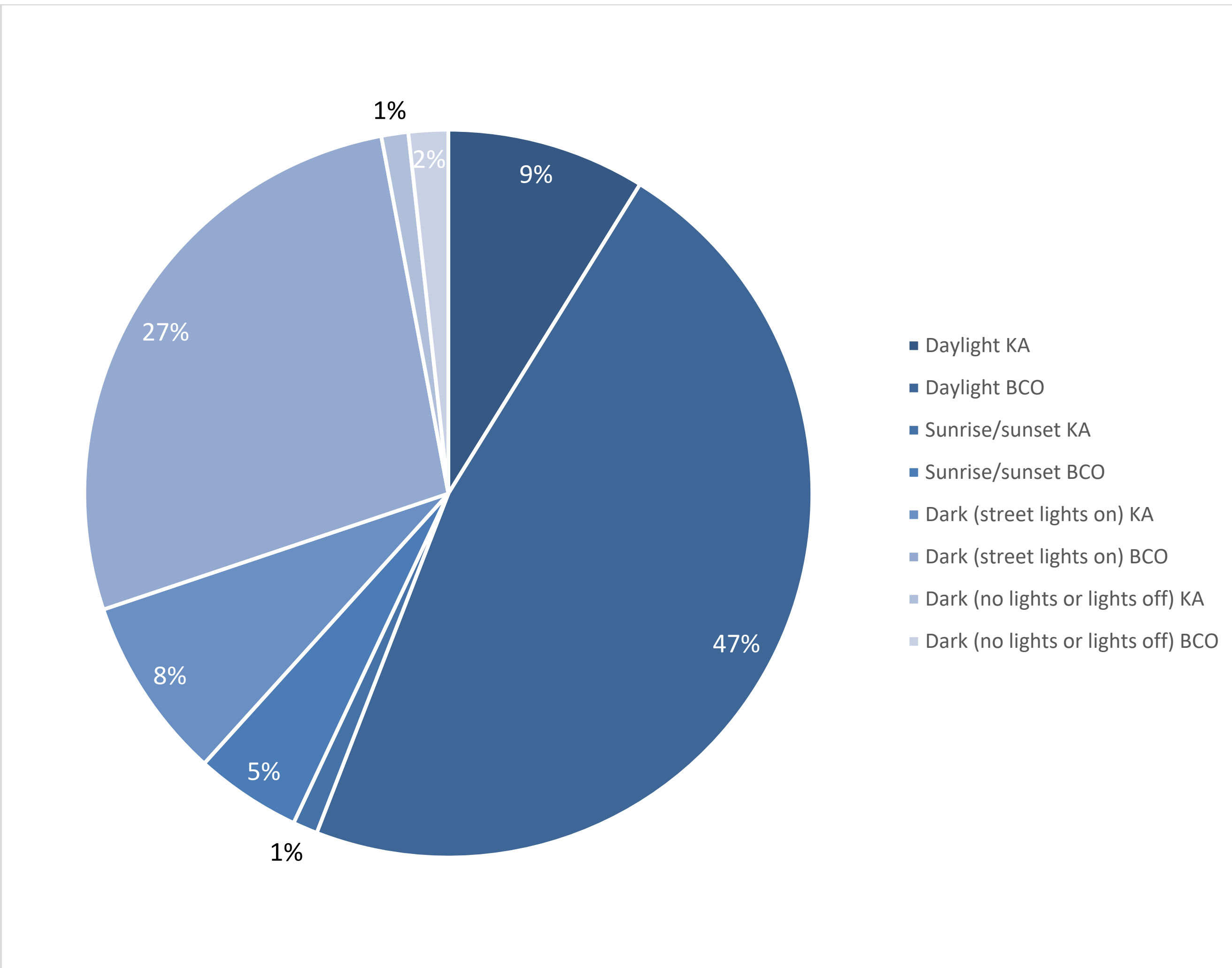
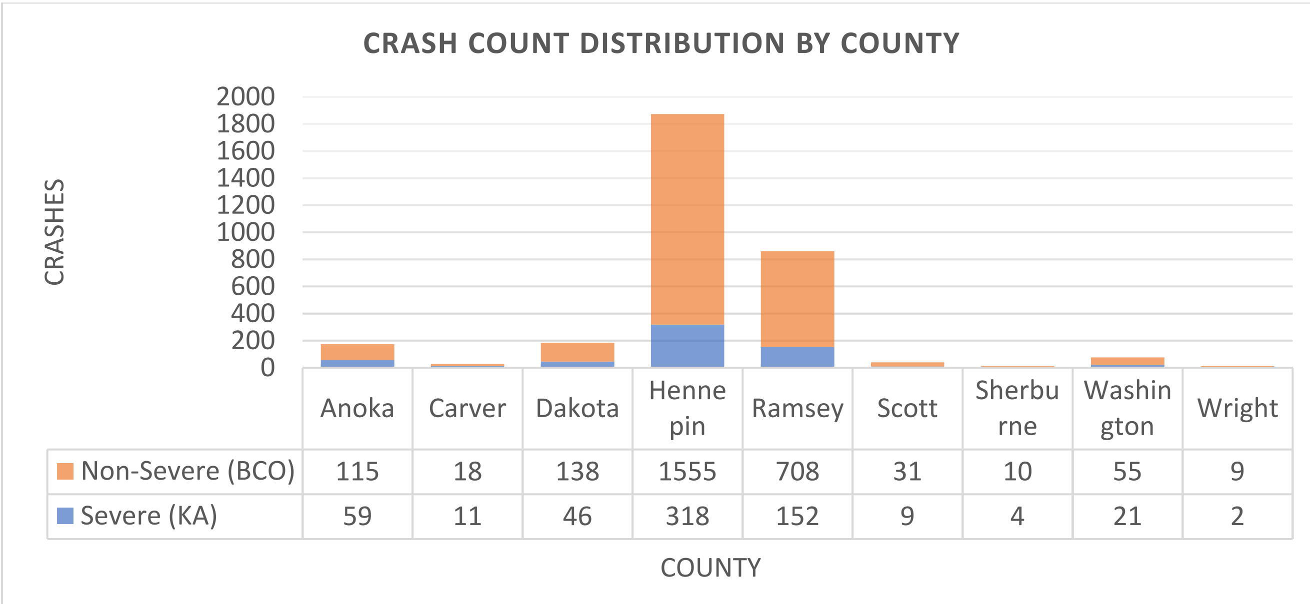


Figure 5. Pedestrian Crashes by Severity and Lighting Condition

[4] *NCHRP 17-97 Strategies to Improve Pedestrian Safety at Night*

Geographic Distribution

The greatest number of crashes and the greatest number of severe crashes generally occurred in urbanized areas. Hennepin and Ramsey counties, the two most densely populated urban counties, have the highest numbers of both All Severities and Severe Crashes (see Figure 6).



	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Sherburne	Washington	Wright
Non-Severe (BCO)	115	18	138	1555	708	31	10	55	9
Severe (KA)	59	11	46	318	152	9	4	21	2

Figure 6. Crash Count Distribution by County

A higher percentage of the pedestrian crashes occurring in the more rural counties with lower population densities resulted in death or serious injury than urban counties (see Figure 7). Although rural areas demonstrate higher severity rates if a crash occurs, pedestrian crashes in urban areas comprise a significantly larger share of the region's pedestrian deaths and serious injuries and tend to be much more geographically concentrated. While attention should be given to rural pedestrian crashes, focusing systemic safety efforts on preventing urban crashes will have a greater impact on reducing the overall number of pedestrian deaths and serious injuries due to the high relative volume in urban areas.

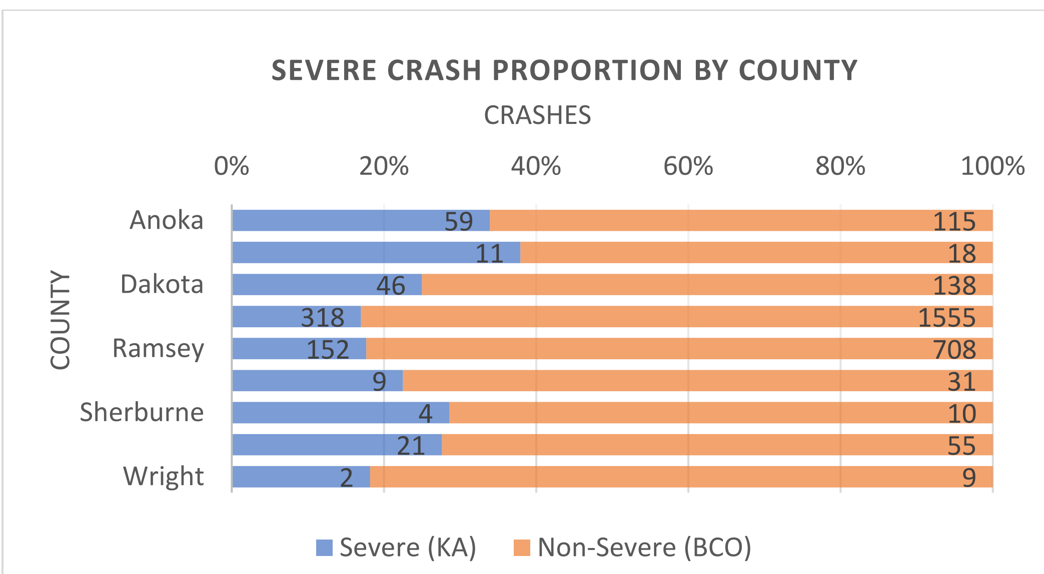


Figure 7. Severe Crash Proportion by County

The Thrive Community Type dataset was used in the Geographic Distribution analysis to provide sub-regional context to the crash data. Thrive Community Type designations[5] ranged from Agricultural to Suburban Edge to Urban Center. The retrospective crash analysis grouped designations into three categories: Urban (representing *Urban Center* Thrive Community Type, which approximately reflects the cities of Minneapolis, Saint Paul, and first ring suburbs), Suburban (representing *Urban, Suburban, Suburban Edge, Emerging Suburban Edge* Thrive Community Types), and Rural (representing *Rural Center, Diversified Rural, Rural Residential, Agricultural, Non-Council Area* Thrive Community Types). Crashes that occur in suburban or rural designated areas had lower frequencies of pedestrian crashes but exhibited a higher proportion of severe crashes (see Figure 8). Nonetheless, the magnitude of both severe and non-severe crashes that occur in the Urban Center Thrive Community Type illustrates it is an important primary area of focus for pedestrian safety. Pedestrian safety countermeasures in urban areas will have the greatest impact on reducing overall numbers of pedestrian deaths and life-altering injuries.

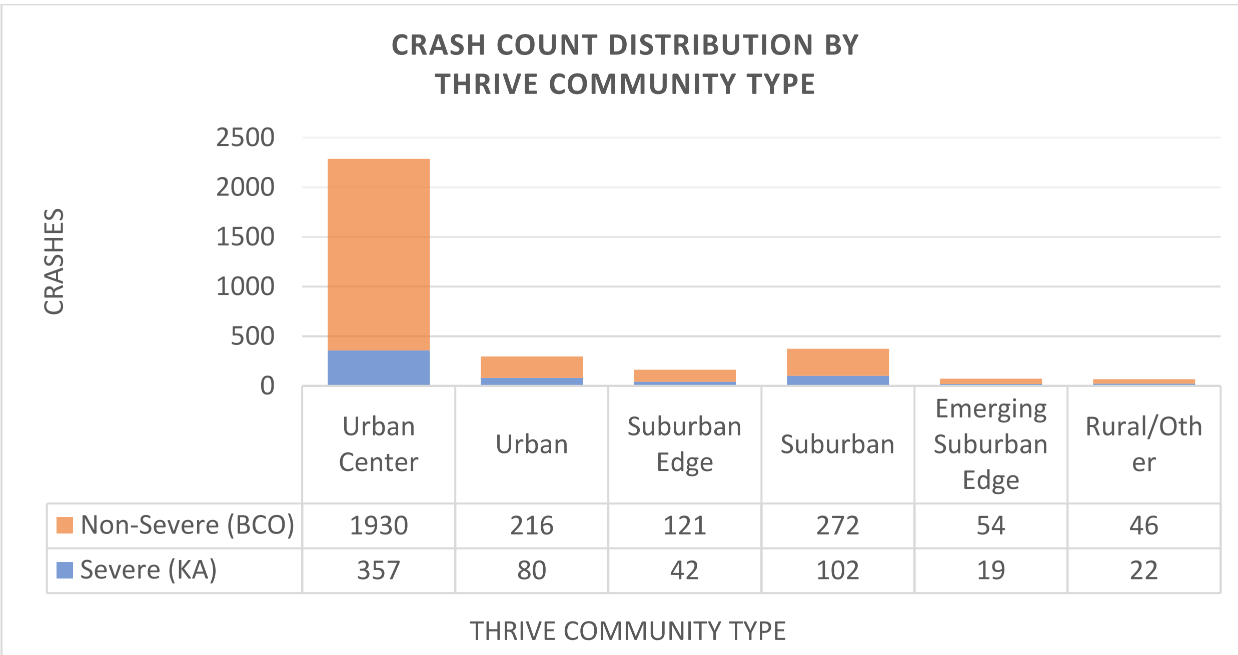


Figure 8. Crash Count Distribution by Thrive Community Type

[5] Metropolitan Council and Minnesota Geospatial Commons. "Thrive MSP 2040 Community Designations". August 20, 2021. https://gisdata.mn.gov/dataset/us-mn-state-metc-society-thrive-msp2040-com-des.

Land Use

Multiple data sets representing different facets of land use were georeferenced with the crash data, including proximity to transit, generalized land use, and Job and Activity Centers. A disproportionate amount of pedestrian intersection crashes occur near transit stops (see Figure 9). Fewer than 25 percent of intersections account for nearly 80 percent of severe pedestrian crashes and 83 percent of pedestrian intersection crashes occur within 500 feet of a transit stop. Due to the very low (less than one percent of severe pedestrian crashes) prevalence of transit vehicles in the pedestrian crash data, transit itself likely is not the cause of pedestrian crashes. However, the strong correlation illustrates that it is important for investments in pedestrian safety near transit stops. This distribution is reflective of where pedestrian activity is most likely to take place and may reflect a surrogate measure for pedestrian exposure.

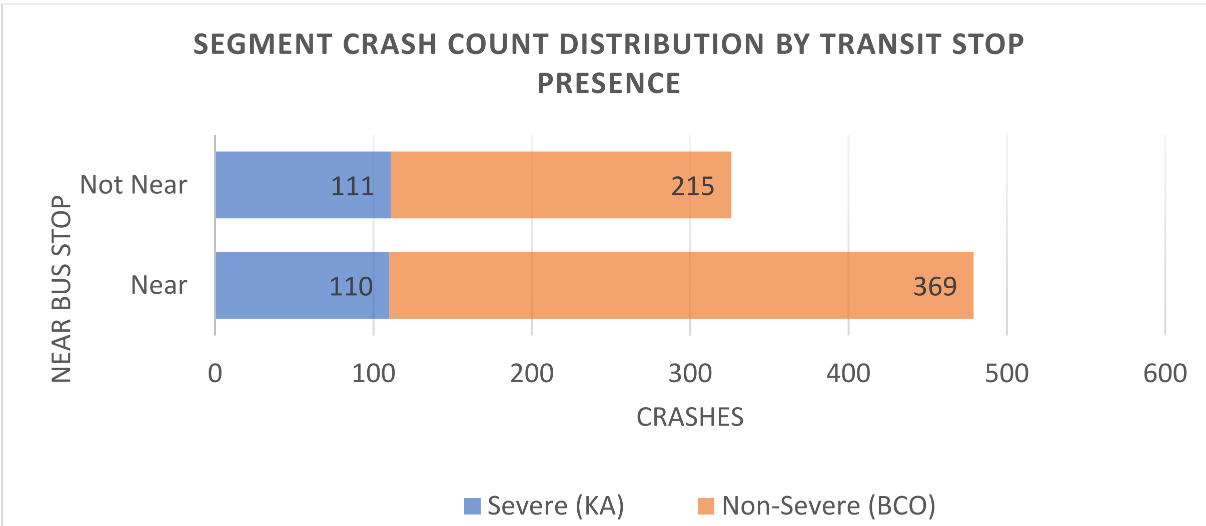


Figure 9. Segment Crash Count Distribution by Transit Stop Presence

The Council's Activity Center dataset was investigated for correlation between specific Activity Center types and pedestrian crashes. The Council provides the following definition for Activity Centers[6]: "Job and Activity Centers describe contiguous areas where there are at least 1,000 jobs and the employment density is at least 10 jobs per acre. Nearly two-thirds of all jobs […] are located within the Jobs and Activity Centers, which are classified into six Scale categories […] based on predominant industry." The six Scale categories are based on the North American Industry Classification System and include:

- **Major:** Diversified workforce, more than 50,000 or major trip generator
- **Professional:** More than 50% jobs in Professional, Education, or Health
- **Industrial:** More than 50% jobs in Industrial, Transportation, Construction & Waste Mgt.
- **Activity:** More than 40% jobs in Retail Trade, Hospitality, or Services
- **Diversified:** Mixed distribution of job classification
- **Non-Activity Center**

[6] Metropolitan Council and Minnesota Geospatial Commons. "Job and Activity Centers". November 17, 2014. https://gisdata.mn.gov/dataset/us-mn-state-metc-society-job-and-activity-centers.

A notable portion of the cities of Minneapolis and Saint Paul are categorized as Professional, Industrial, Major, Activity, or Diversified Activity Center category types. Pedestrian crash data shows non-activity center destinations represent the greatest proportion of pedestrian crashes (see Figure 10). However, Industrial Activity Centers demonstrated a high severity rate, with 33 percent of pedestrian crashes resulting in a fatality or serious injury, compared to 19 percent regionwide (see Figure 11).

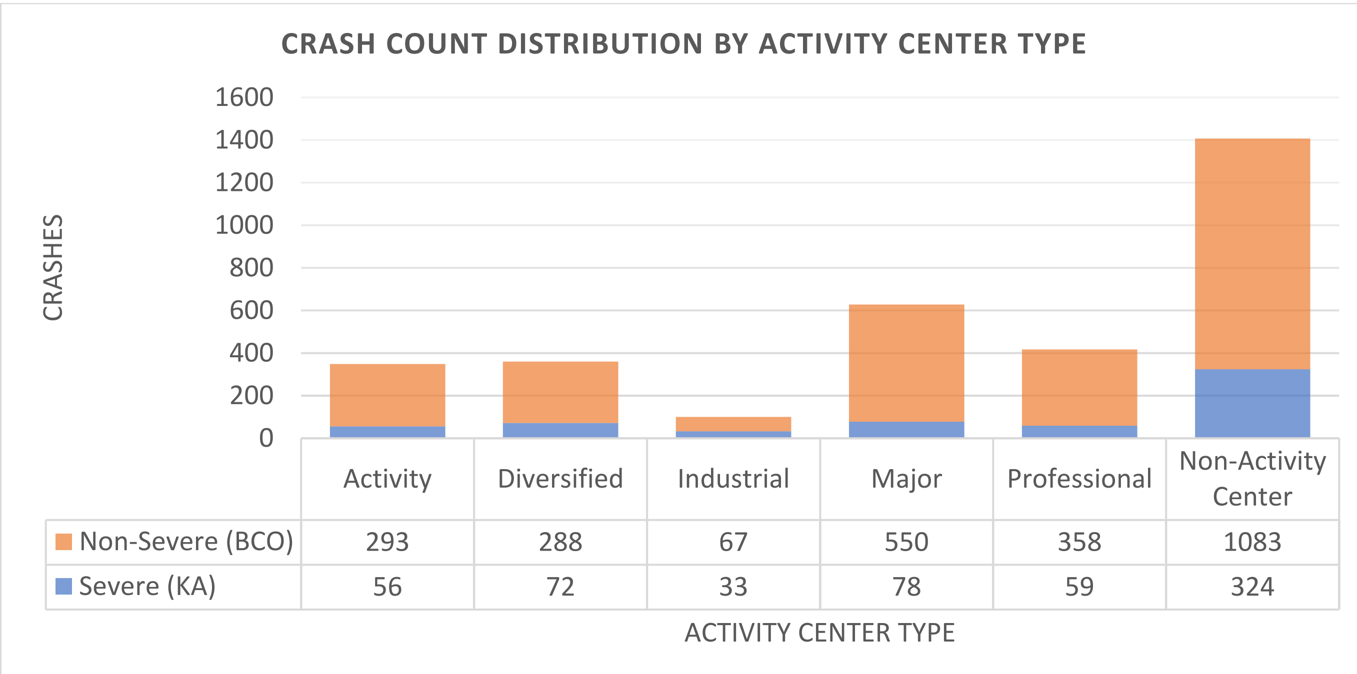


Figure 10. Crash Count Distribution by Activity Center Type

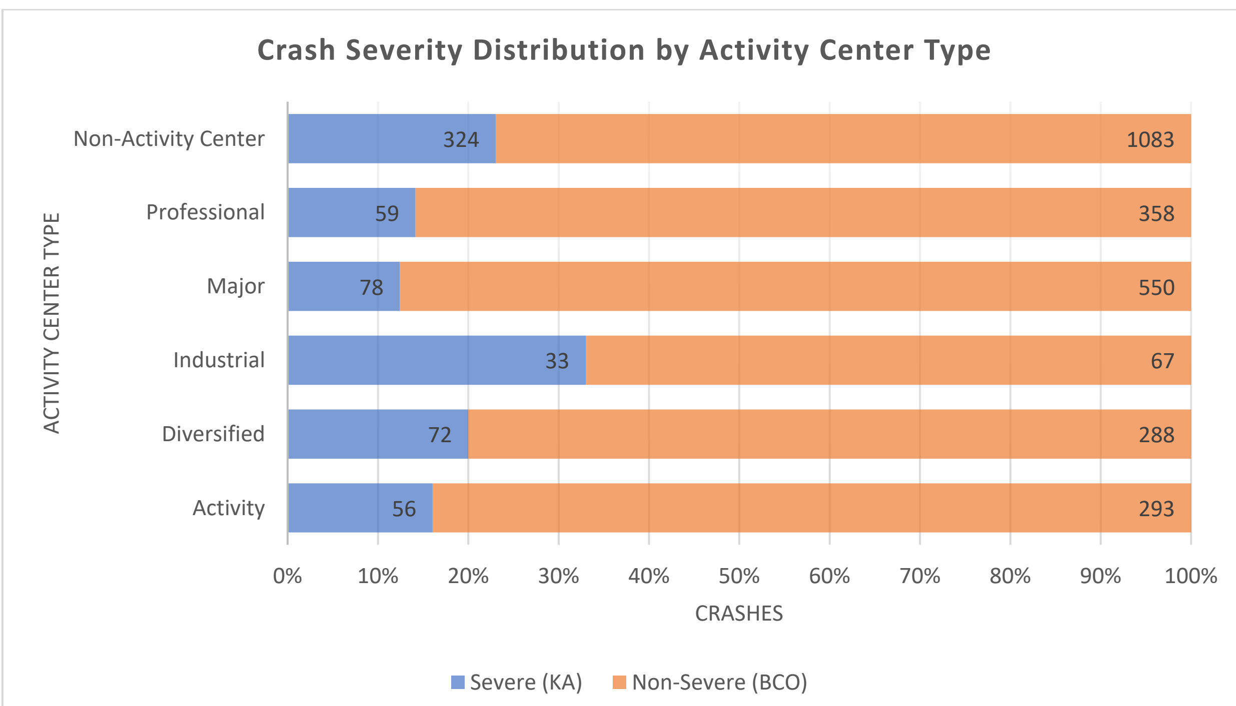


Figure 11. Crash Severity Distribution by Activity Center Type

Youth pedestrian crash data illustrated in Figure 12 shows that there is no overt correlation between youth pedestrian crashes and proximity to schools, though pedestrian safety near schools is still important. Approximately 4 percent of severe youth pedestrian crashes occur within a quarter mile of a school, and 12 percent within a half mile of a school. Compared to 5 percent and 14 percent respectively for severe crashes involving pedestrians of all ages, this does not suggest that proximity to schools increases or decreases risk to youth walking to and from school. Other geographic factors may be involved in the relationship between youth pedestrian safety and schools, such as the presence of existing pedestrian infrastructure and locations generally away from higher functional classifications, higher vehicular traffic volumes, and higher speeds. Youth trips are made for a much broader range of destinations and trip purposes than school alone, so it is reasonable that crashes are not specifically concentrated around schools.

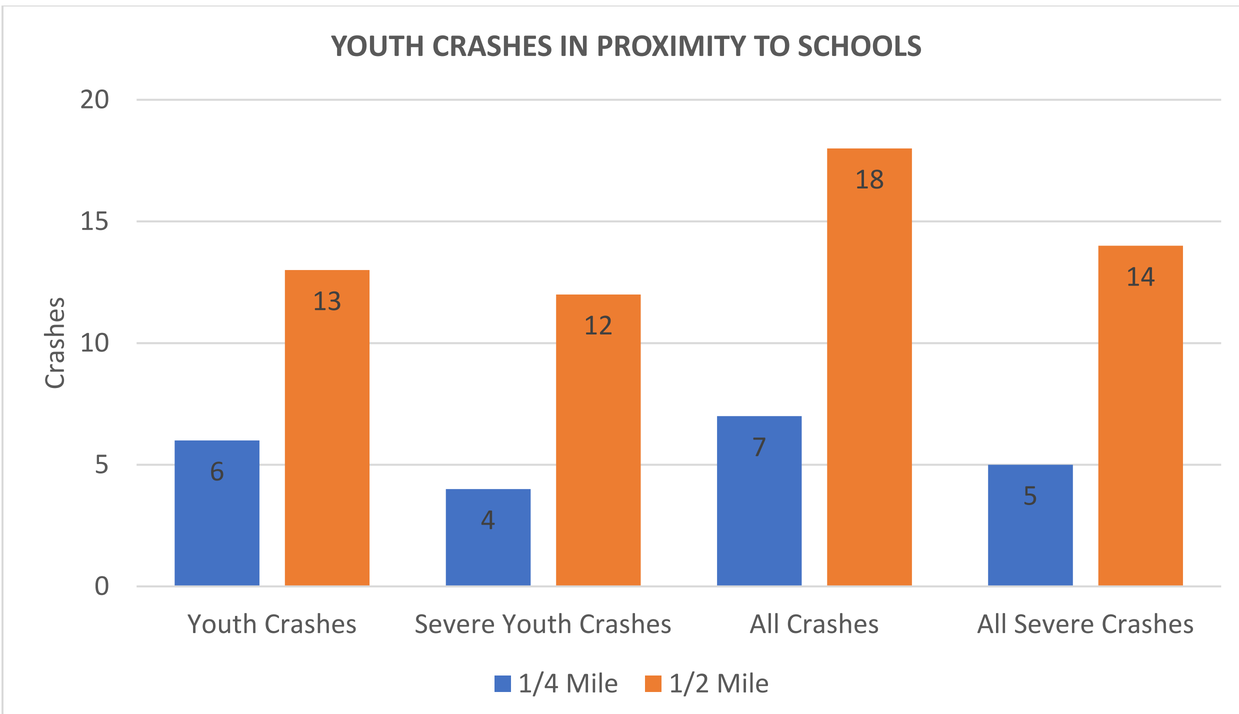


Figure 12. Youth Crashes in Proximity to Schools

Roadway Characteristics

Pedestrian crash data shows most intersection crashes occur at signals (see Figure 13, Figure 14).

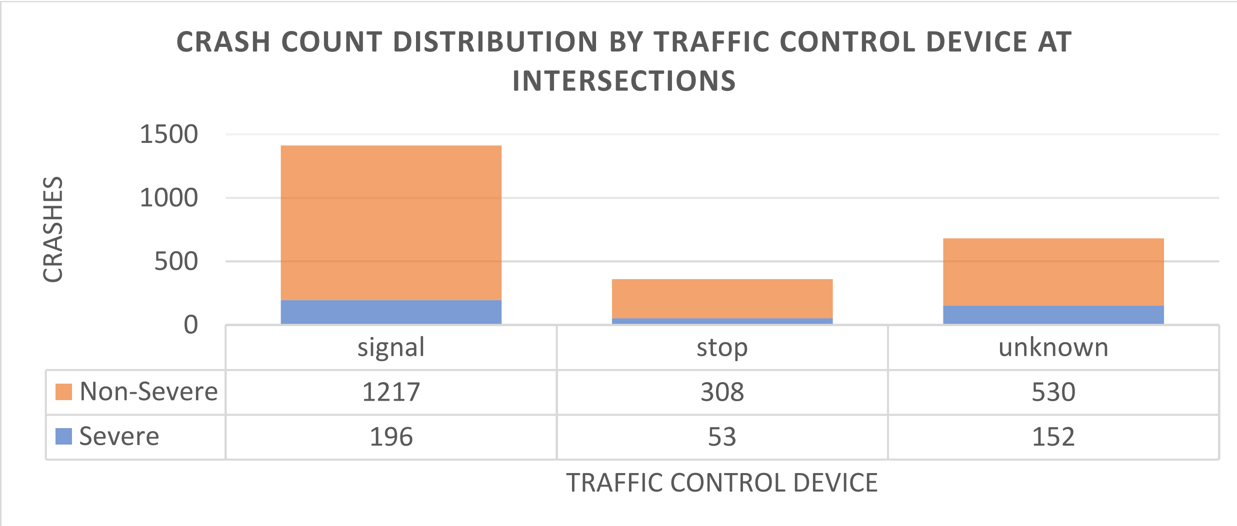


Figure 13. Crash Count Distribution by Traffic Control Device at Intersections

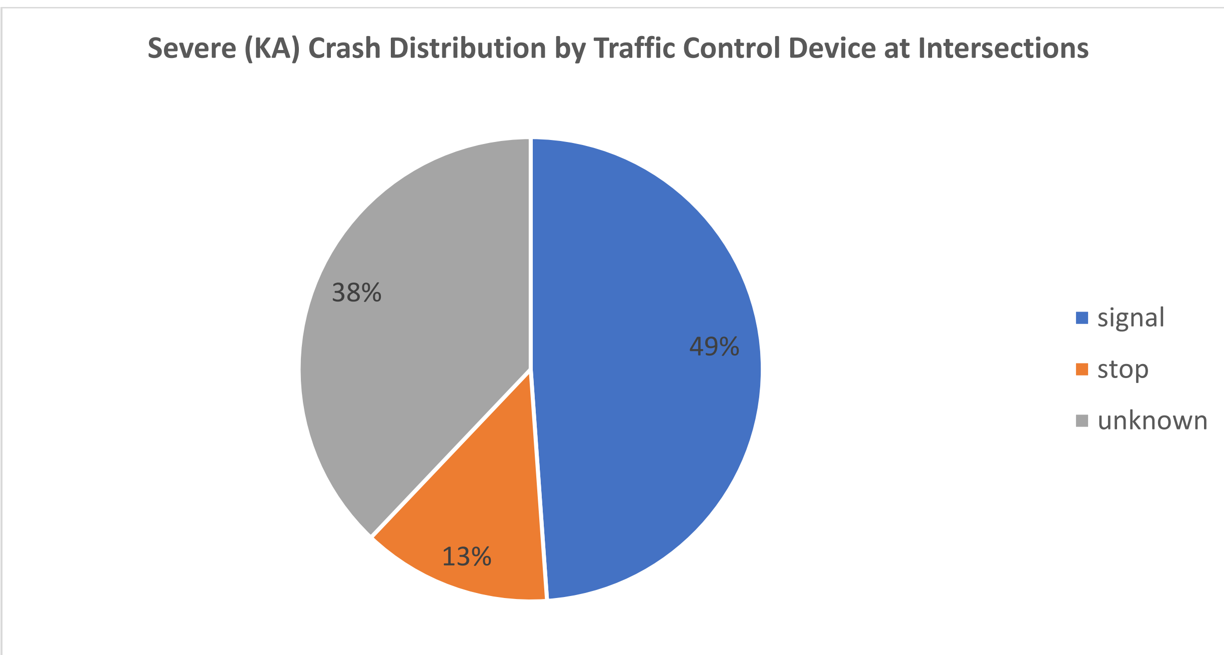


Figure 14. Severe Crash Distribution by Traffic Control Device at Intersections

Most pedestrian intersection crashes occur on minor roadways, accounting for 64 percent of severe pedestrian crashes compared to 14 percent of roadway miles (see Figure 15).

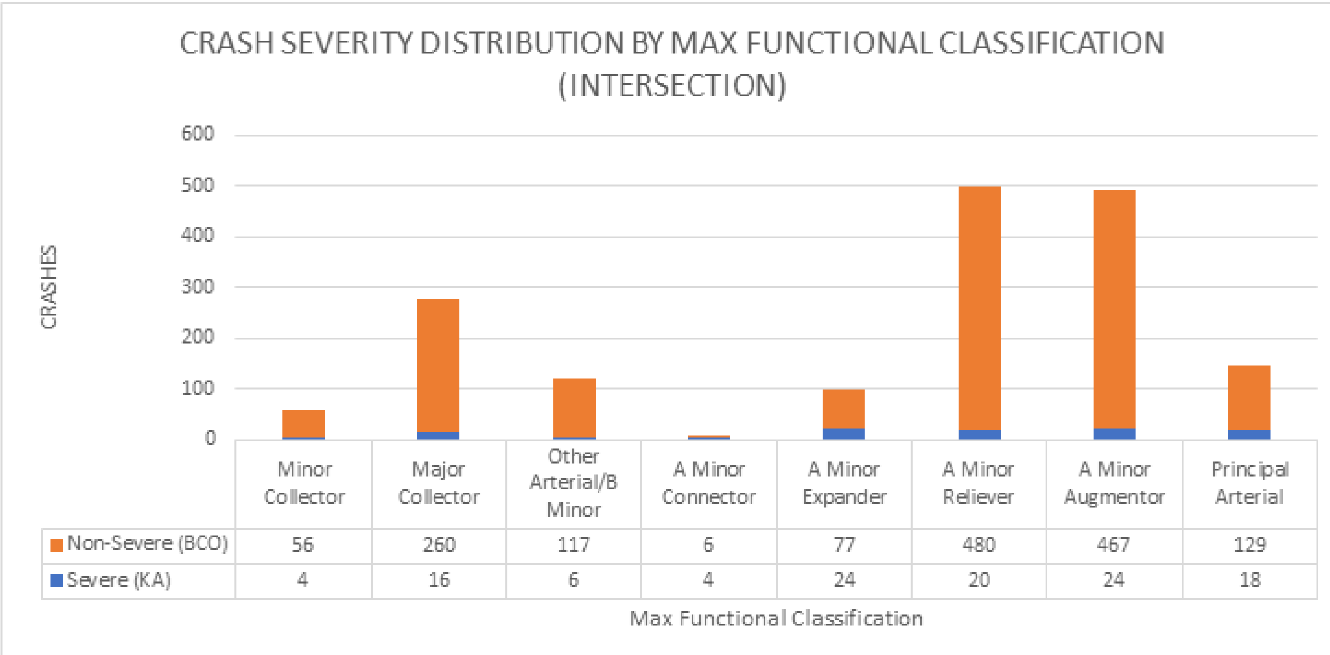


Figure 15. Crash Count Distribution by Maximum Functional Classification

Minor arterials and major collectors together account for 82 percent of all pedestrian crashes. Significantly fewer crashes occur on local or other roadways, accounting for 11 percent of pedestrian crashes compared to 74 percent of roadway miles. Non-interstate principal arterial crashes are not very numerous (6 percent of severe pedestrian crashes), but disproportionately severe (28 percent of these crashes are severe), likely due to the speed of these roadways (see Figure 16). Given the strong correlation between minor arterial and major collector facility type and pedestrian crashes, they can function as rough proxies for systemic risk factors. In absence of other risk factor data, planners and engineers can screen the network to locate these types of roads and evaluate them for pedestrian safety needs. This is consistent with national research about pedestrian fatality hotspots.[7]

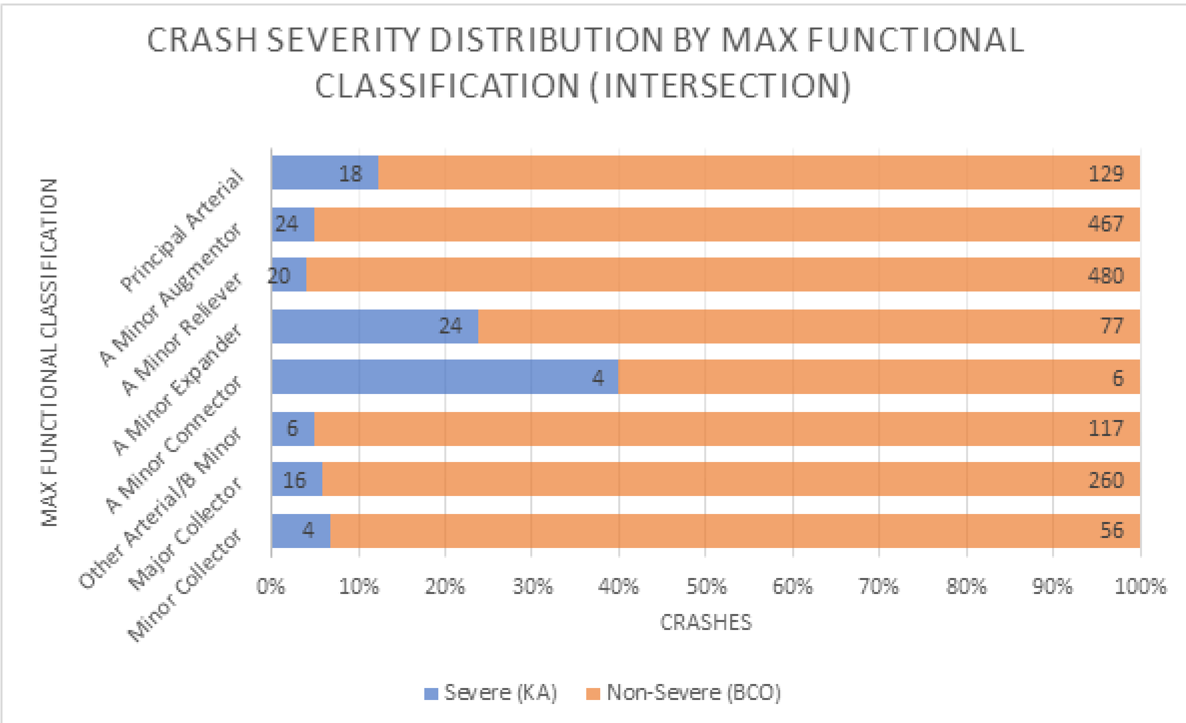


Figure 16. Crash Severity Distribution by Maximum Functional Classification

[7] Schneider, R.J. and Sanders, R. "United States fatal pedestrian crash hot spot locations and characteristics". Journal of Transport and Land Use. January 5, 2021. https://doi.org/10.5198/jtlu.2021.1825

While there is no data about actual, observed motor vehicle travel speeds before reported crashes, higher posted speed limits are correlated to higher severity outcomes for any given pedestrian crash (see Figure 17).[8] However, the overwhelming majority of pedestrian crashes, deaths, and serious injuries are occurring on roadways with lower speed limits (see Figure 18).

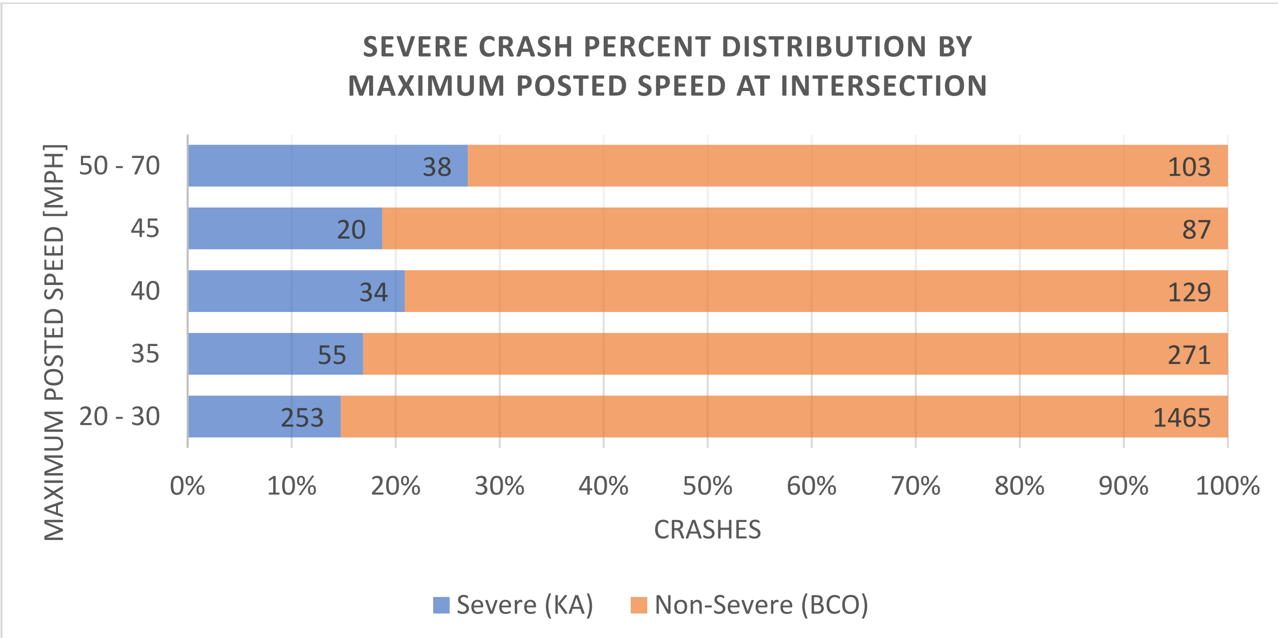


Figure 17. Severe Crash Percent Distribution by Maximum Posted Speed Limit at Intersections

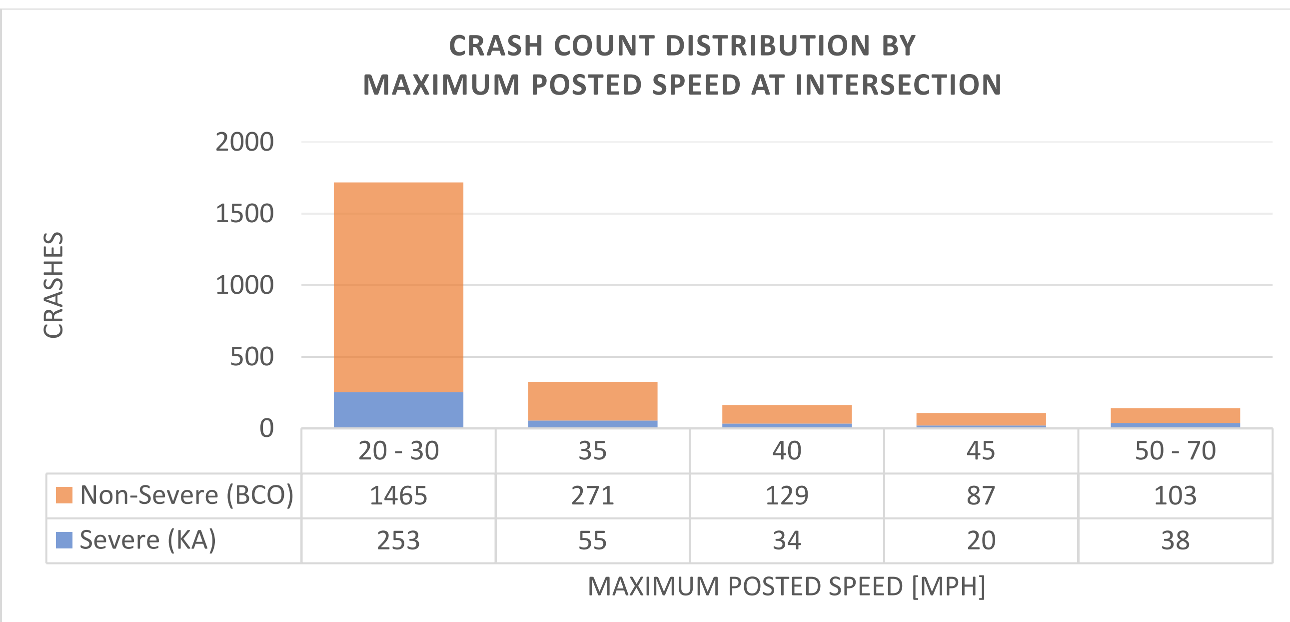


Figure 18. Crash Count Distribution by Maximum Posted Speed at Intersections

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[8] Officer-reported speed in the crash reports tends to refer to the speed limit on the road on which the crash occurred.

While this may seem counter-intuitive, speed limits serve as a proxy for exposure; low- and mid-speed roads are more likely to have people walking along them than very high-speed roads. Nonetheless, the physics involved in higher-speed crashes result in higher risk of serious injury or death. The high concentration of pedestrian deaths and serious injuries on low- and mid-speed roads suggests focusing safety countermeasures in these places may have a greater impact on reducing deaths and serious injuries than targeting the fastest roads.

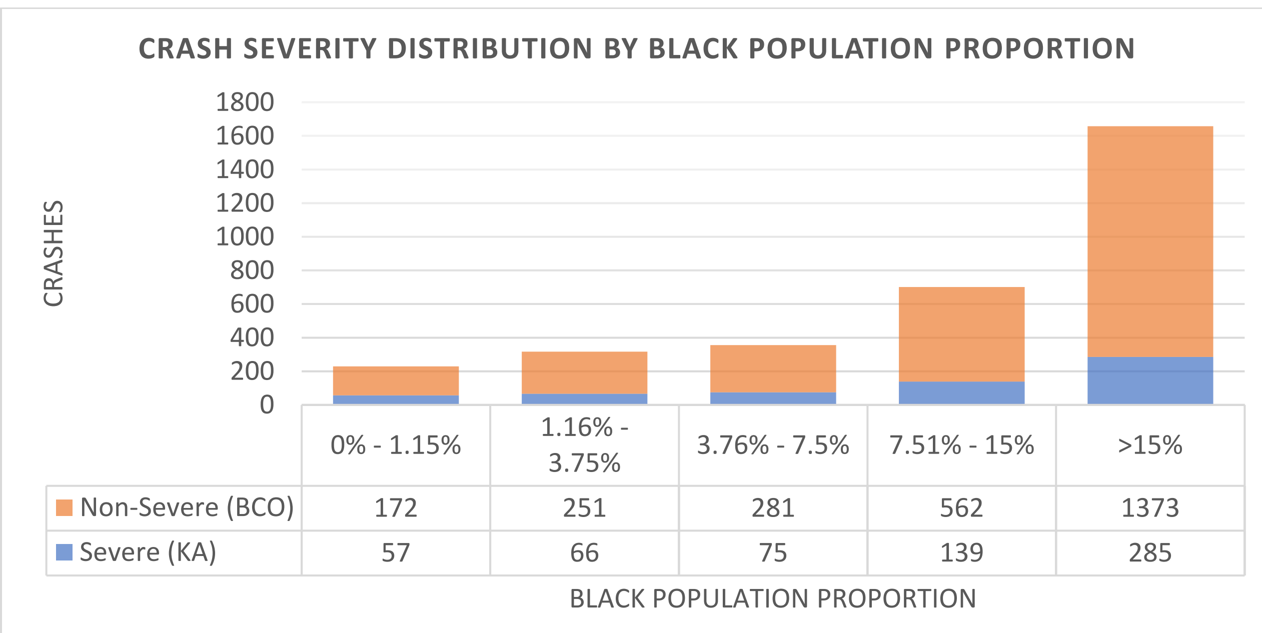
Demographic Characteristics

The National Highway Traffic Safety Administration's Fatal Accident Reporting System (NHTSA, FARS) collects data on the race of fatal crash victims. In the Twin Cities seven-county metropolitan area, per 2014 to 2018 FARS data, 19.3 percent of pedestrian fatalities were Black compared to 9.6 percent of the population in the study area is Black. For Native Americans, 2.8 percent of pedestrian fatalities were Native American compared to 0.48 percent of the population in the study area.

Aside from fatal crashes, race is not collected in crash reports, so this exact statistic cannot be replicated using the crash data available for this study. Instead, prevalence of pedestrian crashes by the racial demographics of the Census tract in which the crash occurred is used. This is an indirect measure but tends to correlate with the individual-level FARS data.

For this analysis quintiles of the Census data are used: five equal-sized parts, each accounting for 20 percent of the metropolitan area population, composed of aggregations of Census tracts based on their relative values for the demographic variables of interest. For example, to investigate the relationship between pedestrian crashes and Black population proportions, the Census tracts are sorted based on the Black proportion of their overall population. The tracts exhibiting the lowest percentage of Black populations are grouped into the lowest quintile, representing the lowest 20 percentile, while those with the highest percentage of Black populations are grouped into the highest quintile.

Pedestrian crashes that occur under varying Black population proportions exhibit differing characteristics with respect to crash type and severity outcome (see Figure 19).



	0% - 1.15%	1.16% - 3.75%	3.76% - 7.5%	7.51% - 15%	>15%
Non-Severe (BCO)	172	251	281	562	1373
Severe (KA)	57	66	75	139	285

Figure 19. Crash Severity Distribution by Black Population Proportion

A majority (51 percent) of pedestrian crashes occur in neighborhoods with more than 15 percent Black population proportion (the highest quintile, representing 20 percent of the metropolitan population), 17 percent of which results in a death or serious injury. Of all severe crashes specifically, 46 percent occur in areas represented in this quintile. Similar trends were demonstrated with American Indian population proportions. Conversely, the quintile representing the highest proportion of white population (greater than 90 percent) represents only 6 percent of pedestrian crashes (see Figure 20). This illustrates that pedestrian crashes occur disproportionately in areas with higher Black population proportions, suggesting the prioritization of investments and engagement in these neighborhoods.

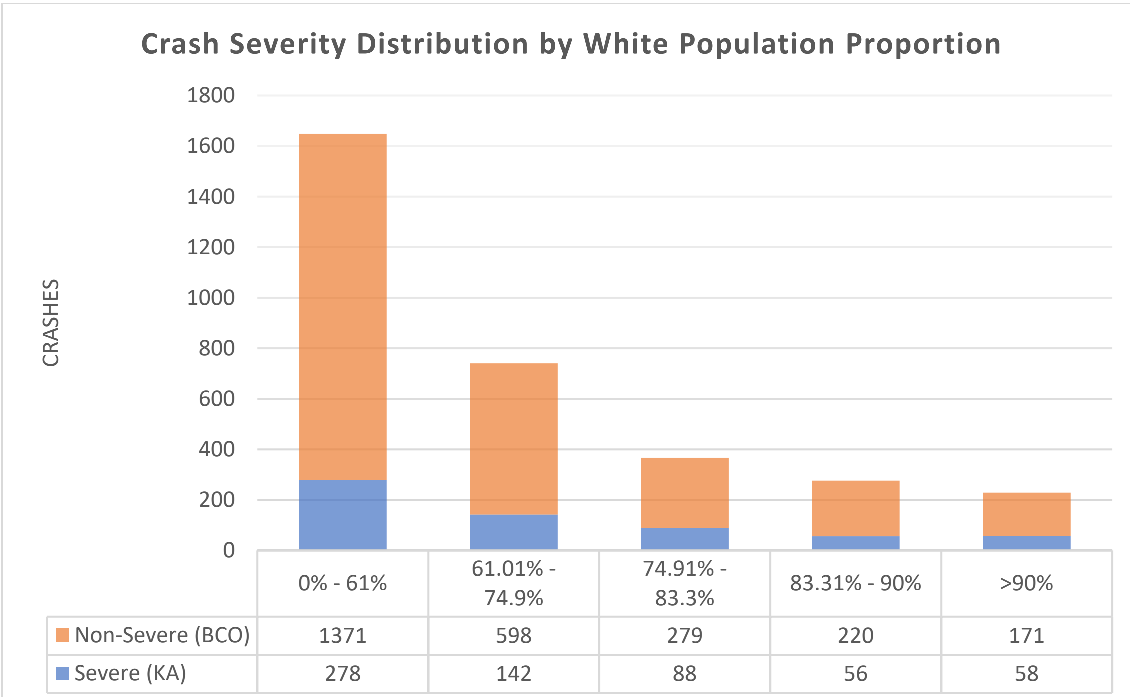


Figure 20. Crash Severity Distribution by White Population Proportion

More severe and non-severe pedestrian crashes occur in areas with higher vision and ambulatory disability population proportions (see Figure 21). The top quintile represents 40 percent of crashes occurring in neighborhoods with more than 7.81 percent of the population having vision or ambulatory disabilities which resulted in serious injury or death. The top two quintiles (40 percent of the population) represent 61 percent of crashes occurring in neighborhoods with more than 5.76 percent of the population having vision or ambulatory disabilities, 18 percent of which resulted in serious injury or death.

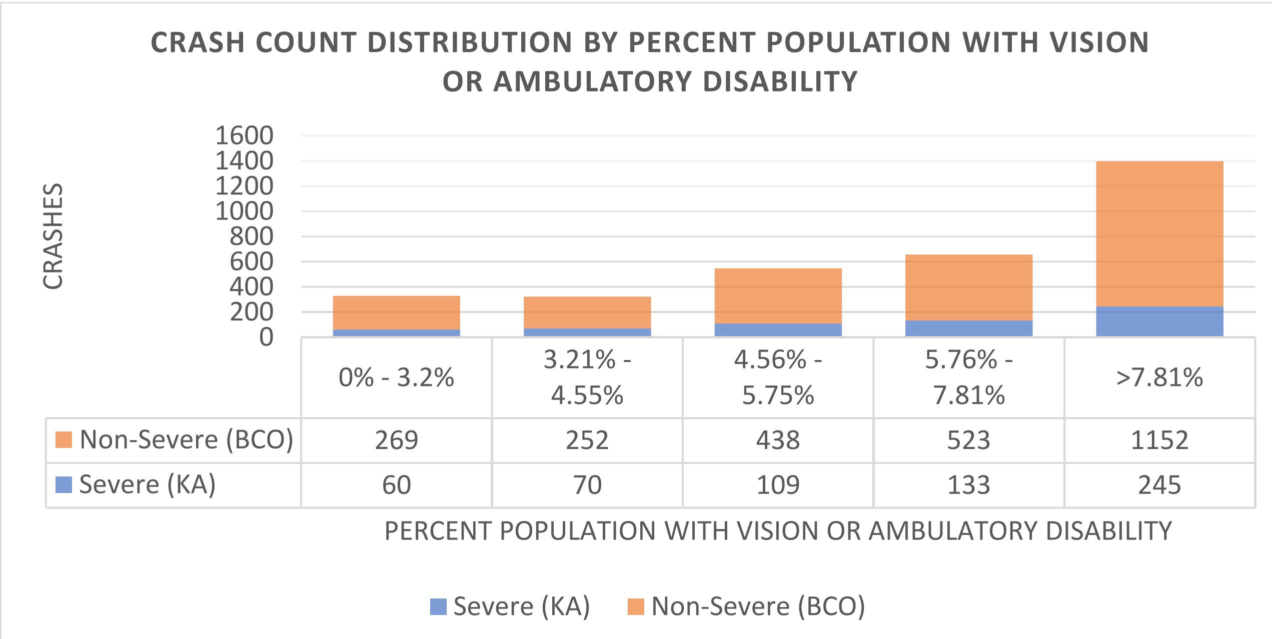


Figure 21. Crash Count Distribution by Percent Population with Vision or Ambulatory Disability

The pedestrian crash data also shows a disproportion between crashes and population with 20 percent of the MPO region population compared to 40 percent of severe pedestrian crashes (see Figure 22). Overall, this suggests prioritizing investments and engagement in neighborhoods with higher percent populations with vision or ambulatory disabilities.

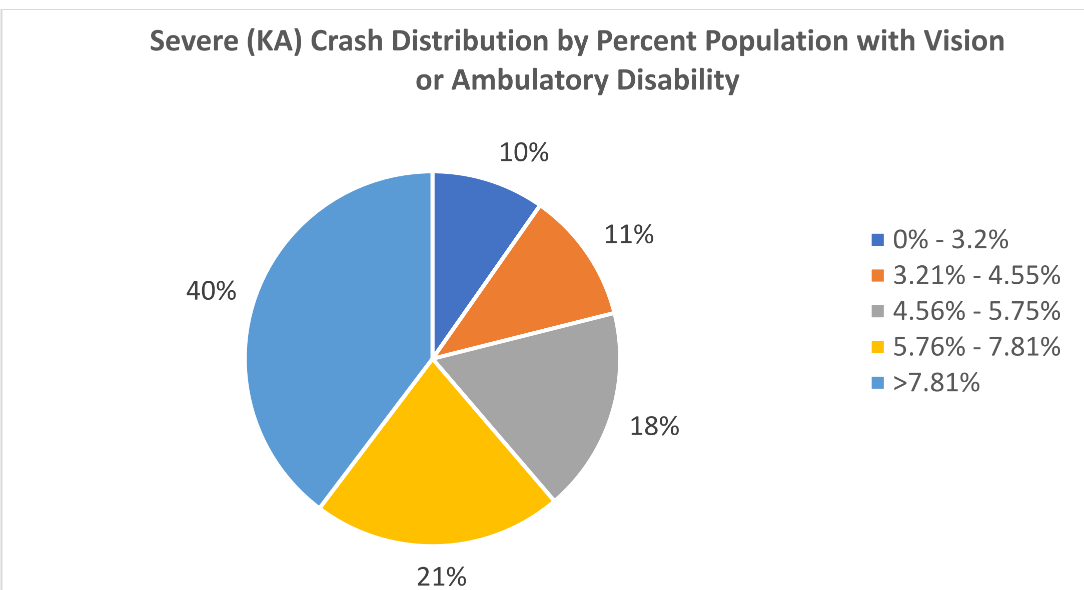


Figure 22. Severe Crash Distribution by Percent Population with Vision or Ambulatory Disability

Pedestrian crashes that occur in neighborhoods with varying percentages of population who speak English at home exhibit differing characteristics with respect to crash type and severity outcome (see Figure 23). The majority of crashes (39 percent) occur in neighborhoods where less than 76.5 percent (the bottom quintile) of the population speak English at home, of which 18 percent result in serious injury or death.

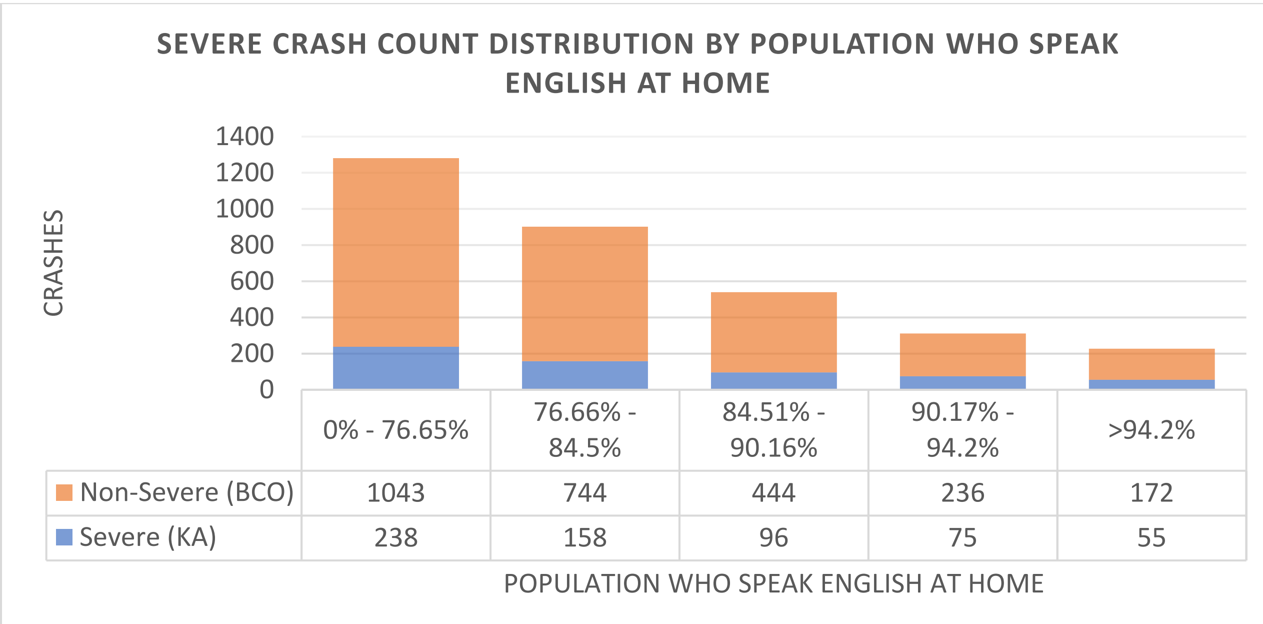


Figure 23. Severe Crash Count Distribution by Population Who Speak English at Home

Of all severe crashes, 38 percent occur in areas within this bottom quintile of the population speaking English at home (see Figure 24). This suggests that non-English speakers experience pedestrian crashes disproportionately to neighborhoods whose populations primarily speak English at home, implying the importance of prioritizing investments and engagement in neighborhoods with populations who do not primarily speak English at home.

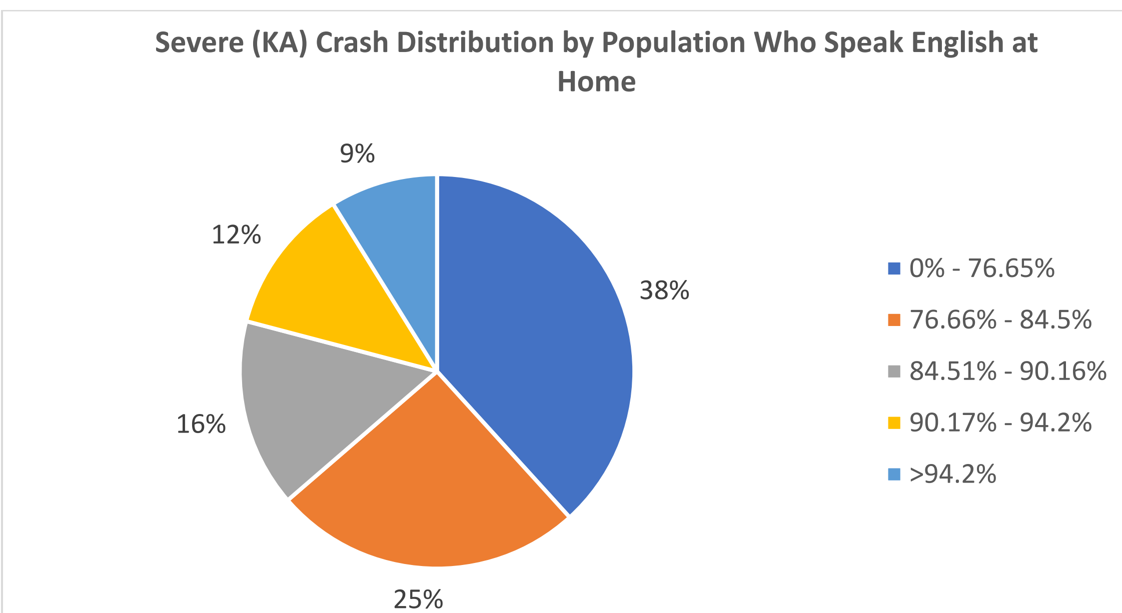


Figure 24. Severe Crash Distribution by Population Who Speak English at Home

Equity is a component of pedestrian safety. Safety outcomes are closely linked to race and mirror historic patterns of racial segregation. Black and Native American residents are disproportionately likely to be killed or seriously injured while walking. Prioritizing investments and engagement in neighborhoods where people of color and people with disabilities live and work will be important to address inequities.

Economic Characteristics

Pedestrian crash data shows pedestrian crashes disproportionately occur in neighborhoods with lower median incomes, higher rates of households in poverty, higher rates of rent-burdened households, higher rates of zero-vehicle households, and higher rates of transit and walk commuting.

Among three measures of household income, poverty, and rent burdens, very similar patterns of disproportionate crash frequency were observed. Conversely, the higher household incomes, lower poverty rates, and low rent-burdens are associated with the lowest frequency of pedestrian crashes.

The lowest household income quintile represents 56.5 percent of pedestrian crashes occurring in areas with the median household income between $0-$56,725 (see Figure 25).

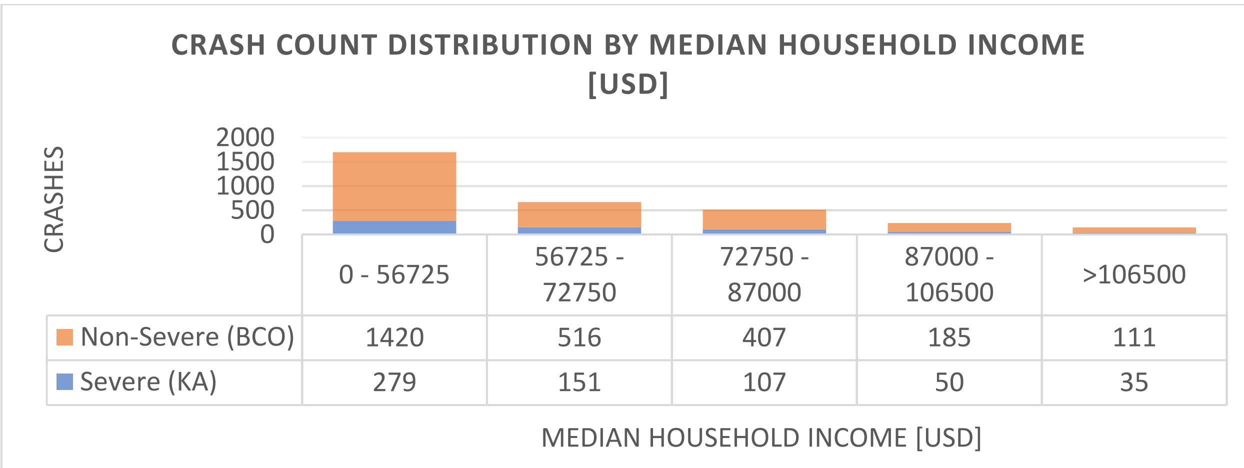


Figure 25. Crash Count Distribution by Median Household Income

Of severe crashes only, 45 percent occur in areas with median household in this lowest quintile (see Figure 26). Conversely, the highest quintile of median household income, greater than $135,000 annual household income, represents only 6 percent of pedestrian crashes and 7 percent of severe pedestrian crashes.

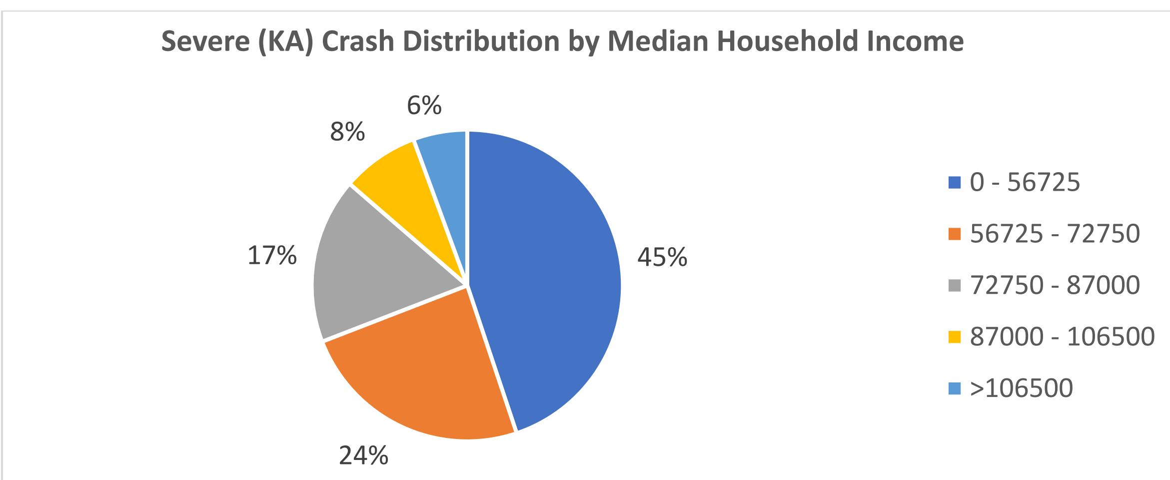


Figure 26. Severe Crash Distribution by Median Household Income

Other economic metrics demonstrate similar trends: 54 percent of pedestrian crashes occur in the top quintile representing areas with 185 percent poverty rates (share of population with income less than 185 percent of the poverty threshold, see Figure 27).

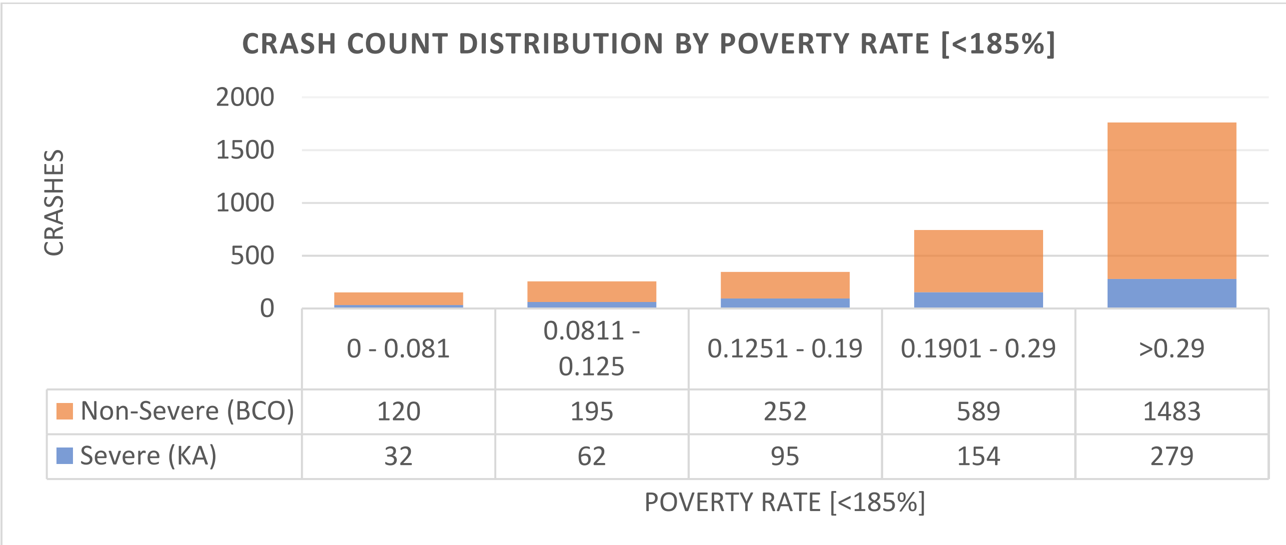


Figure 27. Crash Count Distribution by Poverty Rate

For both the lower median household income and the higher poverty rate areas, about 16 percent result in death or serious injury. Like lower median income areas, 45 percent of all severe pedestrian crashes occur in the top quintile representing areas with the highest proportion of households within the 185 percent poverty rate (see Figure 28).

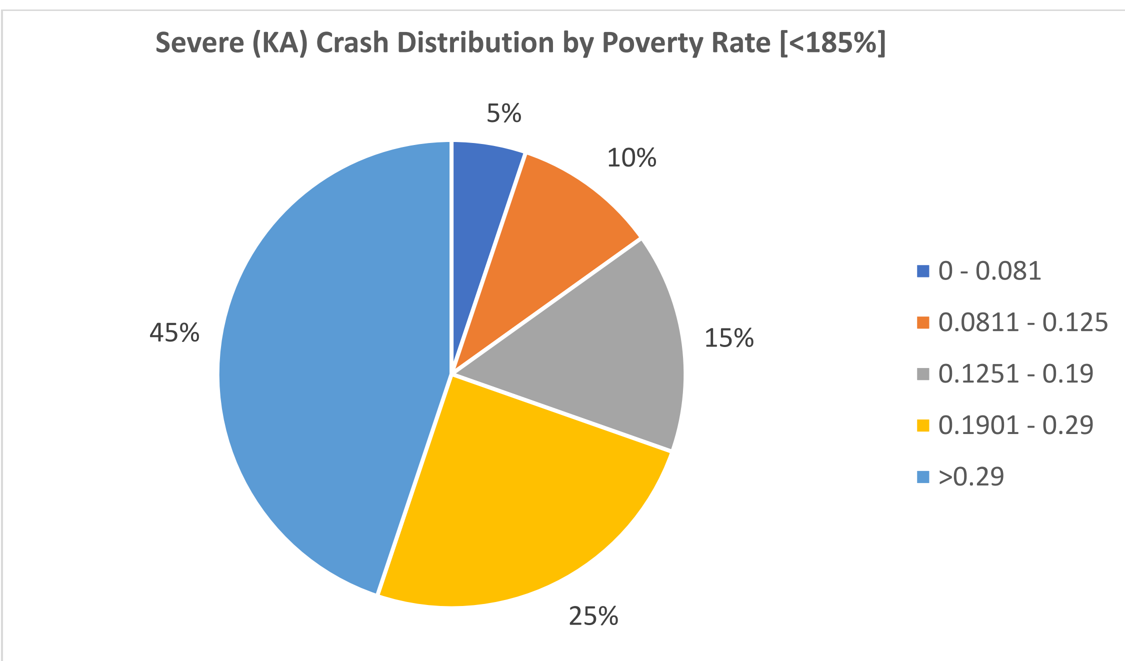
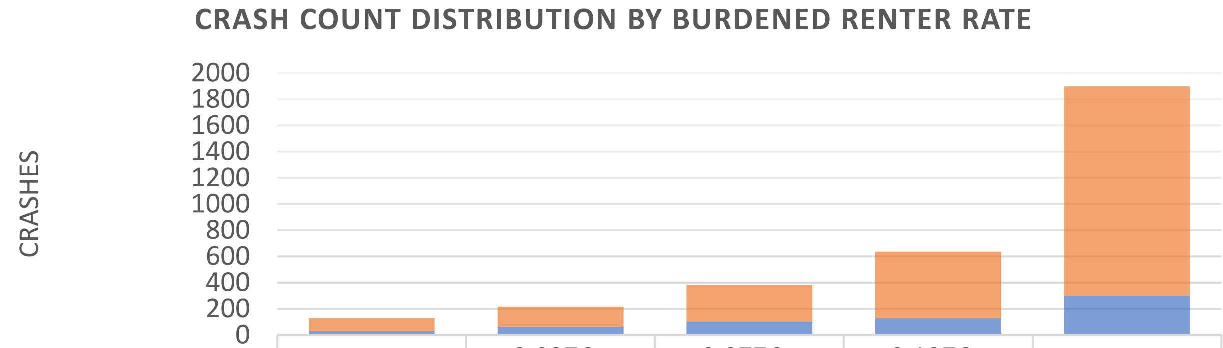


Figure 28. Severe Crash Distribution by Poverty Rate

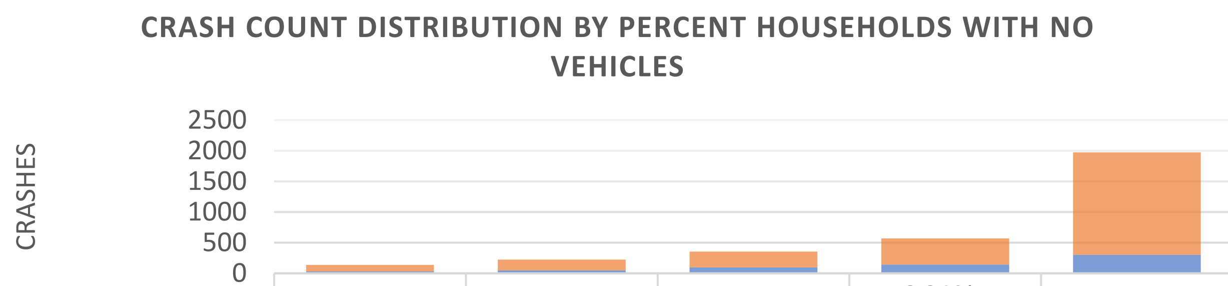
The next chart displays crashes by rent burdened households (households spending 30 percent or more of their income on housing costs). The highest quintile representing 48 percent of severe crashes occur in areas with rent burdened household rates greater than 0.2375, 16 percent of which result in death or serious injury (see Figure 29).



BURDENED RENTER RATE	0 - 0.0375	0.0376 - 0.0775	0.0776 - 0.1375	0.1376 - 0.2375	>0.2375
Non-Severe (BCO)	100	152	280	508	1599
Severe (KA)	28	64	103	128	299

Figure 29. Crash Count Distribution by Burdened Renter Rate

Commute mode is a mixture of both necessity and choice due to transit users reflecting a mix of those who are transit dependent and those who commute via transit for convenience. Therefore commute mode has a weaker relationship with economic position, despite that it correlates with exposure associated with other roadway and land use attributes identified in this analysis. Regardless, vehicle ownership and commute mode show similar patterns of relationships with pedestrian safety. The lowest quintile represents 60 percent of pedestrian crashes occurring in areas with more than 11.5 percent of households with no vehicles (see Figure 30).



PERCENT HOUSEHOLDS WITH NO VEHICLES	0% - 1.5%	1.51% - 3%	3.01% - 6.2%	6.21% - 11.5%	>11.5%
Non-Severe (BCO)	108	177	256	425	1673
Severe (KA)	30	48	98	144	302

Figure 30. Crash Count Distribution by Percent Households with No Vehicles

Within these areas 18 percent of these crashes result in a death or serious injury. Of all severe crashes, an overrepresented 48 percent occur in areas within the bottom quintile of households with no vehicles (see Figure 31).

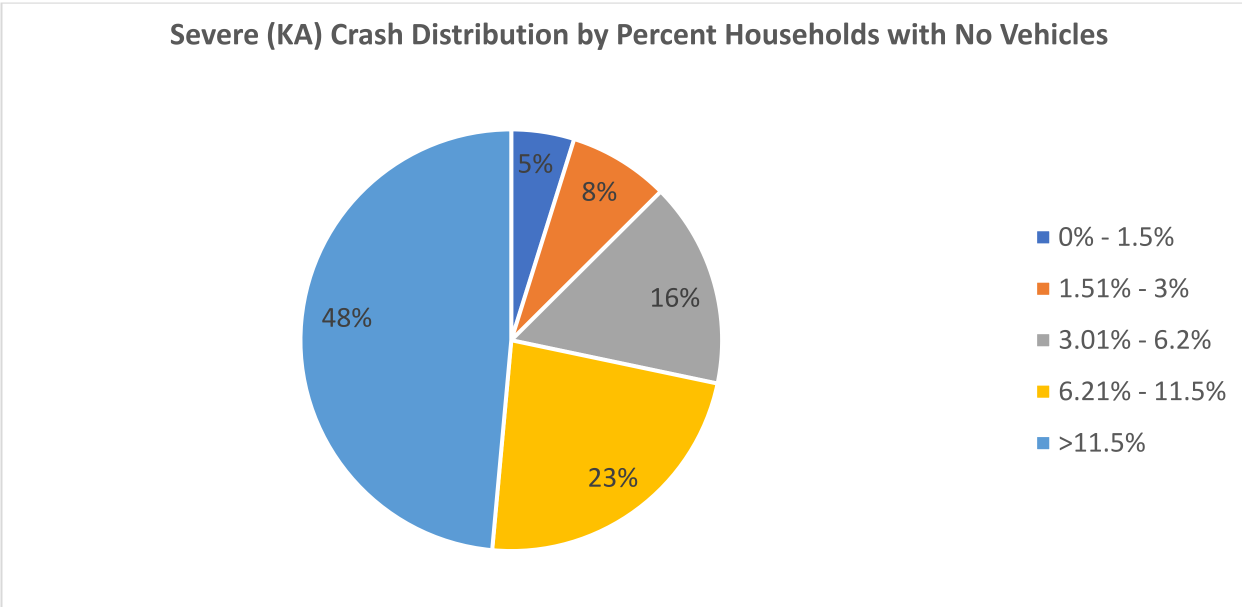
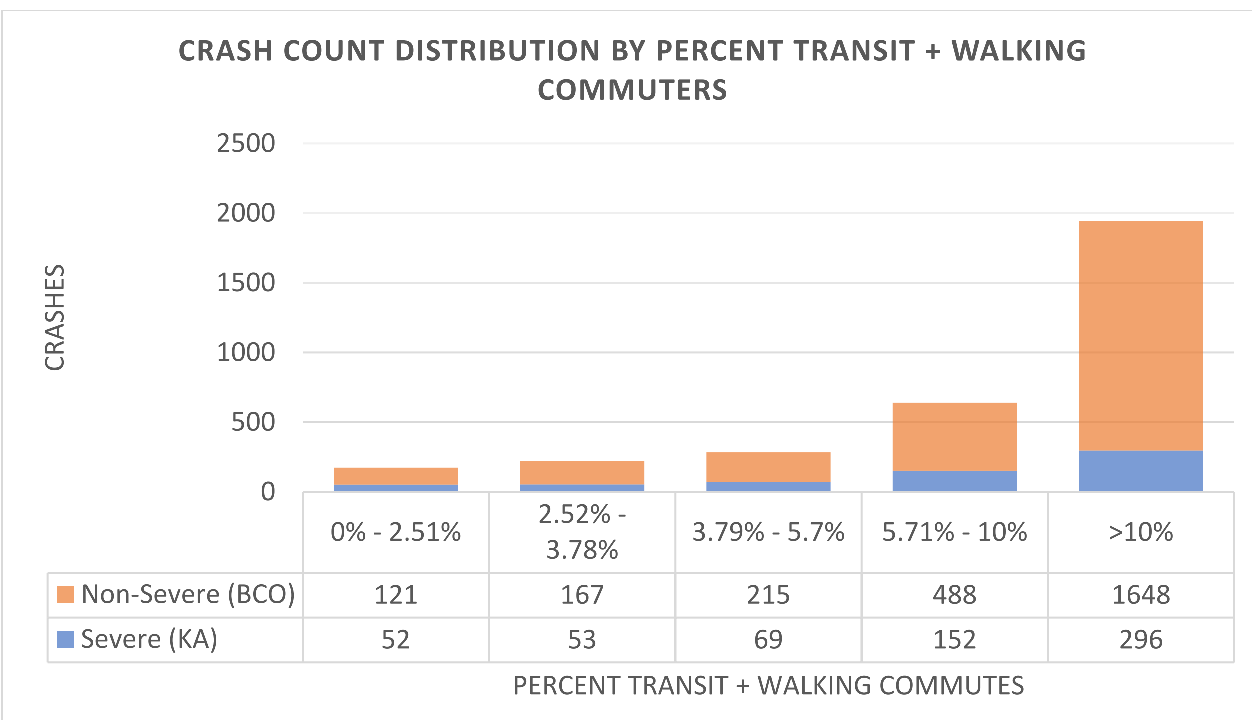


Figure 31. Severe Crash Distribution by Percent Households with No Vehicles

Similarly, the pedestrian crash data shows that a majority (59 percent) of pedestrian crashes occur in the top quintile representing areas with more than 10 percent of commuters using a combination of transit and/or walking, 18 percent of which result in a death or severe injury (see Figure 32). Of the severe crashes, 48 percent occur in areas within the top quintile of transit and walking commuters.



	0% - 2.51%	2.52% - 3.78%	3.79% - 5.7%	5.71% - 10%	>10%
Non-Severe (BCO)	121	167	215	488	1648
Severe (KA)	52	53	69	152	296

Figure 32. Crash Count Distribution by Percent Transit + Walking Commuters

Safety outcomes are closely linked to economic status, with poverty putting individuals at risk and wealth having a protective effect. Prioritizing engagement and investments in neighborhoods where lower income, rent-burdened, and other economically disadvantaged households will be important to improve equity in pedestrian safety.

Conclusion

Proximity to transit, functional classifications, and other land use and roadway features may be used to by practitioners to identify the best locations for pedestrian countermeasure implementation, as they significantly describe where pedestrian crashes occur. This approach can be used in both rural and urban areas, but it is clear that countermeasures are needed in urbanized areas experiencing the majority of pedestrian crashes. Additionally, engagement and investments should be prioritized in neighborhoods where people of color and people with disabilities live, work, travel, etc., as well as in neighborhoods where economically disadvantaged households are because these areas experience higher prevalence of pedestrian crashes, including fatal and serious injury pedestrian crashes.