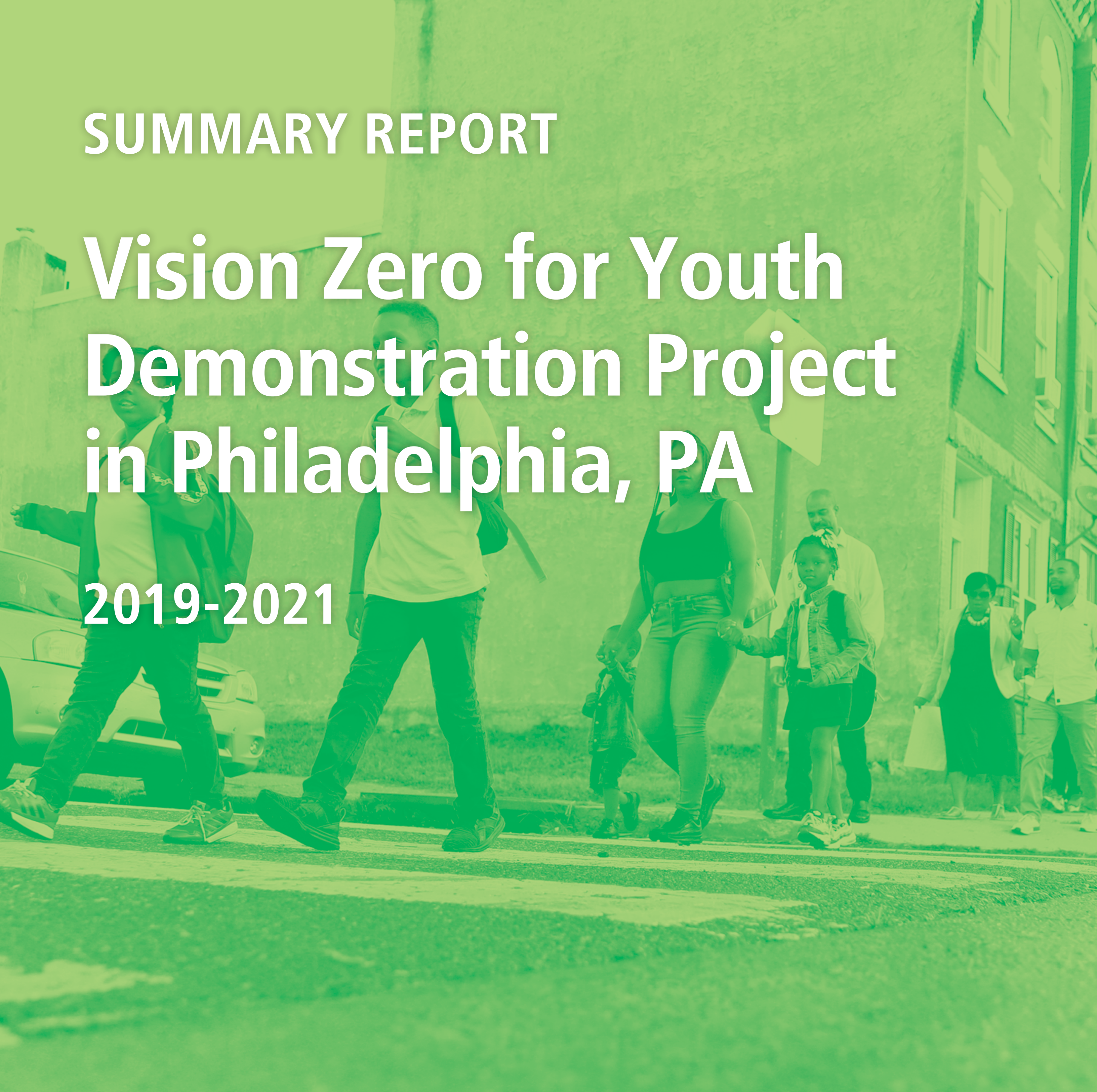

SUMMARY REPORT

Vision Zero for Youth Demonstration Project in Philadelphia, PA

2019-2021

Pedestrian and Bicycle Information Center
www.pedbikeinfo.org

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Introduction

Cities of all sizes are committing to eliminating traffic fatalities and serious injuries, often as part of Vision Zero initiatives. In the US, children fortunately have the lowest rates of pedestrian deaths of all age groups.[1] However, children need and deserve special protection for several reasons. A study using five years of pedestrian crash data and emergency department patient records in North Carolina revealed that older adults and children were more likely to sustain severe and fatal injuries in a pedestrian crash than other age groups. Children also sustained more traumatic brain injuries than adults.[2] Serious injuries can impact a child's growth and social and academic progress, affecting them throughout their lives. Children do not have the same abilities as adults in managing complex tasks they may encounter as pedestrians. During childhood and into the teen years, young people are developing the cognitive abilities necessary to control impulsive behavior, switch tasks, discern speed and direction of motor vehicles and other key behaviors for pedestrian safety that most adults possess. At the same time, their short stature can make it difficult for them to have a clear view of a street crossing and for motorists to see them.[3] While adults are legally able to drive, children may not have other travel modes available to them and walking may be a child and family's only travel mode option. As children grow, learning to navigate through their community to school, park or other destinations helps build independence and active habits, which can benefit them throughout their lifespans.

Communities share widespread agreement on the importance of protecting children and creating the opportunity for them to live their lives to the fullest. This commitment and action for children can help build community support for a broader Vision Zero program or specific actions that will improve road safety for all.

Vision Zero for Youth, initiated by the National Center for Safe Routes to School in 2016, encourages cities to identify and prioritize youth-focused projects and programs to advance safety for all. In October 2019 the Pedestrian and Bicycle Information Center (PBIC) with Toole

Vision Zero, Safe System, and Systemic Planning

Vision Zero is a strategy with the goal of eliminating all traffic fatalities and severe injuries while increasing safe, healthy, equitable mobility for all.[4] The Safe System approach serves as the foundation; how the goal of zero will be achieved.

A Safe System approach accepts that human errors will occur, and, among other principles, road design should plan for human error, using proactive measures to reduce the severity of crashes. Safe System efforts are coordinated between many entities including policymakers, vehicle manufacturers, transportation planners, designers, and road users to prevent future severe injuries and deaths from traffic crashes.[5]

A proactive, systemic approach uses crash and roadway data to identify high-risk roadway characteristics that correlate with crashes. While agencies have traditionally relied on crash history data to identify locations with high crash frequency, severe crashes are often widely dispersed, and their location and occurrence can change over time. Systemic analysis helps agencies identify locations that are at risk for severe crashes, even if there is not a high crash frequency, and provides agencies with information to identify and focus resources on the highest-risk locations.[6] The Safe System approach is critical for our youngest pedestrians and bicyclists who should not have to suffer severe injuries or deaths because of a mistake made near traffic. The systemic approach strengthens traditional approaches to youth travel planning (including Safe Routes to School efforts).

Design partnered with the City of Philadelphia to implement a two-year Vision Zero for Youth Demonstration Project (subsequently referenced as "Demonstration Project"). The aim of the Demonstration Project was two-fold:

- To gain an understanding of tangible strategies to ensure that school-age youth are represented in Vision Zero efforts and to document potential benefits of a youth-focused approach in advancing safety for all road users.[7]
- To provide replicable strategies and tools for other cities to use.

This report summarizes core components of the Demonstration Project, including a youth pedestrian crash analysis, systemic safety analysis, equity analysis, proposed child focused strategies for the city's Vision Zero Action Plan update, countermeasure considerations for child pedestrians, and agency partner input. The report concludes with key takeaways for other cities.

The City of Philadelphia and Vision Zero for Youth

Philadelphia was selected for the Demonstration Project because of its strong priority for children's well-being, road safety and multi-agency collaboration. The City adopted a three-year Vision Zero Action Plan in 2017 that acknowledged pedestrians, bicyclists, and youth as vulnerable populations. The Action Plan noted that people walking and biking were involved in 23 percent of reported crashes, but they represented 40 percent of those killed in crashes on Philadelphia streets, and four children every day were involved in reported traffic crashes.[8]

As part of Mayor Kenney's annual Vision Zero update press conference on Oct 1, 2019, he announced the Vision Zero for Youth Demonstration project and signed the "Vision Zero for Youth Mayors Statement on Safe Walking and Biking for Youth," developed by the National Center for Safe Routes to School.

City of Philadelphia Mayor Kenney's October 2019 Vision Zero update press conference.

Safe People:
VISION ZERO FOR YOUTH

Young people have an important role to play in Vision Zero. On average five children in Philadelphia experience a traffic crash every day. Young people deserve to be able to get to school, go to the playground, or walk to a friend's house without fear. Young people are vulnerable roadway users. Slower speeds, safer vehicles, and safer streets – all of these aspects of a safe system can keep children safe.

Understanding Children and Youth Pedestrian Crashes

In 2019, the City was selected for the Vision Zero for Youth Demonstration Project. This two year project is led by the Pedestrian and Bicycle Information Center with funding from the Federal Highway Administration. It emphasizes making Philadelphia safer for walking and reducing deaths and injuries starting with children. The team focused on child pedestrian crashes and found one quarter of Philadelphia's pedestrian crashes involved one or more person under the age of 19.

Crash analysis showed child crashes happen in different places than adult crashes. In particular, rates of child pedestrian crashes are two to three times higher on roads with the following risk variables:

- Posted speed greater than 25 mph;
- AADT of 5,000[7] or greater;
- More than one vehicle lane in each direction.

The study found that three-quarters of all child pedestrian crashes happen during the day and that children are more likely to be struck mid-block when compared to adults. In addition, the findings showed 78% of child pedestrian crashes occurred within one quarter mile of a school. These findings highlight the importance of proactively implementing countermeasures near schools and in high crash locations to reduce the risk of future crashes that impact children. This study also highlights the importance of continuing to separate data by age and other demographics to better understand how crashes impact different groups.

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Excerpt from the City of Philadelphia Vision Zero Action Plan 2025.

Over the course of the Demonstration Project, various aspects of the work and findings have been integrated into other Philadelphia initiatives. The City of Philadelphia's Vision Zero Pedestrian Safety Study and Action Plan (VZPSSAP) was launched earlier in 2019 to study Philadelphia's pedestrian crashes. The PBIC team developed content which the city integrated into the VZPSSAP report,[9] including text explaining the city's focus on children and teens, a summary of the youth pedestrian crash analysis noting differences between youth pedestrian crashes and all-ages pedestrian crashes, and a section on youth considerations for countermeasure selection that explained age-appropriate abilities and special vulnerabilities of youth and how that might relate to application of pedestrian crash countermeasures.

Additionally, the city's Three-Year Vision Zero Action Plan that was released in 2017 was updated in the fall of 2020. The PBIC team used findings from the youth pedestrian crash and early takeaways from the systemic safety analysis, along with decades of Safe Routes to School and transportation planning experience to draft broad recommendations to be considered for inclusion in the update. Vision Zero for Youth was listed as a priority in the City of Philadelphia Vision Zero Action Plan 2025,[10] and the report included preliminary findings related to youth pedestrian crashes and crash risk variables.

Youth Pedestrian Crash Analysis

As part of this demonstration effort, the PBIC team examined crashes among children and youth under 18 years of age (termed "youth" for the remainder of this section) occurring for the five-year period of 2014-2018 using the same Pennsylvania Department of Transportation crash data set that was used for the Vision Zero Pedestrian Safety Study and Action Plan. The results were based on cross-tabulations and spatial analyses (using buffer and density methods) to identify potential high-occurrence factors associated with youth pedestrian crashes and severity outcomes. Key findings confirmed that youth pedestrians need special attention:

- Approximately 25 percent (n=2009) of all pedestrian crashes (n=8024) appeared to involve one or more pedestrians under 18 years of age.
- Youth were most likely to be hit during the day (74 percent of all youth pedestrian crashes, 67 percent of all fatal and severe crashes).
- Compared to adults, youth were less likely to be in a marked crosswalk at an intersection when struck (38 percent of youth struck, 54 percent of adults struck). This is likely because, compared to adults, children are more often struck on neighborhood streets which tend to not have marked crosswalks.
- Compared to adults, youth were less likely to be struck at the intersection of two major arterials (3.5 percent of youth struck, compared to 7.5 percent of adults struck).

Youth Pedestrian Crash Systemic Safety Analysis

A core component of the Demonstration Project was the pilot testing of a systemic safety analysis of youth pedestrian crashes to proactively identify sites for potential safety improvements based on specific risk variables for youth pedestrians. A systemic approach uses crash and roadway data to identify high-risk roadway characteristics that correlate with crashes. While agencies have traditionally relied on crash history data to identify locations with high crash frequency, severe crashes – particularly pedestrian crashes – are often widely dispersed, and their location and occurrence can change over time. This is observed when pedestrian crashes are mapped in Philadelphia. Systemic analysis helps agencies identify locations that share roadway and traffic characteristics present at locations experiencing higher than expected frequencies of a particular crash type. This gives an opportunity to intervene even if there is not a high crash frequency there yet, and it provides information for agencies to identify and focus resources on the highest-risk locations.[11]

The project team drew from National Cooperative Highway Research Program (NCHRP) Research Report 893: Systemic Pedestrian Safety Analysis[12], which describes a process to identify, prioritize, and select appropriate countermeasures for locations with high risk of pedestrian-related crashes, even when crash occurrence data are sparse. NCHRP Report 893 recommends using either all pedestrian crashes or all fatal and injury crashes to allow an adequate sample of crashes for analysis.

The team analyzed all-injury pedestrian crashes (including fatalities) for youth under age 18 that occurred within the city limits of Philadelphia from 2014 through 2018 and used available GIS roadway data and research to focus on a short list of key roadway characteristics for future crash risk determination. See Appendix A for details on how the data were prepared and processed for this analysis.

YOUTH PEDESTRIAN INVOLVED CRASHES (2014-2018)

2,002 Injury Crashes, 99 Severe or Fatal

INTERSECTION

972 Injury Crashes, 39 Severe or Fatal
49% of All Injury Crashes
39% of All Severe or Fatal Crashes

MID-BLOCK

1,030 Injury Crashes, 60 Severe or Fatal
51% of All Injury Crashes
61% of All Severe or Fatal Crashes

49 percent of youth pedestrian injury crashes occurred at an intersection; 51 percent occurred mid-block.

Figure 1. Youth Pedestrian Crash Locations (2014-2018).

Crash Trees

The PBIC team, drawing upon NCHRP Report 893, used crash trees as the primary systemic safety analytical tool and developed tables that depicted specific youth pedestrian crash types and their associated roadway characteristics. Crash trees show progressive detail of the types and numbers of crashes.[13] Crash types were constructed using combinations of location (intersection or mid-block) and motor vehicle movement[14] (going straight, turning left, turning right) to summarize the dynamics of each crash.

Crash Location

Approximately one-half of youth pedestrian injury crashes occurred at an intersection and one-half occurred mid-block (see Figure 1). By comparison, approximately two-thirds of adult pedestrian injury crashes over the same period occurred at intersections, while one-third occurred mid-block.

Crash Types (Location and Motorist Turning Movement)

Most youth pedestrian injury crashes, and most severe and fatal injury crashes, occurred when the motorist was going straight.

- 75 percent of all youth pedestrian injury crashes occurred when motorists were going straight (27 percent at an intersection, 48 percent at mid-block).
- 88 percent of all youth pedestrian severe and fatal injury crashes occurred when the motorists were going straight, and disproportionately at mid-block (29 percent at an intersection, 59 percent mid-block).
- 13 percent of all youth pedestrian injury crashes occurred at intersections when motorists were turning left.
- 4 percent of all youth pedestrian injury crashes (9 percent of intersection youth pedestrian injury crashes) occurred when motorists were turning left.
- 94 percent of all youth pedestrian mid-block crashes occurred when motorists were going straight.

Assessment of Youth Pedestrian Crash Roadway Risk Variables

As described in NCHRP Report 893, the PBIC team used a combination of two approaches to construct risk variables for systemic analysis: prior research and planning judgment, and the frequency-based method, which assumes that roadway characteristics most prevalent for high-frequency crash types represent elevated risk. The team assessed a short list of roadway risk variables for each of the crash types, focusing on key roadway risk variables that (a) were shown through research to be associated with pedestrian crashes and (b) were readily available and (c)

Roadway Risk Variable	Threshold
Posted Speed	>25 mph
Average Annual Daily Traffic (AADT)	>=5,000
Multi-lane	>2 lanes bi-directional, >1 lane one-way

Table A. City of Philadelphia 2014-2018 Pedestrian Injury Crashes Occurring on the 2020 High Injury Network.

could be widely applicable to other jurisdictions. Risk thresholds were based on a review of prior research on pedestrian crashes with subsequent adjustment to better reflect age appropriate cognitive and gross motor skills and abilities of youth. For example, while thresholds for increased traffic volume risk at unsignalized crossings typically start at 10,000 AADT or greater, our study considered volumes greater than 5,000 vehicles as at higher risk for child crashes in this project. Similarly, higher multi-lane crash thresholds typically start at more than three total lanes, but this study identified more than two bi-directional lanes or more than one one-way lane as an elevated risk threshold for youth.[15] See Table A for the final roadway risk variables and thresholds used in the analysis.

The PBIC team then performed cross tabulations to assess how the roadway risk variables were associated with the identified youth pedestrian injury crash types, both individually and in combination. The team calculated crash rates per mile and crash rates per intersection to normalize the data and account for differences in the number of miles or intersections represented by each risk variable combination and identify locations with relatively higher risk.

Youth Pedestrian Crash Systemic Analysis – Summary of Findings

Through the youth pedestrian crash systemic safety analysis, the team identified three crash types that comprise 89 percent of youth pedestrian crashes (1,782 of 2,002 crashes) and detected which risk variables were most associated with them. The following summarizes key findings.

Crash Type #1: Intersection Crashes, Motorist Going Straight (27 percent of all youth pedestrian crashes)

The PBIC team separated youth pedestrian injury crashes that occurred at intersections where the motorist was going straight by the type of intersection control (stop sign or signal) and then assessed locations and severity of those crashes by the presence of the three roadway risk variables - AADT, posted speed, and multi-lane.

High-risk Locations for Crash Type #1: Youth pedestrian injury crashes at intersections where the motorist was going straight have the highest crash rate at signalized intersections on roads with AADT greater than 5,000, posted speed less than or equal to 25mph, and one lane in each direction.

Note: *other signalized intersections on roads with high AADT and other roadway risk variables had relatively similar crash rates, but there are slightly fewer intersections on the network with this combination of risk variables, making it more attainable to address through systemic application of countermeasures. Similarly, eighteen percent of these types of crashes occurred at stop signs on roads with none of the assessed roadway risk variables; however, there are over 11,000 such locations throughout the City of Philadelphia, so the crash rate per intersection is very low compared to signalized intersections.*

Crash Type #2: Intersection Crashes, Motorist Was Turning Left (13 percent of all youth pedestrian crashes)

The PBIC team separated youth pedestrian injury crashes that occurred at intersections where the motorist was turning left by the type of intersection control (stop sign or signal) and then assessed locations and severity of those crashes by the presence of the three roadway risk variables - AADT, posted speed, and multi-lane.

High-risk Locations for Crash Type #2: Youth pedestrian intersection crashes at intersections where the motorist was turning left have the highest crash rate at signalized intersections on roads with AADT greater than 5,000 and posted speeds of greater than 25mph.

Note: *While the multi-lane risk variable was not associated with the number of crashes per intersection in this analysis of youth pedestrian injury crashes, existing research demonstrates that when assessing risk for pedestrians of all ages (including adults), multi-lane roadways are riskier than two-lane roadways.[10,16] The findings from this analysis simply indicate that the multi-lane risk variable as defined for youth in this project is not an effective screening or prioritization tool, as it had no association with increased youth pedestrian crash history. This finding may be the result of a relatively low number of youth trying to cross busy, multi-lane streets as compared to adult pedestrians.*

Crash Type #3: Mid-block Crashes Where Motorist Was Going Straight (48 percent of all youth pedestrian crashes)

The PBIC team assessed the presence of the three roadway risk variables (AADT, posted speed, and multi-lane) and crash severity at locations of mid-block crashes where the motorist was going straight.

High-risk Locations for Crash Type #3: Youth pedestrian mid-block crashes where the motorist was going straight have the highest crash rate on roads with AADT greater than 5,000, posted speed less than or equal to 25mph, and one lane per direction.

Note: *Significantly more youth pedestrian crashes, and nearly 40 percent of youth pedestrian severe and fatal crashes, occurred on similar roads but with lower traffic volume (i.e. AADT less than 5,000, posted speed less than or equal to 25mph, and one lane per direction), but because there are over 2,000 miles of roads with this combination of risk variables throughout Philadelphia, the resulting crash rate per mile was lower.*

	Off HIN	On HIN	Percent Off HIN
Youth	1224	786	61 percent
Adult	2501	3398	41 percent

Table B. Comparison of City of Philadelphia 2014-2018 Pedestrian Injury Crashes Occurring on and off the 2020 High Injury Network.

High Injury Network Comparison

Many cities identify which locations have the highest frequency of crashes and use that information to prioritize resources. The City of Philadelphia identified its 2020 High Injury Network (HIN),[17] comprised of locations across the city on which fatal crashes and crashes that result in severe injury occur with the most frequency for all travel modes. Using findings from the youth pedestrian crash and systemic safety analysis, the PBIC team examined the extent to which youth pedestrian crashes and crash risk are represented by the city's HIN.

Youth Pedestrian Crashes and the HIN

Most youth pedestrian injury crashes (61 percent of 2014-2018 crashes) occurred outside of the city's HIN. This differs from adult pedestrian crashes in the city as 41 percent of adult pedestrian injury crashes occurred outside of the HIN (Table B). The city's HIN is based on fatal and severe crashes for all modes and youth pedestrian injury crashes are underrepresented within the HIN compared to adult pedestrian injury crashes.

Youth Pedestrian Crash Risk Locations and the HIN

The PBIC team assessed high-risk intersections and road segments for youth pedestrian crashes (based on the three key crash types identified in the systemic analysis) across the City of Philadelphia's street network to determine what percentage

High-risk Locations for Key Youth Pedestrian Crash Types	Percent On the HIN	Percent Off the HIN
Signalized intersections on roads with AADT greater than 5,000 and no other roadway risk variables (Crash type #1)	58 percent (338 intersections)	42 percent (240 intersections)
Signalized intersections on roads with AADT greater than 5,000 and posted speeds of greater than 25mph (Crash type #2)	69 percent (209 intersections)	31 percent (96 intersections)
Roads with AADT greater than 5,000, posted speed less than or equal to 25mph, and not multi-lane (Crash type #3)	29 percent (12.6 miles)	71 percent (31.1 miles)
Roads with AADT less than 5,000, posted speed less than or equal to 25mph, and not multi-lane (also Crash type #3)	3 percent (17 miles)	97 percent (484.3 miles)

Table C. Percentage of High-risk Locations for Youth Pedestrian Crashes That Are Located on the City of Philadelphia 2020 High Injury Network and Within 1/10 Mile of a School.

are located on the HIN. As an example of how to prioritize locations that might be more conducive to youth travel, locations were filtered to include only those within 1/10 mile of a school as a proxy for youth pedestrian exposure.

High-risk intersections for youth pedestrian crashes have greater representation within the HIN than high-risk road segments for mid-block youth pedestrian crashes. Specifically, 58-69 percent of high-risk intersections for youth pedestrian crashes are located on the HIN, but 71-97 percent of high-risk road segments for youth pedestrian crashes are located off the HIN (See Table C).

Equity Analysis of Youth Pedestrian Crash History and Crash Risk

People of color, older adults, and residents of low-income communities are over-represented in pedestrian crashes.[18] As part of the systemic pedestrian safety analysis, the PBIC team conducted an equity analysis to explore the relationships between sociodemographic factors and youth pedestrian crashes and crash risks. The goal was to add prioritization considerations for safety improvements that address disparate outcomes.

Equity in Transportation Planning

In the United States, communities with high concentrations of people of color are frequently underserved by transportation investments and are often subjected to negative effects associated with transportation projects, such as potential pollution and displacement and other impacts that exacerbate systemic racism. Giving precedence to locations with higher concentrations of people of color or lower-income households can help to address historical inequalities and the current discrepancies in crashes and crash risk in underserved communities where inequalities still persist. This work requires engagement with community members to understand their needs and concerns.

Pennsylvania pedestrian crash data does not contain sociodemographic information on the crash victim; however, the City of Philadelphia's Vision Zero Action Plan 2025 acknowledges that traffic crashes in Philadelphia occur disproportionately in neighborhoods where a majority of residents live in poverty or a majority of residents are people of color.

In the equity analysis of youth pedestrian crashes, the PBIC team disaggregated population groups to understand the relationships between sociodemographic factors and youth pedestrian crashes and crash risk factors; the PBIC team assessed the full population of each demographic group (not areas of concentration).

The PBIC team mapped the geographic distribution of eight different demographic factors across 1,336 census block groups[19] using US Census Bureau 2014-2018 American Community Survey five-year estimates, then assessed the geographic distribution of youth pedestrian injury crashes and the proportion of high youth pedestrian crash risk locations relative to each. The sociodemographic factors assessed were:

- Median household income
- Zero vehicle households
- Limited educational attainment (adults over 25 without high school diplomas)
- Limited English proficiency
- Black/African American population
- Hispanic/Latinx population
- Asian population
- White population

Because the equity analysis was designed with consideration of the relatively low number of youth pedestrian crashes (i.e., small sample size for statistical analysis) and the understanding that demographic factors were only one of many factors that could influence crashes, the PBIC team anticipated weak correlations between youth pedestrian crashes and individual demographic factors. But weak correlations can still provide valuable information when compared across like factors such as racial demographic groups. For both youth pedestrian crash history and crash risk, discernable patterns were noticeable when comparing across demographic groups that suggest disparate impacts between groups. Key findings are summarized below. See Appendix B for methodology.

Equity Analysis of Youth Pedestrian Crashes – Summary of Findings

The PBIC team calculated basic descriptive statistics (maximum, minimum, average) of youth pedestrian injury crashes that occurred for each sociodemographic population, then tested the correlation between the number of youth pedestrian crashes in a block group and the number of residents or households within each sociodemographic population in that block group. The data were compared to the number of youth pedestrian crashes for the total population in Philadelphia to identify if certain populations were overrepresented in areas with high numbers of youth pedestrian crashes. The results did not show strong correlations but did show comparative trends for each population:

1. **There are clear disparities between White residents and residents of other races and ethnicities.** For all racial and ethnic populations except the White population, the number of youth pedestrian crashes increases as the population increases. The reverse is true for the White population; youth pedestrian crashes decrease as the White population increases, indicating a protective effect for the White population with respect to youth pedestrian crash occurrences, even given comparable exposure to risk variables.

2. **Household income level is associated with youth pedestrian crashes; lower median income areas saw more crashes and higher median income areas saw fewer**, as shown in Figure 2. This held true in the presence of other sociodemographic factors (e.g. ethnicity) as well.

3. **The Black and Latinx populations and residents without a high school diploma are overrepresented in block groups with more youth pedestrian crashes.**

Other than median income, the Black population and residents without a high school diploma had the strongest relationship to the number of youth pedestrian crashes of all the sociodemographic factors.

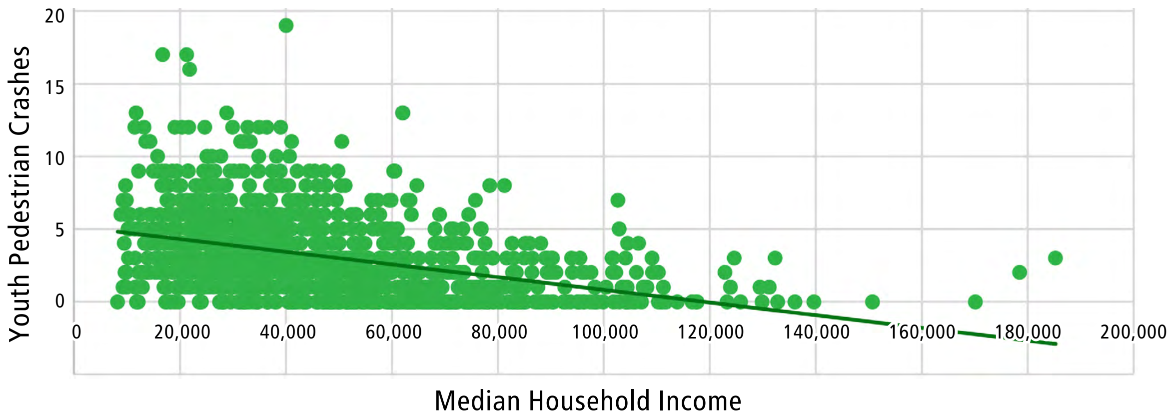


Figure 2. Youth Pedestrian Crashes and Median Household Income.

The Latinx population is also overrepresented, but the correlation is weaker than that of Black population and residents without a high school diploma.

4. **The percentage of Black residents in a block group did not appear to relate to level of crash occurrence.** Unlike other racial and ethnic populations, the number of youth pedestrian crashes in a block group remained relatively constant when the Black population was present, regardless of what percent of the population they comprised. This suggests that focusing on areas with high concentration of the Black population may miss areas with a lower concentration of the Black population that have a similarly high crash occurrence.

Equity Analysis of Youth Pedestrian Crash Risk – Summary of Findings

The PBIC team assessed both the distribution of key crash types and the proportion of high-risk locations in census blocks to assess the impacts across the demographic populations. Determining which populations are overrepresented in areas with high youth pedestrian crashes of a particular type and identifying patterns in the prevalence of the crash risk variables for that type in relation to the population may collectively point to youth pedestrian crash types that have systemic impacts on specific populations as well as locations that may be problematic for specific populations. Takeaways from assessing the geographic distribution of key youth pedestrian crash types and the proportion of their respective high-risk roadway variables by demographic distribution at the census block level include:

Crash Type #1: Intersection Crashes, Motorist Going Straight

This youth pedestrian crash type and crash risk variables (i.e. intersections on roads with AADT greater than 5,000, low posted speed and one lane per direction) do not show distinct demographic patterns.

Crash Type #2: Intersection Crashes, Motorist Was Turning Left

The Latinx and Black populations, residents with limited educational attainment, and residents with limited English proficiency are overrepresented in block groups with more youth pedestrian intersection crashes on roads with AADT greater than 5,000, posted speed greater than 25mph and one lane per direction where the motorist was turning left. For each of these populations, the percent of intersections with risk variables related to this crash type tend to increase with an increase in the population.

Crash Type #3: Mid-block Crashes Where Motorist Was Going Straight

Zero vehicle households, Black residents, and residents without a high school diploma are overrepresented in block groups with more youth pedestrian mid-block crashes on roads with AADT greater than 5,000, posted speed less than or equal to 25mph and one lane per direction where motorist was going straight. For zero car households, the percent of road mileage with risk variables related to this crash type tend to increase with an increase in the population.

Zero vehicle households, Black and Latinx residents, and residents without a high school diploma are overrepresented in block groups with more youth pedestrian mid-block crashes on roads with AADT less than 5,000, posted speed less than or equal to 25mph and one lane per direction where motorist was going straight. There is also a trend toward more Black residents in block groups with a higher percentage of road mileage with risk variables related to this crash type.

Applying Findings

As the final phase of systemic analysis of youth pedestrian injury crashes, the PBIC team worked with the City of Philadelphia to select one youth pedestrian crash type, which was of particular concern, as a focus to identify potential priority locations for systemic application of pedestrian crash countermeasures.

Of the three key youth pedestrian injury crash types — intersections where motorist was going straight, intersection where motorist was turning left, or mid-block where motorist was going straight — city staff selected to pursue prioritization of roads for mid-block youth pedestrian crash countermeasures. Using information from the systemic analysis, the PBIC team drafted prioritization criteria and a scoring rubric customized for Philadelphia's mid-block youth pedestrian crashes. Points totaled 100, with 60 assigned for safety (including crash history) and 40 for equity considerations. These prioritization criteria were applied to two types of roads identified during the systemic analysis as associated with youth pedestrian injury mid-block crashes (including serious and fatal crashes):

1. Road segments with AADT≥5,000, posted speed ≤25mph and one lane per direction (associated with high crash rate per mile)
2. Road segments with AADT<5,000, posted speed ≤25mph and one lane per direction (associated with high prevalence of crashes among all of the location types)

Prioritized Location List Output Summary

The PBIC team applied the prioritization criteria to relevant road segments and generated a list ranked by prioritization score. One Excel table was created for the high-volume (higher risk per mile) roads (AADT≥5,000, posted speed ≤25mph and one lane per direction) that included a total of 2,591 road segments. A second table was created for the low-volume (high crash prevalence) roads (<5,000 AADT, posted speed ≤25mph and one lane per direction) that included a total of 31,388 road segments. Full tables were provided to the city.

Raw prioritization scores were converted to a standardized scale of 0-100 to allow for easier comparison between the road segments (the highest total prioritization score of 68.33 was converted to a scaled score of 100 and subsequent raw segment scores adjusted accordingly). Prioritized ranking of both the high and low volume road segments identified a relatively small subset of each list that could be pursued for initial systemic application of countermeasures. Just 1 percent, or 35 of the high-volume road segments and 0.1 percent or 47 of the low-volume road segments had a scaled prioritization score of 80 or higher.

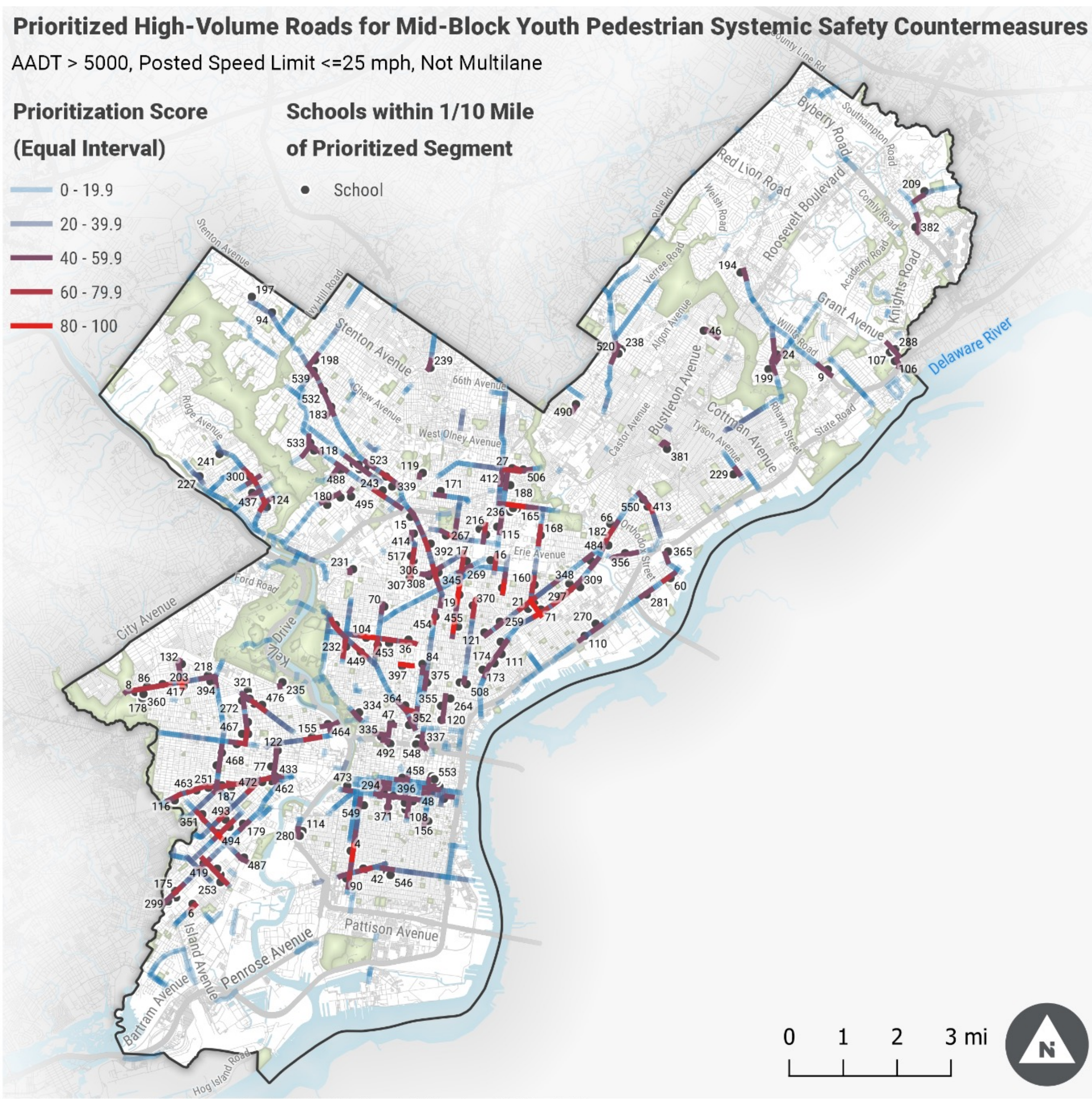
Example Maps to Visualize the Prioritization

There are multiple options for visualization of the prioritization outputs depending on the intended use of the data. The PBIC team developed three example maps to demonstrate possible ways the City of Philadelphia could visually present the prioritization and full detail PDF files were provided to the city. These examples demonstrate the difference between using equal intervals and natural breaks for prioritization scores, and there are trade-offs to each approach:

- Equal interval approach used for example Map 1 and Map 3 categorizes the segments into pre-determined ranges (0-20, 20-40, etc.) based on their prioritization score. In this approach, high priority segments could be defined as the top 20 percent highest scores (i.e. scaled score of 80 or higher), regardless of how many segments may have fallen into the "just under 80 points" category. Using this approach, both maps display fewer high-priority road segments.
- The Jenks Natural Breaks approach, which creates natural groupings of similar values inherent in the data, applied in example Map 2 conveys a distinction in the data between the number of road segments with scores of 57 points or higher and those with scores of 36.5-57, therefore road segments with 57 points or higher could be defined as the higher priority segments. This map clearly displays more high-priority road segments, many of which are linked. In terms of systemic application, the city could use this information to identify longer corridors or multiple linked high-priority segments.

Map 1: Prioritized High-Volume Roads for Mid-block Youth Pedestrian Systemic Safety Countermeasures (Equal Interval Priority Score Categories)

In this map, the 2,591 road segments that fit this priority crash and location type were categorized and color-coded using equal sized score classifications of 0-19.9, 20-39.9, 40-59.9, 60-79.9, and 80-100. This approach shows the full distribution of priority scores and allows planners to focus on smaller subsets of scores (e.g. 80-100) or broader ones (e.g. 60-100). School proximity is shown with a dot indicating location of a school within 1/10 mile of the prioritized segment.

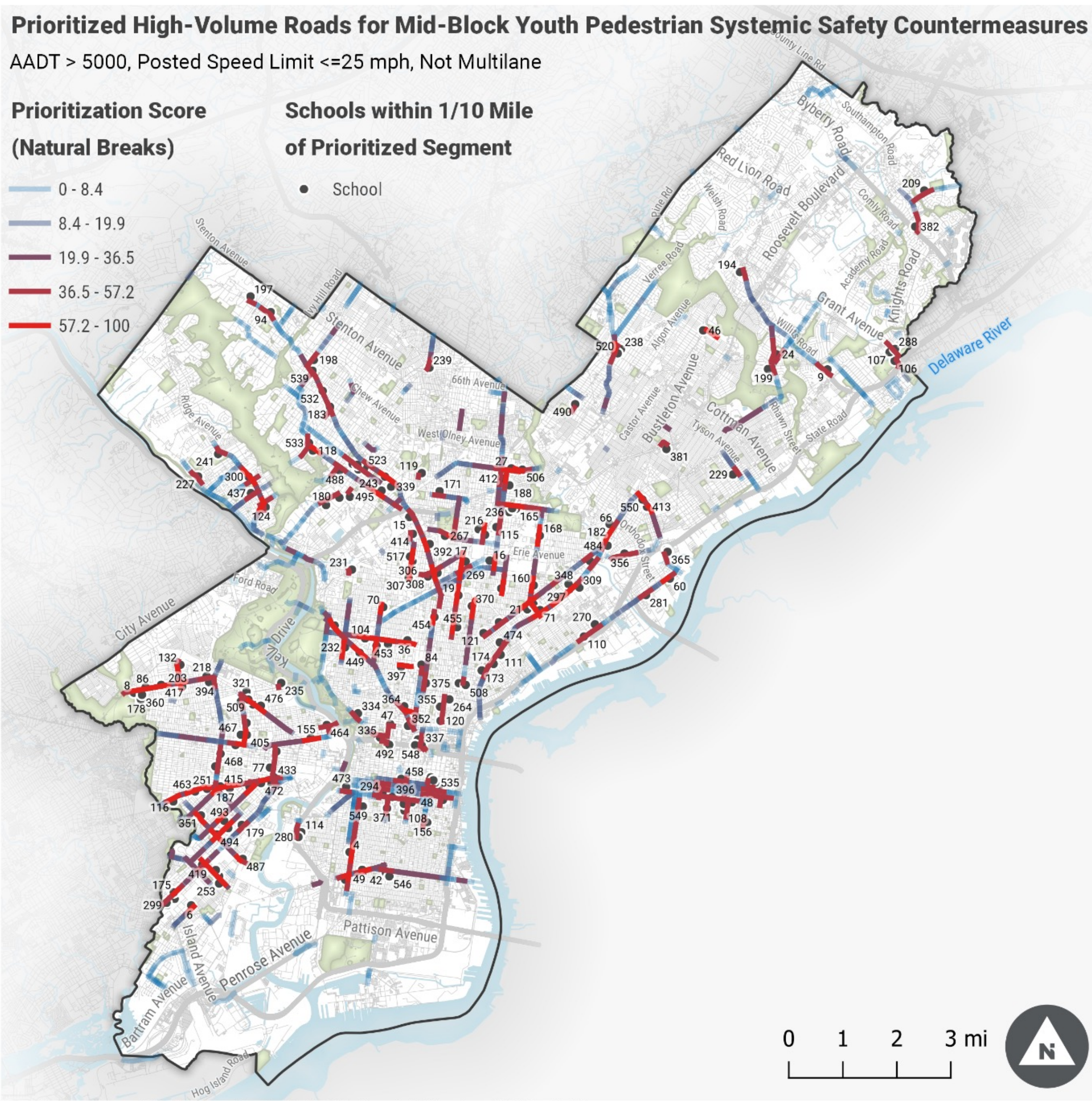


Data Sources: PennDOT "PaStateRoads2019_05". PennDOT Crashes (2014 - 2018)

Figure 3. Prioritized High-Volume Roads for Mid-block Youth Pedestrian Systemic Safety Countermeasures (Equal Interval).

Map 2: Prioritized High-Volume Roads for Mid-block Youth Pedestrian Systemic Safety Countermeasures (Natural Breaks Priority Score Categories)

In this map, 2,591 road segments were categorized and color-coded based on the Jenks Natural Breaks algorithm. This approach results in a larger high-priority score range (57.2-100), and therefore a larger quantity of high-priority segments. Notably, many of these segments are clustered together, which could be considered as single corridors for application of systemic safety countermeasures. School proximity is shown with a dot indicating location of a school within 1/10 mile of the prioritized segment.

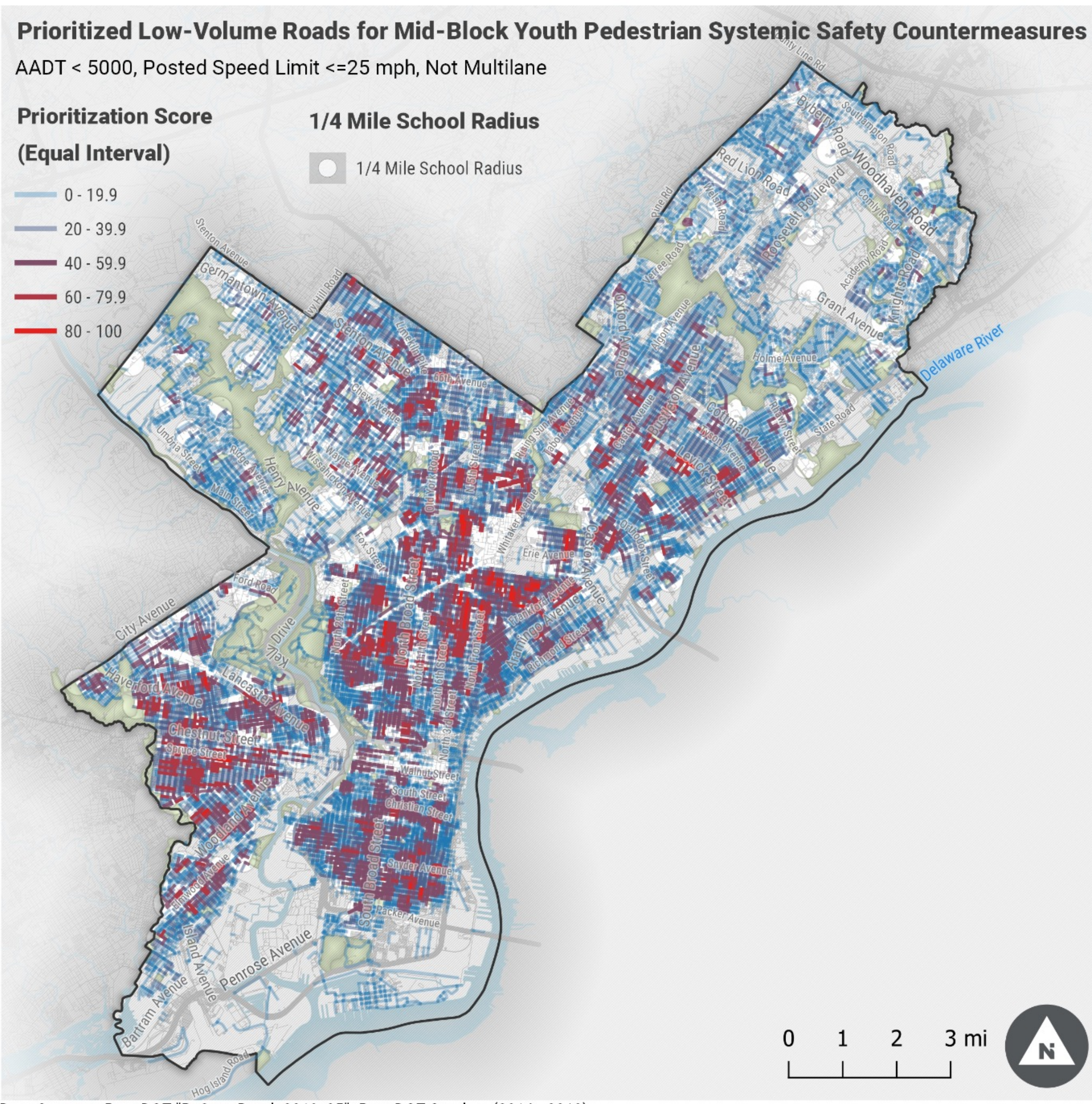


Data Sources: PennDOT "PaStateRoads2019_05". PennDOT Crashes (2014 - 2018)

Figure 4. Prioritized High-Volume Roads for Mid-block Youth Pedestrian Systemic Safety Countermeasures (Natural Breaks).

Map 3: Prioritized Low-Volume Roads for Mid-block Youth Pedestrian Systemic Safety Countermeasures (Equal Interval Priority Score Categories)

In this map, as in Map 1, the 31,388 road segments that fit this priority crash and location type were categorized and color-coded based on equal sized score classifications of 0-19.9, 20-39.9, 40-59.9, 60-79.9, and 80-100. Because there are many segments that fit these criteria across the city, this equal interval visualization approach emphasizes a smaller number of high-priority segments (score range 80-100) that represent the highest priority locations for systemic safety countermeasure application. Notably, the highest priority segments in this crash and location type are also clustered, which may allow for application of systemic safety countermeasures on several adjacent streets. In this example, school proximity is visualized differently than the previous two maps with a white circle indicating 1/4 mile radius around a school (more visible in downloaded map file).



Data Sources: PennDOT "PaStateRoads2019_05". PennDOT Crashes (2014 - 2018)

Figure 5. Prioritized Low-Volume Roads for Mid-block Youth Pedestrian Systemic Safety Countermeasures (Equal Interval).

Consideration of Low-Cost Infrastructure and Operational Countermeasures for Systemic Application

The PBIC team and the City of Philadelphia discussed how the systemic analysis findings and the lists of prioritized road segments may be used with a focus on the Safe System element of Safe Roads.[5] The city will make final decisions on how the information is applied. Considerations include:

- The prioritized lists can guide the city's evaluation of a subset of these high- and low-volume road segments for application of a single systemic pedestrian crash countermeasure or combinations of treatments to calm traffic and improve youth pedestrian safety. They may also be cross-referenced with planned roadway or operations changes to assess opportunities for improvements within existing projects.
- Countermeasures considered should be intended to address mid-block crashes.
- Because of the intent to implement a countermeasure in multiple locations, systemic improvements should primarily be low-cost and rapidly implementable (such as changes to signal timing or high visibility crosswalks). However, including a few higher-cost countermeasures proven to significantly reduce crashes offers an opportunity to consider their use in a limited number of circumstances when safety issues may not be effectively addressed by the low-cost countermeasures.
- Once a preferred subset of locations and countermeasures are selected, field engineering evaluation of each location will be necessary to both consider existing conditions that are not currently available from the assembled GIS data and verify the applicability of the selected systemic countermeasure(s) for each location.
- Field review can also help determine if additional safety engineering changes beyond the selected systemic countermeasure(s) would be necessary to fully address risks from existing conditions, such as vehicle stopping sight distance or supplemental crossing safety enhancements. However, identification of additional safety risks should not preclude or delay the application of near-term, low-cost systemic safety countermeasures designed to address systemic youth pedestrian serious injury or fatality risk, if a given location is suitable for their application.

The *NCHRP Research Report 893 Systemic Pedestrian Safety Analysis* (NCHRP 893)12 includes a chapter on selecting potential countermeasures (Chapter 6) that highlights 12 pedestrian crash countermeasures for potential systemic application, and points to additional resources on pedestrian crash countermeasures generally. The appendix to *NCHRP 893* also provides summaries and images of these treatments, including descriptions of purpose, use, and systemic application considerations.

The PBIC team assembled relevant countermeasures from both the *NCHRP Report* and team member expertise of countermeasures that are suitable for mid-block locations, whether for traffic calming, speed reduction or to improve mid-block crossings (see Table D) to serve as a starting point for the city to develop a short-list of countermeasures for systemic mid-block application that can be considered during field review of the priority locations.

Note that the order of countermeasures listed in Table D does not indicate relative effectiveness. Doing so would require the ability to compare effectiveness information (Crash Modification Factors, or CMFs) for all the treatments, which is not possible due to the lack of information for all countermeasures. CMFs are not fully known for many types of the pedestrian safety measures, like signing, enforcement, radius reduction, crossing guards, curb extensions, parking restrictions, turn wedges, etc.

Additionally, countermeasure options are not all equally appropriate (nor equally effective) for all types of mid-block safety problems. For example, some safety-related countermeasures are more appropriate for multi-lane, higher-speed arterial streets (e.g., advanced motorist yield signs and markings and/or refuge islands), whereas other treatments are better suited for lower-volume, two-lane local streets (e.g., speed humps, high-visibility crosswalk markings and/or adult crossing guards near school crossings). Thus, the expected effectiveness of various treatments depends on such factors as number of lanes, prevailing vehicle speeds, area type (e.g., near a school vs. near residential vs. commercial area), vehicle and pedestrian volumes, time of most pedestrian activities (night vs. day), and other factors.

Additional resources

FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations[20] describes how to enhance pedestrian safety at unsignalized locations (including mid-block crossings). The guide provides details on the six steps which should be taken to identify locations (mid-block and intersection locations) to be considered for improvements, as well as how to best choose from among several different countermeasure options to best improve pedestrian safety.

FHWA Toolbox of Pedestrian Countermeasures and Their Potential Effectiveness[21] provides information on the safety effects of all types of pedestrian treatments, including signs, signals, markings, and geometric improvements.

In-roadway yield-to-pedestrian (R1-6) sign/gateway
Advance stop/yield bar and R1-5/5a sign
Pedestrian hybrid beacon
High-visibility mid-block crosswalk (on longer road segments)
Traffic calming (raised device like raised crosswalk or speed table)
Pedestrian refuge island
Curb extension (with parking restriction to ensure adequate sight lines, if a crosswalk is present at the curb extension location)
Curb extensions to create gateways, pinch points, or chicanes (for traffic calming/speed reduction)
Location-specific lighting improvement
Signs (e.g.15 mph posted speed limit signs, "School Slow Zone" signs; can be implemented individually or as part of a gateway treatment)
Lane narrowing

Table D. Potential Pedestrian Crash Countermeasures Suitable for Mid-block Locations (Including Mid-block Crossings).

Pedestrian Infrastructure and Operational Crash Countermeasures - Age-appropriate Considerations for Children and Youth

In the first year of the Vision Zero for Youth Demonstration Project, the PBIC team submitted additions to the Philadelphia Vision Zero Pedestrian Safety Action Plan that included example considerations of age-appropriate abilities and special vulnerabilities of children and youth relating to pedestrian infrastructure and operational crash countermeasures. While not all countermeasures listed in the table below are suitable for mid-block application or systemic application, the information is important to any efforts to improve youth pedestrian safety. Many younger children are not developmentally ready to walk city streets without a responsible adult, particularly where crossing streets with high speeds and/or volumes of motor vehicles.

Pedestrian Infrastructure or Operational Crash Countermeasures	Considerations for Children and Youth
Crossing Islands	Children can have challenges when crossing wide, multi-lane streets compared to older, more-experienced people. Providing a raised island can simplify the crossing maneuver.
Motor Vehicle Speed Reduction	Children have difficulty perceiving speed of oncoming vehicles and take longer to decide and proceed with crossing, putting them at added risk the faster vehicles are traveling.
Lighting	Lighting can benefit children who cross streets to get to or from a bus stop or school especially during times of the year when they may be traveling to or from school or other destinations in darkness.[22]
Gateways and In-Street Pedestrian Crossing Signs	These have been shown to increase motorist yielding at pedestrian crossings, which would benefit young pedestrians and their challenge with judging vehicle speed and acceptable gaps.
Raised Crossings and Raised Intersections	Raised crossings typically slow the speeds of motor vehicles where pedestrians cross at intersections. Shorter, younger pedestrians can benefit from such speed reductions and from the vertical elevation provided by the raised crossing surfaces.
Posted Speed Limits	Posting speed limits, in addition to selective speed enforcement and other measures (e.g., traffic calming) is a part of an overall effort to keep vehicle speeds at reasonably safe levels, which is essential for safer travel by child pedestrians.
Automated Enforcement	This measure can involve enforcing signal compliance and/or compliance of speed limits, both of which are important to safe walking by children. (Pennsylvania state law currently limits locations where automated enforcement can be implemented.)
Access Management	This measure, among other things, implies the careful placement of driveways and a reduction of conflict points between motorists and pedestrians, which is beneficial to children who are walking on the sidewalk.
Road Diets and Lane Narrowing	Road diets have a proven safety benefit to overall crashes, not just pedestrian crashes. This measure involves eliminating a travel lane which slows vehicle speeds and shortens crossing distance. Lane narrowing can reduce vehicle speeds and shorten the street crossing distance. Both of these measures can be beneficial to child pedestrians, in particular. [23]
Crossing Guards	Particularly at intersections heavily used by young pedestrians, crossing guards can play an important role in determining an appropriate time for crossing and controlling the crossing of young pedestrians. Their presence also serves as a deterrent to speeding drivers.

Table E. Pedestrian Infrastructure or Operational Crash Countermeasures and Considerations for Child and Youth Pedestrians.

Pedestrian Infrastructure or Operational Crash Countermeasures	Considerations for Children and Youth
Neighborhood or School Slow Zones	Neighborhood or School Slow Zones reduce the speed limit and add safety measures within a select area, for example where children are walking, designed to reduce motor vehicle operating speeds. (Note that this definition is different than Philadelphia Neighborhood Slow Zones, which do not include a speed reduction.)
Signal Timing and Automatic Pedestrian Recall	Shorter signal cycles can result in shorter pedestrian wait times for the WALK interval. Pedestrian recall means that pedestrians get the WALK interval every cycle, without having to activate a push-button. Both features have advantages for young pedestrians.
Protected Turn Phases	Providing protected turn phases, such as a protected left-turn phase, allows for pedestrians to cross during a WALK interval, without having to worry about conflicting left-turn traffic. Such a measure reduces the decision burden for young, inexperienced pedestrians when crossing the street at a busy intersection.
Leading Pedestrian Intervals (LPIs)	LPIs provide an interval of a few seconds at the beginning of each signal phase which gives pedestrians priority over turning vehicles. Such a separated interval has the potential to particularly benefit young pedestrians, who typically have added difficulty interacting with turning vehicles at intersections.[24]
Parking Restrictions at Pedestrian Crossings	Since children are shorter than adults, this is a particular benefit for drivers and children to be able to see each other at intersections.
Corner Radius Reduction	This measure reduces the radius of a corner, creating a sharper turn for motor vehicle drivers, which reduces the speed of turning vehicles, while at the same time shortening pedestrian crossing distance at intersections. These are both beneficial features for children who cross such intersections.
Curb Extensions	This treatment shortens the crossing distance, can reduce vehicle speeds (when several are used along a route), and improves sight distance between the driver and pedestrians, which can all benefit child pedestrians.
High-Visibility Crosswalks	These have been shown in a California study to be effective in reducing child pedestrian crashes in school zones, compared to parallel-line crosswalks.
Hardened Centerlines and Turn Wedges	Hardened centerlines can reduce the length of the conflict area between pedestrian crossings and left-turn vehicles at intersections. Turn wedges serve a similar purpose as curb extensions, including shorter crossing distances and slower speeds of right-turning vehicles. Both measures can potentially benefit young pedestrians at intersections, and both are relatively new and low-cost measures.
No Turn on Red (NTOR) Signs	NTOR signs help to reduce the conflict from right-turning vehicles at intersections during the WALK interval, which can benefit young pedestrians.

Figure 6. Workshop Participant-Generated Map of System Dynamics of Child Pedestrian Crashes.

Agency Partner Engagement

Addressing child pedestrian crashes requires looking beyond data to consider broader, systemic issues, collaborating with partners and learning about the preferences and priorities of community members. While this project's timeframe and scope did not allow for direct community engagement, additional funding support from the Collaborative Sciences Center for Road Safety (one of the U.S. Department of Transportation's five National University Transportation Centers) permitted the team to alter the original plan of conducting one to two roundtable meetings to instead facilitate two workshops for a diverse set of Philadelphia agency partners. Workshop presenters introduced and then facilitated the group's application of systems science tools to both advance the city's new commitment to a Safe System approach and to engage partners in discussing the broad range of factors that can contribute to child pedestrian crashes.

The Philadelphia Deputy Director of Complete Streets for the City of Philadelphia gave an overview of child pedestrian crash trends, drawing upon findings from the crash analysis and systemic analysis conducted as part of the Demonstration Project. Facilitators presented a systems map to seed discussion about factors leading to child pedestrian crashes and altered the diagram based on feedback from the group. The group then discussed options for where to make changes and how they could play a role in change. Figure 6 displays the systems map.

Highlights of the Discussion

Streets not designed with children in mind

There are several important factors that affect the number of child and youth pedestrian crashes, injuries, and deaths. Factors include the number of vehicles traveling in an area, the number of children in an area (e.g., in a neighborhood, near a school), and the complexity of the roadway environment (e.g., number of lanes, vehicles speeds), given the developmental abilities of children. A workshop participant noted, "I think one thing that's becoming clear to me is that the roadway system, our transportation system isn't really designed for pedestrians, to begin with. But then the double whammy is that it's not designed for children, and so, when you have a youth pedestrian it's just, you know, they're very, very vulnerable both physically, but then also just because of the way that the system has not been designed with them in mind."

Historic disinvestment and impact of structural racism

Group discussion also included the challenges of vehicle-centric norms and the challenges presented by historic disinvestment that has led to deep-seated distrust in agencies and organizations intervening around transportation safety (due to factors like structural racism, gentrification fears, and competing community priorities like violence reduction). As this distrust increases, there is often less buy-in for transportation-related projects and therefore, fewer pedestrian projects.

Outcomes

Comparing before and after participant comments, facilitators noted a shift in what participants identified as the most important actions, as participants placed greater emphasis on building relationships across sectors, with community members, and with elected officials at the conclusion of the two workshops.

The group expressed interest in focusing efforts around outreach to local communities to establish a firm foundation of trust and collaboration, aligning with core Safe System principles.[2] The group recognized this as a critical next step for long-term sustainable change related to child and youth pedestrian injuries.

The City of Philadelphia team noted that participant comments during the workshops reinforced the importance of community engagement and underscored their interest in continuing work with their city community engagement team.

The city received an online visual storytelling presentation[26] to use with partners to describe outcomes of the workshops including illustrative quotes from participants.

Conclusion

This Demonstration Project sought to identify strategies for inclusion of youth pedestrian safety needs in Vision Zero efforts and much was learned. The team was able to incorporate traditional crash analysis and GIS crash mapping with systemic safety analysis and equity analysis to identify high-risk locations for youth pedestrian crash countermeasures. This final report also points to treatments proven to be effective and/or shown as best practice in other cities. The city's Vision Zero Action Plan 2025[10] included a new section and strategies focused on addressing youth road safety. The city will use results of systemic analysis to start with priority locations. These priority locations are based on risk for future crashes (incorporating information about crashes have occurred in the past) and this proactive planning offers an important contribution towards reaching Vision Zero.

The Demonstration Project uncovered five high-level takeaways important for other cities:

1. The Demonstration Project reinforced that children walk in different places and at different times of day than adults.
2. For all racial and ethnic populations except the White population, the number of youth pedestrian crashes increases as the population in a block group increases. Additionally, while not a new discovery, lower median income areas saw more child crashes and higher median income areas saw fewer.
3. High injury networks should be examined to determine if they will sufficiently address child pedestrian crash risks and assess what further prioritization may be necessary.
4. Education, the most common way that children are included in Vision Zero plans, needs to be coupled with other actions oriented to a Safe System approach, including changes to the built environment.
5. Like pedestrian crashes among adults, child pedestrian crashes occur as a result of range of interconnected, broad factors that require multi-agency, multi-discipline solutions determined in partnership with community members.

The project also sought to understand the value of a youth-focused approach. For Philadelphia, this was certainly the case. It provided an opportunity for partners to come together in the name of children, to understand the unique patterns and needs to prevent child and youth crashes and to solidify a path towards meeting the goal of zero traffic deaths and serious injuries on Philadelphia's streets.

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24 Case Study: NYC showed crash reductions, for example on a two-way protected bike lane along a park, which offers cyclists a safer space, but also serves the dual purpose of reducing lane width, thereby slowing traffic. Leading pedestrian intervals were installed on a service road leading to an expressway, allowing pedestrians to get a head start crossing a street before traffic proceeds. Parking regulations along the corridor were overhauled, extending the 'no-standing' zone during school drop off and pick up hours, and removing several spaces to improve visibility. Slow zones were added, as well as stop controlled high visibility crosswalks. The merge of the two streets was also improved.

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Appendix A – Systemic and Equity Analysis Data Sources, Consolidation and Limitations

Introduction

The first step in the systemic safety analysis of youth pedestrian crashes included collecting, inventorying, and consolidating data necessary to support the analysis. These data included crash reports, roadway attributes, and school locations which will help identify factors that contribute to or undermine youth pedestrian safety. This memo documents the data sources, the process used to consolidate data and join it to crashes and identified data limitations.

Data Sources

Crash

Geocoded crash data is critical to understanding traffic safety patterns. Police reports of collisions, typically aggregated by local or State departments of transportation or police departments, are the primary source available for crash data. Pennsylvania Department of Transportation police crash data was used for this analysis.

While police crash reports are known to systematically underreport pedestrian crashes [1,2], they are often the most complete data source readily available for analysis and provide necessary details for informing selection of safety engineering treatments, such as the location of the collision and dynamics between the parties involved in the crash. For this analysis, public health department or hospital records were not available to cross-reference crash occurrences, locations, collision dynamics, or the injury severities of youth pedestrians involved as reported by police.

Crashes were initially flagged based on the following characteristics:

- Involvement of a youth pedestrian (age < 18, Unit Type = pedestrian)
- If the crash resulted in a suspected injury to the youth pedestrian of any severity
- Whether a suspected serious or fatal youth pedestrian injury resulted from the crash

There were 2,083 youth pedestrians involved in 2,009 crashes in the City during the study period (2014-2018). We excluded only the no injury crashes and were able to geo-code 2,002 crashes. We used 2,002 for systemic analysis. A difference in crashes that small is not expected to substantially affect the results of the systemic analysis, since crash totals for the analysis are aggregated across the city.

Roadway

Roadway data were collected from Pennsylvania DOT (PennDOT) and the Delaware Valley Regional Commission (DVRPC). Annual average daily traffic (AADT) data and posted speed limits were provided by PennDOT and the number of lanes was provided by DVRPC. Binary thresholds for "high-risk" were determined through planning judgement and coded in the consolidated dataset. The percentage of all road miles in the Philadelphia road network where a valid measurement was available for each variable is summarized in the table on page 27.

School Locations

A GIS file with the location of elementary and secondary schools (point dataset) was provided by the City of Philadelphia.

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Roadway Characteristic	Threshold	Data Source	Percentage Network Road Miles Where Measurement Available
Posted Speed	>25 mph	PennDOT	88.25 percent
AADT	>=5,000	PennDOT	26 percent*
Multi-lane	>2 lanes bi-directional, >1 lane one-way	DVRPC	100 percent

*While network coverage for AADT data is low, analysis of the existing dataset revealed that most of the network for which data was not available included nearly 1,900 miles of local and collector roads, which would typically fall under 5,000 AADT. Approximately 56 miles of minor and major arterial roads did not have AADT data, but those roads should be captured with the multi-lane variable.

Census

The PBIC team downloaded additional demographic data from the American Community Survey (ACS) 5-year estimates for 2014 to 2018. This dataset included estimates of the population distribution of eight different sociodemographic populations for 1,336 census block groups for Philadelphia; Census block groups are the smallest geographic area for which the ACS tabulates and publishes data. The sociodemographic factors assessed were:

- Household income
- Zero vehicle households
- Limited educational attainment (adults over 25 without high school diplomas)
- Limited English proficiency
- Black/African American population
- Hispanic/Latinx population
- Asian population
- White population

Of the 1,336 census block groups for Philadelphia, 1,328 had population data (eight block groups had no population data) and 1,326 had household data (nine block groups had no household data).

Consolidation Process and Variables

The purpose of data consolidation is to measure land use (e.g. schools), transportation system, and demographic attributes at the location of each individual pedestrian crash in the dataset.

Intersections

Crashes were determined as occurring at an intersection based on the intersection field in the crash database. This was reported by police officers. There was no exclusion for possible misidentification of driveway crashes by officers as intersection crashes. There was a small subset for which this value wasn't populated, in which case a spatial join was applied, defining any crash within 100' of an intersection AS 'IN INTERSECTION' and all others as 'MID-BLOCK'.

If a crash was indicated as occurring at an intersection, the nearest intersection (within a 200 ft search radius) was assigned to the crash for analysis of roadway characteristics at the crash unit of analysis. The crash characteristics were also reciprocally assigned to the intersection to allow for network screening (e.g. crashes per intersection, across the city).

Segments

Crashes not flagged as occurring at an intersection were coded as mid-block (as long as they occurred within 150 feet of a Philadelphia road). Again, fields from the crash dataset and roadway characteristics were reciprocally assigned to each dataset to allow for analysis of both crashes and network-level analysis.

Appendix B – Equity Analysis of Youth Pedestrian Crash History and Crash Risk: Methodology and Findings

The goal of the equity analysis was to add prioritization considerations for safety improvements that address disparate outcomes between different populations. To reach this goal, the PBIC team used sociodemographic data (see second bulleted list below) in tandem with the systemic safety analysis results to determine disproportionate impacts on populations that have experienced systemic inequities, comparing the geographic distribution of youth pedestrian crashes, crash types, and safety risks to the geographic distribution of the populations to answer several key questions:

- What are the relationships between sociodemographic factors and youth pedestrian crashes?
- Are certain youth pedestrian crash types overrepresented based on sociodemographic factors?
- Are youth pedestrian crash risk variables more prevalent in proximity to key sociodemographic populations?

Eight different sociodemographic factors were selected in consultation with city partners. The PBIC team mapped the geographic distribution of each factor using US Census Bureau 2014-2018 American Community Survey 5-year estimates, then assessed the geographic distribution of youth pedestrian injury crashes and crash risk relative to each. See Appendix A for details on data sources. The sociodemographic factors assessed were:

- Household income
- Zero vehicle households
- Limited educational attainment (adults over 25 without high school diplomas)
- Limited English proficiency
- Black/African American population
- Hispanic/Latinx population
- Asian population
- White population

Note: The equity analysis was designed with consideration of the relatively low number of youth pedestrian crashes and the understanding that sociodemographic factors were only one of many factors that could influence crashes. Specifically, the PBIC team anticipated weak correlations (low r^2) between youth pedestrian crashes and individual sociodemographic factors and did not expect to be able to draw conclusions or explain individual populations. However, weak correlations can still provide valuable information when compared across like factors. Linear trend lines were created to provide a visual representation for comparison between the sociodemographic groups; confidence intervals were not drawn because of the aforementioned weak correlations and the determination that this analysis was not a rigorous research study.

For both youth pedestrian crash history and crash risk, discernable patterns were noticeable when comparing across sociodemographic groups that suggest disparate impacts between populations.

Youth Pedestrian Injury Crashes

The PBIC team calculated basic descriptive statistics (maximum, minimum, average) of youth pedestrian injury crashes that occurred for each sociodemographic population, then tested the correlation between the number of youth pedestrian crashes in a block group and the number of residents or households within each sociodemographic population in that block group. This data was compared to the number of youth pedestrian crashes for the total population in Philadelphia to identify if certain populations were overrepresented in areas with high numbers of youth pedestrian crashes. The results did not show strong correlations (low r^2) but did show comparative trends for each population.

The weak correlation results suggested that a detailed regression analysis would not provide much insight. However, the PBIC team still tested median household income for significance in combination with each other variable individually and confirmed that when income was added to another sociodemographic factor it slightly but consistently increased the correlation with crashes.

Youth Pedestrian Crash Types

The PBIC team assessed the impact of key youth pedestrian crash types identified in the systemic analysis on each sociodemographic population by Census block group, looking at the crash occurrence and the crash risk variables separately and drawing connections where appropriate. Crash occurrence was not normalized by the share of high-risk infrastructure per square mile.

The PBIC team calculated the number of youth pedestrian crashes of each crash type that occurred within 200 feet of a Census block group, then calculated the percentage of each sociodemographic population that lived in block groups with that number of crashes to identify if populations were overrepresented for the crash types. Note: crashes that occurred within 200 feet of two block groups (i.e. on the border of a block group) were counted in both.

Youth Pedestrian Crash Types

Crash Type 1: Signalized intersection on high AADT road where motorist going straight

Crash Type 2: Signalized intersection on high AADT and high posted speed road where motorist turning left

Crash Type 3 (High AADT): Midblock where motorist going straight on high AADT, low posted speed and not multilane road

Crash Type 3 (Low AADT): Midblock where motorist going straight on low AADT, low posted speed and not multilane road

Youth Pedestrian Crash Types reviewed in Equity Analysis. Note that based on findings from the systemic analysis, two high-risk location types were assessed for Crash Type 3 (high AADT and low AADT roads).

The PBIC team also calculated the proportion of high-risk locations (for intersections) and mileage (for mid-block) within 200 feet of each Census block group and tested correlation of this percentage with the number of residents or households in a sociodemographic population within each block groups to determine if any populations were also disproportionately exposed to crash risk locations related to these youth pedestrian crash types. Again, we were able to see comparative trends in both the distribution of youth pedestrian crashes by crash type and the distribution of youth pedestrian crash risk by crash type despite the low r^2.

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Since its inception in 1999, the Pedestrian and Bicycle Information Center's mission has been to improve the quality of life in communities through the increase of safe walking and bicycling as a viable means of transportation and physical activity. The Pedestrian and Bicycle Information Center is maintained by the University of North Carolina Highway Safety Research Center with funding from the U.S. Department of Transportation Federal Highway Administration.