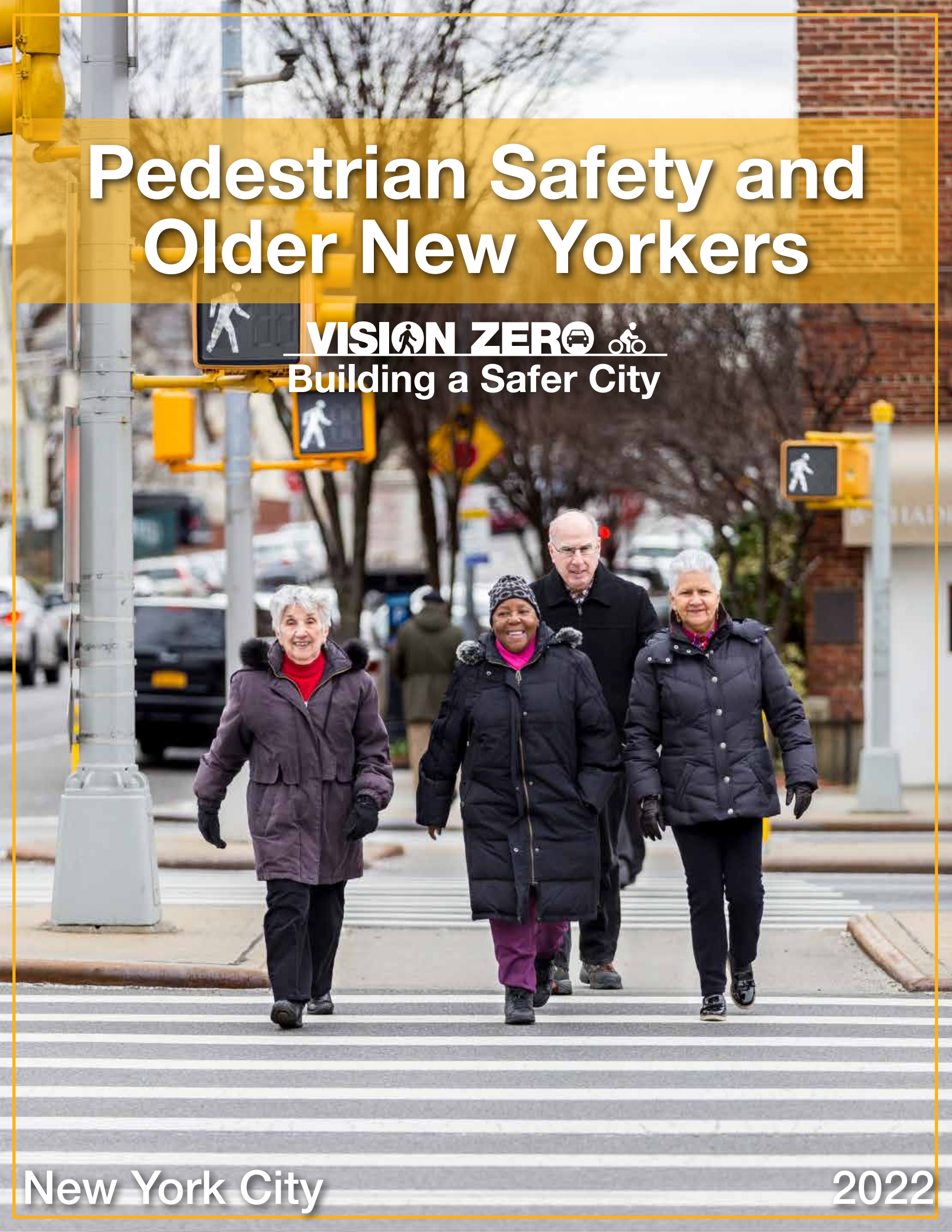
Pedestrian Safety and Older New Yorkers

VISION ZERO

Building a Safer City



New York City

2022

Shore Front Parkway, Queens

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VISION ZERO

Building a Safer City

Letter from the Commissioner

Dear Fellow New Yorkers,

The last two years of the COVID-19 pandemic has been full of frustration for all of us. For the tens of thousands of New York families that lost a loved one, the pandemic has meant deep loss and sadness. Unfortunately, traffic safety was also affected, as New York City has seen a dramatic uptick in fatalities, both during 2020 and again in 2021.

Despite these recent trends, also seen across the nation in an epidemic of reckless driving, the longstanding Vision Zero program has been a great success, bringing greater safety on our streets for our most vulnerable road users. In fact, seven of the eight safest years in the City's history have happened since 2014.

Among the priorities of Vision Zero has been protecting the most vulnerable New Yorkers -- older pedestrians. Though the city has seen many improvements to pedestrian safety under the Vision Zero era, senior pedestrian fatalities and severe injuries have only improved slightly: seniors make up less than 15% of our population but represent over 45% of New York City's annual pedestrian fatalities.

To find new and better ways to address these stubborn trends, NYC DOT has undertaken this comprehensive study of senior pedestrian fatalities and injuries. We learned that senior pedestrians are very similar to younger adults in their behavior and crash patterns and for the most part, they use our streets much like the rest of the population. They are struck no more often than younger pedestrians; however, when they are hit, they suffer far worse outcomes. Because even minor injuries for seniors can become fatal, total avoidance of crashes must be NYC DOT's primary street design goal. This study concludes that reducing exposure when seniors cross the street is key - and the initiatives we commit to herein reflect that insight.

Again, the pandemic was especially difficult for older New Yorkers, who have suffered disproportionately from COVID-19 and often faced stricter social isolation. This study represents part of a broader New York City effort to improve the lives of older New Yorkers who have borne the brunt of the tragedy. Pedestrian safety challenges for this population predate COVID-19 and will exist after the virus has faded. But with the release of this study, New York City is ready to face those challenges head on.

Ydanis Rodriguez, Commissioner

Grand Street, Manhattan

Executive Summary

Key Findings

1. The senior population is growing quickly in New York City
2. Seniors make up less than 15% of New York City's population, but over 45% of pedestrian fatalities
3. The number of senior pedestrian fatalities has remained relatively flat since the start of Vision Zero
4. Pedestrian fatality rate declined for all New Yorkers, but seniors saw a less dramatic drop
5. Crash patterns suggest that senior pedestrians use the street very similarly to younger adults
6. Senior pedestrians are not struck more often, but their injuries are much more severe
7. Crash outcomes for older male pedestrians are more severe than for older females
8. Left turn failure to yield crashes make up nearly twice as many fatalities for seniors than for non-senior adults
9. Backing vehicles are involved in 6% of senior pedestrian fatalities, over 2X the non-senior adult rate
10. Senior pedestrian fatalities are more likely to occur close to home
11. Senior pedestrians tend to be struck in the middle of the day
12. More seniors are injured and killed while riding their bike than by being struck by a cyclist
13. Road Diets, bicycle lanes, pedestrian islands, sidewalk extensions, Turn Calming and leading pedestrian intervals (LPIs) all deliver substantial injury reductions for seniors

Action Plan

1. Create Senior Pedestrian Zones to guide engineering, enforcement and education
2. Extend exclusive pedestrian crossing time (LPIs) in Senior Pedestrian Zones by the end of 2024
3. Add exclusive pedestrian crossing time (LPIs) at all feasible intersections on Priority Corridors in Senior Pedestrian Zones by the end of 2024
4. Extend exclusive pedestrian crossing time (LPIs) during mid-day for all new LPIs
5. Create Senior Turn Calming initiative and install treatments at 50 intersections annually
6. Implement ten or more Senior Street Improvement Projects annually
7. Target Raised Crosswalks to senior pedestrians
8. Target safety improvements to bus stop locations under elevated trains
9. Continue to improve safety for senior pedestrians in Midtown
10. Target Senior Safety Education and Outreach to Senior Pedestrian Zones
11. Work with medical providers on senior pedestrian outreach
12. Add senior pedestrian crash data to Vision Zero View
13. Conduct outreach to Senior Pedestrian Zone stakeholders
14. NYPD will conduct senior pedestrian safety enforcement initiatives focusing on daytime hours and the Senior Pedestrian Zones
15. NYPD will continue to identify seniors with head injuries for enhanced crash investigations
16. Advocate for vehicle designs that increase pedestrian visibility
17. Advocate for mandatory inclusion of safety-focused driver assistance technologies in all new vehicles

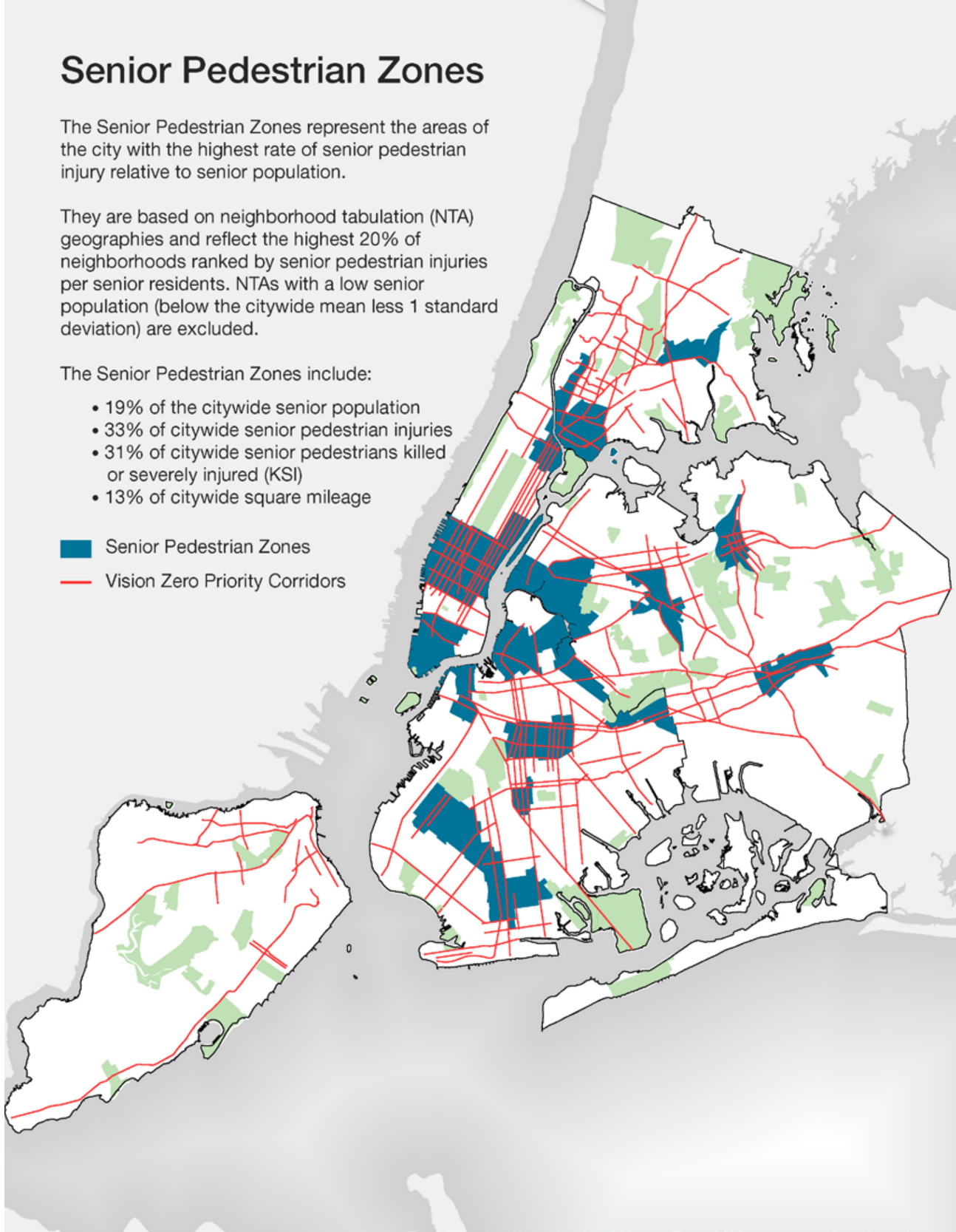
Senior Pedestrian Zones

The Senior Pedestrian Zones represent the areas of the city with the highest rate of senior pedestrian injury relative to senior population.

They are based on neighborhood tabulation (NTA) geographies and reflect the highest 20% of neighborhoods ranked by senior pedestrian injuries per senior residents. NTAs with a low senior population (below the citywide mean less 1 standard deviation) are excluded.

The Senior Pedestrian Zones include:

- 19% of the citywide senior population
- 33% of citywide senior pedestrian injuries
- 31% of citywide senior pedestrians killed or severely injured (KSI)
- 13% of citywide square mileage



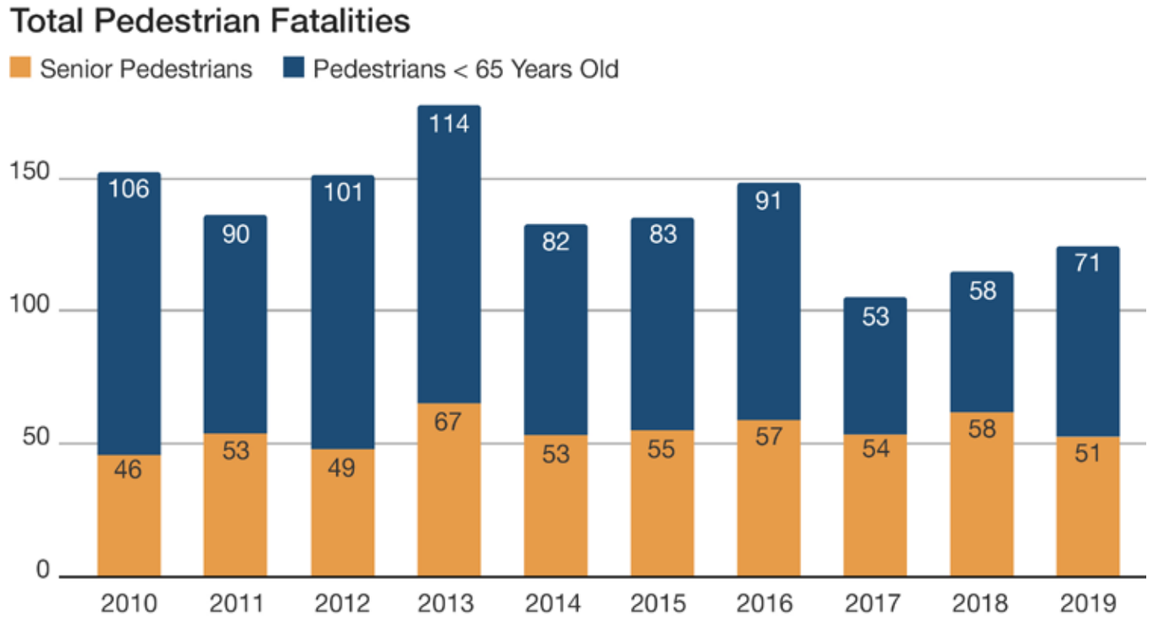
Leavitt St, Queens

1 Introduction

Like the rest of the United States, New York City's senior population is growing faster than the rest of the population. Between 2010 and 2018, the senior population (65 years and older) grew by approximately 29% nationwide while the rest of the population grew by about 2%. Similarly, in New York City, the senior population grew by 25% and the rest of the population shrank by just under 1%. Seniors now make up almost 16% of the population nationwide and nearly 15% of the New York City population.

Older New Yorkers make up less than 15% of the city's population, but over 45% of pedestrian fatalities.

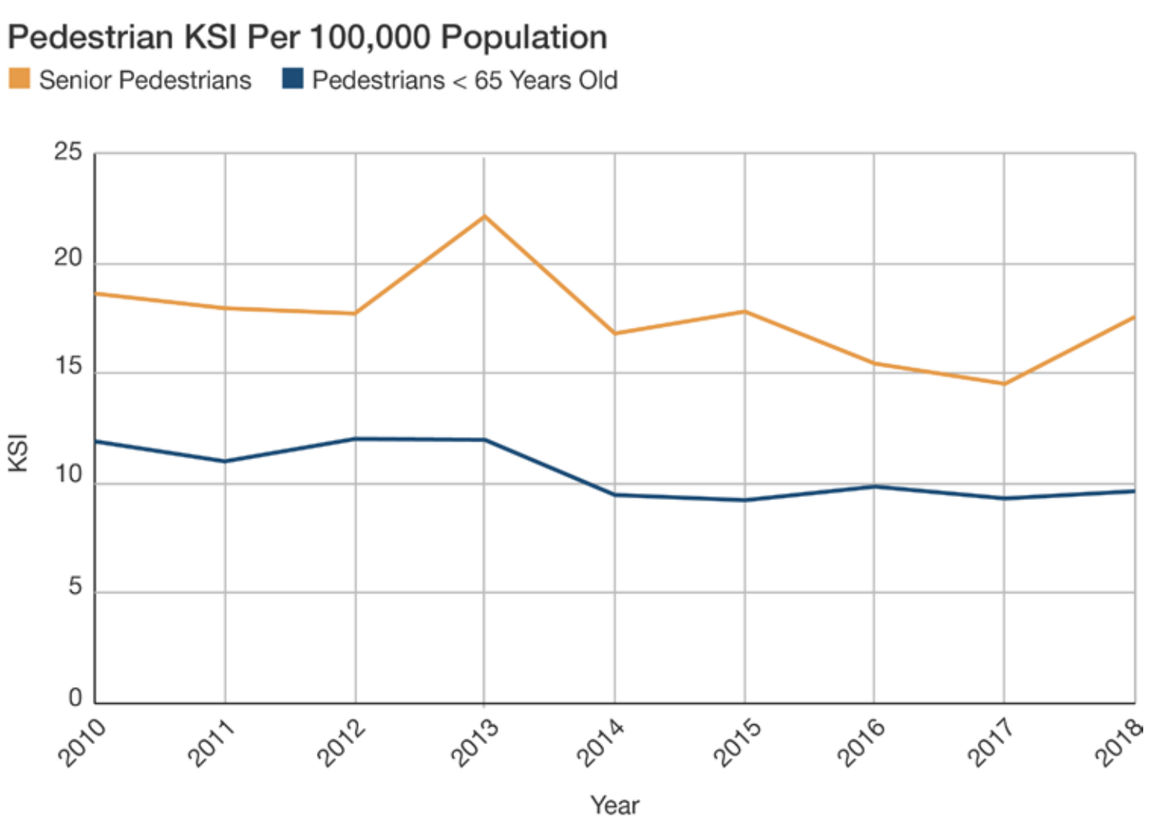
Over the last ten years, the city has become safer for all pedestrians. Pedestrian fatalities continue to decline for the whole population as New York City embraces Vision Zero, a program consisting of engineering, education and enforcement dedicated to eliminating deaths and serious injuries in traffic. For seniors however, pedestrian fatalities have remained relatively unchanged. As fatalities drop for the younger population, seniors now make up a larger percentage of the total annual pedestrian fatalities. In 2010-12, seniors made up 33% of pedestrian fatalities, but over the latest three years of data (2017-19), they have averaged 47%.



The number of senior pedestrian fatalities has remained flat since the start of Vision Zero.

With a growing senior population, we would expect to see an increase in senior pedestrian fatalities. However, the raw number has stayed relatively flat, meaning that per capita risk for seniors has actually declined. Unfortunately, this risk hasn't declined as fast for older pedestrians as it has for the rest of the population. In the three years prior to Vision Zero becoming New York City policy in 2014, there were 5.5 pedestrian fatalities for every 100,000 seniors. In the most recent three years of available data, this number dropped to 4.3, a 22 percent decline. However, the rate for the rest of the population decreased from 1.4 fatalities per 100,000 people to 0.8 fatalities per 100,000 over the same time period, a 40% drop.

While killed or severely injured (KSI) crashes for senior pedestrians have declined in recent years similarly to the rest of the population, their rate remains high. In the three years prior to Vision Zero, senior pedestrians were involved in 19.3 KSI crashes per 100,000 seniors, compared to 15.9 in the latest three years of data available (2016-2018), an 18% drop. The rest of the population experienced 11.7 KSI per 100,000 population in the three years prior to Vision Zero, and 9.6 in the latest three years, also an 18% decline.



Broadway, Manhattan

Older New Yorkers are overrepresented in pedestrian fatalities in all five boroughs relative to population.

Seniors are overrepresented in pedestrian fatalities in all five boroughs relative to population, but to varying degrees. Manhattan and Staten Island's populations both consist of about 15% seniors. However, 45% of Manhattan's pedestrian fatalities are seniors, compared to 31% of those on Staten Island, suggesting land use and travel preferences may be determining factors in where seniors risk being killed. Walking rates among seniors are highest in Manhattan, meaning greater exposure to traffic. Meanwhile, seniors in Staten Island are less likely to walk to their destination than seniors in any other borough *(NYC DOT, 2019)*. In the Bronx, where walking rates are nearly as high as Manhattan, but only 12% of the population is 65 years or older, 31% of pedestrian fatalities are seniors *(NYC DOT, 2019)*.

Senior Population and Pedestrian Fatalities by Borough		
Borough	Seniors (% of Borough Population 2010 - 2019)	Senior Pedestrian Fatalities (% of Total Pedestrian Fatalities)
Bronx	12%	31%
Brooklyn	13%	39%
Manhattan	15%	45%
Queens	14%	41%
Staten Island	15%	31%

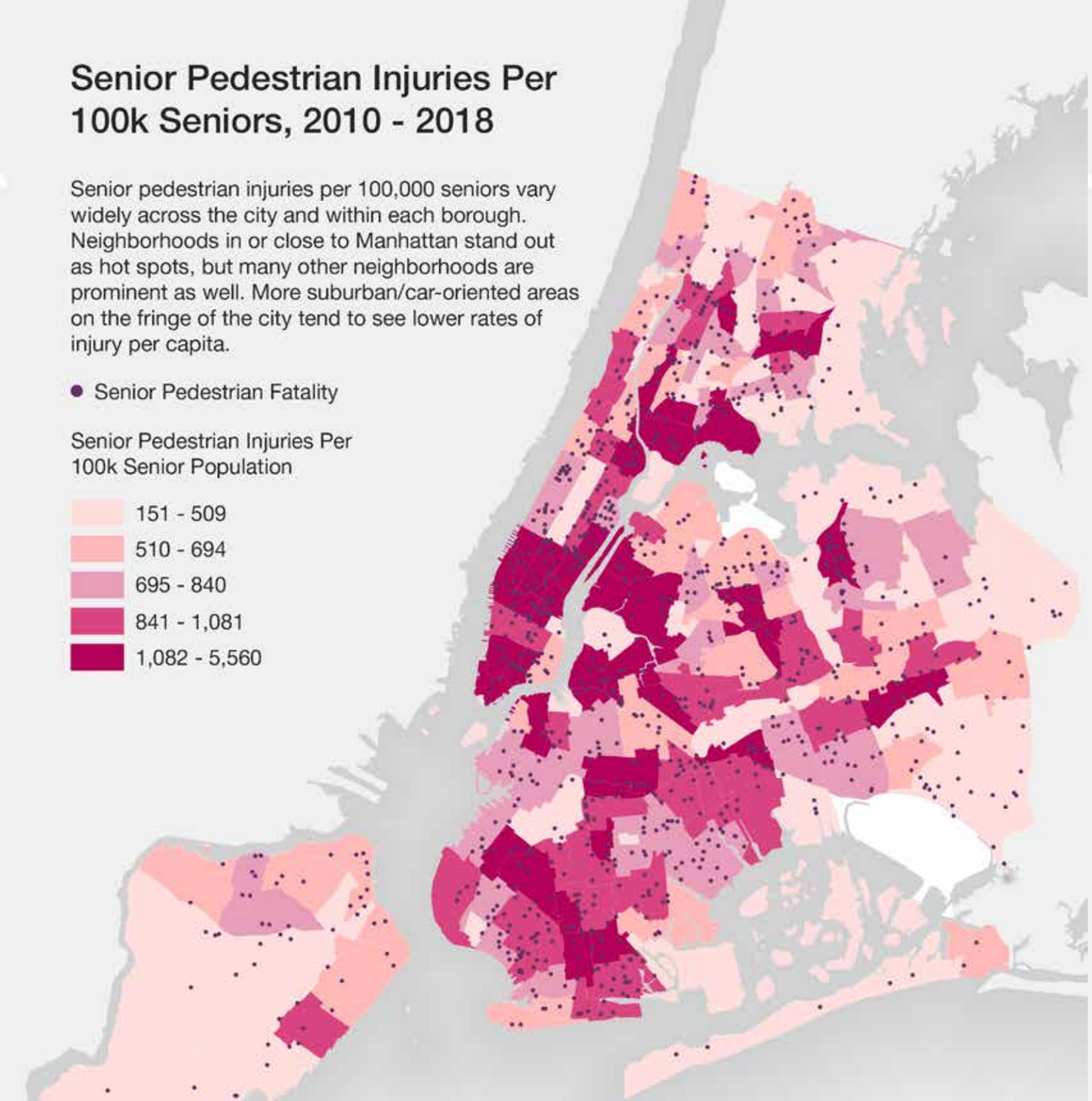
Senior Pedestrian Injuries Per 100k Seniors, 2010 - 2018

Senior pedestrian injuries per 100,000 seniors vary widely across the city and within each borough. Neighborhoods in or close to Manhattan stand out as hot spots, but many other neighborhoods are prominent as well. More suburban/car-oriented areas on the fringe of the city tend to see lower rates of injury per capita.

- Senior Pedestrian Fatality

Senior Pedestrian Injuries Per 100k Senior Population

- 151 - 509
- 510 - 694
- 695 - 840
- 841 - 1,081
- 1,082 - 5,560



Sources:
New York State Department of Transportation/
New York State Department of Motor Vehicles.
Accident Database, 2010-2018.
Albany, NY: NYSDOT/NYSDMV.

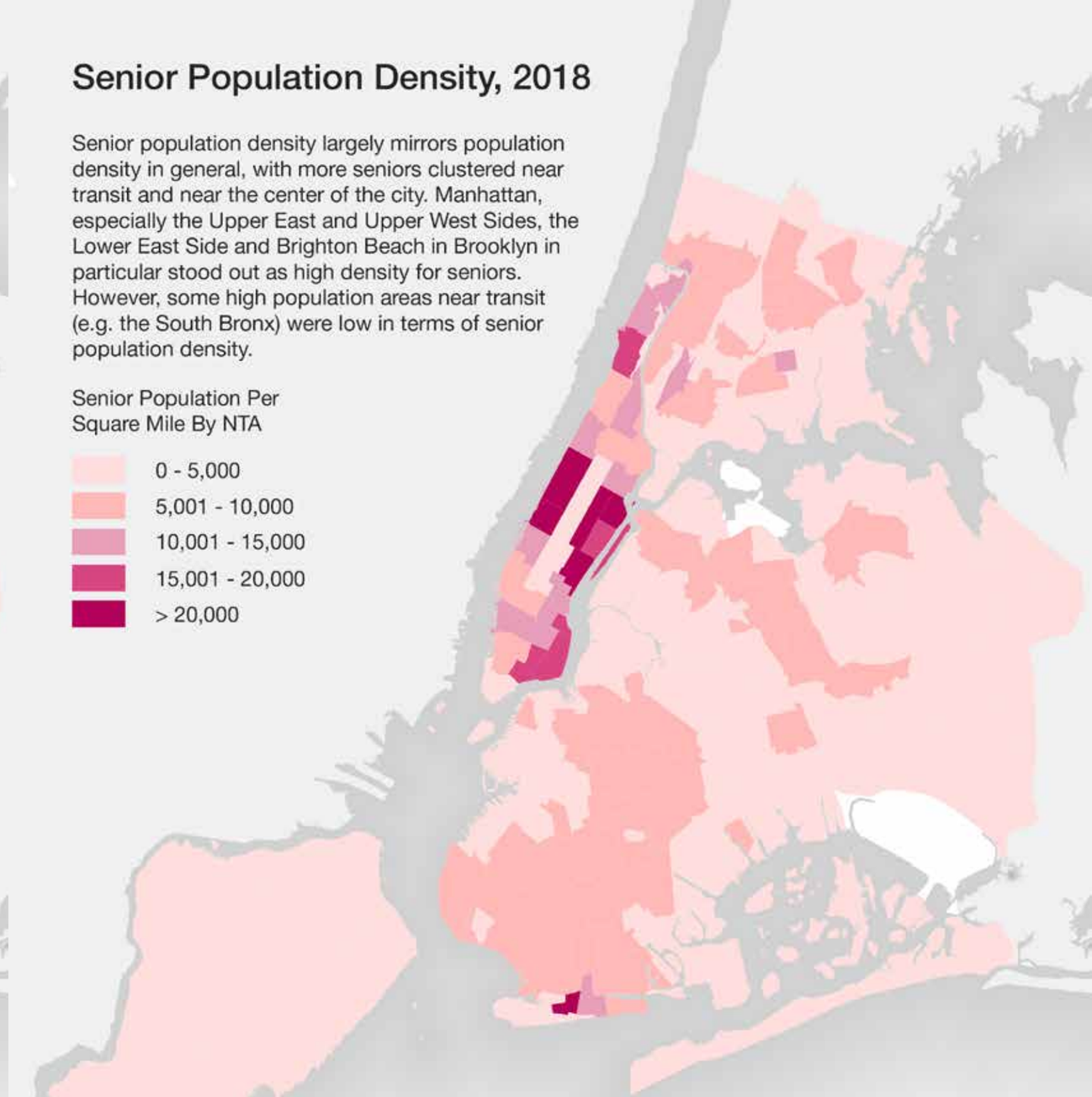
New York City Police Department/
New York City Department of Transportation.
Reconciled Fatality Database, 2010-2018.
NY, NY: NYCDOT/NYPD. All fatality data as of 2/23/2021.
*Note: Seniors refers to victims from the ages of 65-100

Senior Population Density, 2018

Senior population density largely mirrors population density in general, with more seniors clustered near transit and near the center of the city. Manhattan, especially the Upper East and Upper West Sides, the Lower East Side and Brighton Beach in Brooklyn in particular stood out as high density for seniors. However, some high population areas near transit (e.g. the South Bronx) were low in terms of senior population density.

Senior Population Per Square Mile By NTA

- 0 - 5,000
- 5,001 - 10,000
- 10,001 - 15,000
- 15,001 - 20,000
- > 20,000



Source:
U.S. Census Bureau; American Community Survey,
2018 American Community Survey 5 Year Estimates,
Table B01003
*Note: Seniors refers to victims from the ages of 65-100

Past Work

Safe Streets for Seniors (SSFS) was launched in 2008.

The risk faced by senior pedestrians continues to be a persistent problem in New York City despite the significant reductions in fatalities since Vision Zero began. NYC DOT's safety-related work does not appear to be benefiting older New Yorkers as much as the rest of the population. This study seeks to build off previous work and analysis in an attempt to reinvigorate the agency's approach to this problem. The foundation of that previous work was the NYC DOT Safe Street for Seniors (SSFS) program, a pedestrian safety initiative focused on improving walking conditions for older New Yorkers. SSFS was launched in 2008 in response to the disproportionately high rate of senior fatalities on New York City streets. At the time, seniors accounted for 12% of New York City's population but 38% of all pedestrian fatalities (2002-2006). New York City's senior population has continued to grow since then, increasing the need to address roadway safety for our most vulnerable pedestrians.

Wyckoff Avenue, Queens

At the start of SSFS, NYC DOT analyzed all senior pedestrian severe injuries and fatalities to identify spatial clusters where these crashes were concentrated. This spatial analysis led to the creation of the first 25 Senior Pedestrian Focus Areas (SPFAs) in 2008. Following the creation of the initial 25 SPFAs, two subsequent rounds followed in 2012 (12 new Areas) and 2017 (4 new Areas). The methodology for both Rounds II and III built on the initial analysis by including additional factors such as senior housing locations, senior trip generators, and concentration of senior centers.

Senior Center, Queens

Countdown Timer

As part of safety efforts for the SPFAs, the SSFS program conducted outreach at Senior Centers and Community Boards to ensure that safety improvements within the 41 SPFAs addressed the concerns of senior pedestrians. NYC DOT focused treatments on the issues that most concerned senior pedestrians including; re-timing hundreds of signals in order to provide more time to cross the street, installing countdown timers and audible pedestrian signals, reconstructing pedestrian ramps to achieve ADA-compliance, and upgrading roadway markings. These treatments have been implemented throughout all 41 SPFAs.

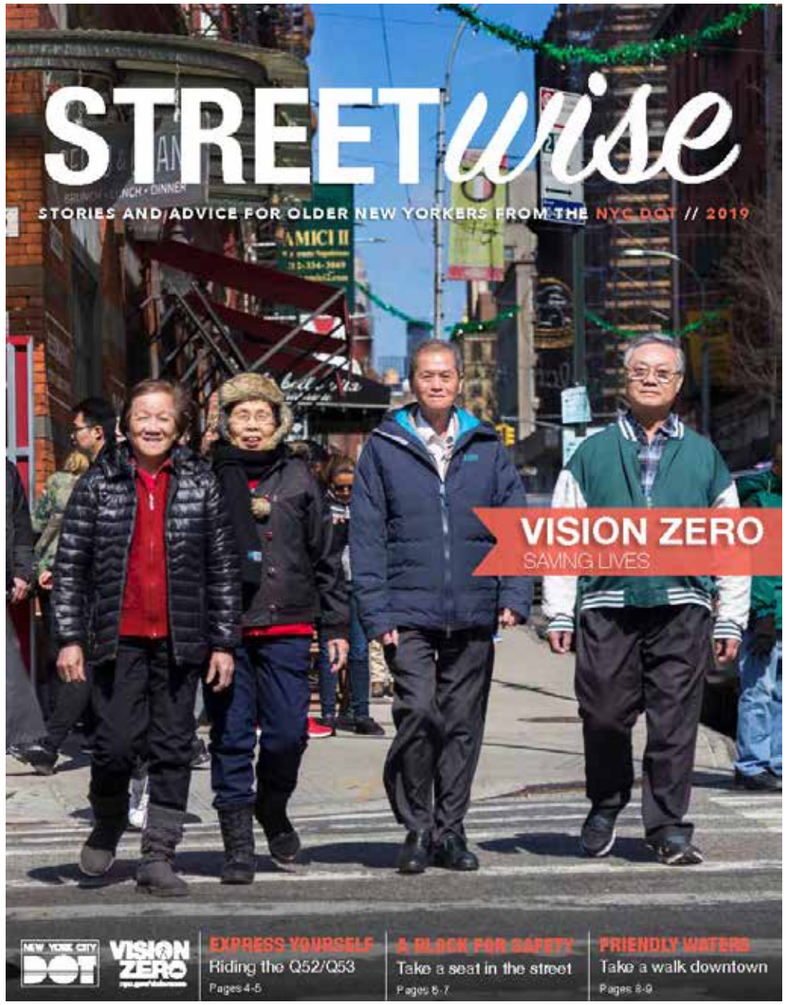
White Plains Road, Bronx

Since 2009, DOT has installed 300 Street Improvement Projects in Senior Pedestrian Focus Areas.

In addition to the program-wide improvements mentioned above, NYC DOT also has implemented a broader program of Street Improvement Projects (SIPs), which take a more comprehensive approach to safety. Since 2009, NYC DOT has installed 300 SIPs within the 41 SPFAs that address unique roadway conditions to improve safety for all roadway users with a particular focus on senior pedestrians. These SIPs have added concrete and painted elements to shorten crossing distances for pedestrians, added new crosswalks, and re-designed streets to reduce speeding and encourage slower, safer turns to increase drivers yielding to pedestrians at intersections. NYC DOT has also installed 177 Turn Calming treatments within SPFAs specifically to encourage slower, safer turns and drivers yielding to pedestrians in order to provide senior pedestrians with added comfort when crossing streets.

In addition to these engineering efforts, NYC DOT's Safety Education and Outreach (SEO) unit and its trained safety educators reach over 150 senior centers each year with several interactive programs, the centerpiece of which is STREETWISE, a tri-lingual traffic safety video (English, Chinese, Spanish). The 60 minute presentation focuses on pedestrian safety and dangerous driver behavior as identified by NYC traffic injury and fatality data, but also includes a review of local NYC DOT street design projects underway, and an opportunity for participants to raise their own neighborhood traffic safety concerns. All participants receive copies of SEO's annual Streetwise magazine

and free safety promotional items. Now with Covid-19 protocols in place, this signature program has been moved to an online session. Traditionally, SEO co-sponsors Grandparents Week with Safe Kids NYC at many senior centers and hospitals, inviting older New Yorkers to meet representatives from a variety of city agencies for answers to their health and safety concerns, and receive a wealth of printed and promotional materials. Finally, SEO and Family Life Theater co-sponsor 25 traffic safety theater performances at senior centers citywide, a program that will run with modification until Covid-19 restrictions are lifted.



2019 Streewise Magazine

2 Literature Review

Senior pedestrian safety has been extensively researched by other transportation agencies and academics around the world. These external studies were particularly valuable to the recommendations of this report, as other researchers have been able to investigate medical and behavioral topics that are outside the realm of NYC DOT's core crash and safety treatment data and analysis.

Injury Risk

Senior pedestrians are more likely to be severely injured in crashes, especially in low speed crashes. Seniors are not struck more often than non-senior adults, but when they are, their injuries are more severe. In older age, people become more fragile, meaning that older pedestrians will suffer more severe injuries than non-senior adults would at a given speed *(Martin et al, 2010)*. In fact, it has been shown that a senior struck at less than 20MPH is three times more likely to die than a 25 to 64 year old at the same speed *(Leaf and Preusser, 1999)*. As a general rule of thumb, Tefft found that the difference in injury risk for a 70 year old compared to a 30 year old is equivalent to the difference in adding 12MPH to the crash speed *(Tefft, 2013)*. Using this calculation, a senior struck at 25MPH will sustain the injuries of a non-senior adult struck at 37MPH.

A senior pedestrian struck at 20 MPH is three times more likely to die than a non-senior adult.

Canal Street, Manhattan

5 Avenue, Manhattan

Crash Risk

There may be other factors that influence how and when seniors are struck. In addition to increased fragility, physical and cognitive abilities often decline with age as well, affecting older pedestrians' ability to judge vehicle speeds, navigate complex intersections, and estimate their own crossing time. Some seniors may underestimate the effect of these changes and inadequately adjust their behaviors when navigating the street.

Yellowstone Boulevard, Queens

Seniors are likely to underestimate the time they need to cross the street.

Several studies have shown seniors are likely to underestimate the time they need to cross a street *(Naveteur et al., 2013; Zivotofsky et al., 2012)*, as well as the speed of oncoming traffic. Researchers found that older pedestrians are more likely to base crossing decisions on the size of the gap between them and a vehicle, but do not take into account the vehicle speed *(Dommes and Cavallo, 2011; Liu and Tung 2014)*. A separate study also found that seniors are less able to increase their walking speed when they underestimate crossing times *(Dommes et al, 2015)*. Compounding these findings, older adults tend to have walking speeds that are slower on average than those of non-senior adults. On average, adults over 65 possess walking speeds of 3 feet per second for males and 2.6 feet per second for females, whereas non-senior adults cover about 4.6 feet per second *(Geraghty et al, 2016)*. Furthermore, a 2010 study by Holland and Hill found that seniors, especially men, may have a delay ("start up delay") between when they decide to cross a street and initiate crossing, related to their motor ability. This delay further reduces their crossing time. Wider streets present a unique danger to seniors, who in addition to walking slower, may run out of crossing time if they don't start crossing at the beginning of a signal phase *(Zeeger et al, 1996)*.

Older pedestrians have more difficulty scanning different directions of traffic.

Diminishing visual functions can also make crossing more risky. In older age, contrast sensitivity, the ability to differentiate between objects, declines by 28% per decade after age 65 *(Dunbar, Holland and Maylor, 2004)*. This results in difficulty identifying moving objects and changes in depth perception.

Riverside Drive, Manhattan

Kappock Street, Bronx

Complex intersections, when five or more legs are present or intersect at unusual angles, can also be difficult for seniors. Older pedestrians have more difficulty simultaneously scanning different directions of traffic *(Carthy, Packham, Salter and Silcock, 1995)*. Instead of processing multiple factors simultaneously, seniors tend to process information and act in succession *(Rabitt, 1985)*, contributing to delayed starts when crossing.

Older pedestrians are also more likely to be injured by vehicles making unexpected movements, like reversing *(Stutts et al, 1996)*. One study showed injury rates from backing vehicles for older pedestrians was over twice that of those under 45 years old *(Zegeer et al., 1994)*. This may be caused by poor anticipation of vehicle movements or lesser ability to adjust to unexpected movements. However, this could also stem from reporting patterns, as older pedestrians are more likely to be injured and report backing crashes, which at lower speeds, are less likely to injure a younger pedestrian.

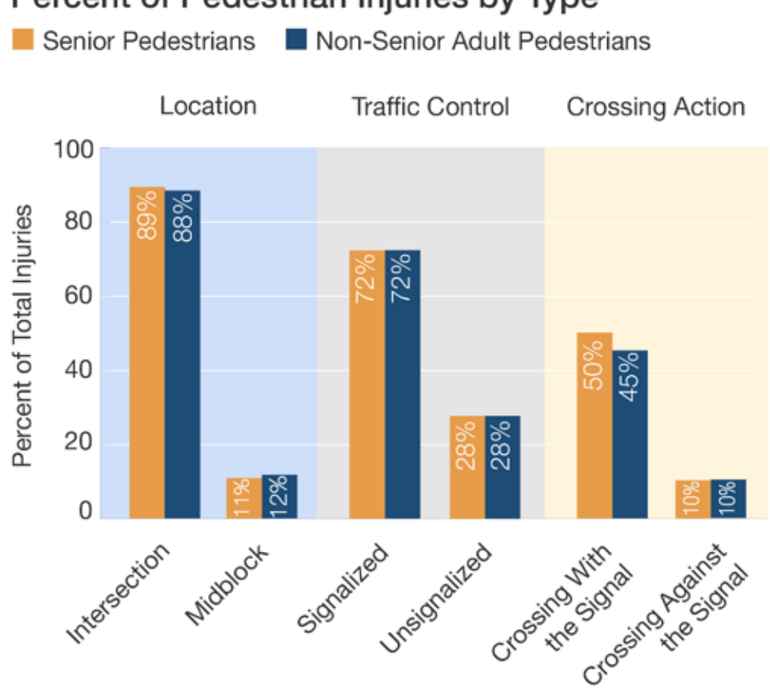
Canal Street, Manhattan

3 Crash Analysis

The overall pattern of how and where seniors are injured is almost identical to non-senior adult injuries, suggesting the two groups have similar behaviors on the street. About 90% of both senior and non-senior adult injuries occur at intersections. Of the intersection crashes, 72% of both senior and non-senior adult injury crashes occur at signalized intersections. Similarly, seniors and non-senior adults had nearly identical shares of crossing against the signal injuries (~10%), and midblock injuries (11% vs 12%) suggesting very similar rates of risky crossing behavior.

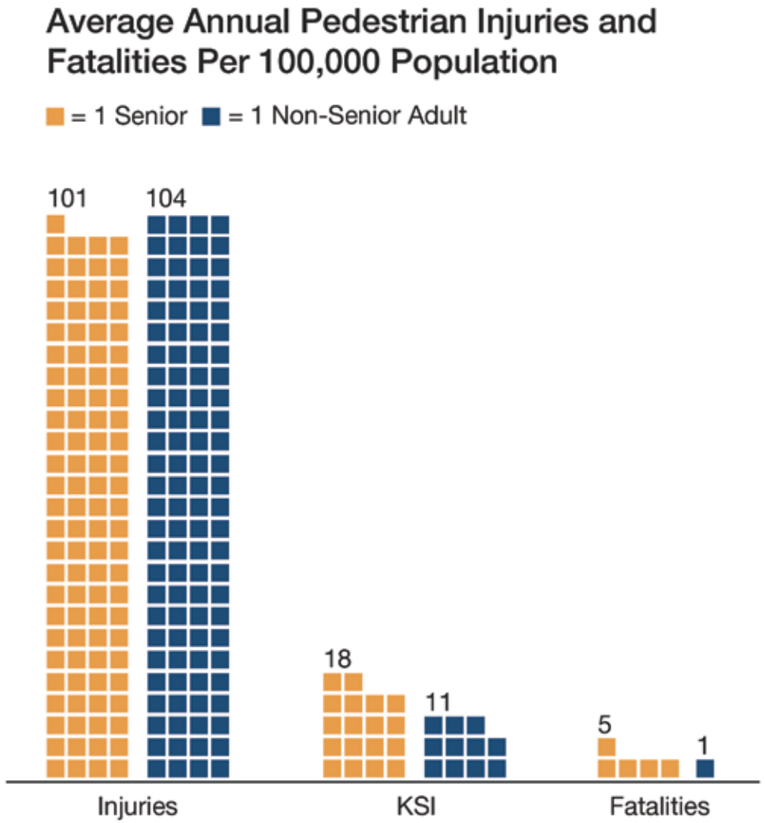
Crash patterns suggest that senior pedestrians use the street very similarly to non-senior adults.

Percent of Pedestrian Injuries by Type



8 Avenue, Manhattan

59 Street, Brooklyn



Senior pedestrians are not struck more often, but their injuries are much more severe.

Despite being hit in much the same way as non-senior adults, seniors are killed and severely injured at higher rates than non-senior adults. Importantly, seniors do not appear to be hit more often.

Normalized by the population of each age cohort, injuries per 100,000 people are very similar for non-senior adults and seniors, about 100 per year. In other words, the rate of being hit for each age group, adjusted for population, is very close (almost all pedestrian crashes result in an injury). However, the KSI rate is more than 50% higher for seniors adjusted for population, and nearly five times the rate for fatalities. These disparities demonstrate the differences in fragility. A crash that may just be a minor injury for a non-senior adult can be a life-altering injury or fatality for a senior.

Methodology

This study analyzes trends and patterns in senior pedestrian injuries, KSI (killed or severely injured) and fatalities in New York City. Because this study uses two distinct datasets for injuries and fatalities, unless otherwise noted, injuries, KSI, and fatalities are limited to non-highway crashes from 2010 to 2018, where the victim age is known. This study also divides the population into two distinct age groups for comparison: non-senior adults and seniors. Seniors are defined as anyone 65 years old to 100 years old. Limiting to 100 years old helps exclude any erroneous data for the age of the crash victim that could skew results. Fatality statistics that include 2019 are not limited to non-highway crashes and include victims over 100 due to a greater reliability in this dataset. 2020 data was not included due to COVID-19's effect on volume of travel, activity and traffic crashes.

The 'non-senior adults' category includes any pedestrian between the ages of 25 and 64. Limiting to 25 year olds as the lower limit for non-senior adults was done to achieve a more behaviorally and cognitively similar cohort to seniors for comparison. The stage of brain development responsible for increased risk-taking in teenagers is shown to extend until about the age of 25 *(Arain, 2013)*. Until then, social, emotional and cognitive development are still occurring, influencing the perception of risk. Limiting the non-senior adult cohort to a minimum age of 25 helps control for outsized risk taking in non-senior adults. Additionally, younger children tend to be tethered to parents, resulting in more conservative behavior. Including child injuries in comparison to seniors could be misleading.

Where injury rates are normalized by population, due to categorization in the Census' American Community Surveys, ages 0 and above 100 are included while being excluded from injuries due to the lack of reliability in this data.

7 Avenue, Manhattan

Average Annual Injuries, KSI and Fatalities by Senior Pedestrian Age Group			
Senior Pedestrian Age Group	Average Annual Injuries Per 100k	Average Annual KSI Per 100k	Average Annual Fatalities Per 100k
65-74 years old	106.9	15.6	3.7
75-84 years old	102.5	20.7	5.6
85-100 years old	70.8	18.7	7.1

These differences are even more disparate for the oldest cohort of seniors. The older the pedestrian, the higher the fatality rate per 100,000 population. Those 85 to 100 years old actually have an injury rate over 30% lower than non-senior adults (70.8 versus 103.6), likely due to less activity and therefore less exposure, but a fatality rate five times greater than non-senior adults. This further demonstrates the role of the fragility of the body in determining the outcome of a crash, regardless of speed, indicating that reducing crossing distances and minimizing exposure to traffic is key to reducing KSI and fatalities for seniors.

Queens Boulevard, Queens

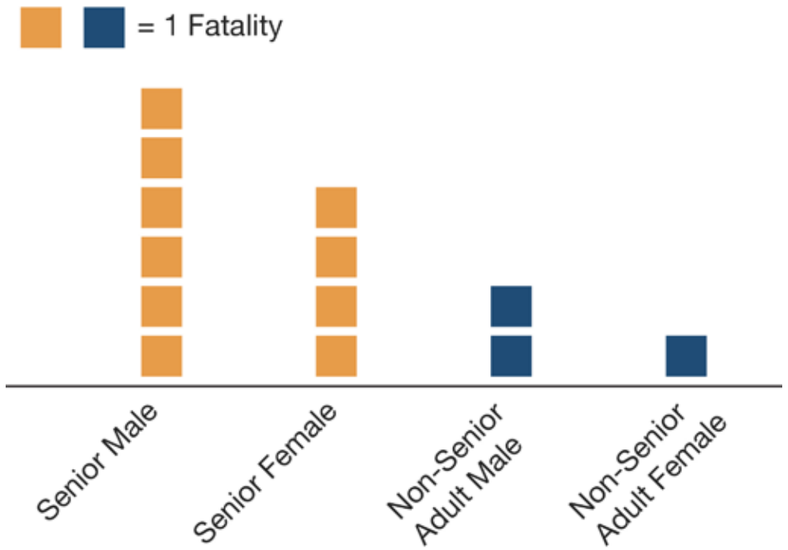
Flatbush Avenue, Brooklyn

Sex

Sex is also a factor in crash outcomes and patterns for older adults. In many types of behavior involving health and injury (motor vehicle crashes, smoking, drug abuse, suicide, etc.), males tend to be more risk prone. Following this pattern, pedestrian KSI and fatality rates in NYC are higher for males in general. This imbalance is somewhat less pronounced for seniors, but crash outcomes for older male pedestrians remain more severe than for older females.

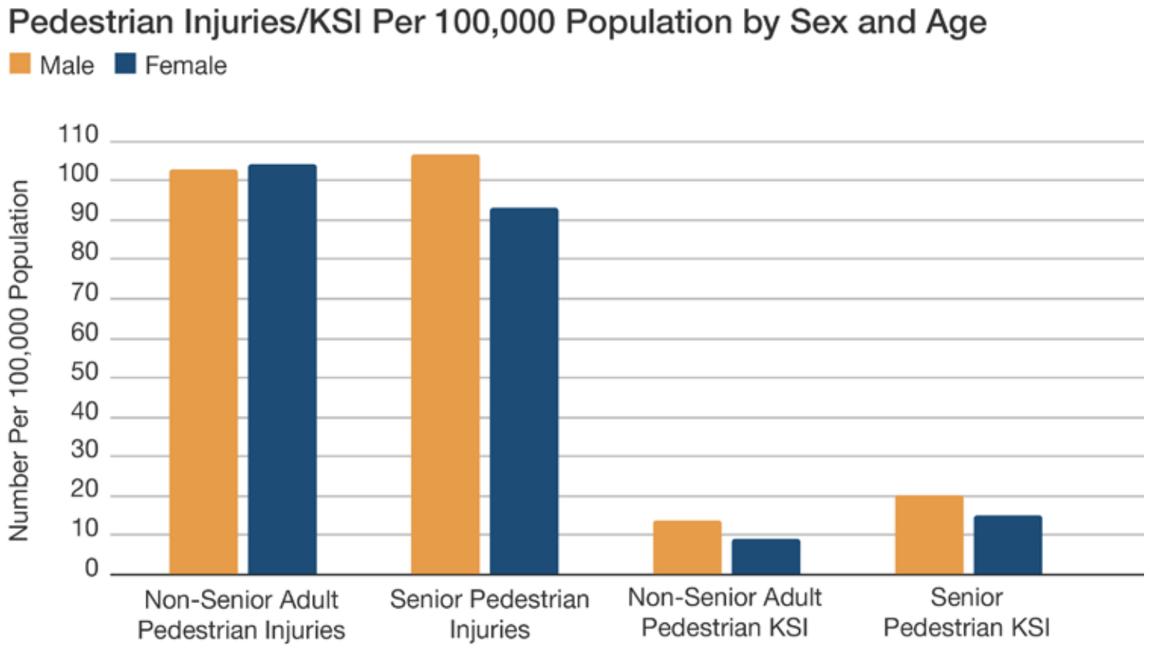
A senior male has a fatality rate more than 1.5x that of a senior female, 3.6x that of a younger male, and almost 7x that of a younger female.

Average Annual Pedestrian Fatalities by Sex Per 100,000 Population



Crash outcomes for older male pedestrians are more severe than for older females.

With no clear indication that males and females have different levels of exposure as they age, and the average age of KSI and fatality victims close to equal between males and females, these findings suggest older males may be similarly risk-prone as younger males, but more vulnerable. While the overall injury rate for non-senior adults is virtually equal between males and females, senior males rates are slightly elevated. They experience 109 injuries per 100,000 population, while females experience 94. Both non-senior adult males and senior males experience substantially higher rates of KSI. Senior males see 21 KSI per 100,000 population annually, compared to 15 for senior females. Non-senior adult males experience 14 KSI per 100,000 population annually, while non-senior adult females experience only 9.



Senior males are overrepresented for injuries at mid-block and at unsignalized intersections.

Crossing midblock (rather than at the corner) is usually more risky for pedestrians, especially on wider streets. Vehicle speeds are higher and pedestrians do not legally have the right of way when crossing midblock, so vehicles are not expected to yield. Similarly, crossing at an intersection that is "uncontrolled" (no traffic signal or stop sign in one more direction) is riskier since vehicles are always moving and tend to yield less to pedestrians at these types of crossings.

Mid-Block Senior Pedestrian Injuries, KSI by Sex			
Sex	% Senior Population	% Senior Mid-Block Injuries	% Senior Mid-Block KSI
Senior Female	59%	50%	44%
Senior Male	41%	50%	56%

Mid-Block Non-Senior Adult Pedestrian Injuries, KSI by Sex			
Sex	% Non-Senior Adult Population	% Non-Senior Adult Mid-Block Injuries	% Non-Senior Adult Mid-Block KSI
Non-Senior Adult Female	52%	43%	33%
Non-Senior Adult Male	48%	57%	67%

Astoria Park South, Queens

Unsignalized Intersection Senior Pedestrian Injuries, KSI by Sex			
Sex	% Senior Population	% Senior Unsignalized Injuries	% Senior Unsignalized KSI
Senior Female	59%	54%	50%
Senior Male	41%	46%	50%

Unsignalized Intersection Non-Senior Adult Pedestrian Injuries, KSI by Sex			
Sex	% Non-Senior Adult Population	% Non-Senior Adult Unsignalized Injuries	% Non-Senior Adult Unsignalized KSI
Non-Senior Adult Female	52%	52%	44%
Non-Senior Adult Male	48%	48%	56%

Non-senior adult males are overrepresented in injuries and KSI at these high risk crossings. Seniors males appear to become less risk-prone as they age, but clear sex disparities still remain while crossing midblock and at unsignalized intersections. For midblock KSI, senior males make up 56% of KSI, despite only being 41% of the senior population. This pattern is also evident at unsignalized intersections where males make up 50% of all senior KSI.

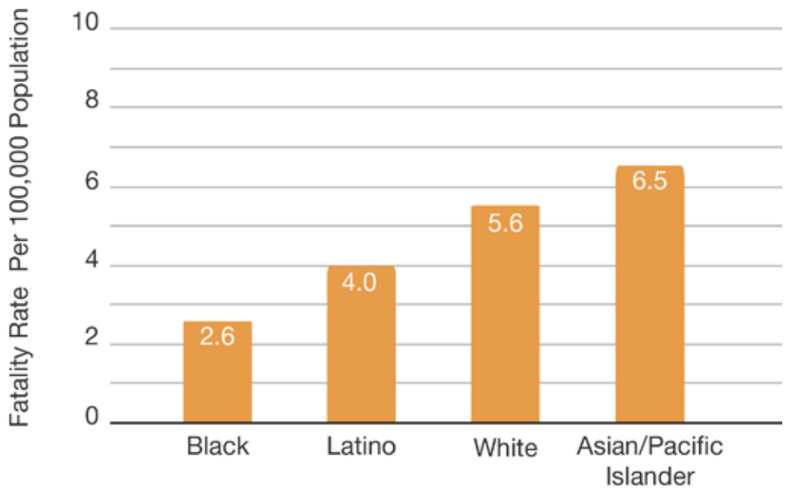
Race/Ethnicity

In addition to age and sex, there are also racial patterns apparent in the crash data. According to data provided by the New York City Department of Health and Mental Hygiene, Asians are overrepresented in senior pedestrian fatalities. This is likely due to older Asian populations being concentrated in denser parts of the city (Manhattan Chinatown, Sunset Park, Flushing, Jackson Heights) where walking rates are higher and car ownership is lower, leading to increased exposure to traffic.

Asians are highly overrepresented in senior pedestrian fatalities.

Canal Street, Manhattan

Senior Pedestrian Fatalities by Race/Ethnicity



White, Black, and Asian/Pacific Islander races exclude Latino ethnicity.
Latino includes Hispanic or Latino of any race.
Source: NYC DOHMH Bureau of Vital Statistics, 2016-2018

Minor Crashes and NYPD Collision Investigation Squad Cases

For seniors, even minor crashes can be deadly. A crash that may not appear to be severe at the scene, can become severe or even fatal in the days or weeks following the collision. Seniors are more likely than non-senior adults to die at the hospital following a crash from pedestrian injuries initially deemed non-life-threatening. Nearly $^{2}/_{3}$ of younger adult fatalities occurred soon after the crash ("DOA"), while most seniors expired at the hospital or later.

Canal Street, Manhattan

Over $^{2}/_{3}$ of non-senior adult fatalities occurred soon after the crash ("DOA"), while most seniors expired at the hospital or later.

The NYPD Collision Investigation Squad (CIS) is a specialized team that investigates every traffic fatality in New York City. However, because not every victim dies at the scene, they also need to investigate crashes where the victim survives, but is considered likely to die. NYPD is guided by on-scene Emergency Medical Services (EMS) personnel who determine if a CIS investigation in required. If someone dies as a result of a crash, but no CIS investigation had been initiated, then the investigation begins at that point. This process is followed, even if it is several days, weeks or even months after the event.

Because of the tendency for minor injuries to become deadly for senior pedestrians, it is more challenging to predict medical outcomes at the crash scene and a disproportionate amount of seniors are investigated in retrospect rather than at the time of the crash. The average age of a pedestrian fatality in New York City is 55 years old, but the average age of victims requiring CIS investigations after the initial crash is 66.

Crash Types

As discussed earlier, senior pedestrians do not appear to be struck at higher rates than non-senior adults, and appear to behave and navigate the street in much the same way as the younger cohort. However, there are some specific differences in how, where, why and when senior pedestrians are injured and killed.

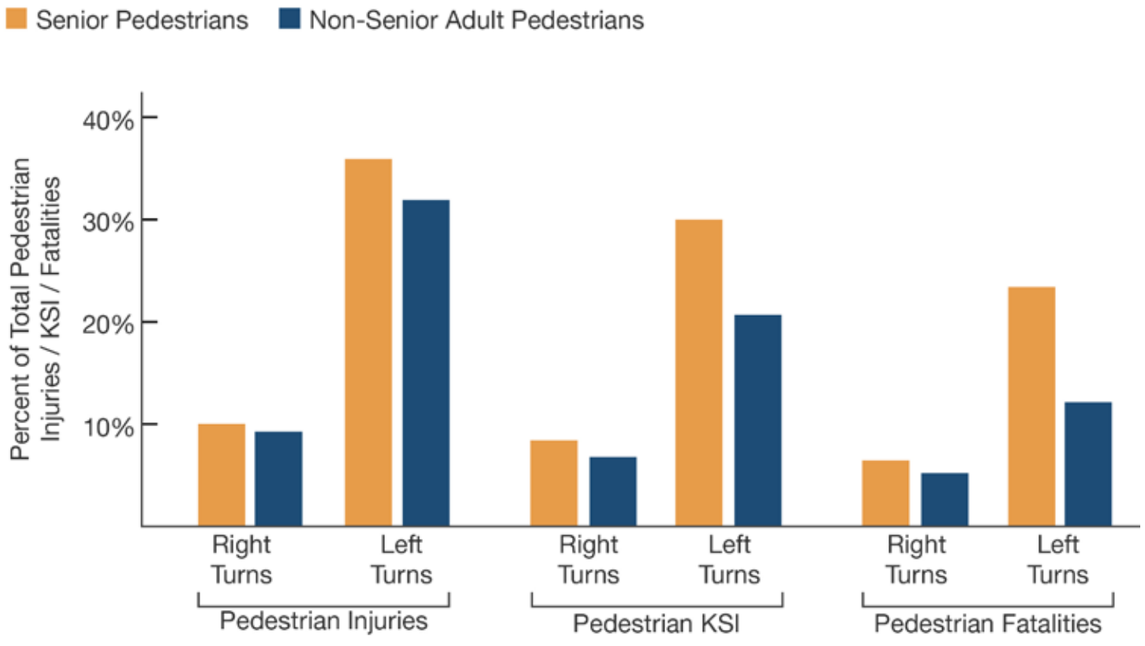
Failure to Yield and Left Turns

Left turn failure to yield crashes are nearly twice as deadly for seniors than for non-senior adults.

Vehicles failing to yield to a pedestrian who has the right of way is the most prominent factor involved in fatal crashes for seniors, accounting for 35% of senior pedestrian fatalities. Moreover, senior pedestrians have a higher rate of KSI and fatalities in failure to yield crashes than non-senior adults, a difference driven heavily by left turn crashes. The share of left turn failure to yield fatalities is more than 80% higher for seniors than for non-senior adults (23% vs 13%).

In general, injuries and fatalities involving left turning vehicles are more prevalent than right turn injury and fatalities for both non-senior adults and for seniors. This is likely due to the fact that left turn speeds tend to be slightly higher than right turn speeds, and pedestrian visibility is more likely to be an issue *(NYC DOT, 2016)*.

Failure to Yield Crashes by Turning Movement and Severity



Queens Boulevard, Queens

Backing

Backing vehicles are involved in 6% of senior pedestrian fatalities, over 2X the non-senior adult rate.

While only responsible for a small share of total fatalities, backing (or reversing) vehicles disproportionately kill and injure seniors. Backing vehicles are involved in 6% of all senior pedestrian fatalities, over double the rate for non-senior adults. In fact, seniors are injured more often by backing vehicles than by drivers making right turns (13% vs 11%). Injuries involving a backing vehicle typically occur when a pedestrian is attempting to cross midblock and is standing between two parked cars, when a driver backs into a crosswalk or when a driver backs out of a driveway across the sidewalk.

Backing crashes are most prevalent at midblock. Injuries involving a backing vehicle make up a third of all midblock injuries for seniors, but less than a quarter of non-senior adult injuries. Pedestrians usually cross between parked cars when crossing midblock, often waiting behind a vehicle for an opportunity to cross.

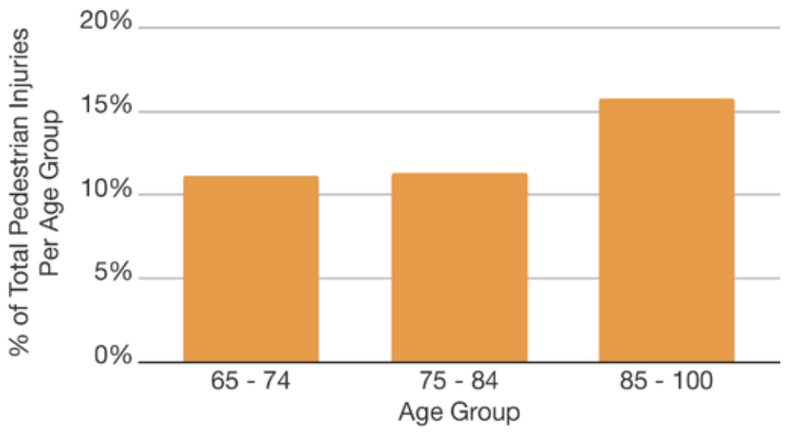
There is also a positive correlation with the progression of age and the share of injuries involving a backing vehicle. In the senior cohort, the older the senior, the higher the rate of injury from crashes involving a backing vehicle.

Percent of Pedestrian Injuries, KSI and Fatalities From Backing Crashes			
Age	% Injuries, Backing Crashes	% KSI, Backing Crashes	% Fatalities, Backing Crashes
Non-Senior Adults	9%	5%	3%
Seniors	13%	9%	6%

This pattern is unique to backing crashes. For all other crash types, injury rates by vehicle movement are more or less constant as seniors age.

The older the senior, the higher the rate of injury from crashes involving a backing vehicle.

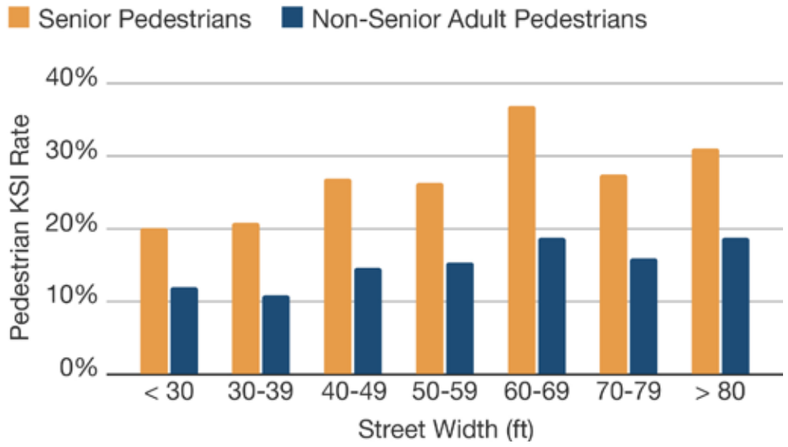
Percent of Pedestrian Injuries From Backing Crashes by Age Group



Backing crashes are typically very slow speed crashes where the pedestrian can usually avoid injury by detecting the moving vehicle and moving away. As senior pedestrians age, they may have a more difficult time quickly detecting and avoiding a backing vehicle. Pedestrian visibility, already constrained when a vehicle is reversing, may also be an issue, as seniors tend to be shorter than non-senior adults.

Street Width

Pedestrians Crossing Midblock: KSI Rate by Street Width



60-69' wide streets have the highest severe injury rate for senior pedestrians.

Pedestrian injuries on wider streets tend to be more severe for all New Yorkers, but the KSI rate (the percent of total injuries that are severe or fatal) for seniors increases more sharply as street width increases than it does for non-senior adults. Interestingly, this difference peaks at streets between 60 and 70 feet wide (about 4-5 travel lanes with parking lanes on each side), rather than on the widest streets. At that width, the severity rate for seniors is 37% as compared to just 19% for non-senior adults, meaning that 37% of all senior injuries on these streets are severe or fatal. In NYC, the majority of streets 70 feet or wider have some sort of separation in the roadway, like a concrete median. This can provide a safe place to wait or pause while crossing, limits exposure to traffic, and reduces the risk of a severe injury, particularly for seniors (see Safety Treatment Evaluation section of this report).

East Fordham Road, Bronx

Distance From Home

Senior pedestrian fatalities are more likely to occur close to home.

Senior pedestrians are often killed very close to home. According to New York City Department of Health and Mental Hygiene data, about one-quarter of senior fatalities occur less than 0.1 miles from their home, vs 14% for adults 18-64. This is a distance of about two short blocks. Conversely, it was nearly twice as common (55% vs 30%) for younger adult pedestrians to be killed farther from home (20+ blocks).

Exposure is always greatest close to home, as it is where most trips start and/or end. But seniors are much more likely to be retired, so their daily activities often do not take them as far from their homes as non-senior adults. They may also have mobility impairments which make longer trips difficult or uncomfortable.

Being close to home, seniors, like everyone else, likely feel confident taking short cuts, like crossing midblock, or against the signal, because the street conditions feel familiar. However, seniors are more likely to misjudge the speed of oncoming traffic and the time they have to cross, or not see oncoming traffic on multi lane roads or at complex intersections. A 2012 study found that even after training older pedestrians on safe street crossings, their ability to take into account the speed of oncoming traffic did not improve, leaving them more vulnerable as traffic speeds increased *(Dommes et al, 2012)*.

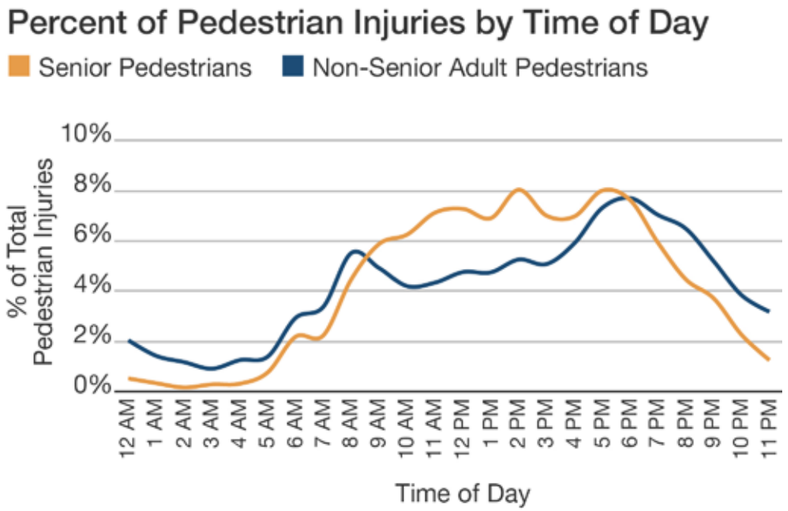
99 Street, Queens

Broadway, Manhattan

Time of Day

Senior pedestrians tend to be struck in the middle of the day.

There are also clear patterns around the time of day seniors are injured. Examining the entire 7-day week, seniors tend to be struck in the middle of the day, peaking at 2pm, while non-senior adult injuries peak in the evening around 6pm and remain high until around 10pm. It is likely that these patterns mimic peak pedestrian activity for both groups. Seniors, especially those who are not working, are more likely to be travelling or on the street midday, as opposed to during commute or nightlife hours. Numerous other studies have shown similar exposure patterns for older and non-senior adults. A Canadian study found that 88% of older people's pedestrian activity took place between 9am and 6pm *(Jonah & Engel, 1983)*.

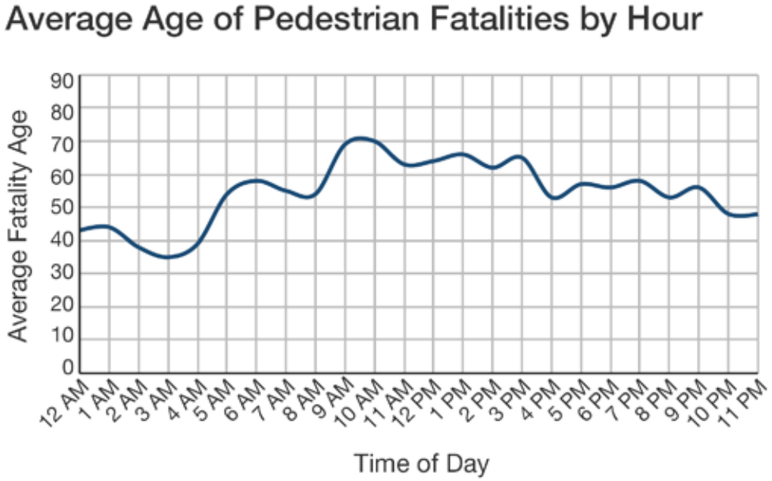


The majority of severe injuries for seniors occur during the work day and peak commute hours between 8am and 6pm, while severe injuries for non-senior adults tend to occur late at night. About 64% of senior KSI occurs between 8am and 6pm, while only 40% of non-senior adult KSI occurs during this time. This difference in severity further demonstrates the difference in fragility between seniors and non-senior adults. A midday crash is likely to be a slower speed crash (due to daytime traffic congestion), but even a slow speed crash can be deadly for a senior.

The average age of a pedestrian fatality is 35 at 3 am, 70 at 10 am.

Throughout the day, the average age of pedestrian fatalities varies widely. Overnight, the average age drops to a low of 35 years old at 3AM, when senior activity is very low. By 10am, the average age doubles to 70 years old when many younger people are at work, but senior pedestrian activity is high. Comparatively, the average age of a pedestrian fatality overall is 55 in New York City and 48 nationwide *(National Center for Statistics and Analysis, 2020)*.

Flatbush Ave, Brooklyn



Vehicle Type

There is a growing discussion around how SUVs present a greater danger to pedestrians than smaller passenger vehicles. NYC DOT does not have reliable data on how much traffic in New York City consists of SUVs, so it is unclear if SUVs make up a disproportionate slice of pedestrian injuries. However, rates for senior and non-senior adult injuries can be compared to see if the greater height and mass of an SUV poses a greater danger to older pedestrians.

Seniors are, in fact, only injured by SUVs at a slightly higher rate than non-senior adults. 48% of all senior pedestrian injuries involve an SUV as compared to 45% of non-senior adult injuries. The overrepresentation is similar for senior KSI (45% vs 42%) and for fatal crashes (28% vs 26%).

Houston Street, Manhattan

East 42 Street, Manhattan

Grand Street, Manhattan

A slightly larger disparity does exist in severe crashes involving oversized vehicles, such as trucks, buses and construction vehicles. 16% of senior pedestrian KSI crashes involve an oversized vehicle compared to 10% for non-senior adults. Still, fatalities involving oversized vehicles, which are the dominant vehicle type involved in pedestrian fatalities, show an identical rate for seniors and non-senior adults (~39%).

Seniors and Bikes

Pedestrian fatalities or injuries from collisions with cyclists are very rare. Between 2017 and 2019, only one senior and two non-senior adult pedestrians died after being struck by cyclists. Over the same time period, approximately 96% of senior injuries and 97% of non-senior adult injuries involved motor vehicles. Less than 1% of senior pedestrian fatalities involved being struck by a cyclist. In fact, more seniors are injured and killed while riding their bike than by being struck by a cyclist. Between 2017 and 2019, 187 senior pedestrians were injured in a crash involving a cyclist, while 406 seniors were injured while riding their bike. During these same years, 12 senior cyclists were killed in crashes involving a vehicle.

In general, cycling infrastructure greatly benefits pedestrian safety. As outlined in the following section, after installing protected bike lanes, senior pedestrian KSI fell by 39% and injuries fell by 22%.

More seniors are injured and killed while riding their bike than by being struck by a cyclist.

In addition, there are many NYC DOT interventions deployed specifically to reduce pedestrian and cyclist conflict. Whenever possible, bike lanes are designed as either two-way or as two one-way pairs on separate streets. Providing a route both ‘to’ and ‘from’ a destination helps keep cyclists off the sidewalk and minimizes biking against traffic, both of which are good for pedestrian safety. Pedestrian refuge islands open up sight lines so cyclists, motorists, and pedestrians can more easily see each other. In some less common instances where motor vehicles are entirely absent, NYC DOT has used flashing yellow lights and bike rumble strips to help focus cyclist attention as they approach uncontrolled pedestrian crossings.

Rivington Street, Manhattan

4 Safety Treatment Evaluation

NYC DOT has completed over 900 street improvement projects since 2010 including over 150 miles of protected bike lanes, retimed signals for 25MPH on over 800 miles of streets and installed over 4,600 leading pedestrian intervals (LPIs). To determine which of these efforts deliver safety benefits to senior pedestrians, NYC DOT conducted a wide-ranging before and after analysis to compare injury, severe injury, and fatality changes between seniors and non-senior adults by safety treatment. Solutions that specifically benefit seniors tend to exhibit four features: slowing vehicle speeds, reducing pedestrian exposure to vehicles (e.g. shortening crossing distance or holding traffic while pedestrians cross), slowing turns, and providing refuge for pedestrians. The best solutions combine two or more of these characteristics. Locations where these street safety treatments were installed saw strong reductions in KSI across the board. Senior injuries dropped more after installation of these treatments than for non-senior adults, an important finding because even a minor injury can become fatal for older pedestrians, meaning these relatively simple treatments can be life-saving.

Broadway, Manhattan

Queens Plaza North, Queens

Columbus Avenue, Manhattan

Still, it is important to note that these are spot, rather than network, treatments and the amount that can be installed in a given year can only cover a small percentage of the thousands of intersections and street miles in the city. The evidence shows these treatments work locally, lowering senior injuries and KSI by up to 60%, but to significantly affect the citywide trend for senior injuries and KSI, many more of these treatments need to be installed.

NYC DOT is also expanding system wide improvements, e.g. speed cameras, lowering of speed limits and signal retiming, that improve safety city wide. These are changes that improve many miles of corridors and intersections at once.

Similarly, efforts like congestion pricing for Manhattan, which requires state and federal action, would reduce traffic in highly congested areas. This would thereby reduce exposure for seniors, especially since Manhattan has high levels of senior pedestrian activity. Cities that have enacted some form of congestion pricing have seen crash reductions. In the five years following the enactment of the congestion zone in London, there was a 40% drop in crashes in the zone compared to 20 other UK cities over the same time frame *(Green et al, 2016)*.

Methodology

This section evaluates the effectiveness of specific safety treatments. NYC DOT employed a simple before/after injury analysis, comparing the average year of crash data before treatment installation to the average year of crash data after installation. In the before scenario, three years of crash data prior to the installation of a treatment were averaged, whereas in the after condition, two years were averaged in cases where three years of data was unavailable, otherwise three years of data were averaged. For this task, the report utilized comprehensive NYSDOT data which classifies injury crashes by severity. However, the availability and completeness of data for each treatment within this data set varies. Accordingly, NYC DOT relied on varying sample sizes for the evaluation of each treatment, ranging from 28 distinct Road Diets to over 1,200 Leading Pedestrian Intervals (LPIs). This part of the study focuses on pedestrian injuries and KSI, however for certain treatments the sample size of the latter was too small to support a reliable finding. When injuries were analyzed, fatal injuries were included as well. The findings demonstrate the effectiveness of the treatment type in mitigating pedestrian injuries and KSI for Younger Adults (aged 25-64) compared to that of Seniors (aged 65-100). Treatments tested include:

Safety Features

- Road Diets (defined as, but not limited to, corridor projects with an added flush median, bike lane or a widened parking lane, and a removed vehicular moving lane for at least 1,000 contiguous feet)
- Conventional Bicycle Lanes (a lane defined only by paint, sometimes referred to as Class II Bicycle Facilities)
- Protected Bicycle Lanes (a lane protected by parking or some other physical barrier, sometimes referred to as Class I Bicycle Facilities)
- Pedestrian Islands (concrete pedestrian islands and medians, as well as extensions of concrete medians)
- Curb and Sidewalk Extensions (includes neckdowns)
- Turn Calming (markings, plastic bollards and/or rubber speed bumps that slow and control turns)
- Leading Pedestrian Intervals (LPIs - providing a pedestrian crossing “head start” before vehicles receive the green light)

Union Square, Manhattan

Citywide Background Trend

6th Avenue, Manhattan

New York City's streets have changed substantially over the last several years as improvements made under Vision Zero emphasize safety for vulnerable road users. These changes, including new signal timing, speed cameras, road diets, protected bike lanes and turn calming, may have played an important role in making the city considerably safer for pedestrians in terms of severe injuries and fatalities. However, all pedestrian injuries (including all minor injuries) rose annually on average over the study period, in line with population growth. Non-senior adult pedestrian injuries rose 3% but KSI was unchanged. Similarly, senior pedestrian injuries rose 4% and KSI rose 3%. However, as discussed earlier in this report, the city's senior population expanded by 24%. Comparing these overall trends to specific treatments helps highlight which solutions work best for seniors.

Safety Features:

Slowing Vehicle Speeds

Encourage lower vehicle speeds, usually by motor vehicle lane reduction or lane narrowing.

Reducing Pedestrian Exposure

Reduce opportunities for pedestrians to be struck, either by shortened crossing distances, reduced travel space for motor vehicles or traffic signals providing pedestrian-only crossing time.

Slowing Turns

Encourage lower motor vehicle turning speeds, either through sharper turns (closer to a 90 degree angle) or by vehicles stopping before making a turn.

Providing Pedestrian Refuge

Create a protected space for pedestrians to stop while crossing the roadway.

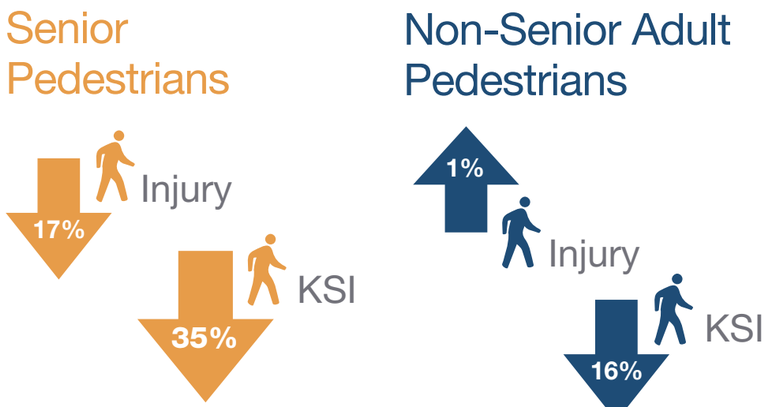
Safety Treatment Effectiveness

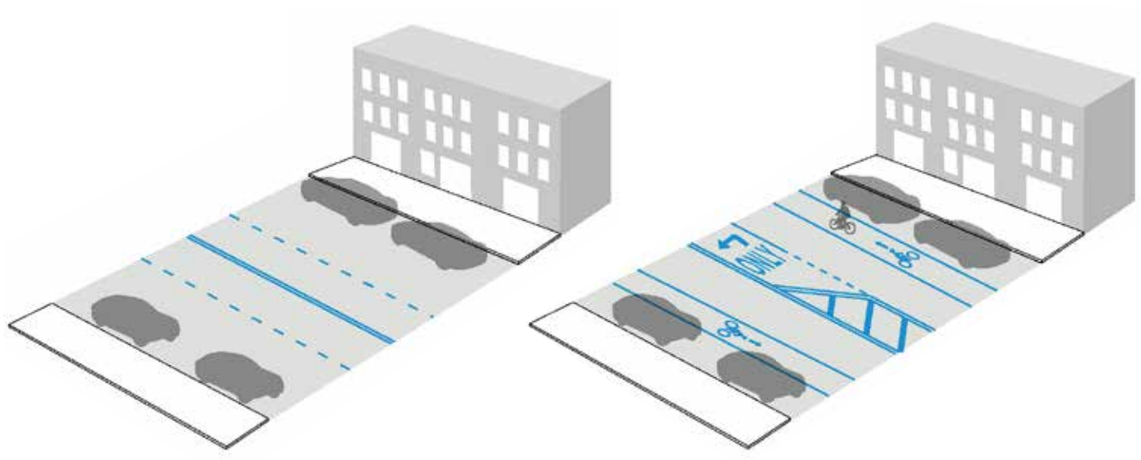
Treatment Name & Safety Features	Senior Pedestrian Injuries	Senior Pedestrian KSI	Non-Senior Adult Pedestrian Injuries	Non-Senior Adult Pedestrian KSI
Road Diets	↓ 17%	↓ 35%	↑ 1%	↓ 16%
Conventional Bike Lanes	↑ 4%	↓ 23%	↑ 8%	↑ 8%
Protected Bike Lanes	↓ 22%	↓ 39%	↓ 9%	↓ 24%
Pedestrian Islands	↓ 20%	↓ 25%	↓ 3%	↓ 39%
Curb and Sidewalk Extensions	↓ 22%	↓ 15%	↑ 1%	↓ 45%
Turn Calming	↓ 19%	↓ 60%	↓ 10%	↓ 2%
Leading Pedestrian Intervals (LPIs)	↓ 15%	↓ 41%	↓ 7%	↓ 26%

Road Diets

Removing or narrowing lanes, often referred to as road diets, can reduce traffic speeds and can also reduce pedestrian exposure to moving vehicles. Lane removal typically means converting a four lane road to three lane road: two travel lanes and one turning lane in the middle. This “right-sizing” of the road provides the appropriate number of travel lanes for vehicular demand. Reducing travel to one lane also reduces vehicle speeds and dangerous weaving movements by eliminating the passing lane.

Additionally, removing a travel lane means less exposure to traffic when a pedestrian crosses the street. Fewer active travel lanes means fewer interactions between pedestrians and turning vehicles. Turning vehicles are involved in about half of all senior injuries.





Roadway Configuration Before Road Diet

Roadway Configuration After Road Diet

Narrowing lanes works similarly to lane removal, by right-sizing the road and better allocating space to all road users. Additionally, because the road is narrower, vehicles tend to travel slower.

86 Street, Brooklyn

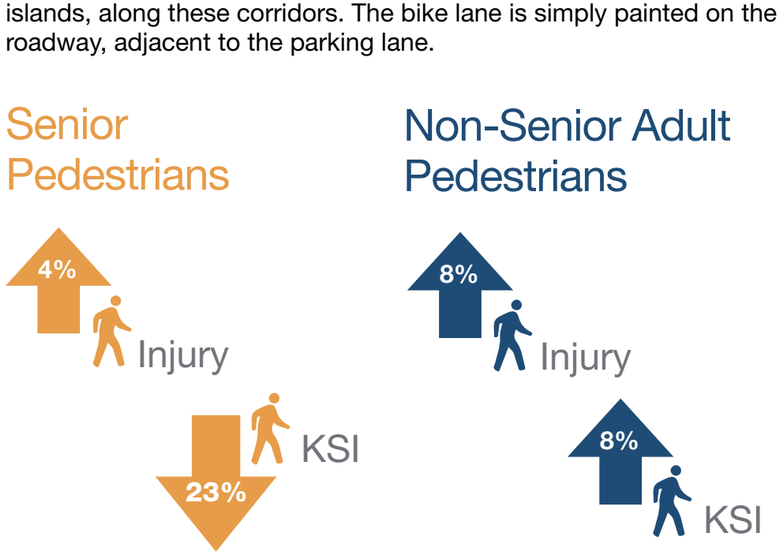
86 Street, Brooklyn

Bike Lanes

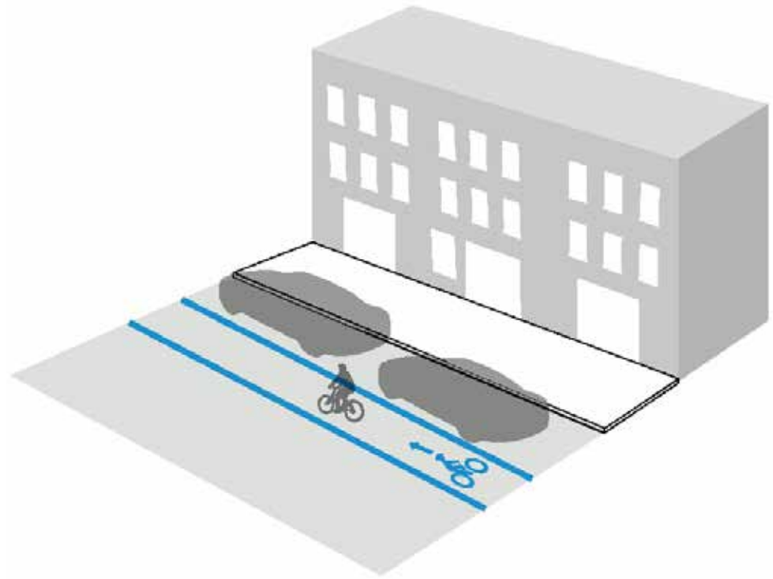
Installation of new bike lanes usually coincides with the removal or narrowing of vehicle lanes. Space for bike lanes is typically made from removing parking, removing a travel lane, or narrowing existing lanes, and sometimes a combination of the above. Bike lanes help slow traffic by visually tightening the roadway, and signaling that other road users, particularly vulnerable road users, are present.

Conventional Bike Lanes

Painted bike lanes, or Class II lanes, are conventional bike lanes that are currently on over 500 miles of NYC streets. Typically, there is no “hard” infrastructure, such as concrete medians or pedestrian islands, along these corridors. The bike lane is simply painted on the roadway, adjacent to the parking lane.



Still, this treatment appears to greatly reduce the severity of crashes involving senior pedestrians. After Class II lanes were installed, those roadways saw a 23% decline in senior pedestrian KSI compared to an 8% increase in KSI for non-senior adults. However, both senior and non-senior adult injuries rose by 4% and 8% respectively. It is difficult to determine why injuries rose after the conventional bike lanes were added. However, it is not uncommon to see minor injuries rise while severity falls, an indication of greater roadway “friction” and slower speed crashes. It is important to note that this study only looks at vehicle-on-pedestrian crashes, so the increase is not driven by bicycle-on-pedestrian crashes.



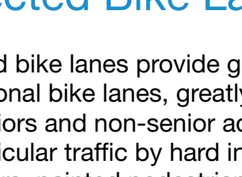
Conventional Bike Lane

West 55 Street, Manhattan

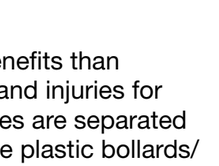
Protected Bike Lanes

Protected bike lanes provide greater safety benefits than conventional bike lanes, greatly reducing KSI and injuries for both seniors and non-senior adults. These lanes are separated from vehicular traffic by hard infrastructure, like plastic bollards/ delineators, painted pedestrian space or a row of parked cars, usually requiring lane or parking removal (or both). At the intersection, protected bike lanes often include pedestrian islands. These islands slow turns, shorten crossing distances for pedestrians and increase pedestrian visibility to drivers. On streets with protected bike lanes, seniors saw a 39% decrease in KSI and a 22% drop in overall injuries. Non-senior adults saw a 24% drop in KSI and 9% drop in overall injuries. So, while this commonly-used road treatment benefits all adults, it especially improves conditions for seniors.

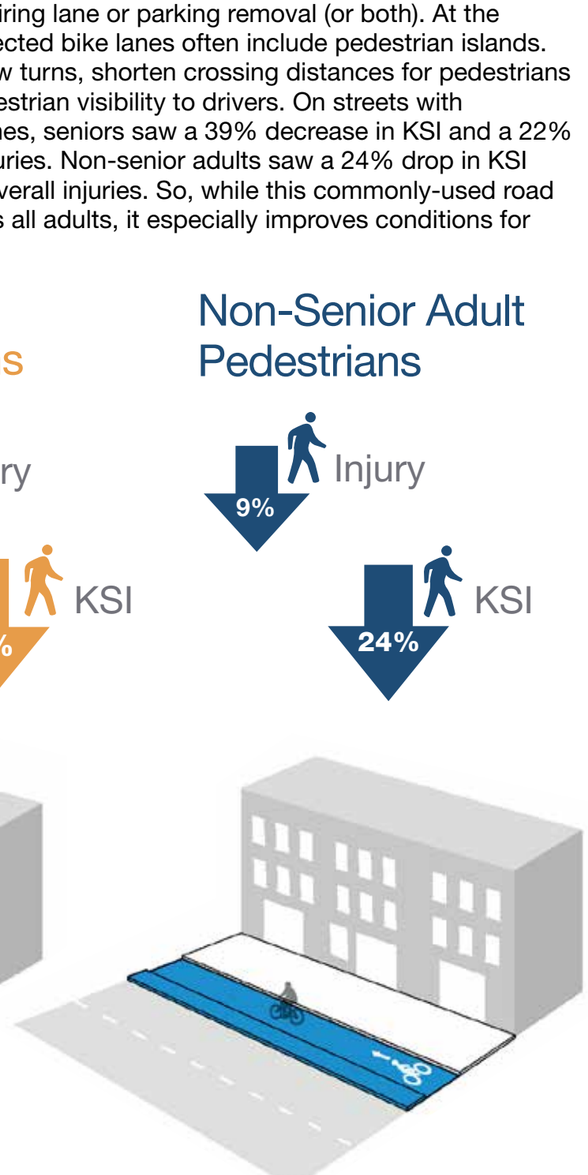
Senior Pedestrians



Non-Senior Adult Pedestrians



Parking Protected Bike Lane



Protected Bike Lane

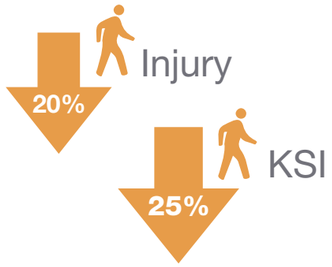
8 Avenue, Manhattan

Central Park West, Manhattan

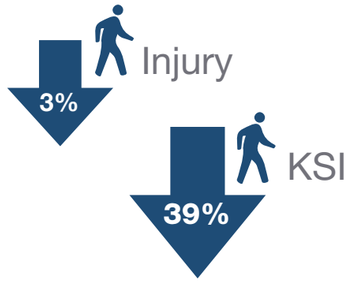
Pedestrian Islands

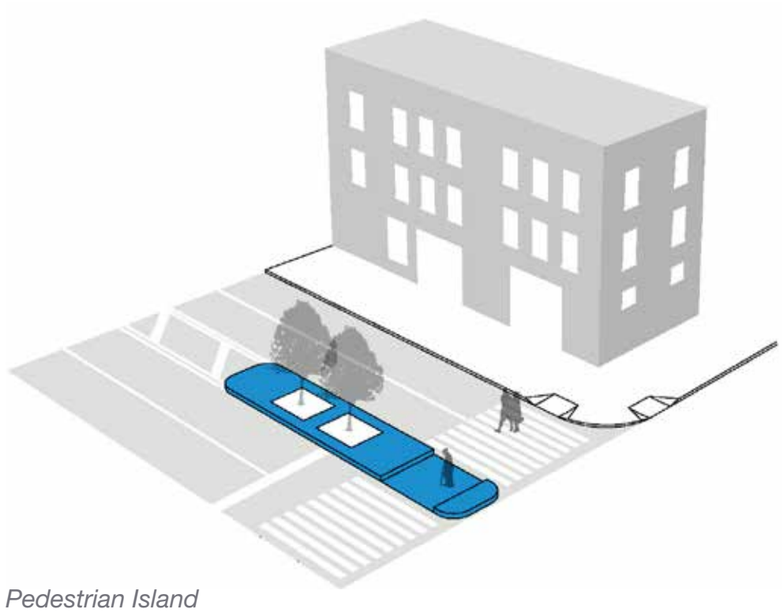
Concrete pedestrian islands (including variations such as center medians and median tips/extensions) provide refuge, reduce exposure and slow vehicular turns. Islands often divide roads into two travel directions, splitting the crossing into two separate lengths and reducing the crossing distance. This separation gives pedestrians a place to wait safely if they do not have enough time to cross the whole road before signals change. Older pedestrians may also require a longer crossing time than non-senior adults. They may not be able to cross an entire street unless they start at the very beginning of the crossing phase, and so the islands provide a safe place to wait for the next signal.

Senior Pedestrians



Non-Senior Adult Pedestrians





Pedestrian Island

116 Street, Manhattan

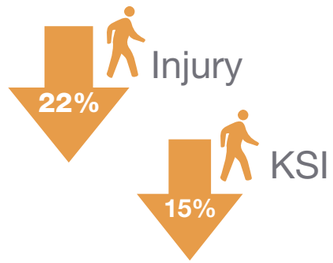
Where pedestrian islands have been installed, there was a 25% decrease in senior KSI, and a 39% decrease for non-senior adults. However, senior injuries decreased by 20% while non-senior adult injuries saw only a small change at a 3% reduction. This is significant given that even minor injuries can turn serious for seniors. Many pedestrian islands can act as a turn calming treatment because they force vehicles to turn at a sharper angle, around the tip of the island. Slower turn speeds would be expected to reduce failure to yield crashes, a special concern for seniors. Slower speeds are likely driving the reduction of severe injuries across the board.

Likewise, seniors have a higher rate of injuries involving turning vehicles, especially left turns, and pedestrian islands installed on the centerline of two-way streets can reduce the speed of left turns. Also, seniors may be physically less able to change direction or speed to avoid vehicles that do not yield. *(Dunbar, Holland & Maylor 2004)* The island provides refuge for pedestrians who may wait until there are no turning vehicles.

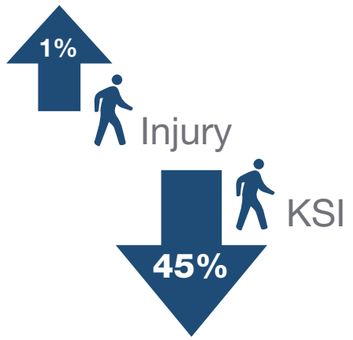
Curb and Sidewalk Extensions

This category of treatment includes any expansion of the sidewalk and curb with painted pedestrian space or concrete, including neckdowns and block long sidewalk extensions. Curb and sidewalk extensions reduce exposure by reducing crossing distances and can slow turn speeds by changing the angle at which drivers must make the turn. Curb extensions also increase visibility at intersections by putting pedestrians who are about to cross more into the drivers' field of view, helping to reduce potential failure to yield crashes. On streets and intersections where sidewalk extensions and curb extensions were installed, injuries dropped 22% for seniors, but were flat for non-senior adults. KSI was down across the board, declining 45% for non-senior adults and 15% for seniors.

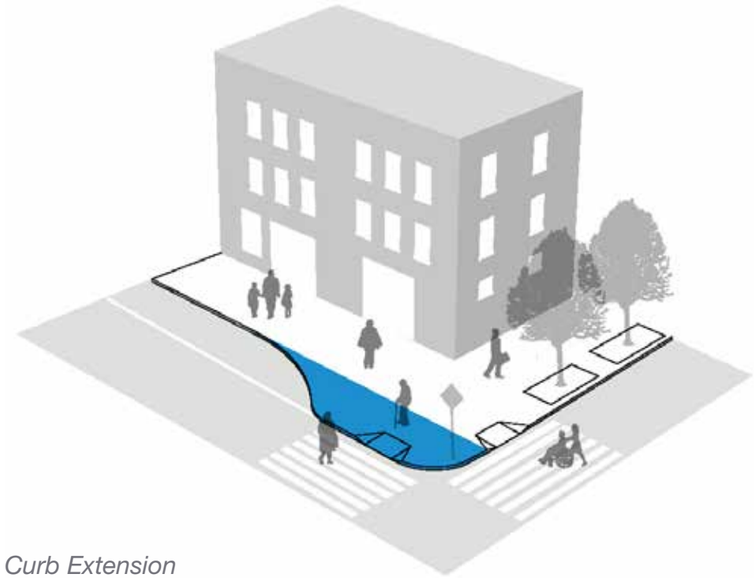
Senior Pedestrians



Non-Senior Adult Pedestrians



Riverside Drive, Manhattan

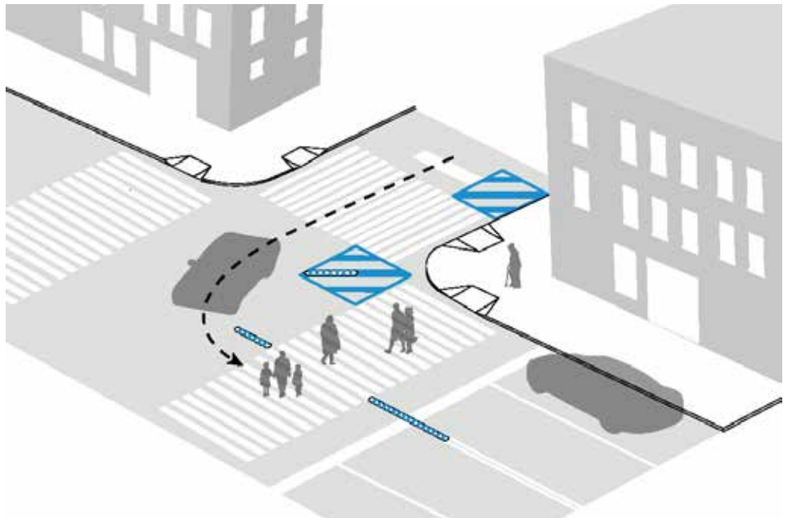


Curb Extension

Willoughby Avenue, Brooklyn

Turn Calming

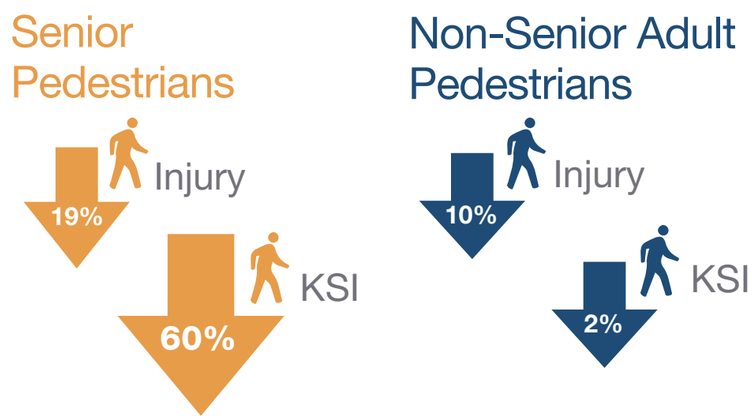
Turn Calming refers to a suite of low-cost interventions deployed at locations with histories of pedestrian and bike injuries involving turning vehicles (mainly left turns). These treatments are used to change the angle of the vehicle turn and to reduce pedestrian exposure in the crosswalk. Rubber speed bumps or plastic bollards are installed on the inside corner of the turn on one-way streets ("slow turn wedge"), or in between travel lanes on two-way streets ("hardened center line") to force vehicles to make turns at more of a right angle. This angle slows turn speeds and puts pedestrians crossing directly in front of the driver's point of view, increasing their visibility. The hardened center line also reduces the exposure of the crossing pedestrians to turning vehicles, as most vehicles will turn to avoid the bollards or rubber speed bumps.



Turn Calming

East 116 Street, Manhattan

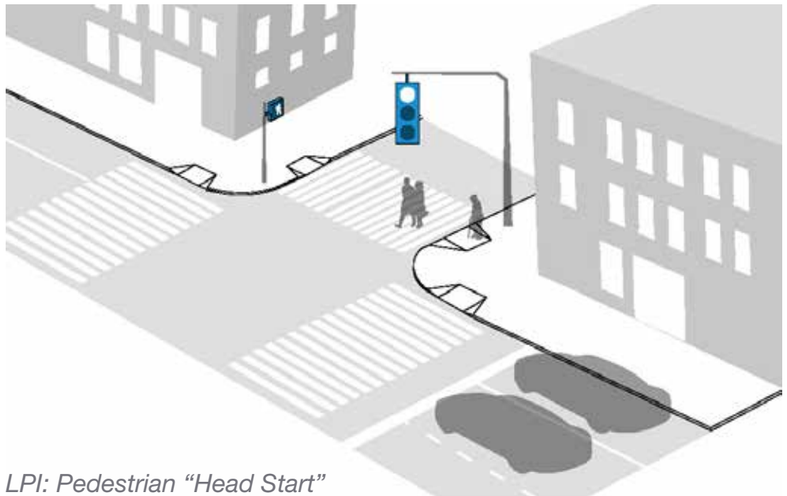
These treatments strongly benefit senior pedestrians in reducing traffic injuries. Seniors saw a 19% decrease in pedestrian injuries after turn calming was installed, while younger pedestrian injuries fell only 10%. Decreases in pedestrian KSI were even more dramatic; it is likely that this treatment benefited seniors more than non-senior adults because it targets a specific crash type (left turning vehicles) that is overrepresented for senior pedestrians in NYC.



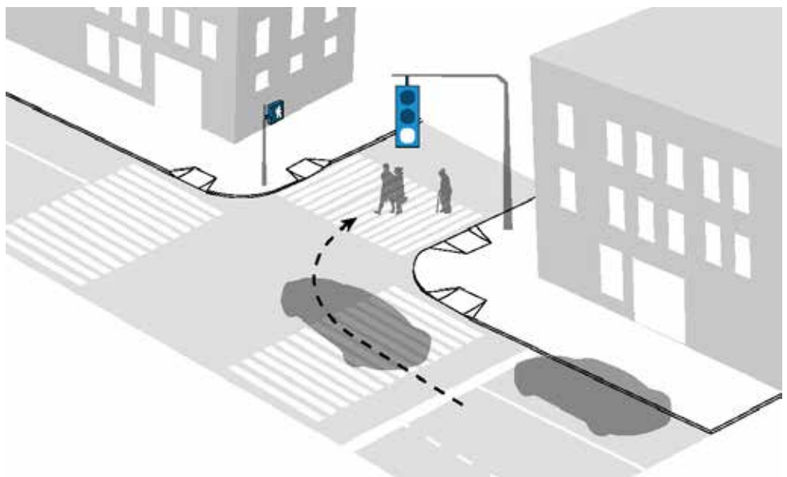
Marcy Avenue, Brooklyn

Leading Pedestrian Intervals (LPIs)

An LPI is a traffic signal treatment where a crossing pedestrian receives several seconds of “head start” on the walk signal before parallel vehicular traffic is permitted to move and turn across the crosswalk. LPIs reduce pedestrian exposure and improve yielding rates by separating pedestrian and vehicle movements at intersections and putting pedestrians in a location more visible to drivers when they begin turning. In NYC, this head start is typically seven seconds. Assuming pedestrians begin crossing when their phase begins, pedestrians may be able to cross most of the street, or be at least towards the middle of the crosswalk before any driver starts turning.

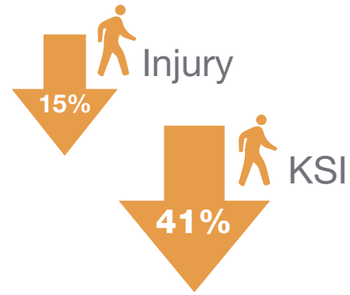


LPI: Pedestrian “Head Start”

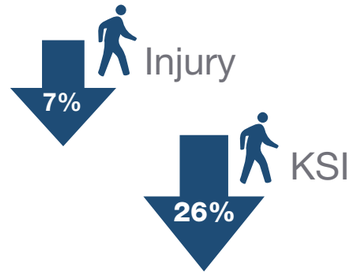


LPI: Parallel Vehicle Traffic Gets the Green Light

Senior Pedestrians



Non-Senior Adult Pedestrians



Since LPIs reduce exposure in the crosswalk and encourage better yielding from motorists, one would expect to see reductions in both injuries (less exposure leading to fewer overall crashes) and KSI (slower turns leading to less severe crashes). This was in fact true for both seniors and non-senior adults, with the most dramatic results for senior KSI. At intersections where LPIs were installed, senior KSI dropped by 41% while non-senior adult KSI dropped by 26%. Injuries at these intersections fell 15% for seniors and 7% for non-senior adults.

Madison Avenue, Manhattan

5 Action Plan

Create Senior Pedestrian Zones to Guide Engineering, Enforcement and Education

The new NYC DOT Senior Pedestrian Zones identify neighborhoods that have the highest proportion of senior pedestrian injuries relative to the residential population of seniors in that neighborhood. These zones will be used to target senior-focused engineering, education and enforcement efforts in the future.

The Senior Pedestrian Zones employ Neighborhood Tabulation Areas (NTAs), a geography developed by the Department of City Planning. The NTAs are collections of Census tracts that loosely reflect established New York City neighborhood boundaries, where at least 15,000 people reside. The Senior Pedestrian Zones represent the highest quintile of NTAs ranked by senior injuries, normalized by senior population. NTAs with very small senior populations (i.e. less than 1 standard deviation below the NTA average, or less than ~2,700 seniors) were excluded from this analysis.

East Fordham Road, Bronx

Senior Pedestrian Zones

The Senior Pedestrian Zones represent the areas of the city with the highest rate of senior pedestrian injury relative to senior population.

They are based on neighborhood tabulation (NTA) geographies and reflect the highest 20% of neighborhoods ranked by senior pedestrian injuries per senior residents. NTAs with a low senior population (below the citywide mean less 1 standard deviation) are excluded.

The Senior Pedestrian Zones include:

- 19% of the citywide senior population
- 33% of citywide senior pedestrian injuries
- 31% of citywide senior pedestrians killed or severely injured (KSI)
- 13% of citywide square mileage

Senior Pedestrian Zones

Vision Zero Priority Corridors

Engineering and Planning

Extend Exclusive Pedestrian Crossing Time (LPIs) in Senior Pedestrian Zones by the End of 2024

NYC DOT will extend protected crossing time for all feasible existing LPIs in Senior Pedestrian Zones, typically extending LPIs from seven to ten seconds. This initiative will be completed by the end of 2024.

Add Exclusive Pedestrian Crossing (LPIs) Time at All Feasible Intersections on Priority Corridors in Senior Pedestrian Zones by the End of 2024

NYC DOT will install new LPIs at all feasible intersections on Priority Corridors in Senior Pedestrian Zones. This initiative will be completed by the end of 2024.

Extend Exclusive Pedestrian Crossing Time (LPIs) during Mid-Day for All New LPIs

Moving forward, all new LPIs citywide will have a new standard of extended pedestrian only phases mid-day, where feasible.

Madison Avenue, Manhattan

6 Avenue, Manhattan

Fulton Street, Brooklyn

Create Senior Turn Calming Initiative and Install Treatments at 50 Intersections Annually

As part of NYC DOT's commitment to doubling the Turn Calming Program, the agency will install senior-targeted turn calming treatments at 50 intersections per year within the Senior Pedestrian Zones. The treatments will include an LPI (new or existing) and rapid-deployment materials such as rubber speed bumps. These materials will be used to create the same "hardened center line" that NYC DOT has deployed for the Turn Calming Program. By reducing pedestrian exposure and by slowing turns, LPIs and hardened centerlines have been shown to greatly reduce senior pedestrian KSI. NYC DOT expects that combining the two treatments together will bring an even larger benefit to seniors, as well as younger New Yorkers.

Implement Ten or More Senior Street Improvement Projects Annually

Street Improvement Projects (SIPs) use NYC DOT's toolkit of street treatments to increase safety for all street users. These interventions can include road diets, bike lanes, pedestrian islands, curb and sidewalk extensions, Turn Calming, LPIs, as well as many other treatments and project types. NYC DOT will implement at least 10 Vision Zero (safety-focused) SIPs annually at locations with documented histories of senior pedestrian injuries. In developing these Senior SIPs, planners will focus on the robust treatments that have been proven to increase safety for seniors such as road diets, pedestrian islands, LPIs, and curb/sidewalk extensions. Senior SIPs will either be Vision Zero SIPs that are constructed within Senior Zones or Vision Zero SIPs where the project area has a substantially higher percentage of senior pedestrian injuries, as compared to the borough average.

Sheepshead Bay Road, Brooklyn

Bedford Street, Manhattan

Target Raised Crosswalks to Senior Pedestrians

In 2022, NYC DOT will begin a program to construct 100 Raised Crosswalks at curb level annually. As part of this effort, NYC DOT will commit to installing additional Raised Crosswalks, targeted near generators of senior activity, like parks and senior homes. Raised Crosswalks are a proven traffic calming treatment that lower turning speeds and increase rates of yielding. Similar to a speed hump, the raised asphalt slows vehicles passing over it, and puts pedestrians in a more visible position to drivers. In addition to these safety benefits, Raised Crosswalks are also more comfortable to cross because they are level with the sidewalk. The seamless transition between sidewalk and crosswalk allows seniors to focus more on turning vehicles than on navigating the street. A positive side-effect of installing Raised Crosswalks is that they also eliminate large puddles or ice that often form at pedestrian ramps and pose their own hazard or force pedestrians to cross outside the crosswalk.

Target Safety Improvements to Bus Stop Locations Under Elevated Trains

The Bus Stops Under the El (BSUE) initiative targets safety improvements to bus stop locations under elevated rail structures through the construction of bus boarding islands or concrete bus bulbs.

Bus stops underneath elevated rail structures in NYC pose unique challenges for bus riders and for seniors in particular. At these locations, subway columns prevent buses from accessing the curb and bus riders are forced to wait for, board, and disembark the bus in the street. This increases exposure by leaving bus riders vulnerable to collisions with vehicles. Even more challenges are present for seniors and those with mobility impairments, who may require the aid of the bus' wheelchair ramp. These populations are also even more likely to rely on the bus, due to the lack of elevators at many subway stations along these corridors.

Westchester Avenue, Bronx

White Plains Road, Bronx

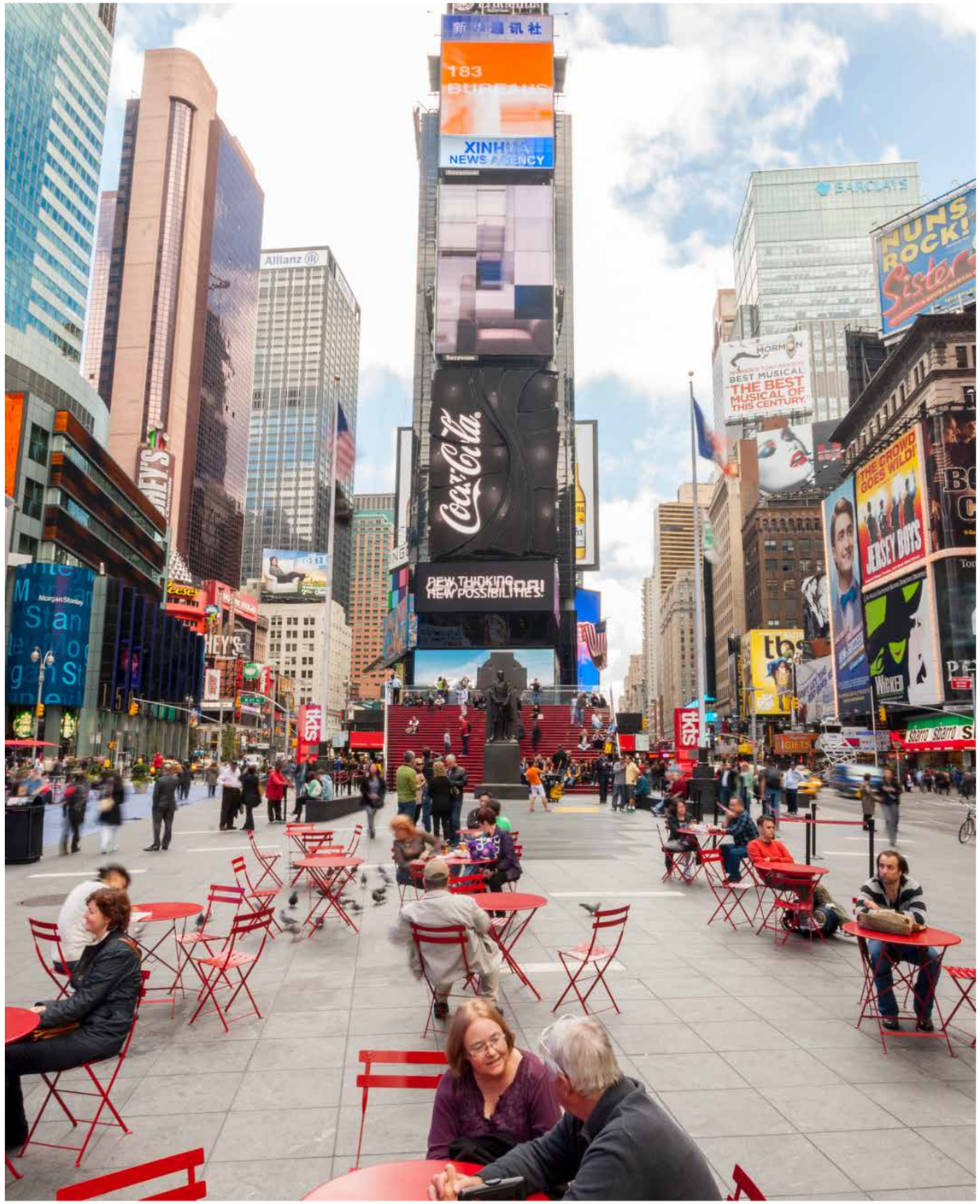
NYC DOT makes improvements at these locations by constructing bus boarding islands and bus bulbs at existing bus stop locations under elevated trains. These improvements provide bus riders refuge by providing a safe space to wait for the bus and a level boarding area. The removal of the travel lanes or service road areas between the columns and the curb also gives pedestrians the ability to access bus stops without additional exposure to vehicles, reducing conflicts between drivers and pedestrians. The improvements also enhance bus operations by increasing visibility, expediting pick up and drop off, and increasing the predictability of vehicle and pedestrian movements.

NYC DOT, in coordination with New York City Transit, plans to continue to make improvements at these locations in the coming years. These improvements will take the form of both in-house and capital projects.

Continue to Improve Safety for Senior Pedestrians in Midtown

Midtown Manhattan, stretching roughly from 34th street to 59th Street, is an outlier group of neighborhoods within New York City, the United States, as well as internationally. Home to most of the city's tallest buildings, busiest transit hubs, and iconic attractions, pedestrians are present and active at all hours of the day and night. Midtown attracts Manhattanites, outer-borough and out-of-state commuters, and tourists from across the globe. Virtually every subway line passes through, while commuter bus and rail lines converge at the city's three major transit terminals. However, Midtown also accounts for one of the densest concentrations of pedestrian (and senior pedestrian) KSI in New York City. Because of these unique conditions, NYC DOT has been investing substantial resources in safety improvements in Midtown for more than a decade and the area boasts some of the city's most ambitious street redesign projects and highest concentrations of safety treatments such as traffic signals and LPIs. NYC DOT has implemented extensive pedestrian plazas at Times Square and Herald Square, many miles of protected bike lanes on iconic Manhattan avenues such as 1st, 2nd, 6th, 8th and 9th, crosstown protected lanes such as 52nd and 55th Streets, and bus lanes on 3rd, 5th and Madison Avenues, as well as on 42nd St, spanning across most of Manhattan. NYC DOT will continue to work to improve safety for senior pedestrians and all road users in Midtown, tailoring projects to the unique challenges and assets of these neighborhoods.

Broadway, Manhattan



Times Square, Manhattan

Education and Marketing

Target Senior Education and Outreach to Senior Pedestrian Zones

NYC DOT will continue to reach out to older New Yorkers at senior centers each year, targeting locations in Senior Pedestrian Zones. Any meetings will strictly adhere to any City and State guidelines for social distancing in the COVID19 era. In-person meetings may be curtailed or limited, but the NYC DOT Safety Education Office will continue to make sure that seniors in New York City continue to receive regular education on pedestrian safety by whatever means available, including remote presentations to senior centers, digital print copies of NYC DOT's magazine for older New Yorkers, Streetwise, as well as online access to digital publications. NYC DOT will refresh their senior pedestrian safety curriculum with the findings of this report, with a special focus on: being alert close to home, avoiding left turning vehicles and backing vehicles, avoiding mid-block crossings on wider, high speed roads, taking advantage of NYC DOT infrastructure like pedestrian islands and protected bike lanes, and techniques for estimating crossing time and the speed of oncoming traffic. In addition to NYC DOT's work, NYPD also conducts outreach to older New Yorkers at places of worship and Naturally Occurring Retirement Communities (NORCs).

DOT Sign Shop, Queens

Work With Medical Providers on Senior Pedestrian Outreach

Working through the NYC Department of Health and Mental Hygiene, NYC DOT will provide instructional materials to physicians and other medical providers to assist them in training older New Yorkers on how to continue using NYC's streets smartly and safely. The materials will be based on the findings of this report and will focus on proven interventions that can help seniors avoid pedestrian injuries. The effort will be modeled on the Health Department's successful program for Preventing Falls in Older Adults and will utilize many of the same resources and communication channels, including the Health Department's Healthy Aging Working Group and the NYC Regional Trauma Advisory Committees (RTAC) Injury Prevention Subcommittee.

Vision Zero View Website

Add Senior Pedestrian Crash Data to Vision Zero View

Vision Zero View is an interactive tool deployed in the city that shows detailed monthly information on traffic injury and fatality crashes in New York City, as well as highlighting Vision Zero safety efforts. NYC DOT will add a new feature to the tool to allow users to map and quantify senior pedestrian injuries and fatalities, similar to the way the current tool handles bicycle and motor vehicle injuries and fatalities.

Conduct Outreach to Senior Pedestrian Zone Stakeholders

NYC DOT will communicate regarding this study to Community Boards, local elected officials and other stakeholders that are within the new Senior Zones. This outreach will alert these stakeholders about the new Zones, the new initiatives contained in this report and that these safety projects will be coming to their respective neighborhoods.

Enforcement

NYPD Will Conduct Senior Pedestrian Safety Enforcement Initiatives Focusing on Daytime Hours and the Senior Pedestrian Zones

In addition to their continued citywide enforcement of Vision Zero Violations, NYPD will begin a sharper focus on the targeting of dangerous driver behavior in areas where senior injuries and population are concentrated. Vision Zero Violations are those that most threaten vulnerable road users, including failure to yield, cell phone use, speeding and disobeying traffic control devices.

NYPD Will Continue to Identify Seniors with Head Injuries for Enhanced Crash Investigations

The NYPD's Collision Investigation Squad (CIS) are the lead investigators of fatal crashes in the city, supporting the prosecution and conviction of dangerous drivers; CIS also collects valuable information that informs NYC DOT's safety efforts. Because even minor injuries can become deadly for seniors in the days or weeks following a crash, at times senior pedestrian fatalities do not receive an immediate CIS investigation. If the investigation starts after the crash site has been cleared and conditions have changed, it is much more difficult to gather the details of the crash. In 2018, NYPD began the practice of engaging the on-scene EMS personnel to assess in greater detail the injury severity of seniors with head injuries. This assessment allows EMS to trigger a CIS investigation, even if the senior's injuries do not seem immediately life-threatening.

14 Street, Manhattan

Legislation and Policy

72 Street, Manhattan

Advocate for Vehicle Designs That Increase Pedestrian Visibility

Blind spots and other visibility issues for vehicle drivers are a safety concern for all pedestrians. These concerns are heightened for seniors, due to their shorter heights and increased vulnerability to low speed crashes. We encourage US DOT to emphasize and develop its vision of fleet safety from the pedestrian perspective as well as the driver. In particular, direct vision trucks reduce visual impairments and improve line of sight for truck operators. Cab forward (flat nose) design and a larger windshield are the primary design features that allow the operator to directly see more of the roadway. The European Union adopted a direct vision standard in 2019, which all new trucks will be required to meet by 2025. New York City adopted similar standards for City vehicle fleet procurement in 2018. In addition, surround camera systems for trucks can also mitigate blind spots and address the line of sight issues that are the cause of so many pedestrian injuries and fatalities.

Advocate for Mandatory Inclusion of Safety-Focused Driver Assistance Technologies in All New Vehicles

NYC DOT will advocate for requiring vehicle manufacturers to include pedestrian detection and automatic braking technologies as standard features on all new vehicles. While this technology exists and is effective, it is costly and considered a luxury add-on for most consumer vehicles. Re-engineering street geometry and designing intersections can help slow speeds and turns and improve visibility, but it can never fully eliminate crashes. However, these engineering efforts, in combination with pedestrian detection and automatic braking technology, can be very effective in reducing not just the severity of crashes, but crashes themselves. For senior pedestrians, who are vulnerable to even minor crashes, this is a key benefit.

Appendix

Safety Treatment Evaluation

Safety Treatment Name	Number of Treatments	Number of Intersections	Miles	Senior Ped Injuries Before	Senior Ped Injuries After	Change in Senior Ped Injuries	Senior Ped KSI Before	Senior Ped KSI After	Change in Senior Ped KSI
Road Diets	28	0	29.12	25.66	21.34	-16.84%	5.64	3.65	-35.28%
Conventional Bike Lanes	542	0	133.72	137.05	142.96	4.31%	27.17	20.91	-23.04%
Protected Bike Lanes	146	0	36.59	120.31	94.26	-21.65%	27.96	16.93	-39.45%
Pedestrian Islands	178	336	2.07	56.62	45.11	-20.33%	10.62	7.96	-25.05%
Curb and Sidewalk Expansions	266	281	9.53	58.16	45.20	-22.28%	10.26	8.77	-14.52%
Turn Calming	107	107	0	24.55	20.00	-18.53%	4.96	2.00	-59.68%
Leading Pedestrian Intervals (LPIs)	1237	1234	0	142.13	120.77	-15.03%	29.79	17.6	-40.92%

Safety Treatment Name	Number of Treatments	Number of Intersections	Miles	Non-Senior Adult Ped Injuries Before	Non-Senior Adult Ped Injuries After	Change in Non-Senior Adult Ped Injuries	Non-Senior Adult Ped KSI Before	Non-Senior Adult Ped KSI After	Change in Non-Senior Adult Ped KSI
Road Diets	28	0	29.12	103.35	104.69	1.30%	14.01	11.80	-15.77%
Conventional Bike Lanes	542	0	133.72	598.53	648.60	8.37%	76.1	82.23	8.06%
Protected Bike Lanes	146	0	36.59	434.64	393.81	-9.39%	58.59	44.82	-23.50%
Pedestrian Islands	178	336	2.07	201.99	195.98	-2.98%	33.28	20.26	-39.12%
Curb and Sidewalk Expansions	266	281	9.53	265.34	266.68	0.51%	47.18	26.05	-44.79%
Turn Calming	107	107	0	98.66	89	-9.79%	8.65	8.5	-1.73%
Leading Pedestrian Intervals (LPIs)	1237	1234	0	549.71	513.5	-6.59%	65.96	48.87	-25.91%

Appendix

Safety Treatment Evaluation

Safety Treatment Name	Number of Treatments	Number of Intersections	Miles	All Ages Ped Injuries Before	All Ages Ped Injuries After	Change in All Ages Ped Injuries	All Ages Ped KSI Before	All Ages Ped KSI After	Change in All Ages Ped KSI
Road Diets	28	0	29.12	221.32	200.18	-9.55%	28.98	20.84	-28.09%
Conventional Bike Lanes	542	0	133.72	1165.35	1151.65	-1.18%	159.42	138.43	-13.17%
Protected Bike Lanes	146	0	36.59	786.3	669.51	-14.85%	111.96	80.96	-27.69%
Pedestrian Islands	178	336	2.07	401.35	372.32	-7.23%	57.91	37.78	-34.76%
Curb and Sidewalk Expansions	266	281	9.53	499.63	428.32	-14.27%	79.84	44.56	-44.19%
Turn Calming	107	107	0	178.69	147	-17.73%	20.28	13.5	-33.43%
Leading Pedestrian Intervals (LPIs)	1237	1234	0	1081.65	904.55	-16.37%	130.72	89.66	-31.41%

Senior Pedestrian Zones

NTA	NTA Name	Senior Pedestrian Injuries	Senior Population	Seniors as a Percent of Total Population	Senior Pedestrian Injuries Per 100k Senior Population
QN31	Hunters Point-Sunnyside-West Maspeth	74	6837	9.87	1082.35
BK77	Bushwick North	45	4140	7.26	1086.96
BK83	Cypress Hills-City Line	46	4220	8.6	1090.05
BK90	East Williamsburg	50	4537	12.59	1102.05
BK63	Crown Heights South	55	4988	12.33	1102.65
BK44	Madison	84	7386	18.03	1137.29
MN31	Lenox Hill-Roosevelt Island	167	14261	17.49	1171.03
BK73	North Side-South Side	50	4227	7.41	1182.87
QN18	Rego Park	73	6120	22.06	1192.81
MN34	East Harlem North	93	7507	11.95	1238.84
MN13	Hudson Yards-Chelsea-Flatiron-Union Square	126	10144	13.2	1242.11
BX63	West Concourse	38	3010	7.9	1262.46
MN15	Clinton	84	6597	13.26	1273.31
MN19	Turtle Bay-East Midtown	161	12558	25.03	1282.05
MN25	Battery Park City-Lower Manhattan	41	3188	6.98	1286.07
QN29	Elmhurst	143	10898	13.33	1312.17
BK25	Homecrest	92	6943	15.43	1325.08
MN27	Chinatown	130	9648	21.9	1347.43
BK46	Ocean Parkway South	45	3282	15.87	1371.12
BX39	Mott Haven-Port Morris	66	4708	8.69	1401.87
BK72	Williamsburg	43	2966	8.63	1449.76
BK34	Sunset Park East	94	6471	9.75	1452.63
BK38	DUMBO-Vinegar Hill-Downtown Brooklyn-Boerum Hill	59	3994	8.76	1477.22
BK61	Crown Heights North	185	12314	11.2	1502.36
MN20	Murray Hill-Kips Bay	112	7393	15.47	1514.95
BK88	Borough Park	176	11183	10.91	1573.82
BX34	Melrose South-Mott Haven North	65	4062	9.47	1600.2
BX37	Van Nest-Morris Park-Westchester Square	55	3344	11.53	1644.74
BK95	Erasmus	65	3903	13.6	1665.39
QN22	Flushing	230	13135	18.71	1751.05
MN24	SoHo-TriBeCa-Civic Center-Little Italy	100	5688	13.32	1758.09
MN21	Gramercy	65	3283	12.19	1979.9
QN61	Jamaica	136	6401	11.87	2124.67
MN17	Midtown-Midtown South	223	4011	14.39	5559.71

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