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Older Road Users Safety in Louisiana: Understanding the Crash Contributing Factors

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13. Abstract
This study investigated crashes involving older road users (ORUs) in Louisiana, specifically drivers, pedestrians, and pedal-cyclists aged 65 and older, to identify contributing factors and recommend effective countermeasures. Recognizing the substantial increase in the state's older population and licensed drivers over the past decade, the research assessed crash trends, risk patterns, and injury severity outcomes affecting this growing and vulnerable demographic group. Twelve years of police-reported crash data from 2010 to 2021 were analyzed to examine age-based differences in crash characteristics, complemented by population and licensing data to normalize crash rates statewide. A combination of statistical and spatial methods was applied. The models incorporated crash, environmental, temporal, driver, and vehicle characteristics to quantify their association with crash severity. Spatial analyses identified high-risk urban and rural hotspots for older drivers and pedestrians. The results revealed that although older driver crash rates per licensed driver have declined, crash severity has increased. Frequent contributing violations included failure to yield, careless operation, and

disregarding traffic control devices. For pedestrians, advanced age, dark conditions without street lighting, and crashes involving heavy vehicles or adverse driver conditions significantly increased the odds of fatal and severe injury outcomes. Spatial analysis showed concentrations of older driver crashes in urban parishes, whereas rural hotspots exhibited greater severity levels. Based on these findings, a comprehensive set of potential engineering, education, and enforcement countermeasures was developed in alignment with the 2022 Louisiana Strategic Highway Safety Plan. The results of this research provide a data-driven foundation for implementing statewide initiatives and policies aimed at reducing crash risk and injury severity among Louisiana's older population.

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LTRC appreciates the dedication of the following Project Review Committee Members in guiding this research study to fruition.

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Abstract

This study investigated crashes involving older road users (ORUs) in Louisiana, specifically drivers, pedestrians, and pedal-cyclists aged 65 and older, to identify contributing factors and recommend effective countermeasures. Recognizing the substantial increase in the state's older population and licensed drivers over the past decade, the research assessed crash trends, risk patterns, and injury severity outcomes affecting this growing and vulnerable demographic group. Twelve years of police-reported crash data from 2010 to 2021 were analyzed to examine age-based differences in crash characteristics, complemented by population and licensing data to normalize crash rates statewide. A combination of statistical and spatial methods was applied. The models incorporated crash, environmental, temporal, driver, and vehicle characteristics to quantify their association with crash severity. Spatial analyses identified high-risk urban and rural hotspots for older drivers and pedestrians. The results revealed that although older driver crash rates per licensed driver have declined, crash severity has increased. Frequent contributing violations included failure to yield, careless operation, and disregarding traffic control devices. For pedestrians, advanced age, dark conditions without street lighting, and crashes involving heavy vehicles or adverse driver conditions significantly increased the odds of fatal and severe injury outcomes. Spatial analysis showed concentrations of older driver crashes in urban parishes, whereas rural hotspots exhibited greater severity levels. Based on these findings, a comprehensive set of potential engineering, education, and enforcement countermeasures was developed in alignment with the 2022 Louisiana Strategic Highway Safety Plan. The results of this research provide a data-driven foundation for implementing statewide initiatives and policies aimed at reducing crash risk and injury severity among Louisiana's older population.

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Implementation Statement

This study conducted a comprehensive analysis of 12 years of Louisiana crash data to identify key crash contributing factors and high-risk contexts for older road users (ORUs), including drivers, pedestrians, and pedal-cyclists aged 65 and older. The findings provide Louisiana DOTD and other stakeholders with a better understanding of how age-related, behavioral, roadway, and environmental factors influence crash severity. The study also recommended a set of potential engineering, education, and enforcement countermeasures. The results can assist DOTD in prioritizing safety improvements, refining Louisiana Strategic Highway Safety Plan (SHSP) strategies, and guiding project selection under the Highway Safety Improvement Program (HSIP). Further, the outcomes of this project can support Louisiana's Destination Zero Deaths goal by helping reduce fatal and serious injury crashes by 50% by 2030.

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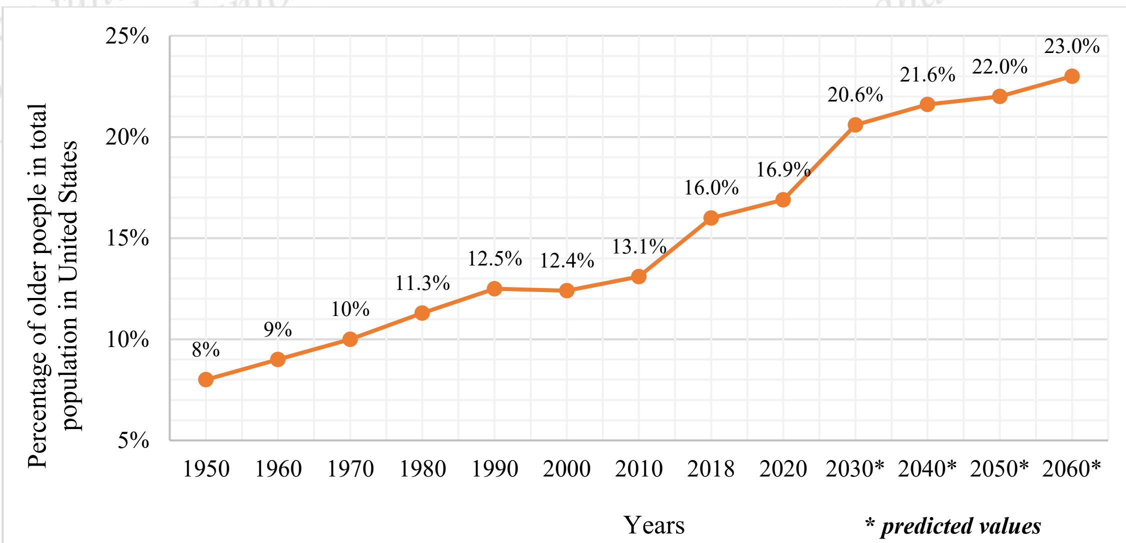
Introduction

The unprecedented growth of the population aged 65 and older is considered one of the most significant demographic trends of this decade. According to the United States Census Bureau, there has been a 37% increase in the older population from 2010 to 2020. In 2010, 13% of the United States' population was 65 and older, which increased to 16.8% in 2020 [1]. As shown in Figure 1, this upward trend in the older population is expected to persist, with individuals in this age group projected to comprise 23% of the total population by 2060.

Figure 1. Share of the older population in the United States by decade (1950-2060) [1]



Similarly, an increasing trend has been observed in the number of older licensed drivers, which increased by 67.5% from 2010 to 2023. During the same period, the total number of licensed drivers in the United States increased by only 8.6%. As of 2023, approximately one-fourth of the licensed drivers in the United States are aged 65 and older [2]. This increase in the older population and licensed drivers has led to a rise in older road users' involvement in traffic crashes. In 2023, approximately one-fifth of all traffic fatalities involved older people, which is 44% higher than that figure in 2010. Approximately 15% of the drivers involved in fatal crashes in 2023 were aged 65 and older, compared to 12.5% in 2010, marking a 51% increase in this age group. In 2023, traffic crashes resulted in 7,891 fatalities and 279,225 injuries among older people across the United States, accounting for 19% of all traffic fatalities and 11% of all people injured in traffic crashes. On average, this equates to approximately 22 fatalities and 763 injuries per day among this age group [3] [4].

Pedestrians and pedal-cyclists, both of which are classified as vulnerable road users, face a higher likelihood of severe crash outcomes due to their lack of protection. Among them, older individuals are at the greatest risk of fatalities due to their age-related fragility [5]. In 2023, they accounted for 22% of all pedestrian fatalities (1,533 of 7,052), reflecting an 86% increase from 2010 [3] [4]. Similarly, older pedal-cyclists accounted for 19% of all pedal-cyclist fatalities (223 of 1,166) in 2023, marking a threefold increase from 2010 [6].

According to the Insurance Institute for Highway Safety (IIHS), Louisiana had the tenth highest fatalities per 100,000 population and the thirteenth highest deaths per 100 million vehicle miles traveled in 2023 [7]. In the same year, Louisiana had a fatality rate of 17.14 per 100,000 population for individuals aged 65 and older, which is 29% higher than the national fatality rate of 13.32 [3]. Older adults have a higher crash risk due to the natural decline in physical, sensory, and cognitive abilities [5].

Due to the increasing trend in fatality and serious injury rates per capita of drivers and pedestrians over the age of 65, Louisiana met the criteria to qualify for the Federal Highway Administration (FHWA) Older Driver and Pedestrian Special Rule 23 U.S.C. 148(g)(2). Therefore, strategies and tactics to mitigate the elevated fatal and severe injury crash risk of older drivers and pedestrians are now incorporated in all four emphasis areas of the updated 2022 Louisiana Strategic Highway Safety Plan (SHSP) [8]. The goal of this research project was to evaluate crashes involving older road users (ORUs), defined as drivers, pedestrians, and pedal-cyclists aged 65 years and older, in Louisiana, to identify contributing factors and recommend effective countermeasures and strategies.

Literature Review

This chapter provides a comprehensive review of literature related to older road users (ORUs). It examines their physical, cognitive, and behavioral characteristics, the factors contributing to their crash involvement, and the strategies implemented to enhance their safety. The review synthesizes findings from peer-reviewed publications, as well as national- and state-level studies, to present an evidence-based understanding of ORUs' safety challenges and effective countermeasures.

The chapter is organized into three subsections. The first subsection discusses the physical, sensory, and cognitive limitations that influence ORUs' ability to navigate roadways safely. The second subsection summarizes key research findings on crash risks, patterns, and contributing factors among ORUs. The third subsection reviews federal and state policies, successful safety initiatives, countermeasures, and roadway design guidelines aimed at improving safety and mobility for ORUs.

Older Road Users' Physical and Cognitive Limitations

The increasing number of active ORUs draws attention to their physical and cognitive limitations on roadways. Various factors impact their safety, including declines in sensory perception, cognitive abilities, and physical functionality. Understanding these limitations is crucial in mitigating their crash risk and promoting a safer environment for older adults.

Aging inevitably brings physical declines that affect a person's driving ability. One critical factor is the loss of vision. Visual acuity, contrast sensitivity, and peripheral vision decline as a person ages, compromising the ability to detect hazards, read signs, and navigate roadways safely, especially in low-light conditions [9] [10]. Additionally, older drivers may experience difficulties in detecting fast-moving objects or making accurate distance judgments [11] [12]. All these factors impede the performance of older drivers, increasing their risk of a crash.

Another physical limitation is mobility and flexibility. As people age, their muscle and joint flexibility decreases, making essential movements, such as head movements and swiftly switching between the brake and accelerator, more difficult. Additionally, older adults have slower reaction times, which can lead to delayed responses in critical situations, such as braking to avoid a collision. Physical declines, such as arthritis or frailty, further exacerbate these difficulties, limiting the ability of older drivers to perform essential driving tasks safely [13] [14].

In addition to physical challenges, the decline in cognitive capabilities of older adults hinders their ability to navigate roadways safely. Memory loss, slower information processing, and reduced attention span can impair older drivers' ability to make quick decisions in a complex driving environment. The onset of mild cognitive impairment (MCI), Alzheimer’s disease, or dementia affects the individual’s ability to effectively interpret and respond to road signs, signals, and hazards. Prior research suggests that approximately 60% of older drivers with MCI and up to 30% of those with dementia continue to drive despite having compromised abilities [15].

The decline in attention and multitasking capabilities also elevates the crash risk of older adults. Driving requires continuous monitoring of various aspects of the environment. However, older adults find it difficult to divide their attention effectively, which is particularly problematic in situations requiring complex decision-making, such as navigating intersections or reacting to unexpected hazards on the roadway. Studies show that hazard perception abilities significantly deteriorate with age, which contributes to their increased crash risk [16].

Along with cognitive issues, age-related declines in motor skills can severely impact older adults' driving abilities. They may face challenges with coordination in tasks such as steering or operating pedals that require fine motor control. Diminishing motor abilities can increase response times, making it more difficult for older drivers to react to hazardous conditions [17]. These limitations can be a severe risk factor when driving at higher speeds in complex environments that require quick reactions to prevent crashes.

Older adults are more likely to suffer from chronic health conditions, such as heart disease, diabetes, or Parkinson’s disease, which can further impair their ability to navigate roadways safely. These conditions may cause sudden medical emergencies or worsen their cognitive and physical limitations. For example, diabetes can lead to vision problems due to diabetic retinopathy, while Parkinson’s disease can affect motor coordination [18] [19] [20]. The combination of chronic health conditions with the natural decline in functional abilities of older people increases their risk of crashes.

Due to the decline in their physical, cognitive, and motor abilities, ORUs often find it challenging to navigate roads safely. These limitations elevate their crash risk, especially in complex driving environments. While many older drivers adopt compensatory strategies, such as restricting driving to daylight hours, avoiding high-speed roadways, and driving on familiar routes to minimize uncertainty, these measures alone may not fully mitigate the risks. A combination of roadway design improvements, technological aids, policy interventions, and adaptations from other road users can help promote a safer environment for ORUs.

Key Findings from Literature

Older drivers have an elevated risk of injuries in crashes due to their increased physical fragility [21]. Studies that used the number of crashes per distance driven reported higher driver involvement rates for fatal crashes among older adults [22]. Drivers aged 70 to 74 have twice the risk of fatality compared to middle-aged cohorts (aged 25 to 64 years), whereas, for drivers aged 80 and older, the fatality risk is five times that of the middle-aged group [23].

Despite driving at slower speeds than their counterparts aged 25 years and younger, older drivers swerve more, exhibit higher speed variability, and maintain longer time and space headways between their vehicle and the vehicle in front of them [24] [25] [26]. Older drivers pay more attention to other vehicles' distance rather than speed when making gap acceptance decisions [27]. Compared to younger groups, older drivers are less alert and feel more nervous while changing lanes and during emergencies [28]. Further, they find some complex driving tasks challenging. For example, due to their slower reaction times, they have an elevated crash risk while braking [25].

According to a 2015 study, driver error was the primary contributing factor for the majority of older driver crashes in the United States [27]. They are over-represented in angle, overtaking, merging, and intersection crashes, often involving failure to yield the right of way, particularly when making left turns [27] [29]. They also require more time to assess when it is safe to enter a roadway, especially when other road users are involved. While drivers aged 70 to 79 more often misjudge whether there is adequate time to enter the roadway, drivers aged 80 and older predominantly fail to see the other vehicles [29]. Moreover, they report difficulties in controlling speed, interacting with other road users, and merging onto expressways [30]. These issues are further worsened by the fact that older adults often use prescription drugs, which can impair driving abilities. Particularly, drivers aged 75 and older report having difficulty driving while being on prescription drugs. This is reflected in the higher number of crashes for this age group, most of which are sideswipe and rear-end crashes [31].

Classroom-based training designed to enhance traffic safety awareness shows that while most older drivers are initially confident of their driving abilities, they report an improved understanding of their declining driving abilities after taking the course [32]. Studies have demonstrated the effectiveness of restricted licensing in improving traffic safety for all road users. While drivers with multiple restrictions on their licenses were found to have a higher crash risk than the general population, those with only one restriction had a lower crash risk. Drivers with multiple restrictions often have several health conditions and may be more fragile. Therefore, their higher crash risk may be due to deteriorating health [33].

Older pedestrians represent approximately 22% of pedestrian fatalities despite being only 18% of the total population [3]. Age has been identified as a critical risk factor in pedestrian crashes, with those 65 and older being the most vulnerable to severe injuries [34] [35]. Older pedestrians are more involved in crashes at intersections than middle-aged and younger groups. In 2023, 30% of older pedestrian fatalities occurred at intersections, compared to 15% for those under 65 [3]. Older adults make unsafe decisions while crossing the road and adopt insufficient safety margins, especially on high-speed roadways [36]. Pedestrians aged 70 to 84 are more likely to make decisions that lead to collisions with approaching vehicles [37]. Older pedestrians are more likely to get into a collision with the approaching vehicle on the nearside of their street crossing [38], though drivers yield more to older pedestrians [39].

Age-related declines in the perceptual and cognitive abilities of older adults have been identified as one of the crash-contributing factors for this group [40] [41]. Research has shown that behavioral or educational safety training for older pedestrians has limited benefits; therefore, road and environmental improvements might mitigate their elevated crash risk [37] [42]. Generally, pedestrians have a higher crash risk at longer crossing intervals [41], which is further elevated for older adults who have difficulty crossing during regular signal timing [43]. Therefore, crosswalk design must account for the greater variability of older pedestrian walking speeds [44].

Existing Guidelines and Countermeasures to Improve Older Road User Safety

Older road users face unique safety challenges due to age-related declines in visual, cognitive, and psychomotor abilities. National guidelines and state-level policies have been developed to address these challenges. This section discusses several of the key findings from those documents.

“Highway Safety Program Guideline No. 13, Older Driver Safety,” published by the National Highway Traffic Safety Administration (NHTSA) in 2014, emphasizes the importance of comprehensive older driver safety programs. These programs aim to reduce crashes, fatalities, and injuries, focusing on elements such as program management, roadway design, driver licensing, law enforcement, and data evaluation. However, their implementation has been inconsistent. The Behavioral Traffic Safety Cooperative Research Program (BTSCRP) report “Promoting Older Driver Safety: Guide for State Practices” reveals that only 17 of the 44 surveyed states have dedicated older driver safety programs administered by state highway safety officials, and interagency coordination faces significant challenges due to conflicting priorities and resource limitations [45]. Further, while most states collect ORU crash data, it is rarely utilized effectively to develop targeted countermeasures. The report emphasizes the need for improved engineering designs and policies to address the unique safety needs of older drivers.

“Handbook for Designing Roadways for the Aging Population,” published by the Federal Highway Administration (FHWA) in 2014, provides additional critical insights into addressing the functional limitations of older road users in roadway design [46]. The handbook identifies challenges, including decreased visual acuity, slower decision-making, and diminished physical capabilities, that affect older drivers’ ability to navigate complex scenarios, such as intersections. To address these challenges, the handbook offers evidence-based countermeasures, including larger and more visible signs, improved lighting, high-contrast lane markings, extended signal clearance intervals, longer pedestrian crossing times, and protected turn phases. It also highlights intersection improvements, such as adding left-turn and channelized right-turn lanes, as well as enhancements to freeway interchanges to reduce complexity and conflict points. A notable strength of the handbook is its provision of rationale and evidence supporting the effectiveness of these measures, linking them to established guidelines like the Manual on Uniform Traffic Control Devices (MUTCD) and the Highway Capacity Manual (HCM). Additionally, it identifies promising practices with the potential to address older driver challenges, even if they are not yet formally evaluated.

NHTSA’s “Countermeasures That Work” report complements these efforts by highlighting strategies for improving older road user safety through licensing reforms, behavioral interventions, and technological solutions [47]. Licensing-related measures, such as periodic vision screenings, tailored restrictions (e.g., daytime-only driving), and in-person renewal requirements, enable early identification of at-risk individuals while balancing safety and mobility. Behavioral programs, such as the All Older Americans (AARP) Smart DriverTEK courses, enhance hazard perception and awareness of age-related limitations, while community-based campaigns promote safe driving habits. Technological advancements, such as Advanced Driver Assistance System (ADAS) and roadway improvements, including enhanced signage and extended signal timings, address physical and cognitive challenges. These measures, supported by evidence from research and practical applications, offer a holistic approach to reducing crash risks and enhancing mobility for ORUs.

The 2013 NHTSA report “Licensing Procedures for Older Drivers” evaluated licensing procedures such as shorter renewal cycles, vision testing, and mandatory road tests [48]. Stricter policies in states such as Illinois and New Hampshire have shown reductions in crashes per licensed driver among older adults, though these policies may limit mobility for older drivers. Further research is needed to refine screening tools and balance safety with independence. Additionally, the BTSCRP report identifies significant gaps in program evaluation, with many states failing to assess the impact of their ORU programs and relying instead on implementation metrics. At-risk older drivers often self-regulate or stop driving without formal interventions, underscoring the need for targeted support. Improved integration of research findings into roadway design practices and expanded training for engineers, medical personnel, and law enforcement can also enhance ORUs’ safety.

At the state level, Florida has emerged as a leader in addressing ORU safety and mobility through its “Livable Florida” initiative under the Age-Friendly State designation from the AARP. With the highest percentage of older residents in the U.S., Florida’s Department of Elder Affairs conducts regular needs assessments through surveys and public engagement to identify gaps in transportation, housing, and healthcare for older adults. The Florida State Plan on Aging 2022-2025 focuses on promoting age-friendly communities, expanding public transit and infrastructure, and supporting universal design principles [49]. It also prioritizes health and wellness by enhancing access to healthcare, mental health services, and chronic disease prevention programs. Performance metrics, such as improved Activities of Daily Living scores and increased caregiver confidence, are used to evaluate the program’s effectiveness. Despite these successes, challenges persist, including the limited availability and accessibility of affordable transportation options for older adults who stop driving and the need to reduce social isolation by encouraging community engagement.

The reviewed guidelines and state-level initiatives suggest several strategic directions for future research. These include developing robust methods to utilize crash data for targeted countermeasures, facilitating interagency collaboration, expanding stakeholder training, and investigating innovative transportation solutions for older adults who transition away from driving. Insights from federal guidelines, successful state initiatives, and resources such as the "Handbook for Designing Roadways for the Aging Population" can guide researchers and policymakers in addressing the complex challenges of ORU safety and mobility, paving the way for safer, more inclusive roadways.

Objective

The objectives of this study were to investigate the factors contributing to older road user (ORU) crashes on Louisiana roadways and recommend effective countermeasures to support the SHSP strategies to enhance ORU safety.

Scope

This project examined crash patterns involving older road users (ORUs) in Louisiana, specifically drivers, pedestrians, and pedal-cyclists aged 65 and older. The goal was to identify key risk factors and crash trends affecting this vulnerable group. To provide a comprehensive assessment, the study also includes crash data for middle-aged (i.e., 25 to 64 years) and younger (i.e., 15 to 24 years) road users. This comparison allows for an evaluation of how crash characteristics, severity, and contributing factors differ across age groups. By analyzing these differences, the study can determine whether ORUs face unique risks, how their crash involvement compares to other groups, and whether certain crash types are more prevalent among ORUs. This comparative approach ensures that any observed trends in ORUs crashes are not merely reflective of overall traffic patterns but are indeed specific to age-related factors.

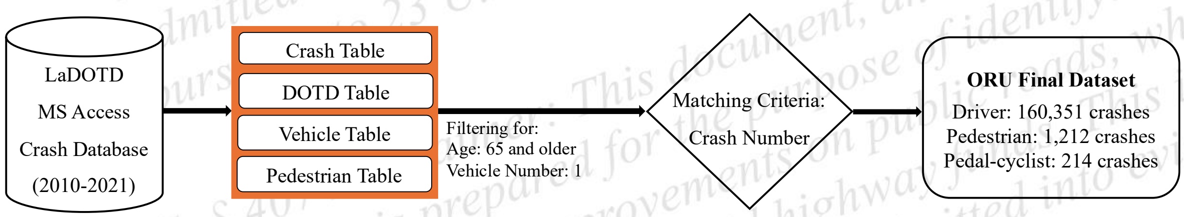
Methodology

Data Preparation

Twelve years of police-reported crash data from 2010 to 2021, obtained from the Louisiana Department of Transportation and Development (DOTD), was used for the analysis. The dataset was analyzed as provided by DOTD, without any additional cleaning. Age-based differences among older, middle-aged (i.e., 25 to 64 years), and younger (i.e., 15 to 24 years) road users were analyzed to identify crash scenarios and locations where older road users (ORUs) are overrepresented.

Louisiana's 2019 Manual for Use of the Traffic Crash Report [50] defines a "pedal-cycle" as a "non-motorized vehicle propelled by pedaling that included bicycles, tricycles, unicycles, pedal cars, etc." Data on environmental, temporal, crash, driver, pedestrian, and pedal-cyclist characteristics were obtained from the database. In the end, three crash datasets were obtained for ORUs: driver (160,351 crashes), pedestrian (1,212 crashes), and pedal-cyclists (214 crashes). The dataset preparation is summarized in Figure 2. Similarly, datasets for the two non-ORUs were prepared. The final dataset for the middle-aged road users contained crashes involving drivers (1,057,120 crashes), pedestrians (10,753 crashes), and pedal-cyclists (2,852 crashes). Likewise, the dataset for younger road users comprised crashes involving drivers (464,430 crashes), pedestrians (3,648 crashes), and pedal-cyclists (1,088 crashes).

Figure 2. Dataset preparation for older road user crash analysis



In addition to crash data, demographic information was obtained to understand the distribution of older adults across Louisiana. Population data was obtained from the U.S. Census Bureau for the years 2010 and 2020 [1]. These datasets provided detailed population counts, including age group distributions, at the state, parish, and tract levels. The geographic granularity offered by the census data was used to calculate population-based crash rates and enabled the identification of high-risk areas with high concentrations of ORU crashes. Further, data on licensed drivers was obtained from the FHWA's Highway Statistics Series

[2], which includes annual reports on driver licensing statistics. The licensed driver data provided age-specific counts for Louisiana, which were used to normalize the crash data, enabling a more accurate comparison of crash risk across different age groups.

In order to perform a future systemic safety analysis, this research tried to identify data gaps. Appendix 1 outlines the potential data availability and gaps relevant to future systemic safety analyses.

Multinomial Logistic Regression

To examine the determinants of injury outcomes among ORUs, separate regression models were specified for drivers and pedestrians to account for differences in the distribution of crash severity across the two groups.

Older Driver Model

For older drivers, a multinomial logistic regression (MNL) model was developed, as the dependent variable (injury severity) comprised three unordered categories: Fatal or Severe Injury (KA), Moderate/Complaint Injury (BC), and No Injury/Property Damage Only (PDO). The MNL framework was selected because it is specifically designed to model categorical outcomes with more than two levels, while the categories have no natural ordering. This approach allows for the simultaneous estimation of the influence of multiple explanatory variables on the probability of each severity outcome. Within the model specification, PDO crashes were designated as the reference category, providing a baseline against which the likelihood of sustaining BC or KA injuries could be assessed.

Older Pedestrian Model

For older pedestrians, a binary logistic regression model was applied. The distribution of injury severity in pedestrian crashes was heavily skewed toward injury outcomes, with very few cases classified as PDO. This reflects the heightened vulnerability of pedestrians, particularly older adults, who are far more likely to sustain injuries when involved in a crash. Due to the low frequency and statistical instability of PDO outcomes, these cases were excluded from the analysis. Consequently, injury severity was modeled as a binary outcome with two levels: KA and BC. Within this framework, BC injury was specified as the reference category, allowing the model to estimate the likelihood of sustaining a KA injury relative to a BC injury.

Model Specification

The regression models employed in this study can be expressed in the following functional form:

$$logit(y = j) = \log\left(\frac{p(y=j)}{p(y=Reference)}\right) = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_1 + \cdots + \alpha_p x_p \qquad (1)$$

where,
y is the injury severity level for each crash;
j represents each non-reference category;
x_1, …, x_p are explanatory variables such as crash time, lighting condition, road type, pedestrian or driver condition, weather, etc.; and
α_0, …, α_p are the coefficients to be estimated.

To facilitate interpretation, the model coefficients were exponentiated to yield odds ratios (OR). An OR greater than 1 indicates that the variable is associated with an increased likelihood of the outcome relative to the reference group, while an OR less than 1 indicates a reduced likelihood.

Analysis was conducted using R statistical software, and models were estimated using the nnet::multinom() function for the multinomial case and glm() for the binary logistic case. Multi-collinearity was assessed using Cramér's V for categorical variables, and variables exhibiting high interdependence (>0.6) were removed or collapsed.

Model fit was evaluated using the Akaike Information Criterion (AIC), computed as:

$$AIC = 2k - 2\ln(\hat{L}) \qquad (2)$$

where,
k is the number of model parameters, and
$\hat{L}$ is the maximum value of the likelihood function.

Smaller AIC values indicate better model fit, balancing both model complexity and explanatory power.

Spatial Analysis

The spatial analysis was designed to identify high-risk locations and compare crash patterns involving older drivers and pedestrians across Louisiana. The analysis began with crash rate mapping, where crash rates were calculated separately for older drivers, pedestrians, and pedal cyclists. For each mode of travel, the number of crashes was divided by the older population in each parish to normalize for population differences. Parishes were then color-coded using Tableau, with higher crash rates displayed in red and lower rates in green, providing an initial statewide visualization of crash disparities. At the census tract level, similar calculations were performed for older drivers and pedestrians using ArcGIS, and tracts were color-coded in the same manner. Pedal-cyclist crashes were excluded from tract-level analysis because of insufficient data; in many cases, entire tracts and even some parishes had no crashes, preventing meaningful spatial interpretation.

To further refine the analysis, urban and rural designations for parishes were obtained from the Federal Office of Management and Budget; see Appendix 2. Parish selection was performed separately for drivers and pedestrians to capture mode-specific patterns. Urban parishes that collectively accounted for more than 50% of all urban older driver crashes were selected for the driver analysis, while rural parishes comprising more than 50% of all rural older driver crashes were retained for rural driver analysis. The same procedure was applied independently for pedestrian crashes, yielding different sets of urban and rural parishes for older pedestrian analysis. This ensured that the most crash-intensive locations for each mode were prioritized for deeper spatial investigation.

Once these parishes were identified, separate shapefiles were created and subdivided into uniform grid cells using the fishnet method in ArcGIS. Crashes were spatially joined to these grid cells, and the Getis-Ord Gi* statistic was applied to identify statistically significant spatial clustering of crashes. The Gi* statistic compares the local sum of crash counts within a given cell and its neighbors to the expected sum under spatial randomness, providing a z-score that indicates whether clustering is unusually high or low. Mathematically, the Gi* for feature i is expressed as:

$$G_i^* = \frac{\sum_j w_{i,j} x_j - \bar{X} \sum_j w_{i,j}}{S \sqrt{\frac{n \sum_j w_{i,j}^2 - \left(\sum_j w_{i,j}\right)^2}{n-1}}} \qquad (3)$$

where,
x_j is the crash count at location j;
$w_{i,j}$ is the spatial weight between features i and j;
n is the total number of features;
$\bar{X}$ is the mean crash count; and
S is the standard deviation.

A statistically significant positive G_i^* value indicates a hotspot, while a negative value indicates a cold spot. For this study, only cells identified as hotspots at the 95% and 99% confidence levels were retained, and the crashes within those cells were extracted to form high-risk datasets.

The resulting hotspot crashes were organized into four distinct datasets: urban-driver, rural-driver, urban-pedestrian, and rural-pedestrian. These datasets served as the basis for comparing crash, roadway, driver, pedestrian, and environmental characteristics across high-risk urban and rural areas. Pedal-cyclist crashes were not included in the comparative analysis due to insufficient data for reliable spatial or statistical examination.

Discussion of Results

Older Driver Demographics and Crash Characteristics

This section presents the significant demographic changes in older drivers and their crash characteristics based on the detailed crash analysis. This research utilized population data from the U.S. Census Bureau's decennial Census, which provides data only for 2010 and 2020 within the study period. Therefore, for consistency, comparisons of crash, population, and licensed driver data are limited to these two years. However, crashes were also analyzed over the entire study period (2010 to 2021) to capture long-term trends.

Table 1 provides data on licensed drivers categorized by older and non-older age groups. It is noted that the number of older licensed drivers increased by 55.5%, which is 20 times higher than the 2.8% increase in middle-aged drivers. Meanwhile, the number of licensed younger drivers decreased by 15.6%. This demographic shift indicates a growing proportion of older drivers in the overall driving population, which may require further investigation to understand its effects on traffic safety.

Table 1. Licensed drivers in Louisiana by age group

Year	**Licensed Drivers by Age Group**			
	Older (65+)	**Middle Aged (25-64)**	**Younger (15-24)**	**Total**
2010	512,627	2,210,810	410,194	3,133,631
2020	797,282	2,273,040	346,326	3,416,648
Change	**55.5%**	**2.8%**	**-15.6%**	**9%**

Table 2 presents the change in the number of driver crashes and crash rates across different age groups between 2010 and 2020. While the total number of crashes involving older drivers increased from 11,020 to 12,485, their crash rate per 1,000 licensed drivers declined from 21 to 16, indicating that the growth in older driver crashes was outpaced by the increase in licensed older drivers. In contrast, middle-aged drivers experienced a decrease in both the number of crashes, from 82,711 to 76,330, and crash rate, from 37 to 34. Similarly, younger drivers saw a reduction in crashes from 39,782 to 32,296, accompanied by a slight decline in their crash rate from 97 to 93. These trends suggest that while the overall crash risk for older drivers has declined, their increasing presence on the roads necessitates continued attention to their safety.

Table 2. Change in the number of driver crashes and rates by age group

Year	Older		Middle Aged		Younger	
	Crashes	Crash Rate*	Crashes	Crash Rate*	Crashes	Crash Rate*
2010	11,020	21	82,711	37	39,782	97
2020	12,485	16	76,330	34	32,296	93

*Crash Rate = Crashes per 1,000 licensed drivers

Table 3 presents a comparison of older driver crashes in Louisiana between 2010 and 2020, highlighting trends across different age groups. While the total number of crashes for all ages decreased by 11.3%, crashes involving drivers aged 65 to 74 increased significantly, with the 70 to 74 age group experiencing a 27.5% rise. However, the crashes involving drivers aged 85 and older decreased by 13.2%. This trend suggests that while overall crashes have declined, the increasing involvement of drivers aged 65 to 79 may indicate a growing exposure or specific risk factors associated with this age group. Conversely, the decline in crashes among drivers aged 85 and older could reflect reduced mobility, self-regulation, or other factors limiting their driving activity.

Table 3. Number of older driver crashes in Louisiana

Year	<65	Older Driver Age Groups				
		65-69	70-74	75-79	80-84	85+
2010	122,493	3,761	2,735	2,081	1,481	756
2020	108,626	4,614	3,488	2,259	1,303	656
Change	**-11.3%**	**22.7%**	**27.5%**	**8.6%**	**-12.0%**	**-13.2%**

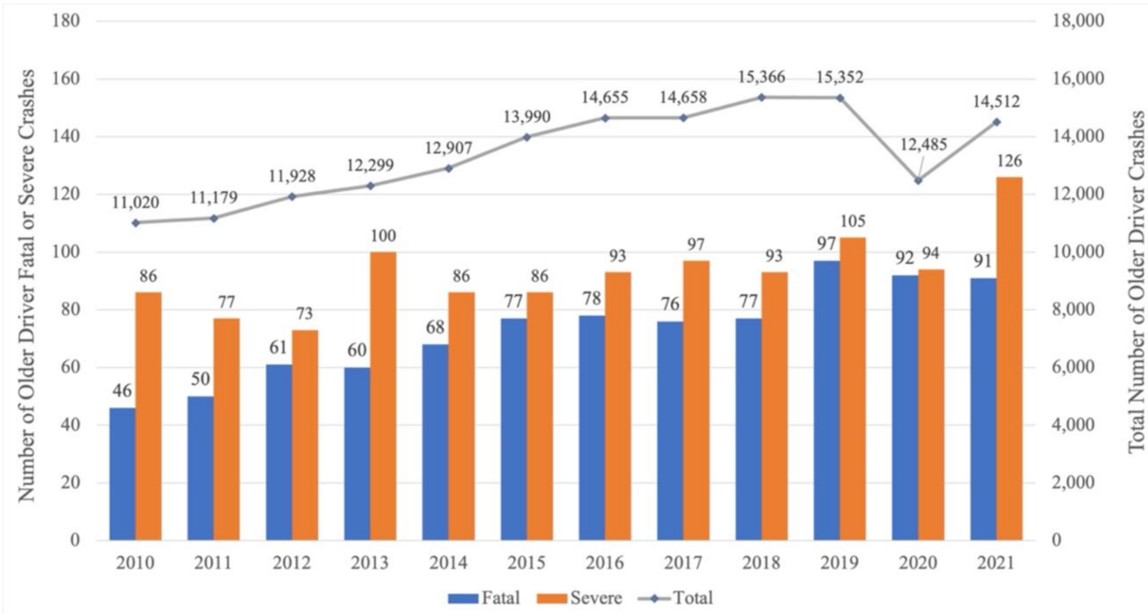
Table 4 compares the fatal and severe crash rates per 100,000 licensed drivers between 2010 and 2020. While the fatal crash rate for drivers under 65 increased by 9.6%, older drivers exhibited varied trends. Fatal crash rates rose significantly for those aged 75 to 79 (74%) and 80 to 84 (45.2%), indicating heightened risk, whereas the increase was more moderate for the 85+ (18.7%), 70 to 74 (24.6%), and 65 to 69 (4.1%) age groups. In contrast, severe crash rates declined slightly for drivers under 65 (-0.3%) and showed mixed trends for older age groups, with substantial decreases for drivers 80 to 84 (-44%) and 70 to 74 (-18%), but an increase for drivers in the 75 to 79 (31%) and 65 to 69 (17%) age groups. These findings indicate a rising fatal crash risk among older drivers, particularly those aged 75 to 84, likely due to age-related declines.

Table 4. Number of older driver fatal and severe crashes per 100,000 licensed drivers

Year	<65		65-69		70-74		75-79		80-84		85+	
	Fatal	Severe	Fatal	Severe	Fatal	Severe	Fatal	Severe	Fatal	Severe	Fatal	Severe
2010	21.6	40.0	9.0	15.0	8.1	20.9	8.5	9.6	10.1	25.9	8.6	13.8
2020	23.6	39.9	9.3	17.5	10.0	17.2	14.8	12.6	14.6	14.6	10.2	12.1
Change	**9.6%**	**-0.3%**	**4.1%**	**17%**	**24.6%**	**-18%**	**74%**	**31%**	**45.2%**	**-44%**	**18.7%**	**-12%**

Figure 3 illustrates the trends in total, fatal, and severe injury crashes involving older drivers from 2010 to 2021. While the total number of crashes generally increased over the decade, a notable decline occurred during 2020. In contrast, fatal crashes rose sharply, more than doubling over the study period, while severe crashes also increased, though at a slower pace. This contrast suggests that while overall crash involvement fluctuated, the severity of crashes among older drivers has become a growing concern.

Figure 3. Older driver total, fatal, and severe injury crashes



Comparison of Driver Crash Characteristics by Age Groups

This sub-section highlights crash scenarios in which older drivers are over-represented compared to other age groups. Figure 4 presents the distribution of intersection and non-intersection crashes across different driver age groups. Older drivers are disproportionately involved in intersection crashes compared to other age groups.

Figure 4. Comparison of intersection and non-intersection crashes by age group

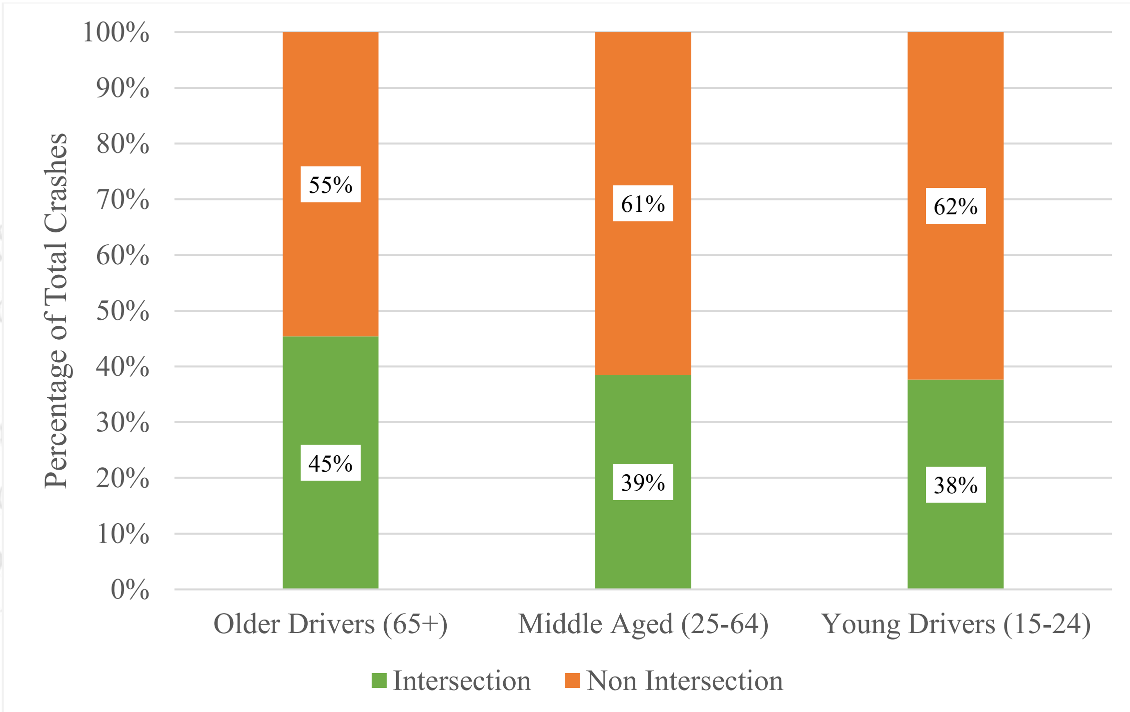


Figure 5 presents the distribution of collision types by different age groups. Older drivers have the highest percentage in right angle (22%), sideswipe (19%), left turn (15%), and right turn (5%) crashes. These facts again highlight the challenges faced by older drivers while navigating complex environments.

Another key finding demonstrated in Figure 5 is the lower proportion of rear-end crashes among older drivers (27%) compared to the other age groups. Rear-end crashes are often associated with aggressive driving behaviors, such as tailgating and rapid lane changes, which are more commonly observed among younger and middle-aged drivers. The lower frequency of rear-end crashes among older drivers suggests a more cautious driving style, with them maintaining greater following distances and reacting more conservatively to traffic.

Figure 5. Comparison of crashes by manner of collision and age group

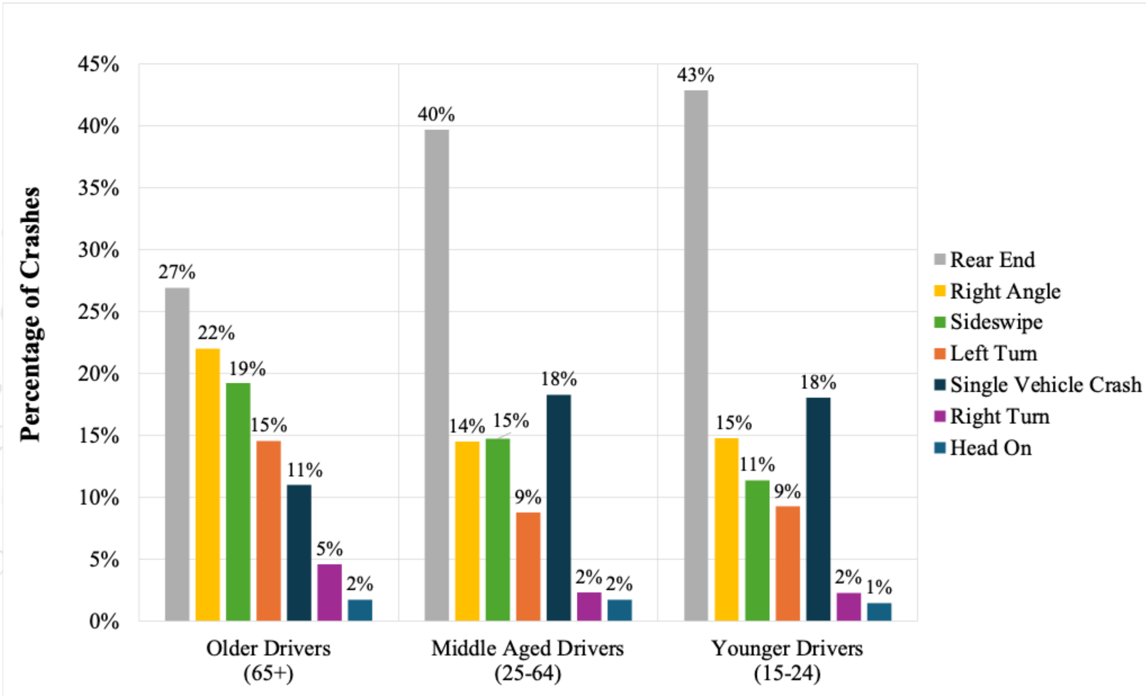


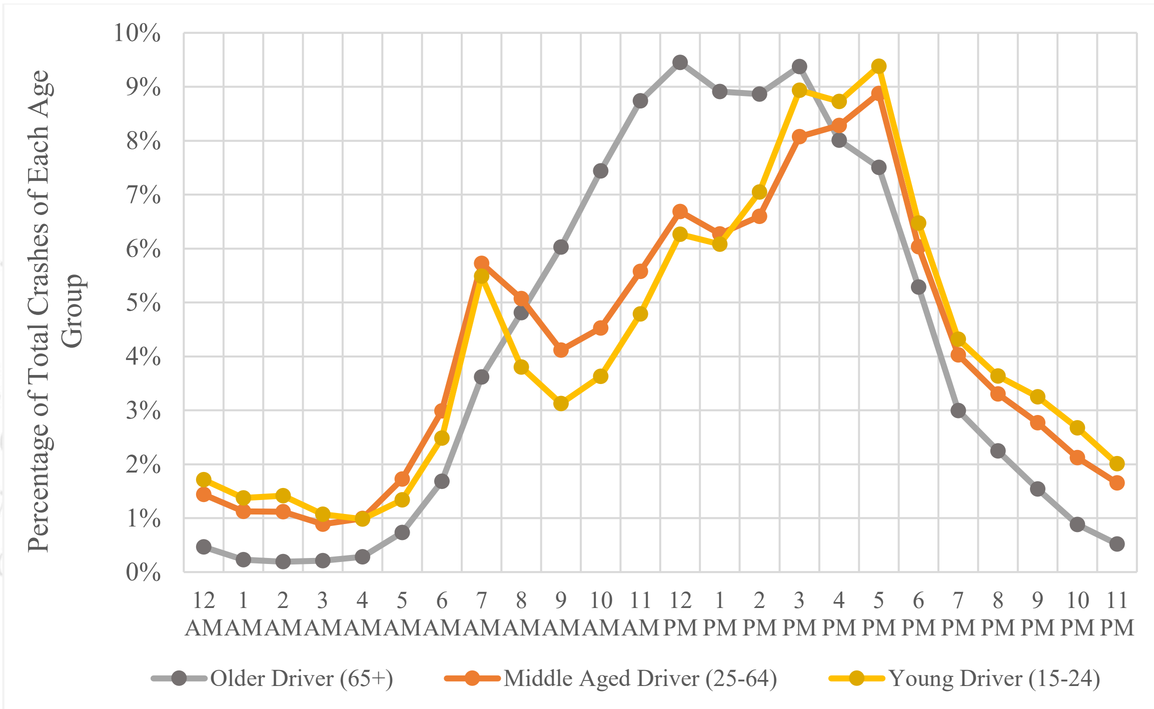
Table 5 compares crash occurrences across different driver age groups under various lighting conditions. The data show that older drivers are more likely to be involved in a traffic crash during daylight (84.8%), compared to younger drivers (71.4%) and middle-aged drivers (73.7%). This indicates older drivers' preference to carry out their activities during the day or under better lighting conditions to compensate for the effect of their age-related vision impairments.

Table 5. Comparison of crashes by age group under different lighting conditions

Lighting Condition	Older Drivers	Middle-Aged Drivers	Younger Drivers
Daylight	84.8%	73.7%	71.4%
Dark with continuous streetlights	7.5%	12.6%	14.2%
Dark with no streetlights	4.3%	8.7%	9.2%
Dark with streetlights at intersections only	1.6%	2.5%	2.8%
Dusk	1.2%	1.5%	1.5%
Dawn	0.6%	1.0%	0.9%

Figure 6 shows the hourly crash distribution among the age groups. Older drivers experience more crashes between 9:00 a.m. and 3:00 p.m., which is significantly different from non-older drivers. This trend is similar to the results shown in Table 5.

Figure 6. Hourly trend for crashes by age group



Key Variables for Older Driver Crash Contributing Factors

Table 6 presents the frequency and percentage distribution of 160,351 older drivers' crash characteristics in the final dataset from 2010 to 2021. The variables shown in Table 6 were used to identify crash risk factors in the modeling step. The summary of those variables is listed below:

- **Collision Manner:** Single-vehicle crashes were the most common for fatal crashes (46.4%), indicating the significant risk of loss-of-control or roadway departure crashes. Meanwhile, right angle collisions were the most frequent for moderate (30.4%) and severe (22.5%) injuries, underscoring the need for access management safety improvements.
- **Violations:** Failure to yield (22.9% fatal, 25.7% severe) and careless operation (25.2% fatal, 16.6% severe) were the most frequently cited violations for older drivers. Disregarding traffic control devices (6.8% fatal, 6.0% severe) was another significant contributor, emphasizing the risks associated with non-compliance at intersections. Additionally, following too closely (0.2% fatal, 3.2% severe, 5.4% moderate) was a common violation for lower-severity crashes. Notably, driving left of center (5.5% fatal, 1.3% severe) played a greater role in fatal crashes than in less severe incidents.

- **Intersection:** Crashes occurring at intersections were more likely to result in severe injuries (49.0%) and moderate injuries (52.1%). Among intersection types, stop-controlled (16.4% fatal, 16.4% severe) and signalized intersections (8.2% fatal, 16.8% severe) were common crash locations.

- **Highway and Road Type:** Crashes involving ORUs were most frequent on two-lane highways, which make up approximately 41,000 centerline miles statewide, the largest share of Louisiana's roadway system. Despite this extensive mileage, these facilities accounted for 43% of fatal crashes, indicating elevated severity risk due to opposing traffic flow and limited roadway width. Four-lane divided highways (≈1,400 miles) contributed to 17.1% of fatal crashes, suggesting greater severity relative to their mileage share, while interstates, totaling roughly 800 miles, had a smaller fatal crash proportion (7.9% for four-lane and 3.2% for six-lane), reflecting the safety benefits of controlled access and median separation. By administrative classification, state highways accounted for the highest share of fatal crashes (48.7%), followed by U.S. highways (22.7%) and city streets (18.6%). Overall, two-way undivided roads remained the most hazardous configuration, contributing to 63.2% of fatal crashes despite generally moderate speed environments.

- **Area Type:** Crashes were more frequent in urban areas (43.0% fatal, 49.4% severe), likely due to higher traffic density, while rural areas had fewer crashes but higher severity (40.4% fatal, 13.2% severe). A large share of the crashes (39.3%) occurred in unknown areas, highlighting the need for improved data collection.

- **Roadway Type by Speed:** Crashes were more frequent on high-speed roadways (speed limit ≥ 40 mph), accounting for 74.3% of fatal crashes and 51.3% of severe crashes, highlighting the increased risk of severe outcomes at higher speeds. Low-speed roadways (speed limit < 40 mph) had a lower share of fatal crashes (21.8%) but contributed more to non-fatal crashes (41.5% severe, 47.0% no injury).

- **Time of Day:** Crashes occurring between 12:00 p.m. and 6:00 p.m. accounted for the highest percentage across all injury severities, including 41.8% of fatal crashes and 46.8% of severe injury crashes. This period aligns with peak traffic volumes, increasing the risk of crashes. Conversely, crashes between 12:00 a.m. and 6:00 a.m. were the least frequent but had a relatively higher proportion of fatal crashes (7.1%), indicating a heightened severity risk during nighttime hours.

- **Lighting Conditions:** Most older driver crashes occurred under daylight conditions, contributing to 67.3% of fatal crashes and 77.6% of severe crashes. However, crashes occurring in dark conditions without streetlights were disproportionately fatal, accounting for 17.5% of fatal crashes, emphasizing the role of reduced visibility in crash severity.

- **Day of the Week:** Crashes were more frequent on weekdays (Monday to Thursday), with an average of 156 fatal crashes per weekday and 205 severe crashes per weekday, compared to 81 fatal crashes per day and 96 severe crashes per day on weekends (Friday to Sunday). This indicates that the daily fatal crashes on weekdays are 92.6% higher, while the daily severe crashes are 113.5% higher than on weekends.
- **Driver Characteristics:** Drivers aged 65 to 69 had the highest crash involvement (31.6% fatal, 35.9% severe), followed by those aged 70 to 74 years old. Male drivers were overrepresented in fatal (69.2%) and severe (62.3%) crashes. Female drivers were more involved in non-injury crashes (43.9%) as compared to injury crashes. Inattentiveness/distraction was the leading driver condition (29.6% fatal, 36.9% severe crashes), while impairment (3.2% fatal) and fatigue (2.9% fatal) had smaller impacts on crash severity.
- **Vehicle Type:** Passenger cars had the highest crash involvement (37.3% fatal, 39.5% severe), followed by light trucks (30.8% fatal, 24.6% severe) and SUVs (17.7% fatal, 20.4% severe). Motorcycles (5.1% fatal, 4.5% severe) had a higher fatality risk despite lower crash numbers.

Table 6. Distribution of selected variables by crash severity for older drivers dataset

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Crash Characteristics												
Manner Of Collision												
Single Vehicle Crash	403	46.4	338	30.5	2,095	22.2	4,013	11.4	8,803	7.7	15,652	9.8
Right Angle	209	24.1	250	22.5	2,868	30.4	8,965	25.4	19,272	17	31,564	19.7
Rear End	80	9.2	146	13.2	1,616	17.1	9,828	27.8	26,728	23.5	38,398	23.9
Head On	75	8.6	44	4	296	3.1	626	1.8	1,409	1.2	2,450	1.5
Sideswipe	23	2.6	84	7.6	511	5.4	2,876	8.1	23,966	21.1	27,460	17.1
Left Turn	61	7	159	14.3	1,534	16.3	5,208	14.7	13,881	12.2	20,843	13.0
Right Turn	4	0.5	21	1.9	188	2	901	2.6	5,477	4.8	6,591	4.1
Other/Unknown	13	1.5	68	6.1	329	3.5	2,907	8.2	14,076	12.4	17,393	10.8
Prior Movement												
Backing	1	0.1	20	1.8	95	1	595	1.7	8,770	7.7	9,481	5.9
Changing Lanes	12	1.4	38	3.4	229	2.4	1,538	4.4	12,958	11.4	14,775	9.2

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Crossed Centerline/Median	85	9.8	35	3.2	263	2.8	657	1.9	1,478	1.3	2,518	1.6
Entering Traffic	32	3.7	44	4	481	5.1	2,013	5.7	7,515	6.6	10,085	6.3
Making Left Turn	110	12.7	202	18.2	2,003	21.2	6,383	18.1	17,322	15.2	26,020	16.2
Making Right Turn	6	0.7	28	2.5	277	2.9	1,305	3.7	7,570	6.7	9,186	5.7
Proceeding Straight Ahead	340	39.2	554	49.9	4,436	47	17,339	49.1	43,029	37.9	65,698	41.0
Ran Off Road	219	25.2	89	8	757	8	1,983	5.6	2,645	2.3	5,693	3.6
Slowing	7	0.8	19	1.7	209	2.2	1,035	2.9	3,245	2.9	4,515	2.8
Stopped	19	2.2	35	3.2	362	3.8	1,488	4.2	5,052	4.4	6,956	4.3
Other/Unknown	37	4.2	46	4.1	325	3.5	988	2.8	4,028	3.5	5,424	3.4
Violations												
Careless Operation	219	25.2	184	16.6	1,976	20.9	7,945	22.5	22,362	19.7	32,686	20.4
Cutting In, Improper Passing	6	0.7	11	1	82	0.9	600	1.7	4,543	4	5,242	3.3
Disregarded Traffic Control	59	6.8	67	6	736	7.8	2,528	7.2	4,774	4.2	8,164	5.1
Driver Condition	55	6.3	83	7.5	441	4.7	1,312	3.7	2,203	1.9	4,094	2.6
Driving Left of Center	48	5.5	14	1.3	126	1.3	354	1	1,106	1	1,648	1.0
Exceeding Speed Limit	8	0.9	8	0.7	44	0.5	101	0.3	241	0.2	402	0.3
Failure To Yield	199	22.9	285	25.7	3,161	33.5	10,691	30.3	29,946	26.4	44,282	27.6
Following Too Closely	2	0.2	36	3.2	509	5.4	3,879	11	11,140	9.8	15,566	9.7
Improper Backing	-	-	9	0.8	53	0.6	399	1.1	6,739	5.9	7,200	4.5
Improper Turning	5	0.6	26	2.3	232	2.5	1,057	3	5,239	4.6	6,559	4.1
Turned From Wrong Lane	-	-	14	1.3	76	0.8	416	1.2	1,743	1.5	2,249	1.4
No Violations	114	13.1	206	18.6	1,016	10.8	2,565	7.3	8,604	7.6	12,505	7.8
Other/Unknown	153	17.6	167	15	985	10.4	3,477	9.8	14,972	13.2	19,754	12.3
Traffic Control												
Green Signal On	37	4.3	97	8.7	732	7.8	2,424	6.9	6,705	5.9	9,995	6.2
Green Turn Arrow On	2	0.2	3	0.3	35	0.4	133	0.4	830	0.7	1,003	0.6
Red Signal On	28	3.2	84	7.6	844	8.9	3,981	11.3	10,847	9.5	15,784	9.8
Yellow Signal On	4	0.5	2	0.2	59	0.6	141	0.4	391	0.3	597	0.4
Stop Sign/Flashing Red	142	16.4	182	16.4	1,831	19.4	6,438	18.2	16,850	14.8	25,443	15.9
Yield Sign	16	1.8	17	1.5	230	2.4	1,018	2.9	3,619	3.2	4,900	3.1
White Dashed Line	181	20.9	232	20.9	1,720	18.2	7,738	21.9	30,038	26.4	39,909	24.9
Yellow Dashed Line	118	13.6	97	8.7	698	7.4	2,346	6.6	5,581	4.9	8,840	5.5

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Yellow No Passing Line	192	22.1	149	13.4	1,264	13.4	4,268	12.1	9,911	8.7	15,784	9.8
No Control	82	9.4	167	15	1,355	14.4	4,673	13.2	21,098	18.6	27,375	17.1
Other/Unknown	66	7.6	80	7.3	669	7.1	2164	6.2	7,742	6.8	10,721	6.7
Environmental and Temporal Factors												
Crash Time												
12:00 a.m. – 6:00 a.m.	62	7.1	46	4.1	296	3.1	772	2.2	2,211	1.9	3,387	2.1
6:00 a.m. – 12:00 p.m.	237	27.3	333	30	2,921	31	11,264	31.9	37,057	32.6	51,812	32.3
12:00 p.m. – 6:00 p.m.	363	41.8	519	46.8	4,671	49.5	18,360	52	59,640	52.5	83,553	52.1
6:00 p.m. – 12:00 a.m.	206	23.7	212	19.1	1,549	16.4	4,928	14	14,692	12.9	21,587	13.5
Lighting Condition												
Daylight	584	67.3	861	77.6	7,576	80.3	29,562	83.7	96,868	85.3	135,451	84.5
Dawn/Dusk	28	3.2	19	1.7	218	2.3	654	1.9	1,954	1.7	2,873	1.8
Dark with Continuous Streetlights	70	8.1	123	11.1	828	8.8	2,769	7.8	8,261	7.3	12,051	7.5
Dark with Streetlights at Intersections Only	24	2.8	22	2	203	2.2	574	1.6	1,749	1.5	2,572	1.6
Dark with No Streetlights	152	17.5	80	7.2	567	6	1,652	4.7	4,341	3.8	6,792	4.2
Other/Unknown	10	1.2	5	0.5	45	0.5	113	0.3	439	0.4	612	0.4
Day of the Week												
Weekday	624	71.9	821	74	7,316	77.5	28,428	80.5	93,526	82.3	130,715	81.5
Weekend	244	28.1	289	26	2,121	22.5	6,896	19.5	20,086	17.7	29,636	18.5
Weather Condition												
Clear	651	75	869	78.3	7,212	76.4	26,432	74.8	85,555	75.3	120,719	75.3
Cloudy	146	16.8	162	14.6	1,447	15.3	5,839	16.5	18,595	16.4	26,189	16.3
Rain	52	6	70	6.3	685	7.3	2,826	8	8,655	7.6	12,288	7.7
Other/Unknown	19	2.1	9	0.9	93	1	227	0.7	807	0.7	1,155	0.7
Area Type												
Urban	373	43	548	49.4	4,785	50.7	19,097	54.1	58,342	51.4	83,145	51.9
Rural	351	40.4	147	13.2	1,329	14.1	4,142	11.7	8,223	7.2	14,192	8.9
Unknown	144	16.6	415	37.4	3,323	35.2	12,085	34.2	47,047	41.4	63,014	39.3
Highway Type												
2-Lane	373	43	252	22.7	2,202	23.3	8,061	22.8	18,874	16.6	29,762	18.6
4-Lane	87	10	151	13.6	1483	15.7	5,503	15.6	17,673	15.5	24,897	15.5
4-Lane Divided	148	17.1	164	14.8	1,518	16.1	5,664	16	16,432	14.5	23,926	14.9

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
4-Lane Interstate	69	7.9	41	3.7	362	3.8	1,445	4.1	4,751	4.2	6,668	4.2
6-Lane	14	1.6	36	3.2	260	2.8	1,183	3.3	4,063	3.6	5,556	3.5
6-Lane Interstate	28	3.2	43	3.9	223	2.4	1,086	3.1	3,752	3.3	5,132	3.2
Other Freeways	5	0.6	8	0.7	66	0.7	297	0.8	1,020	0.9	1,396	0.9
Unknown	144	16.5	415	37.5	3323	35.3	12085	34.2	47047	41.5	63,014	39.3
Highway Administrative Class												
City Street	83	9.6	362	32.6	2,675	28.3	9,897	28	35,937	31.6	48,954	30.5
Parish Road	65	7.5	121	10.9	1,001	10.6	3,563	10.1	15,164	13.3	19,914	12.4
State Hwy	423	48.7	351	31.6	3,315	35.1	12,848	36.4	35,149	30.9	52,086	32.5
U.S. Hwy	197	22.7	190	17.1	1,824	19.3	6,480	18.3	18,867	16.6	27,558	17.2
Interstate	99	11.4	76	6.8	560	5.9	2,323	6.6	7,798	6.9	10,856	6.8
Other/Unknown	1	0.1	10	0.9	62	0.7	213	0.6	697	0.6	983	0.6
Road Type												
One-Way Road	24	2.8	94	8.5	707	7.5	3,109	8.8	10,457	9.2	14,391	9.0
Two-Way Road with a Physical Barrier/Separation	288	33.2	336	30.3	2854	30.2	11,218	31.8	35,767	31.5	50,463	31.5
Two-Way Road with No Physical Separation	549	63.2	668	60.2	5,787	61.3	20,680	58.5	66,176	58.2	93,860	58.5
Other/Unknown	7	0.8	12	1.1	89	0.9	317	0.9	1,212	1.1	1,637	1.0
Intersection												
True	281	32.4	544	49	4,920	52.1	17,195	48.7	49,833	43.9	72,773	45.4
False	587	67.6	566	51	4,517	47.9	18,129	51.3	63,779	56.1	87,578	54.6
Roadway Type by Speed												
High Speed Roadway (Speed Limit ⩾ 40 Mph)	645	74.3	569	51.3	4,990	52.9	18,588	52.6	52,856	46.5	77,648	48.4
Low Speed Roadway (Speed Limit < 40 Mph)	189	21.8	461	41.5	3,909	41.4	14,697	41.6	53,416	47	72,672	45.3
Unknown	34	3.9	80	7.2	538	5.7	2,039	5.8	7,340	6.5	10,031	6.3
Driver and Vehicle Characteristics												
Driver Age Group												
65-69	274	31.6	399	35.9	3,380	35.8	12,895	36.5	41,282	36.3	58,230	36.3
70-74	185	21.3	313	28.2	2,465	26.1	9,137	25.9	29,899	26.3	41,999	26.2
75-79	179	20.6	177	15.9	1,673	17.7	6,269	17.7	20,420	18	28,718	17.9

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
80-84	113	13	119	10.7	1,153	12.2	4,156	11.8	13,246	11.7	18,787	11.7
85+	117	13.5	102	9.2	766	8.1	2,867	8.1	8,765	7.7	12,617	7.9
Driver Gender												
Female	267	30.8	415	37.4	3,960	42	15,576	44.1	49,823	43.9	70,041	43.7
Male	601	69.2	691	62.3	5,454	57.8	19,688	55.7	63,440	55.8	89,874	56.0
Unknown	-	-	4	0.4	23	0.2	60	0.2	349	0.3	436	0.3
Driver Condition												
Inattentive/Distracted	257	29.6	410	36.9	5,049	53.5	21,917	62	74,366	65.5	101,999	63.6
Illness	36	4.1	59	5.3	263	2.8	850	2.4	373	0.3	1,581	1.0
Impaired (Drug/Alcohol)	28	3.2	22	2	169	1.8	483	1.4	874	0.8	1,576	1.0
Fatigued/Asleep/Blackout	25	2.9	31	2.8	359	3.8	912	2.6	732	0.6	2,059	1.3
Normal	128	14.7	372	33.5	2,701	28.6	9,075	25.7	31,845	28	44,121	27.5
Other/Unknown	394	45.4	216	19.5	896	9.5	2,087	5.9	5,422	4.8	9,015	5.6
Vehicle Type												
Passenger Car	324	37.3	439	39.5	3,942	41.8	15,330	43.4	48,074	42.3	68,109	42.5
Light Truck	267	30.8	273	24.6	2,411	25.5	8,665	24.5	28,193	24.8	39,809	24.8
SUV	154	17.7	226	20.4	2,020	21.4	7,958	22.5	26,497	23.3	36,855	23.0
Motorcycle	44	5.1	50	4.5	228	2.4	197	0.6	96	0.1	615	0.4
Van	31	3.6	65	5.9	498	5.3	1,883	5.3	5,830	5.1	8,307	5.2
Truck/Trailer/Tractor	23	2.6	18	1.6	153	1.6	643	1.8	2,478	2.2	3,315	2.1
Other/Unknown	25	2.9	39	3.5	185	2	648	1.8	2,444	2.2	3,341	2.1
Total	**868**	**100**	**1,110**	**100**	**9,437**	**100**	**35,324**	**100**	**113,612**	**100**	160,351	**100.0**

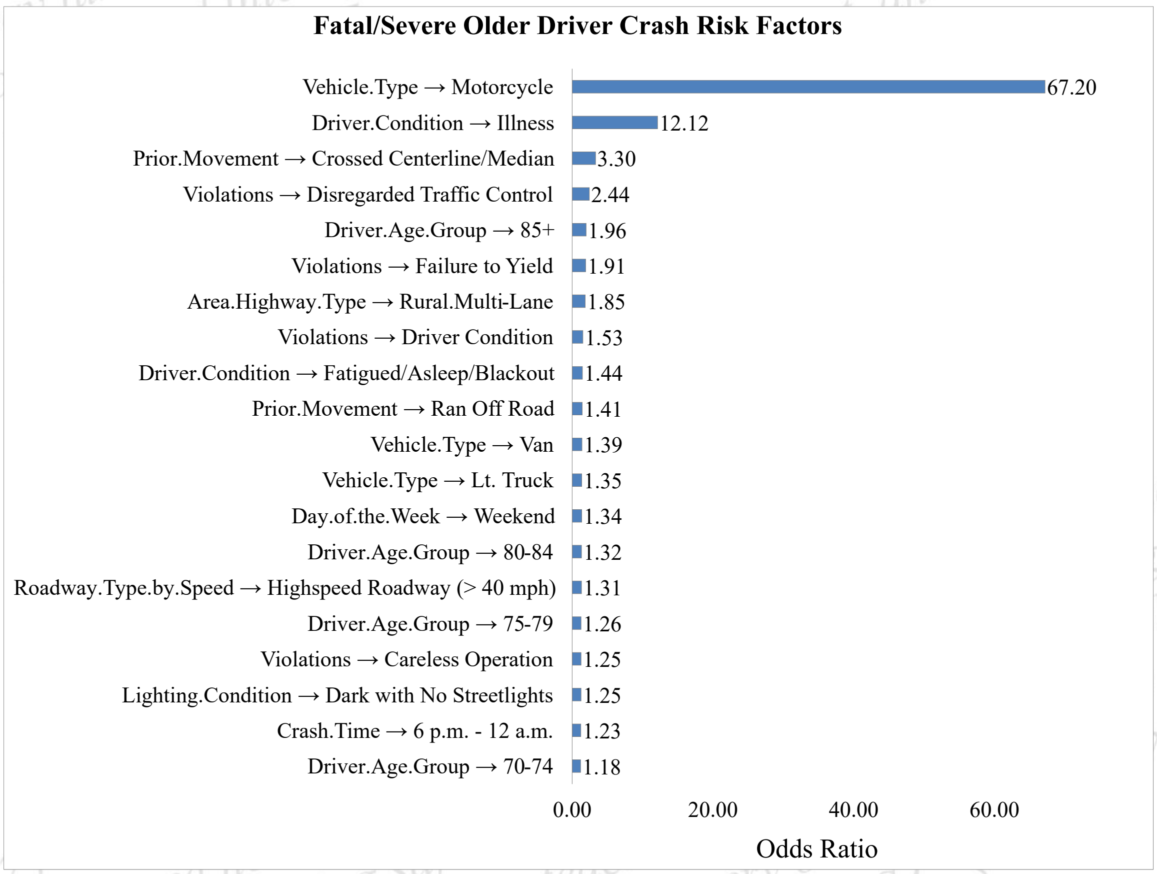
* Percentages may not sum exactly to 100% due to rounding errors.

Multinomial Logit Model Results for Older Driver Crashes

Fatal/Severe Crash Risk Factors for Older Drivers

This section presents the results of the MNL model developed to estimate the likelihood of fatal and severe KA injury outcomes in older driver crashes, using PDO crashes as the reference category. The MNL model was applied to examine how variations in driver characteristics, environmental conditions, vehicle type, roadway features, and traffic violations influence the probability of higher injury severities among older drivers. The purpose of using the MNL approach was to quantify the relative effects of multiple categorical and continuous predictors simultaneously and determine which factors significantly increase the odds of fatal or severe injury outcomes compared to PDO crashes. Only those variables with odds ratios (OR) greater than 1 and p-values ≤ 0.05 were retained for interpretation, indicating a statistically significant increase in the likelihood of KA outcomes. Figure 7 visualizes the odds ratios for the significant predictors of KA injury crashes, highlighting the most influential risk factors affecting older driver safety in Louisiana. Detailed model coefficients, odds ratios, and significance levels are provided in Appendix 3.

Figure 7. Multinomial logit model results for KA crashes involving older drivers



Driver Age

The results indicate a progressive increase in crash severity with advancing age:

- Drivers aged 70 to 74 were 1.18 times more likely to be involved in a KA crash relative to the 65 to 69 age group.

- This risk increased steadily for age groups 75 to 79 (OR = 1.26) and 80 to 84 (OR = 1.32), and was nearly double for drivers aged 85 and older (OR = 1.96, $p < 0.001$).

Driver Condition

Crashes in which the driver was reported to have a medical illness at the time of the crash were associated with an extraordinarily high risk of severe outcomes. The odds of a KA injury were 12.1 times higher for ill drivers compared to those reported in normal conditions. Additionally, drivers who were fatigued, asleep, or experienced a blackout were 1.4 times more likely to be involved in a crash resulting in a KA-level injury.

Traffic Violations

Violations emerged as strong predictors of KA crash risk among older drivers:

- Disregard of traffic control devices was associated with a 2.4-fold increase in the odds of a crash resulting in KA injuries, whereas failure to yield increased the odds by 1.9 times.
- Violations related to driver condition (e.g., impaired operation due to illness or distraction) were also significant (OR = 1.53).
- Careless operation, a general indicator of risky driving behavior, was associated with a 1.25 times higher likelihood of crashes resulting in KA injuries.

Vehicle Type

Vehicle type significantly influenced crash outcomes:

- Involvement of a motorcycle increased the odds of KA injury by a staggering 67 times, underscoring the extreme vulnerability of motorcyclists, especially older adults, in crash events.
- Crashes involving vans (OR = 1.39) and light trucks (OR = 1.35) also exhibited higher severity risks compared to those involving passenger cars.

Roadway and Environmental Characteristics

- Crashes occurring on rural multi-lane highways were 1.8 times more likely to result in KA injury compared to rural two-lane roads.
- High-speed roadways were associated with a 1.3 times higher likelihood of KA injury outcomes compared to low-speed facilities, underscoring the influence of higher kinetic energy on crash severity.

- Weekend crashes were 1.34 times more likely to result in KA injuries compared to weekday crashes.

Lighting and Crash Timing

- Crashes occurring under dark conditions without street lighting were 1.25 times more likely to result in KA injuries, consistent with older drivers' known difficulties with night vision, reduced contrast sensitivity, and diminished hazard perception under low illumination.
- Crashes occurring during the evening (6:00 p.m. to 12:00 a.m.) were associated with a 1.23 times higher likelihood of KA injuries compared to crashes occurring during the afternoon.

Pre-Crash Maneuvers

- Vehicles that crossed the centerline or median prior to the crash had more than three times the odds of a KA injury compared to vehicles that were proceeding straight ahead. This is indicative of potential lane departure or head-on collision scenarios.
- Similarly, crashes in which vehicles ran off the road were associated with a 1.4 times higher likelihood of resulting in KA injuries.

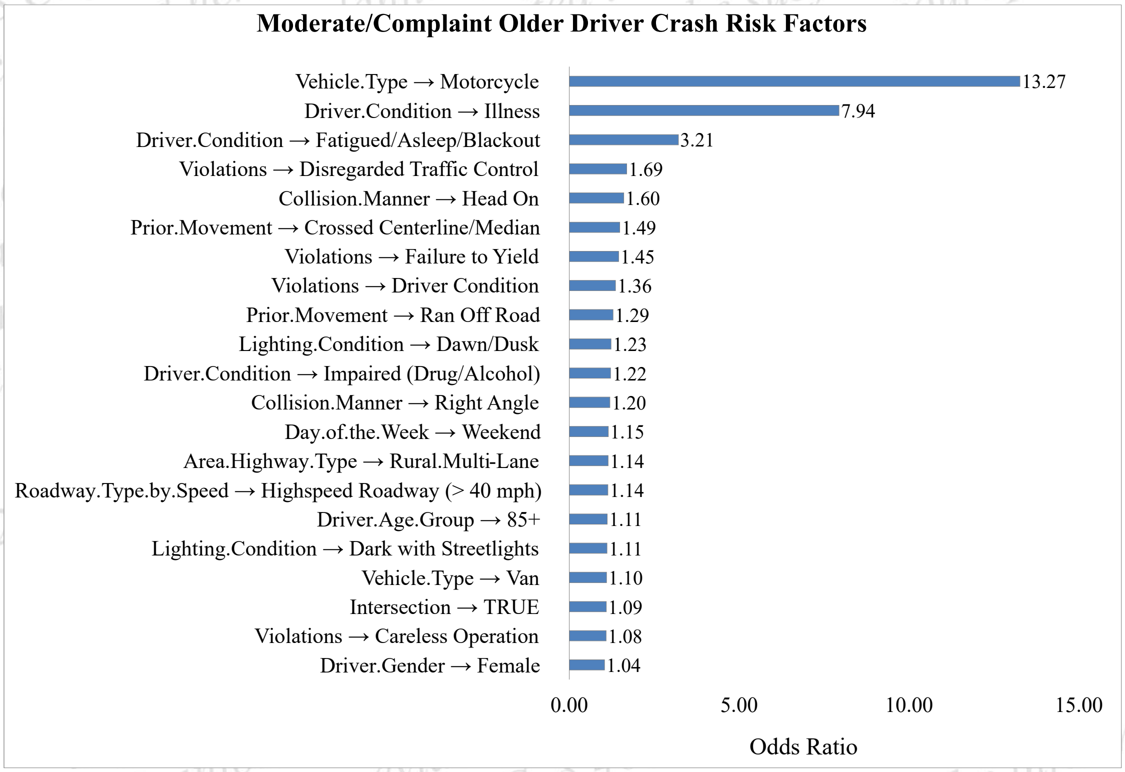
The findings underscore the multi-factorial nature of crash severity among older drivers, implicating not only driver characteristics such as age and health, but also contextual variables including time of day, lighting, roadway design, vehicle type, and behavioral violations.

Moderate/Complaint Injury Crash Risk Factors for Older Drivers

This section presents the results of the MNL model estimating the likelihood of BC injury outcomes in crashes involving older drivers, with PDO crashes serving as the reference category. The MNL model was used to examine how driver demographics, roadway characteristics, vehicle types, environmental conditions, pre-crash maneuvers, and traffic violations influence the probability of sustaining BC injuries. The purpose of this model was to quantify the relative impact of these contributing factors and identify those that significantly increase the odds of moderate or complaint injuries among older drivers, compared to PDO outcomes. Only variables with OR greater than 1 and p-values ≤ 0.05 were retained for interpretation, indicating a statistically significant increase in the likelihood of BC outcomes.

Figure 8 illustrates the odds ratios for the significant predictors, highlighting the key risk factors associated with elevated but non-fatal/severe injuries among older drivers in Louisiana. Detailed model coefficients, odds ratios, and significance levels are provided in Appendix 4.

Figure 8. Multinomial logit model results for BC crashes involving older drivers



Driver Characteristics

- Older drivers aged 85 and above had a 1.1 times higher likelihood of experiencing a BC injury compared to those aged 65 to 69.
- Crashes involving drivers impaired by drugs or alcohol had a 1.22 times higher likelihood of resulting in BC injuries. Similarly, crashes involving drivers who were fatigued, asleep, or experienced a blackout were associated with a more than threefold increase in BC injury risk. Most notably, crashes involving drivers who experienced a medical illness showed an exceptionally higher likelihood (7.9 times greater) of resulting in BC injuries.

Traffic Violations

Violations were consistently associated with increased risk of BC injury outcomes:

- Disregarding traffic control devices (OR = 1.69)
- Failure to yield (OR = 1.45)
- Violations related to driver condition (OR = 1.36)
- Careless operation (OR = 1.08)

These findings emphasize that unsafe or unlawful driving behavior significantly contributes to BC injury outcomes.

Vehicle Type

- Crashes involving motorcycles were associated with a 13.3 times greater risk of BC injury compared to those involving passenger cars, underscoring the exposure and vulnerability of motorcyclists in the older population.
- Vans (OR = 1.10) also showed a modestly higher BC injury risk compared to passenger cars.

Lighting and Environmental Conditions

- Crashes occurring during dawn or dusk (OR = 1.23) and dark conditions with street lighting (OR = 1.11) were both associated with increased BC injury risk compared to daylight conditions.
- Weekend crashes showed a 1.15 times increase in risk of BC injuries.

Roadway Characteristics

- Crashes occurring on high-speed roadways had a 1.14 times higher likelihood of resulting in BC injuries, highlighting the influence of speed on non-fatal injury outcomes.
- Similarly, rural multi-lane roads were riskier than rural two-lane roads (OR = 1.14).
- Intersection-related crashes were 1.09 times more likely to result in BC injuries.

Crash Characteristics

- Right angle crashes (OR = 1.20) and head-on collisions (OR = 1.60) were significantly more likely to result in BC injuries than single-vehicle crashes.
- Pre-crash maneuvers such as crossing the centerline or median (OR = 1.49) and running off the road (OR = 1.29) were also significantly associated with higher injury risk.

The results reveal that a complex interplay of driver health and behavior, roadway context, crash dynamics, and environmental visibility influences BC injury outcomes among older drivers. While less severe than KA injury crashes, these injuries still represent a substantial burden in terms of healthcare costs, long-term recovery, and quality of life for ORUs.

Geospatial Analysis of Older Driver Crashes

The geospatial analysis of older driver crashes aims to identify high-risk areas across Louisiana by examining spatial patterns of crash distribution. This analysis helps in understanding regional disparities in crash rates and highlights locations where targeted safety interventions may be necessary. Using crash data from 2010 to 2021, this study normalizes older driver crashes per 1,000 older residents to provide a clearer picture of crash risk at different geographic levels.

Figure 9 shows the spatial distribution of older driver crashes per 1,000 older population, revealing disparities between urban and rural areas. The highest crash rates are observed in southern Louisiana, particularly in Lafayette, West Baton Rouge, and East Baton Rouge Parishes. Interestingly, Orleans Parish has a lower crash rate despite having the third-largest older population in the state.

Figure 9. Spatial distribution of total older driver crash rates across parishes in Louisiana

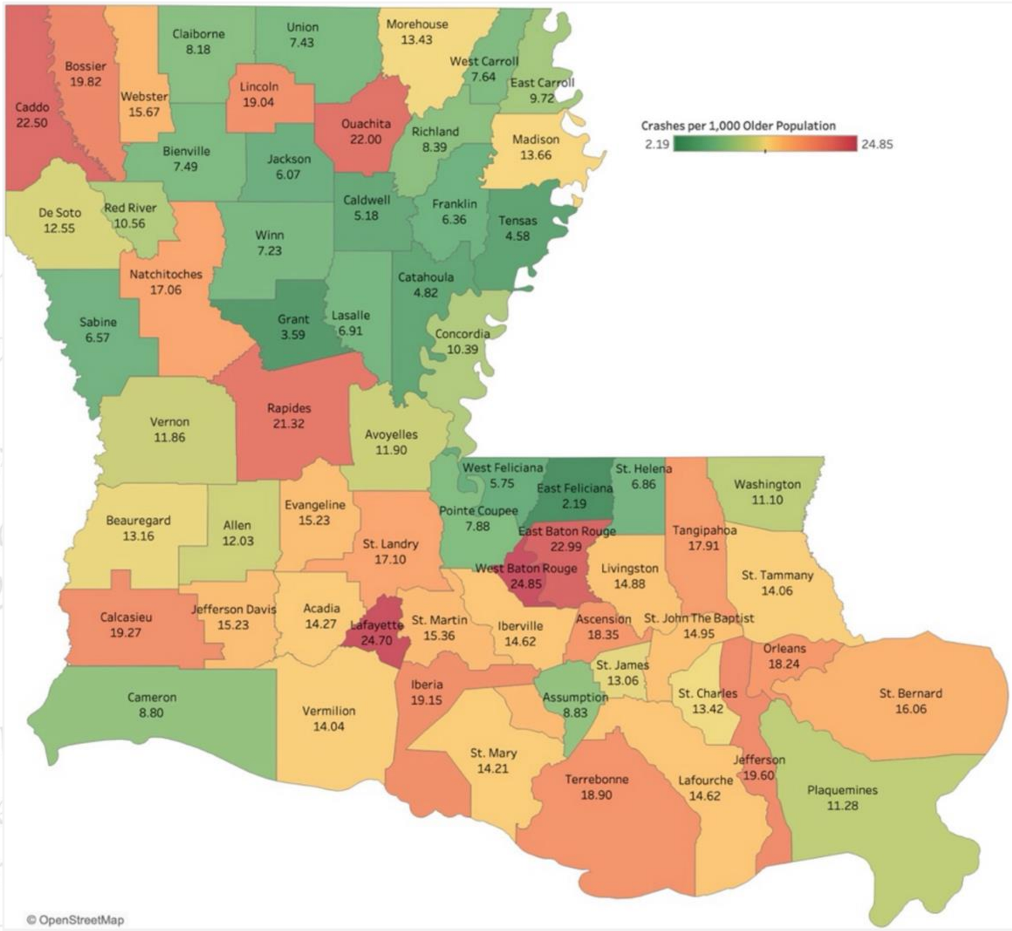


Figure 10 illustrates the spatial distribution of older driver fatal and severe crash rates, measured per 1,000 older population. The state's northeastern parishes (e.g., Madison and East Carroll) show the highest rates (≥ 0.55), while southern and western parishes report lower rates (< 0.30). While central and southeastern parishes (e.g., West Feliciana and St. Tammany) fall within the moderate crash range, other parishes in the region, such as Pointe Coupee, West Baton Rouge, and St. Helena, exhibit a high crash rate. The urban-rural divide in crash rates is evident: rural areas, except West Baton Rouge Parish, experience higher fatal and severe crash risks. Appendix 5 presents comprehensive parish-level statistics for older drivers, detailing the older population, total crashes, crash rates, and KA crash frequencies for all 64 parishes in Louisiana.

Figure 10. Spatial distribution of older driver fatal and severe crash rate across parishes

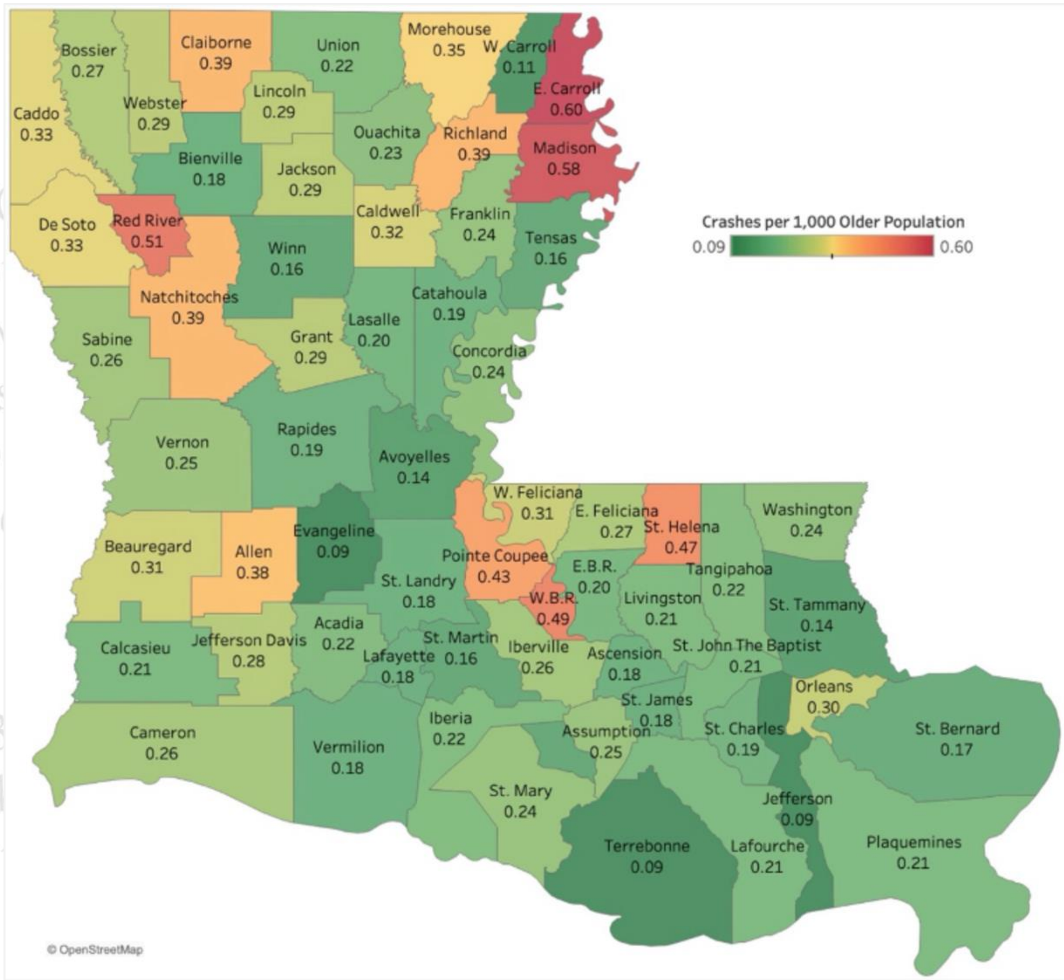


Figure 11 illustrates the spatial distribution of older driver crash risk across Louisiana census tracts, highlighting areas with elevated crash rates. A total of 1,388 census tracts were analyzed in this study. It presents the overall older driver crash rate, normalized to 1,000 older adults, with warmer colors (e.g., orange and red) indicating higher crash rates and cooler colors (e.g., green) representing lower-risk areas. In the figure, the number of tracts in each color category is enclosed in square brackets. The results suggest that high-crash-risk tracts are predominantly located in urban regions, which may be attributed to higher traffic volumes and increased exposure to complex roadway environments. In contrast, Figure 12 highlights the fatal and severe crash rate among older drivers, emphasizing tracts where crashes resulted in serious injuries or fatalities. The distribution of these crashes follows a similar pattern to the overall crash rate but reveals a more pronounced concentration in some areas. This analysis is critical for identifying locations where targeted safety interventions, such as improved roadway design, enforcement measures, or driver education programs, may be necessary to mitigate risks for older drivers.

Figure 11. Spatial distribution of total older driver crash rate across Louisiana census tracts

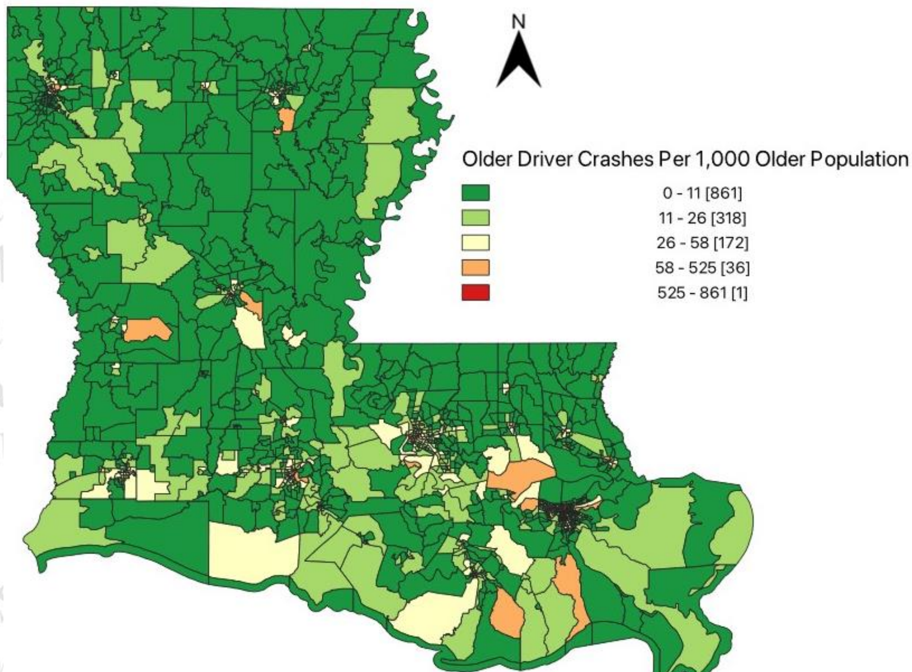
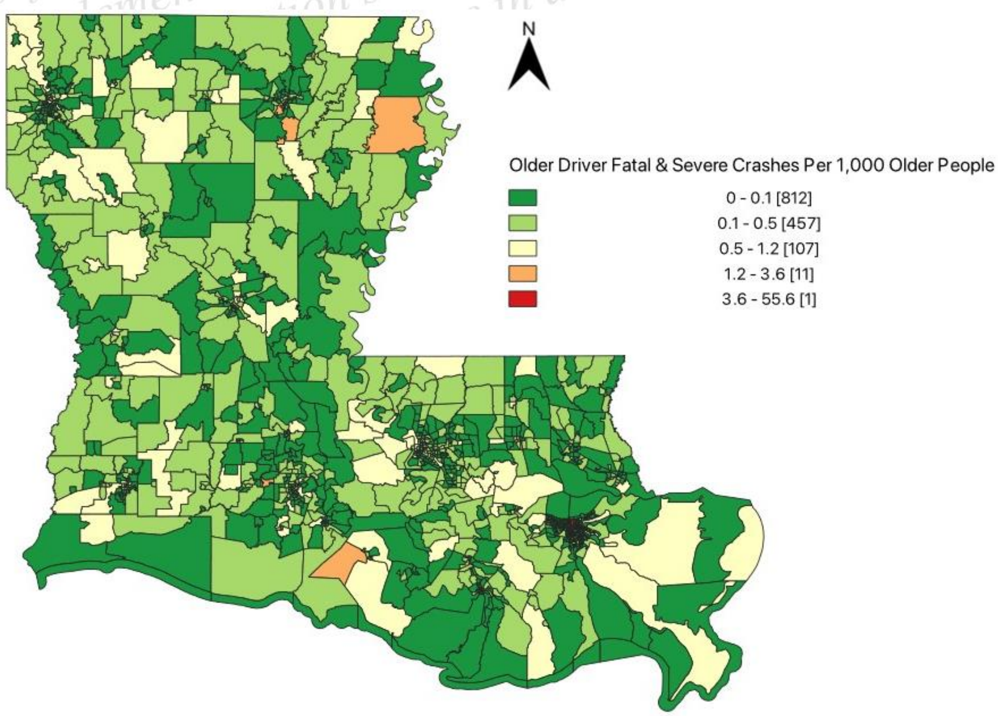


Figure 12. Spatial distribution of older driver fatal and severe crash rate across Louisiana census tracts



Hotspot Analysis of Older Driver Crashes in Urban and Rural Parishes

To complement the parish- and tract-level spatial analyses, a Getis-Ord Gi* hotspot analysis was conducted to statistically identify clusters of high crash intensity among older drivers. This approach highlights areas where crash concentrations are significantly higher than would be expected by chance, enabling a more rigorous identification of locations with critical safety concerns. Crashes occurring within tracts classified as hotspots at the 95% and 99% confidence intervals were extracted for further investigation.

The extracted hotspot crashes were stratified by location type, distinguishing between urban and rural parishes. The selected urban parishes (East Baton Rouge, Jefferson, Orleans, Caddo, and Lafayette) were identified based on their disproportionately high share of crashes, collectively representing 54.57% of all urban crashes in Louisiana, out of 24 urban parishes. The selected rural parishes (Tangipahoa, Iberia, Vermilion, Lincoln, St. Mary, Natchitoches, Washington, and Evangeline) were chosen due to their elevated number of crashes, accounting for 51.01% of all rural crashes statewide, out of 40 rural parishes. In total, these 13 urban and rural parishes together comprise 54.6% of all crashes involving older drivers in Louisiana. In addition to the selected parishes, the overall statewide crash distribution was analyzed as a benchmark for comparison.

Table 7 presents the comparative results, highlighting the distribution of crash, driver, roadway, and environmental characteristics across the three analysis categories. Only variables demonstrating notable differences between urban and rural settings were included.

Table 7. Comparison of older driver crash characteristics in urban and rural hotspots

Variable	Urban Hotspot Crashes N = 34,890	Rural Hotspot Crashes N = 8,321	All Crashes N = 160,376
	%	%	%
Crash Characteristics			
Collision Manner			
Rear End	26.7	20.7	23.9
Sideswipe	19.8	16.8	17.1
Right Angle	19.7	22.6	19.7
Left Turn	12.1	14.3	13.0
Right Turn	4.4	4.0	4.1
Single Vehicle Crash	6.4	8.4	9.8
Head On	1.3	1.9	1.5
Other/Unknown	9.5	11.2	10.6

Variable	Urban Hotspot Crashes N = 34,890	Rural Hotspot Crashes N = 8,321	All Crashes N = 160,376
	%	%	%
Prior Movement			
Proceeding Straight Ahead	41.0	39.4	41.0
Making Left Turn	16.0	17.3	16.2
Changing Lanes	11.8	9.0	9.2
Making Right Turn	6.4	5.2	5.7
Entering Traffic	6.3	7.5	6.6
Backing	5.0	7.2	5.9
Stopped	4.2	4.5	4.3
Slowing	3.0	2.8	2.8
Ran Off Road	2.1	3.0	3.5
Crossed Centerline/Median	1.2	1.3	1.6
Other/Unknown	3.0	2.8	3.0
Violations			
Failure to Yield	27.7	31.0	27.6
Careless Operation	21.2	19.6	20.4
Following Too Closely	10.5	8.6	9.7
No Violations	6.5	6.5	7.8
Disregarded Traffic Control	5.4	5.2	5.1
Cutting In, Improper Passing	3.9	2.9	3.3
Improper Backing	3.8	5.5	4.5
Improper Turning	3.6	4.3	4.1
Driver Condition	1.8	2.5	2.6
Turned From Wrong Lane	1.3	2.2	1.4
Driving Left of Center	0.8	1.2	1.0
Exceeding Speed Limit	0.1	0.2	0.3
Other/Unknown	13.4	10.3	12.3
Traffic Control			
White Dashed Line	29.9	21.7	24.9
No Control	15.8	18.4	17.1
Stop Sign/Flashing Red	13.9	19.3	15.9
Red Signal On	11.0	9.6	10.0
Yellow No Passing Line	7.3	9.8	9.8
Green Signal On	7.0	6.1	6.2
Yellow Dashed Line	3.6	5.3	5.5

Variable	Urban Hotspot Crashes N = 34,890	Rural Hotspot Crashes N = 8,321	All Crashes N = 160,376
	%	%	%
Yield Sign	3.5	2.8	3.1
Green Turn Arrow On	0.9	0.6	0.6
Yellow Signal On	0.4	0.3	0.4
Other/Unknown	6.8	6.2	6.4
Environmental and Temporal Factors			
Lighting Condition			
Daylight	85.6	85.6	84.5
Dark with Continuous Streetlights	8.7	7.2	7.5
Dark with No Streetlights	2.6	3.9	4.2
Dawn/Dusk	1.5	1.5	1.8
Dark with Streetlights at Intersections Only	1.3	1.5	1.6
Other/Unknown	0.3	0.3	0.4
Day of the Week			
Weekday	82.6	81.8	81.5
Weekend	17.4	18.2	18.5
Highway Type			
4-Lane	15.1	20.5	15.5
4-Lane Divided	14.3	12.9	14.9
2-Lane	11.4	21.9	18.6
6-Lane	6.0	2.5	3.5
6-Lane Interstate	4.5	2.4	3.2
4-Lane Interstate	3.4	3.8	4.2
Other Freeways	1.6	0.6	0.9
Unknown	43.7	35.4	39.3
Highway Administrative Class			
City Street	30.6	32.4	30.5
State Hwy	29.0	33.1	32.5
U.S. Hwy	16.9	19.8	17.2
Parish Road	16.1	8.0	12.4
Interstate	7.0	6.0	6.8
Other/Unknown	0.4	0.7	0.6

Variable	Urban Hotspot Crashes N = 34,890	Rural Hotspot Crashes N = 8,321	All Crashes N = 160,376
	%	%	%
Road Type			
Two-Way Road with No Physical Separation	51.3	64.2	58.5
Two-Way Road with a Physical Barrier/Separation	39.7	23.5	31.5
One-Way Road	7.9	11.6	9.0
Other/Unknown	1.0	0.6	1.0
Intersection			
True	44.3	48.4	45.4
False	55.7	51.6	54.6
Roadway Type by Speed			
High Speed Roadway (Speed Limit ⩾ 40 mph)	51.4	40.9	48.4
Low Speed Roadway (Speed Limit < 40 mph)	43.9	52.0	45.3
Unknown	4.7	7.0	6.3
Driver and Vehicle Characteristics			
Driver Age Group			
65 to 69	36.9	34.9	36.3
70 to 74	26.1	25.7	26.2
75 to 79	17.4	18.7	17.9
80 to 84	11.4	12.3	11.7
85+	8.2	8.3	7.9
Driver Condition			
Inattentive/Distracted	68.4	66.7	63.6
Normal	24.0	25.2	27.5
Other/Unknown	5.0	5.2	5.6
Illness	0.9	1.0	1.0
Fatigued/Asleep/Blackout	0.9	1.0	1.3
Impaired (Drug/Alcohol)	0.9	0.9	1.0
Vehicle Type			
Passenger Car	45.5	42.9	42.5

Variable	Urban Hotspot Crashes N = 34,890	Rural Hotspot Crashes N = 8,321	All Crashes N = 160,376
	%	%	%
SUV	23.7	22.2	23.0
Light Truck	21.6	25.8	24.8
Van	5.4	5.1	5.2
Truck/Trailer/Tractor	2.3	2.5	2.6
Other/Unknown	1.2	1.2	1.5
Motorcycle	0.3	0.3	0.4
Total	**100**	**100**	**100**
* Percentages may not sum exactly to 100% due to rounding errors.			

The analysis of older driver crashes reveals distinct patterns between urban and rural hotspots, with several notable contrasts when benchmarked against statewide distributions.

- **Crash Characteristics**: Rear-end (26.7%) and sideswipe (19.8%) collisions were more prevalent in urban hotspots compared to rural areas (20.7% and 16.8%, respectively). In contrast, rural hotspots exhibited higher proportions of right angle (22.6% vs. 19.7%), single-vehicle (8.4% vs. 6.4%), and head-on crashes (1.9% vs. 1.3%). With respect to driver movements prior to crashes, lane-changing (11.8% urban vs. 9.0% rural) was more common in urban hotspots, while backing (7.2% rural vs. 5.0% urban) and roadway departures (3.0% rural vs. 2.1% urban) were more common in rural hotspots. Failure to yield was the most frequent violation in both contexts, though it was slightly more common in rural areas (31.0% vs. 27.7%). Following too closely was more characteristic of urban crashes (10.5% vs. 8.6%), while improper backing (5.5% vs. 3.8%) and improper turning (4.3% vs. 3.6%) were more common in rural hotspots.
- **Environmental and Temporal Factors**: Most crashes occurred during daylight hours (≈85%), with minimal variation between rural and urban settings. Rural crashes, however, were more likely to occur under dark conditions without street lighting (3.9% vs. 2.6%). Crash distribution by day of the week was similar, with approximately 82% occurring on weekdays. Clear geographic differences were observed in roadway types: urban crashes were concentrated on six-lane arterials and interstates, while rural crashes were more common on two-lane roads (21.9% vs. 11.4%). State and U.S. highways accounted for a larger share of rural crashes (33.1% and 19.8%, respectively), while city streets accounted for a larger share in urban areas (30.6%). Two-way roads without physical separation accounted for the majority of rural crashes (64.2%), compared with

51.3% in urban areas. Crashes at intersections were slightly more common in rural hotspots (48.4% vs. 44.3%). Speed environment also varied, with urban crashes more frequent on high-speed roads (51.4%), while rural crashes were more common on lower-speed facilities (52.0%).

- **Driver and Vehicle Characteristics**: The age distribution of older drivers involved in crashes was consistent across geographies, with the 65 to 69 age group comprising the largest share (≈36%) and proportions declining steadily with age. The 85+ age group still accounted for nearly 8% of crashes in both rural and urban settings. The driver condition revealed that distraction or inattention was the most critical factor across both groups (68.4% urban, 66.7% rural), far exceeding other conditions, such as impairment, fatigue, or illness, each of which accounted for approximately 1% of crashes. In terms of vehicle type, passenger cars were more common in urban crashes (45.5% vs. 42.9%), while light trucks were more frequent in rural areas (25.8% vs. 21.6%). SUVs comprised approximately one-quarter of vehicles in both contexts.
- **Comparison with Statewide Distribution:** When benchmarked against all statewide crashes involving older drivers, the patterns in urban and rural hotspots reveal meaningful deviations. Rural hotspots were over-represented in high-severity crash types and roadway contexts, including two-lane undivided highways, dark conditions without lighting, and head-on or single-vehicle crashes. Urban hotspots were overrepresented in congestion-related collisions, such as rear-end, sideswipe, and following-too-closely crashes, as well as in contexts involving multi-lane arterials. Although distraction was the leading driver condition statewide (63.6%), its prevalence was even higher in the high-risk hotspots (≈67–68%). Despite these contextual differences, the distribution of crashes across older driver age groups remained nearly identical between urban, rural, and statewide data, underscoring that roadway and environmental conditions, rather than driver age stratification, influence the observed geographic contrasts.

Older Pedestrian Demographics and Crash Characteristics

This section presents the findings of a comprehensive analysis of older pedestrian crashes and demographics in the older population. Table 8 provides an overview of population changes across different age groups in Louisiana according to the U.S. Census Data information available for the years 2010 and 2020. The older population increased by 36.8%, while the middle-aged and younger populations declined by 0.4% and 6.8%, respectively. Despite these shifts, the total population increased by only 2.7%, highlighting the rising proportion of older residents in the state.

Table 8. Change in population in Louisiana by age group

Year	Older (65+)	Middle-Aged (25-64)	Younger (15-24)	Total Population
2010	557,857	2,382,969	665,088	4,533,372
2020	763,143	2,373,661	619,695	4,657,757
Change	**36.8%**	**-0.4%**	**-6.8%**	**2.7%**

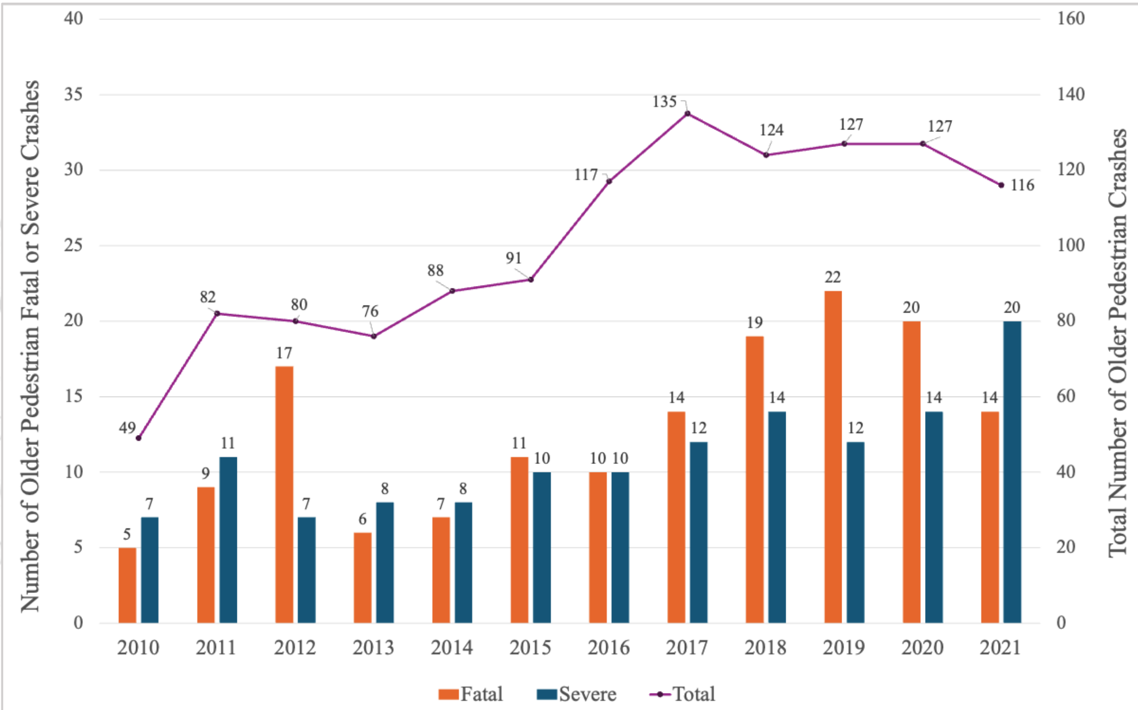
To see if this increase in population resulted in an increase in crashes involving older pedestrians, pedestrian crashes and crash rates were also analyzed in these two years. Table 9 presents the pedestrian crashes across different age groups in 2010 and 2020. During this time, the older pedestrian crashes increased sharply by 159%, while crashes involving middle-aged pedestrians rose by 15%. Conversely, crashes among younger pedestrians declined by 22%.

Table 9. Change in number of pedestrian crashes and rates by age group

Year	Older		Middle-Aged		Younger	
	Crashes	Crash Rate*	Crashes	Crash Rate*	Crashes	Crash Rate*
2010	49	8.8	745	29.2	283	39.5
2020	127	16.6	859	36.2	219	35.3
Change	**159%**	-	**15%**	-	**-22%**	-
* Crash Rate = Crashes per 100,000 population						

Figure 13 illustrates the trend in fatal and severe injury crashes involving older pedestrians from 2010 to 2021. Over this period, total crashes increased by 137%, fatal crashes surged by 180%, and severe crashes nearly tripled, highlighting a significant rise in crash severity and emphasizing the growing safety risks for older pedestrians.

Figure 13. Older pedestrian total, fatal, and severe injury crashes



Comparison of Pedestrian Crash Characteristics by Age Groups

Table 10 presents the distribution of pedestrian crashes at intersection and non-intersection locations across different age groups. The data indicates that older pedestrians are involved in a higher proportion of intersection-related crashes (46%) compared to middle-aged (39%) and younger pedestrians (38%). This trend highlights the increased crash risk older pedestrians face in complex traffic environments, particularly at intersections with multiple conflict points.

Table 10. Pedestrian crashes at intersection and non-intersection locations by age group

Average annual crashes in 12 years			
	Older ***(% of total older pedestrian crashes)***	**Middle-Aged** ***(% of total middle aged pedestrian crashes)***	**Younger** ***(% of total younger pedestrian crashes)***
Intersection	47 *(46)*	345 *(39)*	117 *(38)*
Non-Intersection	54 *(54)*	551 *(61)*	187 *(62)*

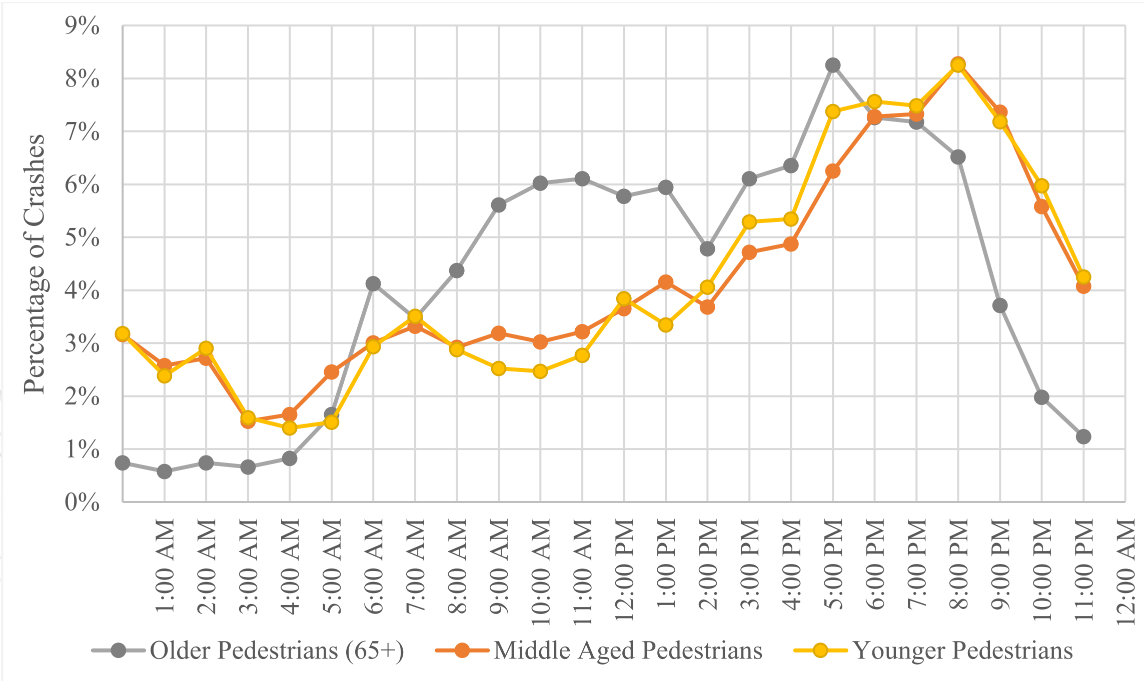
Table 11 presents the distribution of pedestrian crashes across different lighting conditions for older, middle-aged, and younger pedestrians. As shown in the table, 64% of older pedestrian crashes occurred during daytime, which is significantly higher than middle-aged (44.94%) and younger pedestrians (47.02%). This may be attributed to older adults engaging in activities during the daytime, indicating their preference for well-lit conditions. However, 17.5% of older pedestrian crashes occurred under dark conditions despite having continuous streetlights, highlighting their increased vulnerability in low-light environments, likely due to age-related declines in vision and mobility.

Table 11. Distribution of pedestrian crashes by lighting condition and age group

Lighting Condition	Older	Middle-Aged	Younger
Daylight	64.0%	44.94%	47.02%
Dark with continuous streetlights	17.5%	28.12%	26.64%
Dark with no streetlights	9.4%	16.95%	16.17%
Dark with streetlights at intersections only	5.3%	7.39%	7.26%
Dusk	2.2%	1.59%	1.66%
Dawn	1.7%	1.01%	1.25%

Figure 14 illustrates the hourly trend of pedestrian crashes across age groups, showing a notable over-representation of older pedestrians between 6:00 a.m. and 5:00 p.m. This pattern aligns with the findings in Table 11, reinforcing the tendency of older pedestrians to be involved in crashes during the daytime.

Figure 14. Hourly trend for pedestrian crashes by age group



Key Variables for Older Pedestrian Crash Contributing Factors

Table 12 presents the frequency and percentage distribution of 1,212 older pedestrian crashes in the final dataset from 2010 to 2021. The variables listed in Table 12 were used to identify crash risk factors in the modeling step. A summary of these variables is provided below.

- **Prior Movement:** The majority of fatal (70.8%) and severe injury (57.9%) pedestrian crashes involved vehicles that were proceeding straight ahead, highlighting the risk of mid-block crossings or walking along roadways. Left-turning vehicles contributed to a notable share of severe (15.0%) and moderate (17.9%) crashes, highlighting intersection-related risks.

- **Violations:** Careless operation was a major contributing factor in fatal (10.4%) and severe (10.5%) crashes. Failure to yield played a significant role in severe (9.0%) and moderate (15.2%) injury crashes. Notably, no traffic violations were reported in 53.9% of fatal crashes, suggesting that crash severity may also be influenced by other external factors.

- **Traffic Control:** Dashed road lines (i.e., uncontrolled locations) accounted for 65.6% of fatal crashes, while signalized intersections (4.6%) and stop sign-controlled (2.6%) locations had a lower share, indicating that older pedestrian crashes in Louisiana often occur in areas without proper traffic control.

- **Crash Time and Lighting Condition:** Fatal crashes were most frequent between 6:00 p.m. and 12:00 a.m. (46.1%), likely due to reduced visibility and driver fatigue, while severe crashes peaked in the afternoon (39.8%), coinciding with higher pedestrian activity. Daylight conditions accounted for 33.8% of fatal crashes but were the most common for severe (58.6%) and moderate (68.3%) crashes. However, dark conditions without streetlights contributed to 27.9% of fatal crashes, highlighting the critical role of visibility in determining the severity of older pedestrian crashes.

- **Day of the Week:** Fatal crashes were more prevalent on weekdays (57.8%) than weekends (42.2%), with similar trends in severe crashes. However, the proportion of no-injury crashes (47.1%) on weekends was higher compared to the other injury severities.

- **Highway and Road Type:** Fatal crashes were most frequent on state highways (31.8%) and U.S. highways (20.8%), whereas city streets accounted for 29.2% of fatal crashes but were the primary locations for severe (53.4%) and moderate (58.4%) injury crashes, likely due to higher pedestrian activity. Two-way roads without physical separation posed the highest risk, contributing to 51.3% of fatal crashes and 61.7% of severe crashes.

- **Intersection**: Intersections are associated with lower injury severity in crashes involving older pedestrians. While 58.6% of no-injury crashes occur at intersections, only 31.8% of fatal crashes take place at these locations. This underscores the heightened risk for older pedestrians at non-intersection sites.

- **Roadway Type by Speed:** High-speed roadways (speed limits ≥ 40 mph) accounted for 60.4% of fatal crashes, whereas low-speed roadways had a significantly higher share of all non-fatal crashes.

- **Pedestrian Demographics:** Older pedestrians aged 65 to 69 had the highest crash involvement across all severity levels, while involvement decreased for those aged 70 and older, likely due to reduced mobility and exposure. Older males were overrepresented in pedestrian crashes, accounting for 77.9% of fatal crashes and 60.9% of severe crashes, whereas females were more frequently involved in moderate (42.0%) and complaint-type injuries (33.9%).

- **Pedestrian Condition and Actions:** Inattentiveness and distraction contributed to 13.6% of fatal crashes and 23.3% of severe crashes, while alcohol and drug impairment were involved in 5.2% of fatal crashes. Crossing at non-intersection locations emerged as a major risk factor, accounting for the highest proportion of fatal crashes (27.9%), while crossing at intersections was the most frequent pedestrian action in all non-fatal crashes.

- **Pedestrian Clothing:** Light clothing accounted for the highest proportion of crashes across all injury severities. This aligns with the tendency of older adults to conduct their activities during daylight hours, where the color of their clothing may be less critical. However, dark clothing was associated with 38.3% of fatal crashes and 33.8% of severe crashes, highlighting the increased risk in low-light conditions and reinforcing the importance of visibility-enhancing measures such as reflective gear.

- **Vehicle Type:** Passenger cars were the most frequently involved vehicle type across all severities, contributing to 31.8% of fatal crashes and 39.8% of severe crashes. Light trucks (29.2% fatal, 29.3% severe) and SUVs (25.3% fatal, 22.6% severe) also played a notable role, reflecting their prevalence on the roadways.

- **Drivers Involved in Older Pedestrian Crashes:** Older pedestrian fatal crashes involved middle-aged drivers most frequently, accounting for 63.6% of such crashes, despite this group comprising only 51% of the total population. Younger drivers were involved in 11.7% of fatal crashes with older pedestrians, while representing 13.3% of the population. In contrast, older drivers were involved in only 8.5% of these crashes, despite constituting 16.4% of the population. This suggests that older drivers, despite their population share, are less frequently involved in fatal crashes with older pedestrians compared to other age groups.

- **Driver Distraction:** Driver distraction was reported in 6.5% of fatal crashes and 11.3% of severe crashes involving older pedestrians. Among distracted driving cases, outside-the-vehicle distractions were the most prevalent, while cell phone use and in-vehicle distractions had a minimal impact, each contributing to only 2.0% of fatal crashes.

Table 12. Distribution of selected variables by crash severity for older pedestrian dataset

Variable	**Fatal**		**Severe**		**Moderate**		**Complaint**		**No Injury**		**Total**	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Crash Characteristics												
Prior Movement												
Proceeding Straight Ahead	109	70.8	77	57.9	224	46.1	135	36.6	34	48.6	579	47.8
Making Left Turn	7	4.6	20	15.0	87	17.9	75	20.3	9	12.9	198	16.3
Ran Off Road	6	3.9	4	3.0	4	0.8	10	2.7	1	1.4	25	2.1
Stopped	4	2.6	5	3.8	23	4.7	24	6.5	3	4.3	59	4.9
Backing	3	2.0	9	6.8	40	8.2	34	9.2	4	5.7	90	7.4
Changing Lanes on Multi-Lane Road	3	2.0	1	0.8	4	0.8	3	0.8	-	-	11	0.9
Crossed Centerline/Median	2	1.3	2	1.5	5	1.0	3	0.8	3	4.3	15	1.2

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Making Right Turn	2	1.3	4	3.0	43	8.9	38	10.3	6	8.6	93	7.7
Slowing	2	1.3	3	2.3	13	2.7	8	2.2	1	1.4	27	2.2
Entering Traffic from Driveway/Shoulder/Median	1	0.7	1	0.8	14	2.9	10	2.7	2	2.9	28	2.3
Other/Unknown	15	9.7	7	5.3	29	6.0	29	7.9	7	10.0	87	7.2
Violations												
Careless Operation	16	10.4	14	10.5	73	15.0	47	12.7	4	5.7	154	12.7
Driver Condition	10	6.5	8	6.0	14	2.9	4	1.1	2	2.9	38	3.1
Failure To Yield	5	3.3	12	9.0	74	15.2	50	13.6	6	8.6	147	12.1
Disregarded Traffic Control	2	1.3	2	1.5	8	1.7	10	2.7	2	2.9	24	2.0
Improper Backing	2	1.3	5	3.8	16	3.3	17	4.6	2	2.9	42	3.5
Improper Turning	1	0.7	1	0.8	2	0.4	4	1.1	-	-	8	0.7
No Violations	83	53.9	61	45.9	190	39.1	134	36.3	33	47.1	501	41.3
Other/Unknown	35	22.7	30	22.6	109	22.4	103	27.9	21	30.0	298	24.6
Traffic Control												
Dashed Road Line	101	65.6	53	39.8	125	25.7	94	25.5	24	34.3	397	32.8
Red Signal On	1	0.7	7	5.3	20	4.1	23	6.2	5	7.1	56	4.6
Yellow Signal On	-	-	-	-	2	0.4	2	0.5	-	-	4	0.3
Green Signal/Arrow	6	3.9	16	12.0	80	16.5	46	12.5	12	17.1	160	13.2
Stop Sign	4	2.6	15	11.3	54	11.1	58	15.7	8	11.4	139	11.5
Yield Sign	1	0.7	-	-	6	1.2	3	0.8	-	-	10	0.8
Crosswalk	1	0.7	3	2.3	23	4.7	8	2.2	1	1.4	36	3.0
No Control	20	13.0	29	21.8	125	25.7	85	23.0	12	17.1	271	22.4
Other/Unknown	20	13.0	10	7.5	51	10.5	50	13.6	8	11.4	139	11.5
Environmental and Temporal Factors												
Crash Time												
12:00 a.m. – 6:00 a.m.	18	11.7	8	6.0	18	3.7	18	4.9	1	1.4	63	5.2
6:00 a.m. – 12:00 p.m.	34	22.1	27	20.3	162	33.3	110	29.8	27	38.6	360	29.7
12:00 p.m. – 6:00 p.m.	31	20.1	53	39.8	192	39.5	151	40.9	24	34.3	451	37.2
6:00 p.m. – 12:00 a.m.	71	46.1	45	33.8	114	23.5	90	24.4	18	25.7	338	27.9
Lighting Condition												
Daylight	52	33.8	78	58.6	332	68.3	262	71.0	44	62.9	768	63.4
Dawn/Dusk	7	4.6	3	2.3	25	5.1	9	2.4	2	2.9	46	3.8

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Dark with Continuous Streetlights	33	21.4	28	21.1	81	16.7	59	16.0	9	12.9	210	17.3
Dark with Streetlights at Intersections Only	16	10.4	7	5.3	18	3.7	16	4.3	6	8.6	63	5.2
Dark with No Streetlights	43	27.9	16	12.0	28	5.8	19	5.2	7	10.0	113	9.3
Other/Unknown	3	2.0	1	0.8	2	0.4	4	1.1	2	2.9	12	1.0
Day of the Week												
Weekday	89	57.8	79	59.4	305	62.8	240	65.0	37	52.9	750	61.9
Weekend	65	42.2	54	40.6	181	37.2	129	35.0	33	47.1	462	38.1
Weather Condition												
Clear	111	72.1	107	80.5	388	79.8	285	77.2	47	67.1	938	77.4
Cloudy	28	18.2	14	10.5	72	14.8	59	16.0	14	20.0	187	15.4
Rain	12	7.8	11	8.3	22	4.5	18	4.9	8	11.4	71	5.9
Other/Unknown	3	2.0	1	0.8	4	0.8	7	1.9	1	1.4	16	1.3
Highway Administrative Class												
City Street	45	29.2	71	53.4	284	58.4	183	49.6	38	54.3	621	51.2
Parish Road	12	7.8	18	13.5	56	11.5	64	17.3	10	14.3	160	13.2
State Hwy	49	31.8	27	20.3	79	16.3	84	22.8	9	12.9	248	20.5
U.S. Hwy	32	20.8	13	9.8	56	11.5	29	7.9	10	14.3	140	11.6
Interstate	16	10.4	-	-	5	1.0	5	1.4	1	1.4	27	2.2
Other/Unknown	-	-	4	3.0	6	1.2	4	1.1	2	2.9	16	1.3
Road Type												
One-Way Road	7	4.6	17	12.8	82	16.9	62	16.8	7	10.0	175	14.4
Two-Way Road with Physical Barrier/Separation	66	42.8	30	22.6	125	25.8	72	19.5	20	28.5	313	25.8
Two-Way Road with No Physical Separation	79	51.3	82	61.7	266	54.7	221	59.9	42	60.0	690	56.9
Other/Unknown	2	1.3	4	3.0	13	2.7	14	3.8	1	1.4	34	2.8
Intersection												
False	105	68.2	74	55.6	251	51.6	192	52.0	29	41.4	651	53.7
True	49	31.8	59	44.4	235	48.4	177	48.0	41	58.6	561	46.3
Roadway Type by Speed												

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
High Speed Roadway (Speed limit > 40 mph)	93	60.4	36	27.1	109	22.4	81	22.0	21	30.0	340	28.1
Low Speed Roadway (Speed limit < 40 mph)	49	31.8	90	67.7	334	68.7	253	68.6	43	61.4	769	63.4
Unknown	12	7.8	7	5.3	43	8.9	35	9.5	6	8.6	103	8.5
Pedestrian, Vehicle, and Driver Characteristics												
Pedestrian Age Group												
65 to 69	61	39.6	59	44.4	219	45.1	191	51.8	32	45.7	562	46.4
70 to 74	43	27.9	32	24.1	131	27.0	86	23.3	15	21.4	307	25.3
75 to 79	22	14.3	19	14.3	60	12.3	52	14.1	12	17.1	165	13.6
80 to 84	15	9.7	13	9.8	46	9.5	23	6.2	8	11.4	105	8.7
85+	13	8.4	10	7.5	30	6.2	17	4.6	3	4.3	73	6.0
Pedestrian Gender												
Female	33	21.4	52	39.1	204	42.0	125	33.9	17	24.3	431	35.6
Male	120	77.9	81	60.9	281	57.8	242	65.6	53	75.7	777	64.1
Unknown	1	0.7	-	-	1	0.2	2	0.5	-	-	4	0.3
Pedestrian Condition												
Inattentive/Distracted	21	13.6	31	23.3	107	22.0	85	23.0	12	17.1	256	21.1
Illness/Fatigue	3	2.0	3	2.3	3	0.6	3	0.8	-	-	12	1.0
Impaired (Drug/Alcohol)	8	5.2	3	2.3	8	1.7	12	3.3	1	1.4	32	2.6
Physical Impairment	1	0.7	2	1.5	6	1.2	4	1.1	3	4.3	16	1.3
Normal	31	20.1	45	33.8	244	50.2	198	53.7	34	48.6	552	45.5
Not Impaired	1	0.7	1	0.8	3	0.6	1	0.3	2	2.9	8	0.7
Other/Unknown	89	57.8	48	36.1	115	23.7	66	17.9	18	25.7	336	27.7
Pedestrian Actions												
Crossing Road Not at Intersection	43	27.9	34	25.6	123	25.3	79	21.4	13	18.6	292	24.1
Crossing Road at Intersection	24	15.6	41	30.8	188	38.7	132	35.8	20	28.6	405	33.4
Walking on the Road	22	14.3	15	11.3	45	9.3	44	11.9	9	12.9	135	11.1
Standing in Roadway	10	6.5	4	3.0	18	3.7	11	3.0	5	7.1	48	4.0
Working on Roadway	7	4.6	5	3.8	15	3.1	6	1.6	4	5.7	37	3.1
Not in Roadway	9	5.8	14	10.5	26	5.4	31	8.4	5	7.1	85	7.0
Other/Unknown	39	25.3	20	15.0	71	14.6	66	17.9	14	20.0	210	17.3

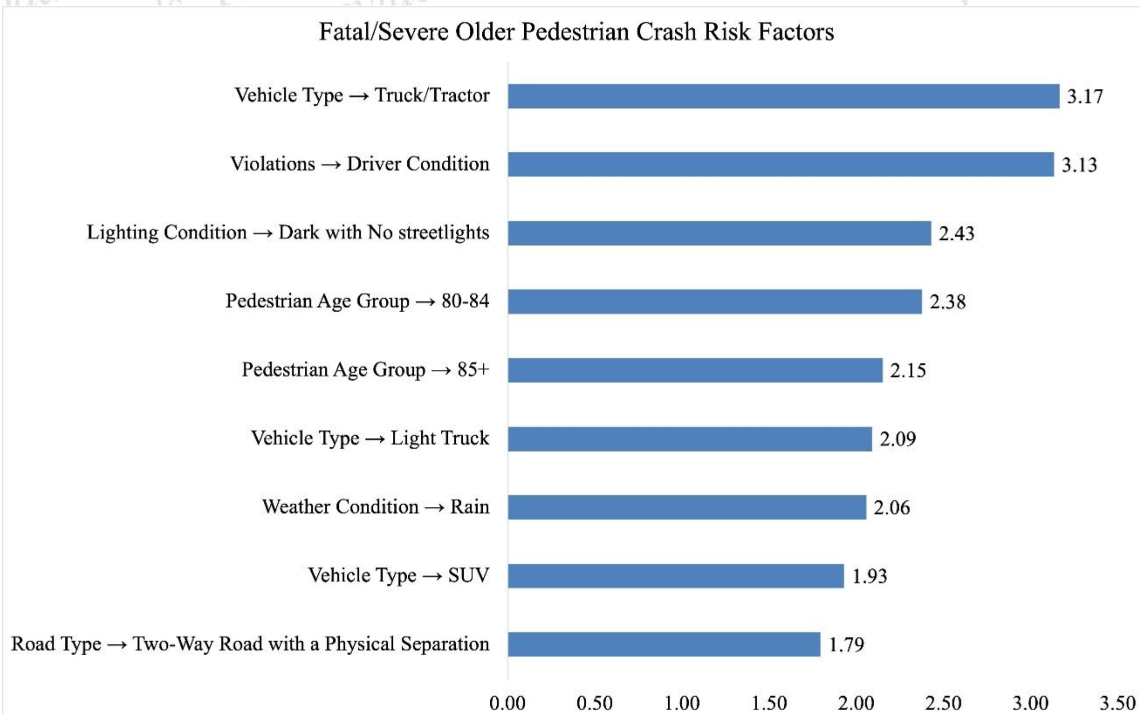
Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Pedestrian Clothing												
Dark Clothing	59	38.3	45	33.8	130	26.7	106	28.7	21	30.0	361	29.8
Light Clothing	95	61.7	88	66.2	356	73.3	263	71.3	49	70.0	851	70.2
Vehicle Type												
Passenger Car	49	31.8	53	39.8	244	50.2	160	43.4	28	40.0	534	44.1
Light Truck	45	29.2	39	29.3	88	18.1	94	25.5	19	27.1	285	23.5
SUV	39	25.3	30	22.6	100	20.6	71	19.2	12	17.1	252	20.8
Van	8	5.2	2	1.5	22	4.5	20	5.4	3	4.3	55	4.5
Truck/Tractor	6	3.9	2	1.5	6	1.2	3	0.8	1	1.4	18	1.5
Other/Unknown	7	4.6	7	5.3	26	5.4	21	5.7	7	10.0	68	5.6
Driver Age Group												
15 to 24	18	11.7	17	12.8	61	12.6	38	10.3	7	10.0	141	11.6
25 to 64	98	63.6	84	63.2	283	58.2	215	58.3	39	55.7	719	59.3
65 to 69	7	4.6	5	3.8	33	6.8	28	7.6	4	5.7	77	6.4
70 to 74	2	1.3	6	4.5	22	4.5	9	2.4	3	4.3	42	3.5
75 to 79	3	2.0	2	1.5	14	2.9	9	2.4	-	-	28	2.3
80 to 84	3	2.0	5	3.8	7	1.4	4	1.1	2	2.9	21	1.7
85+	3	2.0	1	0.8	5	1.0	2	0.5	1	1.4	12	1.0
Unknown	20	13.0	13	9.8	61	12.6	64	17.3	14	20.0	172	14.2
Driver Distraction												
Cell Phone	3	2.0	4	3.0	3	0.6	1	0.3	-	-	11	0.9
Other Inside the Vehicle	3	2.0	3	2.3	16	3.3	4	1.1	2	2.9	28	2.3
Other Outside the Vehicle	6	3.9	8	6.0	18	3.7	11	3.0	1	1.4	44	3.6
Not Distracted	95	61.7	75	56.4	296	60.9	236	64.0	42	60.0	744	61.4
Unknown	47	30.5	43	32.3	153	31.5	117	31.7	25	35.7	385	31.8
Total	**154**	**100.0**	**133**	**100.0**	**486**	**100.0**	**369**	**100.0**	**70**	**100.0**	**1212**	**100.0**

* Percentages may not sum exactly to 100% due to rounding errors.

Binary Logistic Regression Results for Older Pedestrian Crashes

This section presents the results of the binary logistic regression model estimating the likelihood of KA outcomes in crashes involving older pedestrians, using BC injury crashes as the reference category. The model incorporated a broad set of predictors related to pedestrian characteristics, driver condition, environmental factors, vehicle type, and roadway features. Only variables with an OR greater than 1 and p-values ≤ 0.05 were retained for interpretation, indicating a statistically significant increase in the odds of KA outcomes relative to BC injury outcomes. Figure 15 visualizes the odds ratios for the significant predictors of KA injury crashes, highlighting the most influential crash risk factors affecting older pedestrians in Louisiana. Detailed model coefficients, odds ratios, and significance levels are provided in Appendix 6.

Figure 15. Binary logistic regression model results for KA crashes involving older pedestrians



Pedestrian Age

Crash severity increased with advancing age among older pedestrians. Those aged 80 to 84 were 2.38 times more likely to sustain a KA injury relative to the aged 65 to 69 reference group. Similarly, pedestrians aged 85 and older faced more than double the odds of a KA injury (OR = 2.15). These findings underscore the heightened physical vulnerability of the oldest pedestrian age groups.

Driver Condition

Crashes involving drivers reported with abnormal conditions (e.g., distraction, illness, impairment) were strongly associated with severe pedestrian outcomes. The odds of a KA injury were more than tripled when driver condition was flagged compared to cases with no violations (OR = 3.13).

Vehicle Type

Larger vehicle types substantially increased the risk of severe pedestrian injuries. Pedestrians struck by trucks or tractors were over three times as likely to sustain a KA injury compared to those struck by passenger cars (OR = 3.17). Light trucks (OR = 2.09) and SUVs (OR = 1.93) were also significantly more likely to cause KA injuries, aligning with prior research that highlights the elevated risks posed by higher-profile vehicles.

Environmental Conditions

Environmental factors further contributed to injury severity. Crashes occurring in dark conditions without street lighting were 2.43 times more likely to result in KA injury compared to daylight crashes. Similarly, crashes during rainy weather increased the odds of KA injury by a factor of 2.06.

Roadway Characteristics

Roadway design was also influential. Crashes on two-way roads with a physical separation were associated with a 1.79 times higher likelihood of KA injury compared to crashes on one-way roads.

Overall, KA injury outcomes for older pedestrians were most strongly associated with older age, adverse driver conditions, larger vehicle involvement, poor lighting, and inclement weather. These findings underscore the need for targeted countermeasures to address the factors that disproportionately elevate crash severity for older pedestrians.

Geospatial Analysis of Older Pedestrian Crashes

The geospatial analysis of older pedestrian crashes aims to identify high-risk areas across Louisiana by examining spatial crash distribution patterns. This analysis provides insights into regional disparities in crash rates and highlights locations where targeted pedestrian safety interventions may be necessary. By normalizing older pedestrian crashes per 1,000 older residents, this study offers a clearer understanding of crash risk in different geographic areas.

Figure 16 presents the distribution of the older pedestrian crash rate, measured per 1,000 older residents. Orleans Parish exhibits the highest crash rate (0.52), significantly surpassing other parishes, likely due to higher pedestrian activity and urban density. Several rural parishes, including Union, Grant, and Avoyelles, report the lowest crash rates (<0.1), which may be attributed to lower pedestrian volumes and reduced walking dependency. The spatial distribution highlights the urban-rural divide, with urbanized regions generally having higher crash rates, likely due to greater pedestrian-vehicle interactions. Appendix 7 provides detailed parish-level statistics for older pedestrian crashes, including older population, total crashes, crash rates, and area characteristics for all the parishes in Louisiana.

The research team also examined the spatial association between older pedestrian crashes and nursing home locations using facility data obtained from the Louisiana Department of Health. However, the analysis did not reveal any significant spatial correlation, as crash points were generally located outside the buffer zones established around nursing home facilities.

Figure 16. Spatial distribution of older pedestrian crash rate across Louisiana parishes

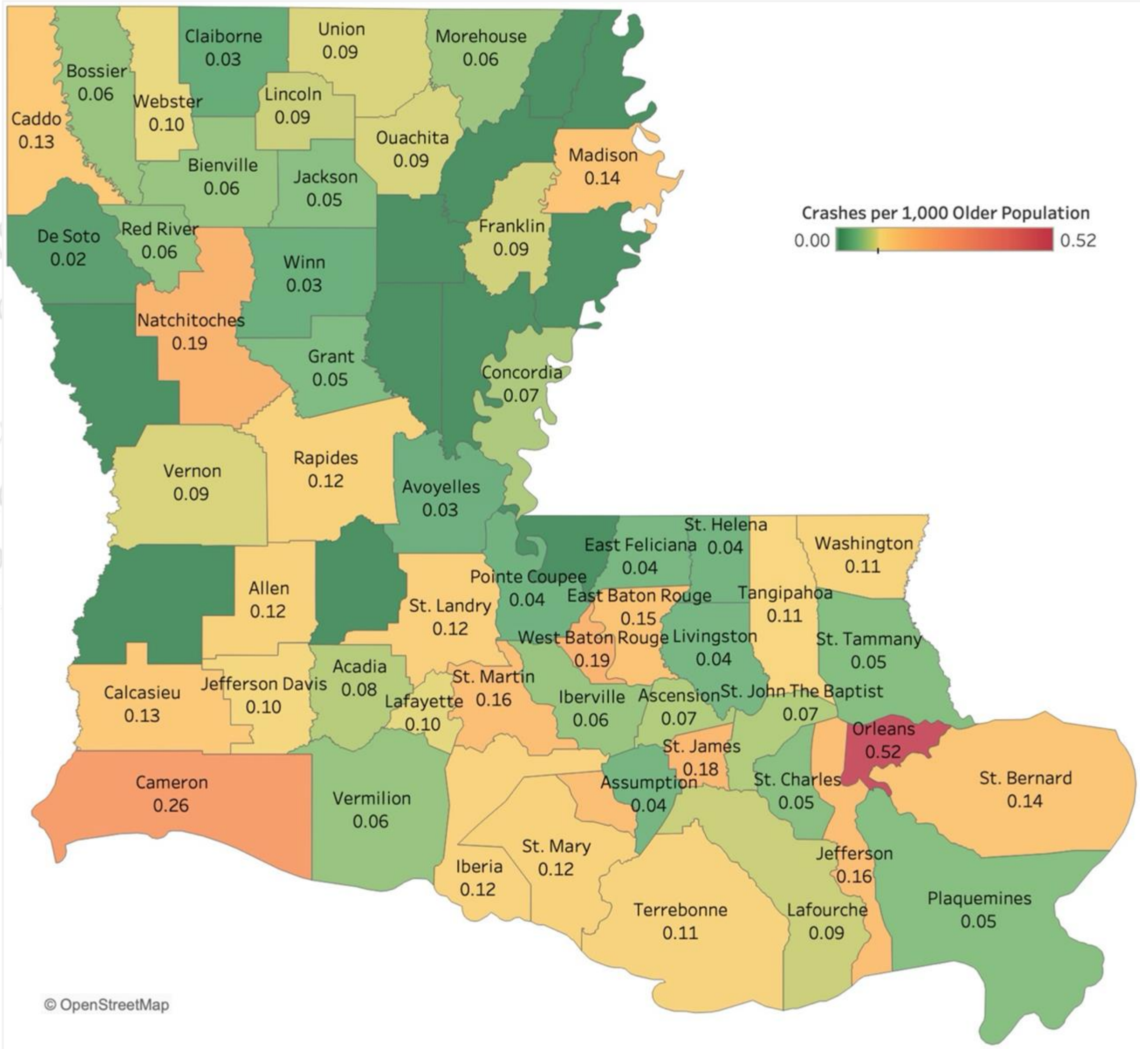


Figure 17 illustrates the spatial distribution of older pedestrian crash risk across Louisiana census tracts. It presents the overall older pedestrian crash rate per 1,000 persons in the older population, with warmer colors indicating higher crash risk. Within the figure, the number of tracts in each color category is enclosed in square brackets. High-risk areas are concentrated in urban regions with greater pedestrian activity, though some rural tracts also exhibit elevated crash rates, likely due to inadequate pedestrian infrastructure. Figure 18 highlights fatal and severe older pedestrian crashes, showing a more concentrated distribution in some urban and suburban tracts. These areas may have high-speed roadways, poor pedestrian facilities, or limited visibility, increasing the severity of crashes. The results underscore the importance of implementing targeted safety measures, including enhanced pedestrian infrastructure, lower speed limits, and improved crossing facilities, to mitigate risks for older pedestrians in high-crash areas.

Figure 17. Spatial distribution of older pedestrian crash rate across Louisiana census tracts

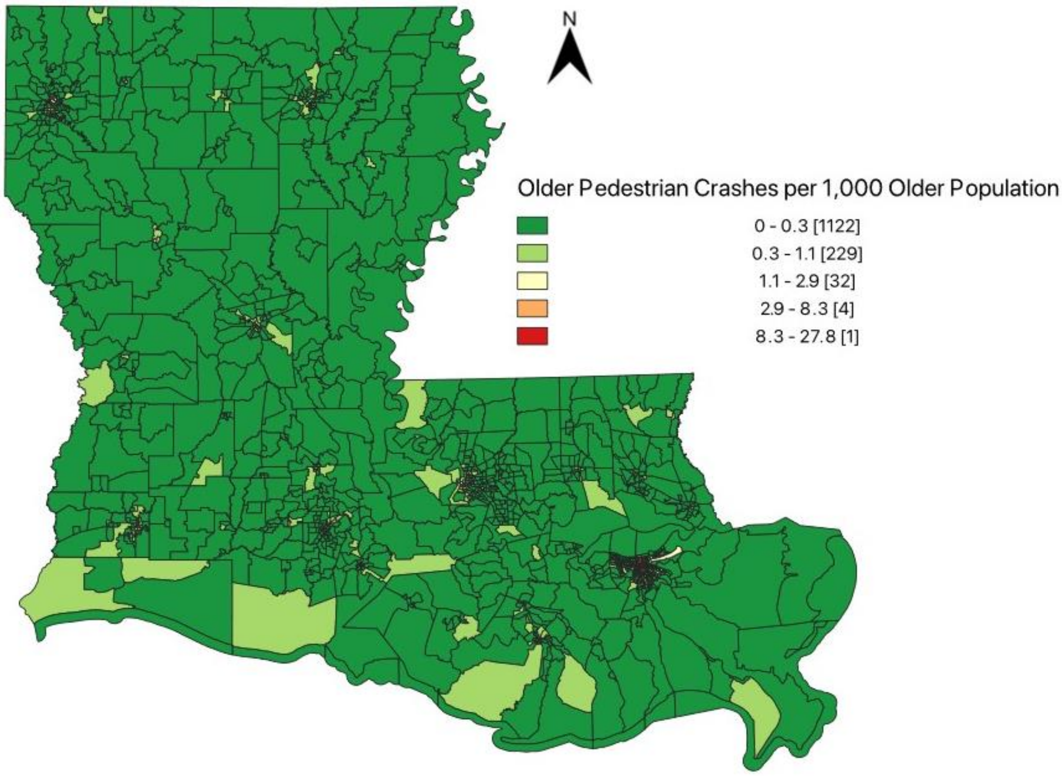
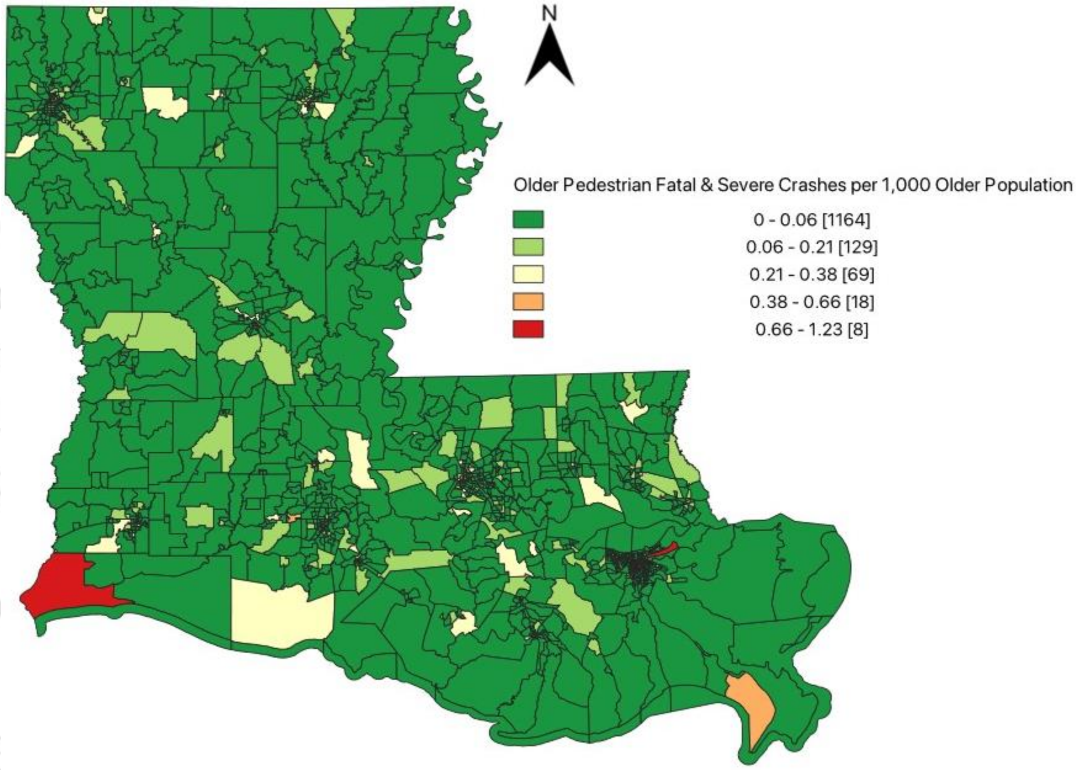


Figure 18. Spatial distribution of older pedestrian fatal/severe crash rate across Louisiana census tracts



Hotspot Analysis of Older Pedestrian Crashes in Urban and Rural Parishes

A Getis-Ord Gi* hotspot analysis was applied to older pedestrian crashes to identify statistically significant concentrations of crashes. This spatial approach distinguishes areas where crash densities are unlikely to be the result of random variation, thereby highlighting priority locations for further safety evaluation. To better understand contextual differences, hotspot crashes were further categorized by location type, separating urban and rural parishes. Based on the hotspot results, eight parishes exhibiting the highest concentrations of older pedestrian crashes were selected for detailed analysis, categorized by urban and rural settings.

Among urban parishes, Orleans, Jefferson, and East Baton Rouge accounted for over half (59.5%) of all urban older pedestrian crashes. In rural areas, Iberia, Natchitoches, St. Mary, Tangipahoa, and Washington represented 50.9% of all rural crashes. Combined, these 8 parishes accounted for 58% of all rural pedestrian crashes among older adults statewide. To place these findings in context, the overall statewide crash distribution was also examined as a benchmark.

Table 13 summarizes the comparative results, presenting the distribution of crash, pedestrian, driver, roadway, and environmental characteristics across the three analysis groups. Only those variables showing notable rural–urban contrasts were retained for presentation, while factors without meaningful differences were omitted.

Table 13. Comparison of older pedestrian crash characteristics in urban and rural hotspots

Variable	Urban Hotspot Crashes N = 181	Rural Hotspot Crashes N = 83	All Crashes N = 1,212
	%	%	%
Crash Characteristics			
Prior Movement			
Proceeding Straight Ahead	34.3	49.2	47.8
Making Left Turn	18.2	19.0	16.3
Making Right Turn	17.1	1.6	7.7
Stopped	3.9	3.2	4.9
Backing	5.5	6.3	7.4
Entering Traffic from Driveway/Shoulder/Median	2.8	4.8	2.5
Slowing	3.3	3.2	2.2
Ran Off Road	1.1	6.3	2.1
Changing Lanes on Multi-Lane Road	1.1	-	0.9
Crossed Centerline/Median	-	-	1.2
Other/Unknown	12.7	6.3	7.0
Violations			
No Violations	37.0	54.0	41.3
Failure To Yield	18.8	11.1	12.1
Careless Operation	13.3	12.7	12.7
Improper Backing	4.4	1.6	3.5
Driver Condition	1.1	6.3	3.1
Disregarded Traffic Control	2.2	3.2	2.0
Following Too Closely	1.1	-	0.3
Improper Turning	-	-	0.7
Other/Unknown	22.1	11.1	24.6
Traffic Control			
Dashed Road Line	22.1	23.8	24.3
No Control	17.7	14.3	22.4
Green Signal On	17.1	4.8	12
Stop Sign	9.9	23.8	11.5
Red Signal On	10.5	1.6	4.6
Crosswalk	3.3	3.2	3.0

Variable	Urban Hotspot Crashes N = 181	Rural Hotspot Crashes N = 83	All Crashes N = 1,212
	%	%	%
Yellow No Passing Line	2.8	20.6	8.5
Yield Sign	2.2	1.6	0.8
Green Turn Arrow On	1.7	1.6	1.2
Yellow Signal On	-	-	0.3
Other/Unknown	12.7	4.8	11.4
Hit and Run			
True	15.5	7.9	15.5
False	84.5	92.1	84.5
Environmental and Temporal Factors			
Crash Time			
12:00 a.m. – 6:00 a.m.	3.3	1.6	5.2
6:00 a.m. – 12:00 p.m.	34.3	22.2	29.7
12:00 p.m. – 6:00 p.m.	37.0	50.8	37.2
6:00 p.m. – 12:00 a.m.	25.4	25.4	27.9
Lighting Condition			
Daylight	70.7	71.4	63.4
Dark with Continuous Streetlights	17.7	7.9	17.3
Dark with Streetlights at Intersections Only	3.9	6.3	5.2
Dark with No Streetlights	2.8	6.3	9.3
Dawn/Dusk	3.3	7.9	3.8
Other/Unknown	1.7	-	1.0
Weather Condition			
Clear	74.0	85.7	77.4
Cloudy	21.5	11.1	15.4
Rain	3.9	3.2	5.9
Other/Unknown	0.6	-	1.3
Day of the Week			
Weekday	86.2	81.0	80.4
Weekend	13.8	19.0	19.6
Highway Administrative Class			
City Street	37.0	46.0	51.2
Parish Road	26.5	4.8	13.2

Variable	Urban Hotspot Crashes N = 181	Rural Hotspot Crashes N = 83	All Crashes N = 1,212
	%	%	%
U.S. Hwy	21.0	14.3	11.6
State Hwy	12.2	31.7	20.5
Interstate	1.1	1.6	2.2
Other/Unknown	2.2	1.6	1.3
Road Type			
Two-Way Road with Physical Barrier/Separation	47.5	9.5	25.8
Two-Way Road with No Physical Separation	33.1	79.4	56.9
One-Way Road	15.5	11.1	14.4
Other/Unknown	3.9	-	2.9
Intersection			
True	49.7	46.0	46.3
False	50.3	54.0	53.7
Roadway Type by Speed			
High Speed Roadway (Speed Limit ⩾ 40 mph)	19.3	25.4	28.1
Low Speed Roadway (Speed Limit < 40 mph)	74.6	66.7	63.4
Other/Unknown	6.1	7.9	8.5
Pedestrian, Vehicle, and Characteristics			
Pedestrian Age Group			
65 to 69	41.4	42.9	46.4
70 to 74	26.5	28.6	25.3
75 to 79	13.3	12.7	13.6
80 to 84	12.2	9.5	8.7
85+	6.6	6.3	6.0
Pedestrian Condition			
Normal	53.0	41.3	45.5
Inattentive/Distracted	23.2	30.2	21.1
Impaired (Drug/Alcohol)	3.3	-	2.6
Illness/Fatigue	0.6	1.6	1.0
Not Impaired	1.1	-	0.8
Other/Unknown	18.8	27.0	29.0

Variable	Urban Hotspot Crashes N = 181	Rural Hotspot Crashes N = 83	All Crashes N = 1,212
	%	%	%
Pedestrian Actions			
Crossing Road Not at Intersection	23.2	23.8	24.1
Crossing Road at Intersection	44.8	34.9	33.4
Walking on the Road	6.6	17.5	11.1
Standing in Roadway	1.7	4.8	4.0
Working on Roadway	2.8	3.2	3.1
Not in Roadway	6.1	7.9	7.0
Other/Unknown	14.9	7.9	17.3
Vehicle Type			
Passenger Car	39.2	52.4	44.1
Light Truck	19.9	19.0	23.5
SUV	23.2	20.6	20.8
Van	12.2	3.2	4.5
Truck/Tractor	1.1	3.2	1.4
Motorcycle	0.6	-	0.5
Other/Unknown	3.9	1.6	5.2
Driver Age Group			
15 to 24	6.6	9.5	11.6
25 to 64	66.9	55.6	59.3
65 to 69	5.0	9.5	6.4
70 to 74	6.1	7.9	3.5
75 to 79	1.1	4.8	2.3
80 to 84	2.2	1.6	1.7
85+	-	1.6	1.0
Other/Unknown	12.2	9.5	14.2
Driver Distraction			
Cell Phone	1.1	-	0.9
Other Inside the Vehicle	1.7	1.6	2.1
Other Outside the Vehicle	2.8	6.3	3.6
Not Distracted	70.2	73.0	61.5
Other/Unknown	24.3	19.0	31.9
Total	**100**	**100**	**100**

* Percentages may not sum exactly to 100% due to rounding errors.

The analysis of older pedestrian crashes shows important distinctions between urban and rural hotspots, with differences also apparent when compared to the statewide distribution.

- **Crash Characteristics:** Both urban (34.3%) and rural (49.2%) hotspot crashes most frequently involved vehicles proceeding straight ahead. Left-turn movements accounted for similar shares in both settings (18.2% urban, 19.0% rural), while right-turn movements were far more prevalent in urban areas (17.1% urban, 1.6% rural). Rural hotspots exhibited higher proportions of roadway departure crashes (6.3% vs. 1.1%) and backing maneuvers (6.3% vs. 5.5%). Violation patterns varied substantially; the share of crashes with no recorded violation was much higher in rural hotspots (54.0% vs. 37.0%), while urban hotspots had more failure-to-yield (18.8% vs. 11.1%) and careless-operation violations (13.3% vs. 12.7%).
- **Traffic Control:** Urban hotspot crashes were more frequently associated with signalized intersections, including green signals (17.1%) and red signals (10.5%). Rural hotspots, in contrast, were disproportionately linked to stop signs (23.8% rural, 9.9% urban) and yellow no-passing zones (20.6% rural, 2.8% urban).
- **Hit-and-Run:** Hit-and-run events were more common in urban hotspots (15.5%) than rural hotspots (7.9%).
- **Environmental and Temporal Factors:** Crash timing patterns differed noticeably; urban hotspots had a higher share of crashes between 6:00 a.m. and 6:00 p.m. (71.3%), whereas rural hotspots peaked during the afternoon (12:00 p.m. to 6:00 p.m.) with 50.8%. Both environments saw most crashes occur during daylight (70.7% urban, 71.4% rural), though rural hotspots more frequently occurred in dark conditions with no streetlights (6.3% vs. 2.8%) and at dawn/dusk (7.9% vs. 3.3%). Clear weather predominated in both settings but was slightly more common in rural hotspots (85.7% vs. 74.0%).
- **Roadway Characteristics:** City streets accounted for a large share of crashes in both settings (37.0% urban, 46.0% rural), though urban hotspots showed a much higher proportion on parish roads (26.5% urban, 4.8% rural). Rural hotspots were more likely to occur on state highways (31.7% rural, 12.2% urban) and on two-way roads without physical separation (79.4% rural, 33.1% urban). Urban hotspots, by contrast, had a much higher prevalence of two-way roads with physical separation (47.5% urban, 9.5% rural). Intersection-related crashes were similar across contexts (49.7% urban, 46.0% rural). Speed environments also varied; urban hotspots were more likely to occur on low-speed roads of less than 40 mph (74.6% vs. 66.7%), whereas rural hotspots had more crashes on high-speed facilities (25.4% vs. 19.3%).

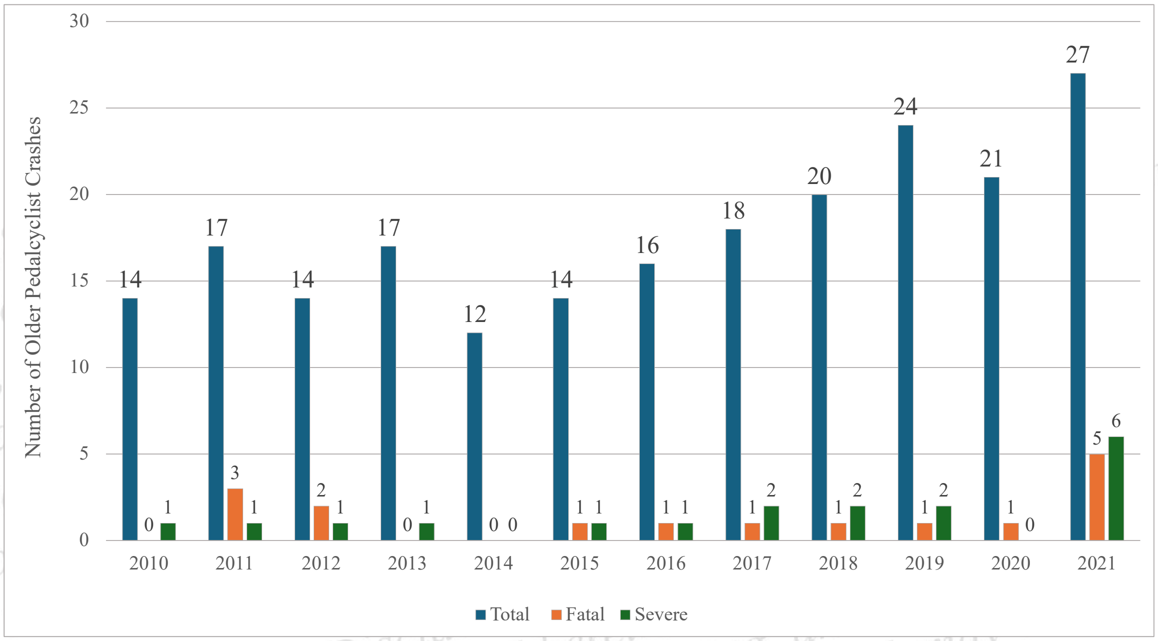
- **Pedestrian Characteristics:** Age distributions were generally consistent between urban and rural hotspots. The aged 65 to 69 group represented the largest share in both (41.4% urban, 42.9% rural), followed by declining percentages across older age brackets. Pedestrian condition differed more substantially; 53.0% of pedestrians were reported as "normal" in urban hotspots compared to 41.3% in rural areas. Inattentive or distracted pedestrians were more common in rural crashes (30.2% rural, 23.2% urban).
- **Pedestrian Actions:** Crossing at intersections was more common in urban hotspots (44.8% urban, 34.9% rural), while rural hotspots showed higher proportions of pedestrians walking along the roadway (17.5% rural, 6.6% urban) or standing in the roadway (4.8% rural, 1.7% urban). Mid-block crossings were similar across contexts (23.8%).
- **Driver and Vehicle Characteristics:** Passenger cars accounted for the highest share of striking vehicles in both settings but were more prevalent in rural hotspots (52.4% rural, 39.2% urban). Vans were more common in urban areas (12.2% urban, 3.2% rural). Most involved drivers were aged 25 to 64 (66.9% urban, 55.6% rural), though rural hotspots showed higher proportions of both younger drivers (15 to 24; 9.5% rural, 6.6% urban) and older drivers aged 65 and older (≈25% rural, ≈14% urban). Driver distraction was infrequently reported, with "not distracted" recorded in 70.2% of urban and 73.0% of rural crashes; however, both contexts exhibited sizeable shares of "other/unknown" distraction codes (19 to 24%), indicating the limited reliability of distraction reporting.
- **Comparison with Statewide Distribution:** Compared with the statewide distribution of older pedestrian crashes, both urban and rural hotspots exhibit distinctive patterns in crash circumstances, roadway environments, and pedestrian and driver characteristics. Statewide, straight-ahead vehicle movements dominate (47.8%), aligning closely with rural hotspots (49.2%) but occurring far more often than in urban hotspots (34.3%). Right-turn crashes are substantially overrepresented in urban hotspots (17.1% vs. 7.7% statewide), while rural hotspots show elevated run-off-road incidents relative to statewide trends. Hotspot violation patterns diverge as well; rural locations have a much higher share of crashes with no recorded violation (54.0% vs. 41.3% statewide), while urban hotspots disproportionately involve failure-to-yield violations. Urban hotspots have more crashes at signalized intersections than statewide, while stop-sign and no-passing-zone crashes are far more common in rural hotspots. Statewide lighting and weather distributions fall between the two hotspot contexts, though statewide crashes show higher proportions under dark, unlit conditions, suggesting that reduced-visibility events are more dispersed and not concentrated in hotspot clusters. Roadway classifications also differ, with statewide crashes more frequently occurring on city streets, whereas urban

hotspots involve more parish roads and rural hotspots more state highways. Pedestrian age patterns statewide are similar to hotspot locations. Normal pedestrian conditions are more common statewide than in rural hotspots and less common than in urban hotspots. Compared to statewide patterns, urban hotspot crashes involve more pedestrians crossing at intersections, while rural hotspots involve more pedestrians walking along the roadway. Vehicle and driver profiles also vary; passenger cars are more prevalent statewide than in urban hotspots but less than in rural hotspots. Statewide driver age distributions fall between those observed in urban and rural hotspot locations, with 11.6% of crashes involving younger drivers and roughly 14% involving older drivers, indicating that rural hotspot crashes disproportionately involve the youngest and oldest driver groups, while urban hotspots reflect a more middle-aged driver profile. Together, these differences indicate that older pedestrian hotspots do not simply reflect statewide patterns but instead represent concentrated contexts in which specific behaviors, roadway conditions, and interaction patterns elevate crash risk.

Older Pedal-Cyclist Demographics and Crash Characteristics

This section presents the findings from the comprehensive crash analysis for older pedal-cyclists. Figure 19 illustrates the trend in older pedal-cyclist crashes in Louisiana from 2010 to 2021. The number of crashes has increased substantially over the period, representing a 92.8% increase. This growth far outpaces the 36.8% increase in the older population, suggesting a disproportionate rise in crash involvement among older pedal-cyclists. Additionally, 2021 saw a notable surge in fatal and severe crashes, further emphasizing the heightened vulnerability of older pedal-cyclists.

Figure 19. Trend in older pedal-cyclist crashes in Louisiana



Comparison of Pedal-Cyclist Crash Characteristics by Age Groups

Table 14 presents the distribution of pedal-cyclist crashes at intersection and non-intersection locations across different age groups over a 12 year period. The data indicate that 58% of the older pedal-cyclists' crashes occur at intersections, a trend that aligns with middle-aged (57%) and younger (57%) pedal-cyclists. This consistency across all age groups suggests that intersections are high-risk locations for all pedal-cyclists. However, given the age-related decline in physical, cognitive, and mental abilities of older adults, intersection-related crashes may result in more severe or fatal outcomes.

Table 14. Number of intersection crashes in 12 years by age group

	Older Pedal-Cyclists	Middle-Aged Pedal-Cyclists	Younger Pedal-Cyclists
Intersection	124 *(58%)*	1611 *(57%)*	619 *(57%)*
Non-Intersection	90 *(42%)*	1240 *(43%)*	469 *(43%)*

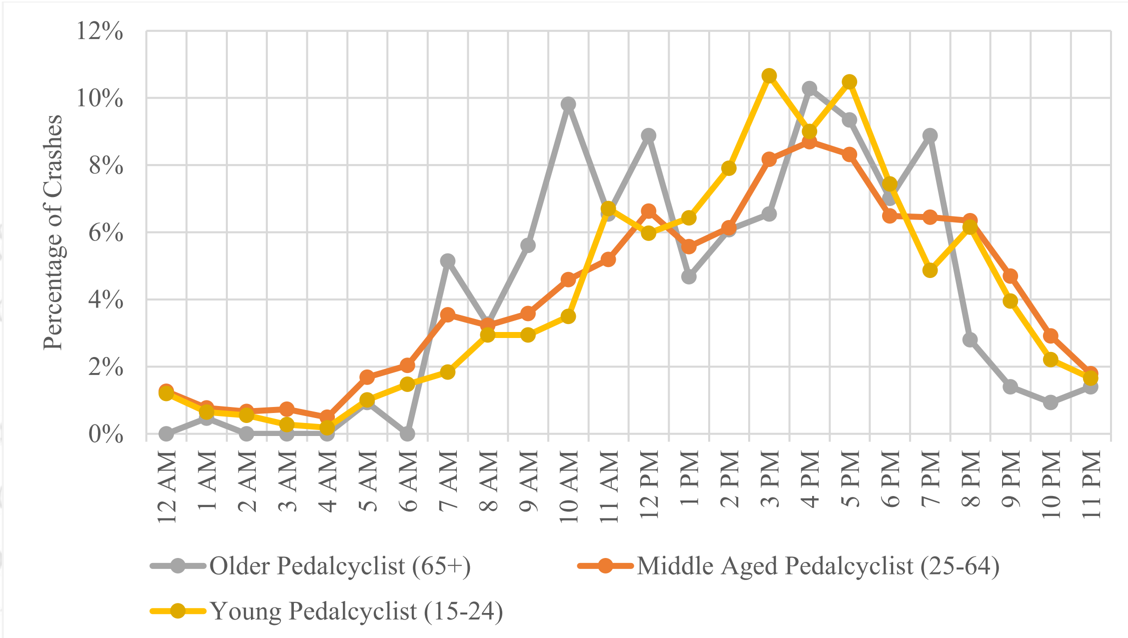
Table 15 presents the distribution of pedal-cyclist crashes across different lighting conditions and age groups. As shown in the table, most crashes across all age groups occur in daylight, with older pedal-cyclists having the highest proportion (78.04%). In contrast, crashes in dark conditions without streetlights were least frequent among older pedal-cyclists (4.67%). This trend may be influenced by the increased exposure during daylight hours.

Table 15. Distribution of pedal-cyclist crashes by lighting condition and age group

Lighting Condition	Older Pedal-Cyclists	Middle-Aged Pedal-Cyclists	Younger Pedal-Cyclists
Daylight	78.04%	68.08%	71.97%
Dark with continuous streetlights	12.62%	17.15%	14.25%
Dark with no streetlights	4.67%	8.63%	6.80%
Dusk	2.80%	1.61%	2.11%
Dark with streetlights at intersections only	1.40%	3.47%	3.95%
Dawn	0%	0.70%	0.46%
Other/Unknown	0.47%	0.35%	0.46%

Figure 20 illustrates the hourly distribution of pedal-cyclist crashes by age group. For older pedal-cyclists, peak crash times coincide with times of greater activity, such as early morning or late afternoon trips.

Figure 20. Hourly trend for pedal-cyclist crashes by age group



Descriptive Analysis of Crash Characteristics for Older Pedal-Cyclists

Table 16 provides a descriptive summary of the crash-contributing factors for 214 older pedal-cyclist crashes that occurred from 2010 to 2021, categorized by severity levels. The summary of those factors is provided below:

- **Prior Movement:** The majority of fatal crashes involved pedal-cyclists proceeding straight ahead (25.0%) or entering traffic from the shoulder (25.0%), while severe crashes most frequently involved traveling straight (72.2%). Making left turns accounted for 12.5% of fatal crashes, indicating increased risk during crossing maneuvers. Traveling the wrong way contributed to 6.3% of fatal crashes and 14.3% of moderate crashes.
- **Violations:** Failure to yield was a key contributing factor in 31.3% of fatal crashes and 38.9% of severe crashes, followed by disregarding traffic controls (12.5% fatal, 16.7% severe). Improper turning was reported in 18.8% of fatal crashes, while careless operation was a factor in 25.0% of no-injury crashes.
- **Traffic Control:** Crashes at signalized locations were associated with stop signs (12.5% fatal, 16.7% severe) and red signals (18.8% fatal, 11.1% severe). No-control locations accounted for 12.5% of fatal crashes and 22.2% of severe crashes.
- **Crash Time:** Fatal crashes predominantly occurred during the evening and night (6:00 p.m. – 12:00 a.m.), accounting for 43.8% of cases, while severe crashes were also most

frequent during this period (50.0%). In contrast, moderate, complaint, and no-injury crashes were most common during daylight hours (12:00 p.m. – 6:00 p.m.), making up 42.9%, 57.0%, and 37.5%, respectively. This suggests that nighttime riding is associated with greater crash severity, possibly due to reduced visibility and driver perception issues.

- **Lighting Condition:** The majority of crashes occurred in daylight, with 37.5% of fatal and 61.1% of severe crashes. However, crashes under dark conditions without streetlights represented 31.3% of fatal crashes, highlighting the increased risk in areas with poor visibility.
- **Day of the Week**: Crashes were evenly distributed between weekdays and weekends across all severity levels, with 50.0% of fatal and severe crashes occurring on each.
- **Weather Condition**: Clear weather was the most common condition for all severity levels, contributing to 81.3% of fatal crashes and 83.3% of severe crashes. Rainy weather accounted for a relatively smaller proportion of the fatal (12.5%) and severe (11.1%) crashes.
- **Highway Administrative Class**: Fatal crashes were most frequent on state highways (50.0%) and U.S. highways (25.0%), while severe crashes were more prevalent on city streets (55.6%). This indicates that state and U.S. highways pose a higher fatal crash risk, possibly due to higher vehicle speeds and limited bicycle-friendly infrastructure.
- **Road Type**: Two-way roads without physical separation accounted for the majority of fatal (56.3%) and severe (61.1%) crashes, suggesting that cyclists are more vulnerable on roads with mixed traffic. Roads with physical barriers had a lower proportion of fatal crashes (25.0%).
- **Intersection**: More than half of fatal (56.3%) and severe (66.7%) crashes occurred at intersections, underscoring their role in older pedal-cyclists' crash risk. This trend is consistent across other injury severity levels as well.
- **Speed Limit**: Low-speed roadways (speed limit < 40 mph) accounted for the majority of crashes across all severity levels, contributing to 43.8% of fatal and 61.1% of severe crashes. This suggests that older pedal-cyclists are more likely to ride on local streets with lower speed limits, potentially due to perceived safety, familiarity, or accessibility.
- **Pedal-Cyclist Age Group**: Older cyclists aged 65 to 69 had the highest crash involvement across all severities, comprising 50.0% of fatal crashes and 61.1% of severe crashes. The proportion of crashes decreased for older age groups, with those aged 80 to 84 and 85+ accounting for a smaller but notable share of severe and moderate crashes.

- **Pedal-Cyclist Gender**: Male cyclists were overwhelmingly overrepresented in crashes, accounting for 100.0% of fatal and severe crashes. Female cyclists had a small presence in moderate (6.3%) and complaint (9.7%) crashes, which could indicate lower exposure or different cycling behaviors.

Table 16. Descriptive statistics of crash contributing factors by crash severity for older pedal-cyclists

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Crash Characteristics												
Prior Movement												
Proceeding Straight Ahead	4	25.0	13	72.2	28	44.4	54	58.1	13	54.2	112	52.3
Changing Lanes on Multi-Lane Road	-	-	-	-	3	4.8	1	1.1	-	-	4	1.9
Crossed Center Line/Median	0	0	0	0	1	1.6	1	1.1	0	0	2	0.9
Entering Traffic from Median/Driveway	1	6.3	2	11.1	2	3.2	2	2.2	1	4.2	8	3.7
Entering Traffic from Shoulder	4	25.0	-	-	6	9.5	4	4.3	1	4.2	15	7.0
Making Left Turn	2	12.5	1	5.6	6	9.5	2	2.2	4	16.7	15	7.0
Making Right Turn	-	-	-	-	1	1.6	2	2.2	-	-	3	1.4
Slowing	-	-	-	-	-	-	1	1.1	-	-	1	0.5
Stopped	1	6.3	1	5.6	2	3.2	2	2.2	0	0.0	6	2.8
Traveling Wrong Way	1	6.3	-	-	9	14.3	12	12.9	4	16.7	26	12.1
Other/Unknown	3	18.8	1	5.6	5	7.9	12	12.9	1	4.2	22	10.3
Violations												
Careless Operation	-	-	-	-	6	9.5	6	6.5	6	25.0	18	8.4
Driver Condition	-	-	-	-	1	1.6	1	1.1	-	-	2	0.9
Disregarded Traffic Control	2	12.5	3	16.7	5	7.9	12	12.9	-	-	22	10.3
Improper Passing	-	-	-	-	1	1.6	2	2.2	-	-	3	1.4
Improper Turning	3	18.8	1	5.6	4	6.3	1	1.1	1	4.2	10	4.7
Driving Left of Center	-	-	1	5.6	-	-	4	4.3	1	4.2	6	2.8
Failure To Yield	5	31.3	7	38.9	14	22.2	18	19.4	7	29.2	51	23.8

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
No Violations	-	-	-	-	2	3.2	6	6.5	-	-	8	3.7
Other/Unknown	6	37.5	6	33.3	30	47.6	43	46.2	9	37.5	94	43.9
Traffic Control												
Bike Lane	-	-	-	-	6	9.5	2	2.2	-	-	8	3.7
Crosswalk	-	-	-	-	-	-	4	4.3	-	-	4	1.9
Green Signal On	-	-	1	5.6	3	4.8	2	2.2	1	4.2	7	3.3
Yellow Signal On	-	-	-	-	1	1.6	-	-	-	-	1	0.5
Red Signal On	3	18.8	2	11.1	5	7.9	9	9.7	1	4.2	20	9.3
Stop Sign	2	12.5	3	16.7	9	14.3	9	9.7	5	20.8	28	13.1
No Control	2	12.5	4	22.2	14	22.2	24	25.8	3	12.5	47	22.0
White Dashed Line	1	6.3	2	11.1	5	7.9	14	15.1	8	33.3	30	14.0
Yellow Dashed Line	3	18.8	2	11.1	5	7.9	3	3.2	1	4.2	14	6.5
Yellow No Passing Line	3	18.8	2	11.1	3	4.8	13	14.0	3	12.5	24	11.2
Other/Unknown	2	12.5	2	11.1	12	19.0	13	14.0	2	8.3	31	14.5
Environmental and Temporal Factors												
Crash Time												
12:00 a.m. - 6:00 a.m.	2	12.5	-	-	-	-	1	1.1	-	-	3	1.4
6:00 a.m. - 12:00 p.m.	4	25.0	3	16.7	24	38.1	26	28.0	8	33.3	65	30.4
12:00 p.m. - 6:00 p.m.	3	18.8	6	33.3	27	42.9	53	57.0	9	37.5	98	45.8
6:00 p.m. - 12:00 a.m.	7	43.8	9	50.0	12	19.0	13	14.0	7	29.2	48	22.4
Lighting Condition												
Daylight	6	37.5	11	61.1	52	82.5	79	84.9	19	79.2	167	78.0
Dusk	-	-	1	5.6	2	3.2	2	2.2	1	4.2	6	2.8
Dark with continuous streetlights	3	18.8	6	33.3	7	11.1	9	9.7	2	8.3	27	12.6
Dark with no streetlights	5	31.3	-	-	2	3.2	3	3.2	-	-	10	4.7
Dark with streetlights at intersections only	2	12.5	-	-	-	-	-	-	1	4.2	3	1.4

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Unknown	-	-	-	-	-	-	-	-	1	4.2	1	0.5
Day of the Week												
Weekday	8	50.0	9	50.0	38	60.3	66	71.0	18	75.0	139	65.0
Weekend	8	50.0	9	50.0	25	39.7	27	29.0	6	25.0	75	35.0
Weather Condition												
Clear	13	81.3	15	83.3	52	82.5	72	77.4	21	87.5	173	80.8
Cloudy	-	-	1	5.6	7	11.1	19	20.4	3	12.5	30	14.0
Rain	2	12.5	2	11.1	3	4.8	2	2.2	-	-	9	4.2
Other/Unknown	1	6.3	0	0	1	1.6	0	0	0	0	2	0.9
Highway Administrative Class												
City Street	4	25.0	10	55.6	33	52.4	33	35.5	11	45.8	91	42.5
Parish Road	-	-	-	-	-	-	11	11.8	1	4.2	12	5.6
State Hwy	8	50.0	3	16.7	22	34.9	29	31.2	8	33.3	70	32.7
U.S. Hwy	4	25.0	4	22.2	8	12.7	18	19.4	3	12.5	37	17.3
Interstate	-	-	-	-	-	-	1	1.1	1	4.2	2	0.9
Other/Unknown	0	0	1	5.6	0	0	1	1.1	0	0	2	0.9
Road Type												
One-Way Road	3	18.8	2	11.1	6	9.5	8	8.6	4	16.7	23	10.7
Two-Way Road with Physical Barrier/Separation	4	25.0	5	27.8	27	42.9	31	33.3	6	25.0	73	34.1
Two-Way Road with No Physical Separation	9	56.3	11	61.1	29	46.0	52	55.9	13	54.2	114	53.3
Other	-	-	-	-	1	1.6	2	2.2	1	4.2	4	1.9
Intersection												
True	9	56.3	12	66.7	41	65.1	47	50.5	15	62.5	124	57.9
False	7	43.8	6	33.3	22	34.9	46	49.5	9	37.5	90	42.1
Roadway Type by Speed												
High Speed Roadway	5	31.3	5	27.8	18	28.6	35	37.6	8	33.3	71	33.2

Variable	Fatal		Severe		Moderate		Complaint		No Injury		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
(Speed limit ≥ 40 mph)												
Low Speed Roadway (Speed limit < 40 mph)	7	43.8	11	61.1	37	58.7	46	49.5	13	54.2	114	53.3
Unknown	4	25.0	2	11.1	8	12.7	12	12.9	3	12.5	29	13.6
Pedal-Cyclist Characteristics												
Pedal-Cyclist Age Group												
65 to 69	8	50.0	11	61.1	34	54.0	52	55.9	13	54.2	118	55.1
70 to 74	2	12.5	3	16.7	12	19.0	26	28.0	5	20.8	48	22.4
75 to 79	4	25.0	-	-	7	11.1	8	8.6	4	16.7	23	10.7
80 to 84	2	12.5	3	16.7	8	12.7	4	4.3	1	4.2	18	8.4
85+	-	-	1	5.6	2	3.2	3	3.2	1	4.2	7	3.3
Pedal-Cyclist Gender												
Male	16	100.0	18	100.0	59	93.7	82	88.2	21	87.5	196	91.6
Female	-	-	-	-	4	6.3	9	9.7	1	4.2	14	6.5
Unknown	-	-	-	-	-	-	2	2.2	2	8.3	4	1.9
Total	**16**	**100.0**	**18**	**100.0**	**63**	**100.0**	**93**	**100.0**	**24**	**100.0**	**214**	**100.0**

* Percentages may not sum exactly to 100% due to rounding errors.

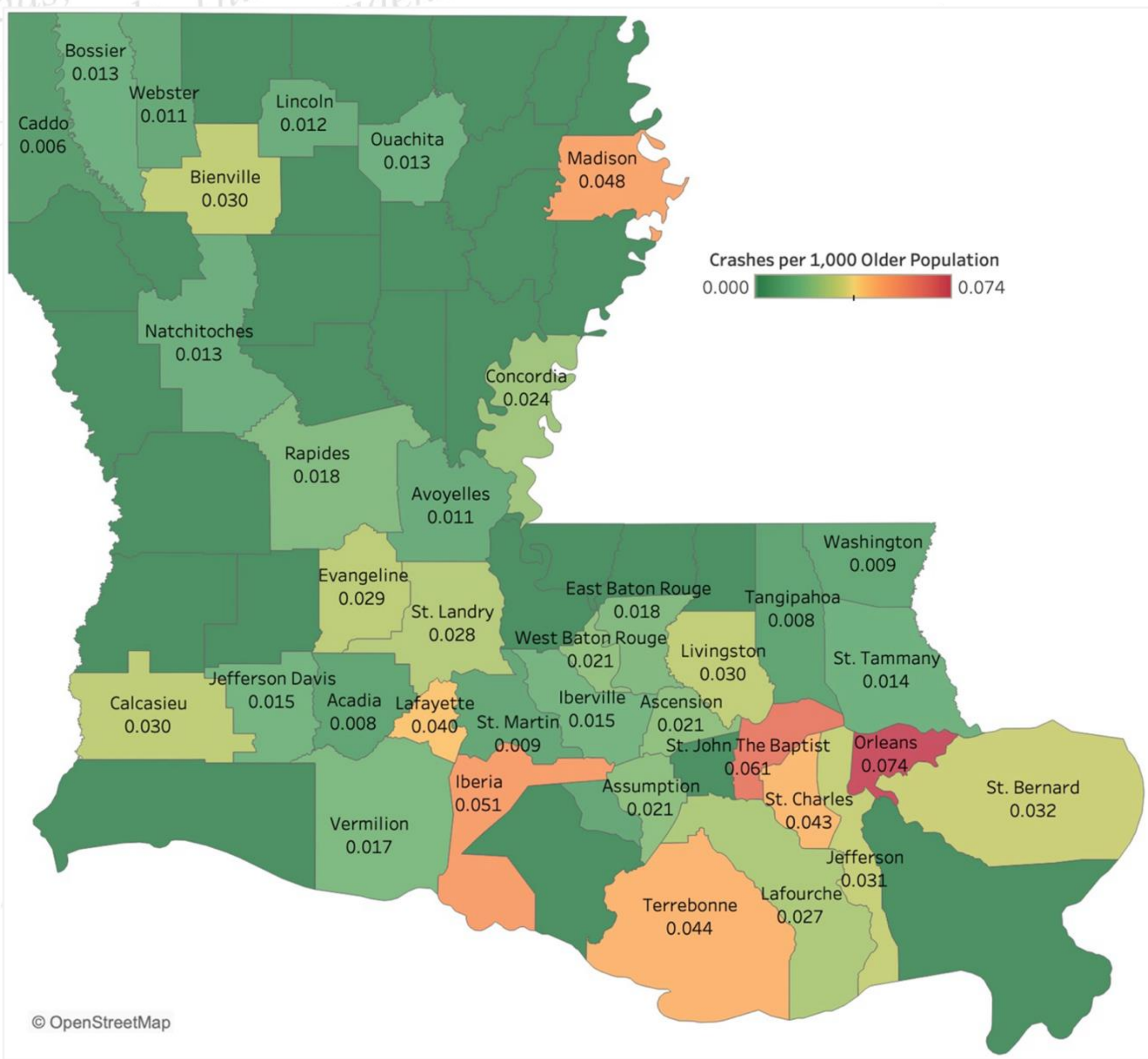
Given the relatively low number of older pedal-cyclist crashes recorded over the 12-year period, the likelihood of statistical error and variation remains high. Due to these limitations, the research team decided not to conduct crash risk modeling for older pedal-cyclists, as the results may not yield reliable or generalizable insights.

Geospatial Analysis of Older Pedal-Cyclist Crashes

The geospatial analysis of older pedal-cyclist crashes examines the spatial distribution of crash risk across Louisiana, highlighting areas where older cyclists face higher exposure to crashes. By normalizing crash occurrences per 1,000 older residents, this study provides a clearer understanding of regional disparities in bicycle safety for older adults.

Figure 21 presents the spatial distribution of the older pedal-cyclist crash rate, measured per 1,000 older residents. Orleans Parish exhibits the highest crash rate (0.074), followed by St. John the Baptist (0.061), Iberia (0.051), and Terrebonne (0.044), indicating that urbanized and semi-urban areas pose greater risks for older cyclists. These areas likely have higher cycling activity and vehicle interactions, increasing exposure to crashes. In contrast, most rural parishes report minimal crash rates, suggesting lower cycling engagement among older adults. Appendix 8 lists the top ten parishes in Louisiana with elevated older pedal-cyclist crash risk, providing parish-level crash frequencies, rates, and area characteristics.

Figure 21. Heatmap of older pedal-cyclist crash risk across Louisiana parishes



Figures 9, 16, and 21, presented earlier in this report, illustrate the spatial distribution of crash risk for older drivers, pedestrians, and pedal-cyclists, respectively. Older driver crashes exhibit the highest overall risk, with concentrations in urbanized and high-traffic parishes such as West Baton Rouge (24.85), Lafayette (24.70), East Baton Rouge (22.99), and Rapides (21.32). This pattern suggests that exposure, traffic complexity, and urban congestion contribute to increased crash risk for older drivers. In contrast, older pedestrian crashes display a different distribution, with the highest risk observed in Orleans Parish (0.52), followed by Cameron (0.26), St. James (0.18), and St. Martin (0.16).

The lower overall crash rates for pedestrians suggest reduced exposure compared to drivers, with risks more localized in urban areas with high pedestrian activity. Older pedal-cyclist crashes present the lowest crash rates among the three groups, with the highest recorded in Orleans (0.074), St. John the Baptist (0.061), and Iberia (0.051). Unlike driver crashes, which are widespread, and pedestrian crashes, which are concentrated in urban centers, pedal-cyclist crashes exhibit a more dispersed pattern, with moderate risk in select rural areas such as Madison Parish.

The findings suggest that older drivers face the greatest crash risk due to higher exposure, while pedestrian and pedal-cyclist crashes are more location-dependent, influenced by infrastructure, traffic density, and pedestrian or cyclist activity. These differences emphasize the need for tailored safety measures, with statewide interventions for older driver safety and localized strategies focusing on pedestrian and cyclist infrastructure improvements in high-risk areas.

Potential Countermeasures

This section compiles a comprehensive set of countermeasures aimed at mitigating crash risk and severity among ORUs in Louisiana. Its purpose is to translate the analytical findings of this study into actionable safety strategies that support engineering, education, and enforcement initiatives statewide. Recognizing that older drivers, pedestrians, and pedal-cyclists face distinct challenges, the recommended measures adopt a Safe System approach focused on creating forgiving roads, safer users, and equitable mobility for all.

The countermeasures were developed through an extensive review of national and state safety guidance, including FHWA's Proven Safety Countermeasures, NHTSA's Countermeasures That Work (2024), and Louisiana SHSP. Each measure is aligned with the relevant SHSP emphasis area, strategy, and tactic to ensure consistency with statewide safety priorities. In this section, the SHSP reference follows the X.Y.Z format, where X represents the emphasis area, Y the strategy number, and Z the specific tactic (e.g., 4.7.B → emphasis area 4 [Infrastructure & Operations], strategy 7, and tactic B). The 2022 Louisiana SHSP has incorporated strategies and tactics to address older drivers and pedestrians across the four emphasis areas: Distracted Driving (emphasis area 1), Impaired Driving (emphasis area 2), Occupant Protection (emphasis area 3), and Infrastructure and Operations (emphasis area 4).

Two user groups are addressed in this section: older drivers and older pedestrians/pedal-cyclists. Countermeasures are organized under three key domains: Infrastructure, Education & Outreach, and Enforcement & Policy.

Table 17 summarizes countermeasures aimed at improving safety outcomes for older drivers in Louisiana. The listed strategies address the high-risk crash contexts identified in this study, including left-turn conflicts, roadway departures, etc. Each countermeasure is categorized by domain and linked to the specific crash characteristics it is intended to mitigate, supported by national guidance references and corresponding SHSP strategies to facilitate implementation within Louisiana's roadway safety framework.

Table 17. Potential older driver countermeasures

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
		Infrastructure Countermeasures			
1	Centerline & Shoulder Rumble Strips	Install centerline and edge/shoulder rumble strips on undivided roads to alert to drift and opposing-lane encroachment.	Single-Vehicle Crashes/Ran Off Road	FHWA-SA-21-036	4.7.B
			Two-Way Roads with No Physical Separation		
			Lane Departures		
			Inattentive/Distracted Driver		
			Fatigue/Asleep/Blackout		
2	High-Friction Surface Treatment (HFST)	Apply HFST on curves and high-speed intersection approaches to increase skid resistance and reduce loss-of-control.	Single-Vehicle Crashes/Ran Off Road	FHWA-SA-21-052	4.7.B
			High-Speed Roadways		
			Failure to Yield		

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
3	Enhanced Roadway Segment & Intersection Lighting	Install roadway segment and intersection lighting, and upgrade luminaire type and placement to improve nighttime visibility.	Dark Conditions with No Streetlights	FHWA-SA-21-050	4.6.D
4	Retroreflective Signal Backplates	Add fluorescent yellow retroreflective borders to signal backplates to improve visibility and reduce angle crashes.	Signalized Intersections Right-Angle Crashes Disregarding Traffic Control Devices Dark Conditions with No Streetlights	FHWA-SA-21-039	4.6.C
5	Protected or Protected-Permissive Left-Turn Phasing	Use protected or PPLT phasing to remove risky gap-acceptance decisions.	Signalized Intersections Left-Turn Crashes Failure to Yield	FHWA/LA.22/669	4.6.C
6	Auxiliary Left Turn Lanes	Provide exclusive and/or positively offset left-turn lanes to improve opposing sight distance and reduce conflict points.	Signalized Intersections Left-Turn Crashes Failure to Yield Careless Operation	FHWA-SA-21-041	4.6.C
7	Roundabout Conversions	Convert stop-controlled or signalized intersections with a high frequency of KA crashes to single-lane or multi-	Signalized Intersections Stop-Controlled Intersections Left-Turn Crashes Right-Angle Crashes Failure to Yield	FHWA-SA-21-042	4.6.C

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
		lane roundabouts to reduce conflict points and lower operating speeds.	Careless Operation Disregarding Traffic Control		
8	Restricted Crossing U-Turn (RCUT/J-Turn)	Replace direct left-turn and through movements from the minor road with an RCUT design on high-speed divided highways to reduce severe angle conflicts.	Right-Angle Crashes Rural Multilane Highways High-Speed Roadways Failure to Yield Careless Operation	FHWA-SA-21-030	4.6.C
9	Road Diets	Reconfigure a four-lane undivided roadway to three lanes with two through lanes and a center two-way left-turn lane (TWLTL) to calm speeds, reduce conflict points, and improve safety for all users.	Rural Multilane Highways High-Speed Roadways Right-Angle Crashes Left-Turn Crashes	FHWA-SA-21-046	4.6.D
10	Median Barriers / Corridor Division	Install cable, guardrail, or concrete median barriers to prevent cross-median head-on collisions and lane departures; consider converting corridors to divided roadways where appropriate.	Two-Way Roads with No Physical Separation Rural Multilane Highways Lane Departure Inattentive/Distracted Driving Fatigue/Asleep/Blackout	FHWA-SA-21-037	4.7.B

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
11	Speed Management Treatments (e.g., variable speed limits, appropriate speed limits for all road users)	Set context-appropriate speed limits and deploy variable speed limit systems that adapt to congestion, weather, incidents, or work zones to reduce excessive speeds, limit speed variability, and lower crash risk and severity.	High-Speed Roadways Weekend Crashes Careless Operation	FHWA-SA-21-034, FHWA-SA-21-054	4.6.B, 4.6.F
12	Older Driver Oriented Signing/Markings	Use larger, high-contrast signs and markings, with advance or overhead street-name signs and retroreflective materials, to improve conspicuity, legibility, and decision time for older drivers.	Stop-Controlled Intersections Signalized Intersections Failure to Yield Disregarding Control	FHWA-SA-14-015	4.6.D
Education & Outreach Countermeasures					
13	AARP Smart Driver® Refresher Course	Classroom-based training that enhances older drivers' awareness, decision-making, and defensive driving skills, covering	Failure to Yield Signalized Intersection Stop-Controlled Intersection Inattentive/Distracted Driving Left-Turn Crashes	All Older Americans (AARP)	1.1.E, 3.5.B, 3.5.C, 3.5.E, 4.4.D, 4.6.B

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
		intersections, speed management, distraction avoidance, and safe vehicle operation to reduce crash risk and improve driving confidence.	Right-Angle Crashes High-Speed Roadways Dark Conditions with No Streetlights		
14	Smart DriverTEK™ Workshop (ADAS education)	Interactive workshops teaching older drivers how to use crash-avoidance technologies, such as forward collision warning, lane keeping assist, blind-spot warning, and intersection assist, to mitigate common older driver crash patterns.	Single-Vehicle Crashes/Ran Off Road Right-Angle Crashes Left-Turn Crashes Rear-End Crashes Failure to Yield Careless Operation Afternoon Crashes (12:00 p.m. – 6:00 p.m.) Inattentive/Distracted Driving Fatigue/Asleep/Blackout Lane Departure	AARP	1.4.B, 1.4.C
15	CarFit® (vehicle fit & visibility)	A national educational program by American Automobile Association, AARP, and the American Occupational Therapy Association in which trained	Left-Turn Crashes Failure to Yield Stop-Controlled Intersections Signalized Intersections	CarFit	3.3.B

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
		volunteer CarFit Technicians facilitate a vehicle-fit assessment, adjusting seat position, mirrors, restraints, and driver access to essential controls, to optimize visibility, ergonomics, and control, and to reduce scanning lapses and driver error.	Light Truck/SUV Involvement Single-Vehicle Crashes		
16	Clinician Counseling & Referral	Evidence-based clinical approach in which primary-care and geriatric teams apply NHTSA's Clinician's Guide to Assessing and Counseling Older Drivers, using the "Plan for Older Driver Safety" algorithm and "Clinical Assessment of Driving Related	Fatigue/Asleep/Blackout Inattentive/Distracted Driving Medical Illness Condition	NHTSA	1.1.E

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
		Skills" to identify medical, cognitive, or functional deficits, review medications, and refer at-risk drivers to Certified Driver Rehabilitation Specialists (CDRS) for evaluation or retraining.	Drivers 75+		
17	Medication Review (Beers Criteria®)	Systematic evaluation of prescription, over-the-counter, and supplemental medications using the AGS Beers Criteria® to identify agents that may impair alertness, cognition, or coordination. Clinicians adjust therapy, address polypharmacy, and counsel older drivers on medication-related driving risks following NHTSA's Clinician's Guide to Assessing and Counseling Older Drivers.	Medical Illness Condition	NHTSA	2.1.B
			Inattentive/Distracted		
			Fatigue/Asleep/Blackout		

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
19	Family Engagement ("We Need to Talk")	Free, evidence-informed program developed by AARP, The Hartford, and MIT AgeLab to help families identify signs of declining driving ability, assess risk factors, and hold effective conversations about driving limitations or cessation before a crash occurs.	Drivers 75+ Medical Illness Fatigue/Blackout	AARP	-
20	CDRS Evaluation and Training	Comprehensive clinical and on-road assessment conducted by a CDRS to evaluate medical, cognitive, and functional abilities related to safe driving. The specialist provides individualized driver training, recommends adaptive equipment or vehicle modifications, and advises on appropriate driving restrictions or cessation when necessary.	Medical Illness Fatigue/Blackout Drivers 75+	The Association for Driver Rehabilitation Services	2.1.B

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
21	Motorcyclist Awareness and Visibility Campaigns	Statewide outreach campaigns, including "Share the Road" and "Look Twice for Motorcycles," promote safe driver/rider interactions by encouraging visual scanning at intersections, maintaining safe following distances, and improving motorcyclist visibility to prevent right-of-way and intersection crashes.	Motorcycle Involvement	NHTSA	4.4.A
			Left-Turn		
			Careless Operation		
			Failure to Yield		
22	Advanced & Refresher Rider Training Programs	Offer tailored refresher or advanced rider training (e.g., MSF Basic RiderCourse 2 or equivalent) for experienced and older riders to reinforce hazard recognition, braking, cornering, control precision, and risk-avoidance techniques.	Motorcycle Involvement	NHTSA	4.4.B

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
23	Helmet and High-Visibility Gear Promotion	Promote the consistent use of Department of Transportation-compliant helmets, high-visibility or reflective apparel, and other protective clothing to enhance rider conspicuity, reduce impact forces, and lower the likelihood of fatal or severe injuries, especially on high-speed and low-light roadways.	Motorcycle Involvement	NHTSA	4.4.A
			Dark Conditions with No Streetlights		
			High-Speed Roadways		
Enforcement & Policy Countermeasures					
24	High-Visibility Enforcement (HVE)	Implement data-driven, highly visible enforcement campaigns addressing common older-driver violations such as failure-to-yield, disobeying signals, and improper left turns. Emphasize enforcement at locations and times with high older-driver crash	Failure to Yield	NHTSA	1.3.A, 3.1.C, 4.7.E
			Right-Angle		
			Left Turn		
			Careless Operation		
			Disregarding Traffic Control Devices		
			Stop-Controlled Intersections		
			Signalized Intersections		
			High-Speed Roadways		
			Inattentive/Distracted Driving		

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
		involvement, combining police visibility with media outreach to increase deterrence and awareness.	Motorcycle Involvement		
25	Red-Light Safety Cameras (where permitted)	Automated enforcement to deter red-light running and reduce fatal or severe right-angle crashes at signals.	Right-Angle Crashes Signalized Intersections	IIHS	4.6.B
26	Automated and Targeted Speed Enforcement on High-Risk Corridors (where permitted)	Deploy automated speed safety cameras and high-visibility police patrols on corridors and rural multi-lane roadways with frequent older driver speed-related crashes. Use crash and citation data to guide enforcement at peak risk times and locations. Combine enforcement with public outreach to enhance deterrence and promote compliance with posted limits.	High-Speed Roadways Rural Multilane Highways	NHTSA	4.6.B, 4.7.E

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
27	Medical Review and Case-by-Case Licensing Restrictions for Older Drivers	Implement individualized driver licensing restrictions, such as daylight-only driving, limited geographic area, or reduced speed allowances, for medically at-risk or functionally impaired older drivers. Restrictions are determined through medical evaluation, vision testing, or functional assessments to extend safe mobility while minimizing crash risk.	Medical Illness Condition Drivers 75+	NHTSA	-
28	Periodic Vision Screening and In-Person License Renewal for Older Drivers	Require regular in-person license renewal with vision screening for older drivers to identify age-related vision decline. Establish referral pathways for medical evaluation or remediation when visual standards are not met, ensuring continued safe mobility while reducing vision-related crash risks.	Drivers 75+ Medical Illness/Vision Conditions	NHTSA	-

#	Countermeasure	Countermeasure Description	Targeted Older Driver Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
* For example: SHSP reference 4.7.B → SHSP emphasis area 4 (Infrastructure & Operations), strategy 7, and tactic B					

Table 18 summarizes countermeasures designed to improve safety outcomes for older pedestrians and pedal cyclists, who are among the most vulnerable road users due to age-related declines in mobility, vision, and cognitive abilities. The measures address the high-risk crash contexts identified in this study and integrate infrastructure enhancements, visibility improvements, education campaigns, and enforcement programs, reflecting the multi-disciplinary Safe System approach. Each countermeasure is aligned with the corresponding Louisiana SHSP emphasis area, strategy, and tactic, ensuring a coordinated, evidence-based framework for improving safety and mobility for older pedestrians and pedal-cyclists statewide.

Table 18. Potential older pedestrian/pedal-cyclist countermeasures

#	Countermeasure	Countermeasure Description	Targeted Older Pedestrian/Pedal-Cyclist Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
Infrastructure Countermeasures					
1	Enhanced Corridor and Intersection Lighting	Install energy-efficient LED lighting that provides uniform illumination along pedestrian routes and concentrated light at intersections to improve visibility and detection of older pedestrians and pedal-cyclists during nighttime and adverse weather conditions.	Evening/Nighttime (6:00 p.m.–12:00 a.m.)	FHWA-SA-21-050	1.4.D, 4.6.D
			Dark with No Streetlight		
			Rain or Adverse Weather		

#	Countermeasure	Countermeasure Description	Targeted Older Pedestrian/Pedal-Cyclist Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
2	Crosswalk Visibility Enhancements	Improve pedestrian visibility at crossings by applying high-contrast ladder or continental markings, advance yield or stop lines with appropriate signage, and targeted crosswalk lighting.	Uncontrolled/Unsignalized Crossings Midblock Crossings Failure To Yield Dark Condition with No Streetlights	FHWA-SA-21-049	1.4.D
3	Pedestrian Hybrid Beacons	Install pedestrian hybrid beacons at mid-block and uncontrolled crossings on multi-lane or high-speed roadways to provide positive stop control, improve driver yielding, and allow older pedestrians and pedal-cyclists to cross safely when adequate gaps in traffic are not available.	Two-Way Roads Midblock Crossings Dark Conditions with No Streetlights Uncontrolled Crossings	FHWA-SA-21-045	4.4.D
4	Rectangular Rapid Flashing Beacons (RRFBs)	Install pedestrian-activated RRFBs at uncontrolled marked crosswalks to enhance pedestrian conspicuity and driver awareness.	Uncontrolled Crossings Inattentiveness/Distraction Dark with No Streetlights Rain/Adverse Weather	FHWA-SA-21-053	4.4.D

#	Countermeasure	Countermeasure Description	Targeted Older Pedestrian/Pedal-Cyclist Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
		The alternating high-intensity LED flashes increase yielding compliance, improving crossing safety for non-motorized road users.	Failure to Yield		
5	Medians and Pedestrian Refuge Islands	Install raised medians or pedestrian refuge islands on multi-lane urban or suburban roadways to separate opposing traffic and provide a safe waiting area, allowing older pedestrians to cross one direction of traffic at a time.	Two-Way Roads Mid-Block Crossings	FHWA-SA-21-044	4.5.F
6	Raised Crosswalks	Install raised crosswalks flush with the sidewalk to slow vehicle speeds and increase pedestrian visibility. The elevated design improves driver yielding and provides safer, at-grade crossings for older pedestrians on low-speed urban and collector roads.	Low-Speed Roads Distracted/Inattentive Drivers Failure to Yield	FHWA	-

#	Countermeasure	Countermeasure Description	Targeted Older Pedestrian/Pedal-Cyclist Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
7	Curb Extensions (Bulb-Outs)	Extend curb or sidewalk into the parking lane at intersections or mid-block crossings to shorten pedestrian crossing distance, improve visibility between pedestrians and drivers, and reduce vehicle turning speeds for safer crossings of older pedestrians.	Intersections Failure to Yield Distracted/Inattentive Drivers Pedestrians aged 80+	PEDSAFE	4.5.F, 4.6.D
8	Leading Pedestrian Intervals	Provide pedestrians a 3- to 7-second head start before parallel vehicle movements to increase visibility, reduce turning conflicts, and improve safety for older pedestrians at signalized intersections.	Intersections Left-Turning Vehicles	FHWA	4.5.G

#	Countermeasure	Countermeasure Description	Targeted Older Pedestrian/Pedal-Cyclist Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
9	Reduction in Design Walking Speeds	Adopt a reduced design walking speed of 3 ft./sec. and extend pedestrian clearance intervals to accommodate older pedestrians with slower gait and delayed start-up time, ensuring sufficient time to cross signalized intersections safely.	Pedestrians aged 80+	FHWA	4.5.G
			Intersections		
10	Protected Left-Turn Phasing	Use protected-only left-turn phases to reduce pedestrian-vehicle conflicts.	Left-Turn Crashes	PEDSAFE	4.6.C
			Failure to Yield		
11	Separated Bike Lanes	Install separated or raised bicycle lanes using vertical elements or buffers to physically divide pedal-cyclists from motor vehicle traffic, reducing conflicts and improving comfort and safety for older and vulnerable riders on higher-volume or higher-speed roadways.	Wrong-Way Riding	FHWA	4.5.F
			Entering Traffic from the Shoulder or Driveway		

#	Countermeasure	Countermeasure Description	Targeted Older Pedestrian/Pedal-Cyclist Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
13	Walkways	Provide continuous sidewalks or paved shoulders along both sides of roadways to eliminate gaps, reduce pedestrian exposure to traffic, and improve safety for older pedestrians walking along two-way or rural roads.	Two-Way Roads Walking Along Roadways	FHWA	4.5.G
Education & Outreach Countermeasures					
14	Adult Bicyclist Safety Education	Educate adult bicyclists on traffic laws, safe riding practices, visibility, and use of helmets and reflective gear to promote predictable and safer on-road behavior.	Wrong-Way Riding Dark or Non-Reflective Clothing Entering Traffic from Shoulder or Driveway Male Pedal-Cyclists	NHTSA	4.4.B, 4.4.D
15	Bicycle Helmet Use Promotion Campaigns	Conduct public education campaigns and helmet distribution events to promote consistent helmet use and reduce the severity of bicycle-related head injuries among older pedal-cyclists.	Male Pedal-Cyclists Inattentive/Distracted Pedal-Cyclists	NHTSA	4.5.H

#	Countermeasure	Countermeasure Description	Targeted Older Pedestrian/Pedal-Cyclist Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
16	Share the Road Awareness Media Campaigns	Implement targeted media campaigns to educate drivers and vulnerable road users on sharing the road safely, emphasizing attentiveness, speed management, and yielding to pedestrians and bicyclists.	Failure to Yield; Inattentiveness/Distraction	NHTSA, LHSC	1.1.A-H, 2.2.A-D, 4.4.A-E
17	Driver Education on Pedestrian and Bicycle Safety	Incorporate pedestrian and bicyclist safety awareness into driver education programs to improve yielding behavior, reduce turning conflicts, and promote shared road responsibility.	Failure to Yield	NHTSA	4.4.B
			Left-Turning Vehicles		
			Inattentive or Distracted Driving		
18	Operation Bright Light (Visibility and Safety Program)	Distribute reflective backpacks, bike lights, and safety materials to increase visibility of pedestrians and bicyclists, especially in low-light conditions.	Evening and Nighttime Crashes (6:00 p.m.–12:00 a.m.)	Existing Program	-
			Dark or Non-Reflective Clothing		
			Walking Along Roadways		

#	Countermeasure	Countermeasure Description	Targeted Older Pedestrian/Pedal-Cyclist Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
Enforcement & Policy Countermeasures					
19	Bicycle Helmet Law Enforcement and Awareness	Enforce Louisiana's helmet law for riders under 12 and promote voluntary helmet use among adults to reduce the risk of severe bicycle-related head injuries.	Male Pedal-Cyclists	NHTSA	-
20	Safe Passing Law Enforcement for Motorists	Enforce Louisiana's law requiring motorists to maintain a minimum 3 ft. clearance when passing bicyclists to prevent sideswipe crashes.	Two-Way Roads	NHTSA, Louisiana State Legislature	4.6.E
21	Hands-Free and Distracted Driving Law Enforcement	Enforce Louisiana's handheld device and texting bans, focusing on school zones and high pedestrian or pedal-cyclist activity areas to reduce distraction-related crashes.	Inattentiveness/Distraction	GHSA, LHSC	1.2.A
22	High-Visibility Enforcement Campaigns	Conduct coordinated enforcement and public awareness campaigns targeting	Inattentiveness/Distraction Failure to Yield	NHTSA	1.3.A, 3.1.C, 4.7.E

#	Countermeasure	Countermeasure Description	Targeted Older Pedestrian/Pedal-Cyclist Crash Characteristic/Context	Reference for Countermeasure	SHSP Strategy Reference*
		speeding, distraction, impairment, and failure-to-yield violations in high-risk pedestrian and pedal-cyclist areas.	Disregarding Traffic Control		
23	Complete Streets Policy Implementation	Implement Louisiana's Complete Streets policy to ensure multimodal design features in all new and reconstructed projects, improving safety and accessibility for pedestrians and bicyclists.	Low-Speed Roadways Mid-Block Crossings Uncontrolled/Unsignalized Crossings Two-Way Roads	DOTD	4.3.A, 4.6.E, 4.6.G
24	Pedestrian Safety Zone Programs	Implement targeted education, enforcement, and engineering strategies in high-crash pedestrian zones to address concentrated safety issues and maximize intervention effectiveness.	Two-Way Roads Uncontrolled/Unsignalized Crossings Mid-Block Crossings	NHTSA	4.3.C

* For example: SHSP reference 1.4.D → SHSP emphasis area 1 (Distracted Driving), strategy 4, and tactic D

Conclusions

This study analyzed 12 years of Louisiana crash data from 2010 to 2021 to evaluate safety outcomes and contributing factors for older road users (ORUs) aged 65 and older, including drivers, pedestrians, and pedal-cyclists. The analysis aimed to identify critical crash contributing factors and locate high-risk areas to recommend targeted countermeasures that support the Louisiana Strategic Highway Safety Plan (SHSP). Using statewide police-reported crash data from DOTD, combined with demographic data from the U.S. Census and FHWA exposure data, the research employed descriptive, statistical, and spatial techniques to identify high-risk contexts for ORUs. To determine the unique crash characteristics of this group, comparisons were made among older, middle-aged (25 to 64 years), and younger (15 to 24 years) road user crashes.

A comprehensive descriptive analysis revealed that Louisiana's licensed older driver population increased by 55.5% during the study period, while their total crashes rose moderately by 13%. However, fatal crashes among older drivers more than doubled, with the highest rate increases observed among the 75 to 84 age cohort. Most older-driver crashes occurred at intersections, during daylight hours, and between 12:00 p.m. and 6:00 p.m., while fatal and severe crashes were overrepresented under dark-no-lighting and higher-speed conditions. Turning, right angle, and sideswipe collisions were the most frequent crash types, and male drivers were more often involved in severe crashes.

Multinomial logit model results identified several significant predictors of injury severity. For fatal and severe injury (KA) outcomes, risk increased with age and was substantially elevated when medical illness, fatigue/asleep/blackout, or distraction were reported. Behavioral violations such as disregarding traffic control devices, failure to yield, and careless operation were also strongly associated with higher severity. Roadway and environmental conditions influenced outcomes, with rural multi-lane highways, run-off-road crashes, higher speed limits, unlit conditions, and weekend periods associated with increased odds of severe injury. Motorcycle involvement represented the single largest predictor of severity, highlighting an area that requires focused attention.

Older pedestrian crashes in Louisiana increased disproportionately relative to demographic growth. Fatal and severe crashes were most frequent on two-way undivided roads, under dark conditions, and often involved larger vehicles such as light trucks and SUVs. Logistic regression results confirmed that increasing age, adverse driver condition, inclement weather, larger vehicle type, and low-visibility environments were significant predictors of severe injury.

Older pedal-cyclist crashes, although fewer in number, also showed an upward trend. Most crashes occurred during daytime travel and at intersections, but severe and fatal injuries were concentrated in evening hours and low-illumination conditions. Two-way undivided facilities and failure-to-yield or red-signal violations were common contributing factors. Due to the limited sample size, statistical modeling was not conducted; however, descriptive and spatial findings highlighted urban and suburban parishes as priority areas for countermeasure implementation.

The spatial analysis of ORU crashes across Louisiana revealed distinct patterns by user type and geography. Older driver crashes showed the highest overall risk, concentrated in urbanized parishes in the southern part of the state, such as Lafayette, West Baton Rouge, and East Baton Rouge. In contrast, KA crashes were more common in rural parishes, including Madison and East Carroll. Older pedestrian crashes were heavily concentrated in urban areas, with Orleans Parish exhibiting the highest crash rate. Older pedal-cyclist crashes were least frequent and mainly clustered in urban or semi-urban parishes such as Orleans, St. John the Baptist, and Iberia. Overall, urban areas exhibited higher exposure-related crash frequency, while rural areas experienced greater severity.

The study developed a coordinated list of potential engineering, education, and enforcement countermeasures aligned with Louisiana's SHSP emphasis areas. For older drivers, recommended engineering strategies include protected or protected-permissive left-turn phases, auxiliary left-turn lanes, roundabout or RCUT conversions, road diets, rumble strips, lighting upgrades, and speed management treatments. For older pedestrians and pedal-cyclists, effective strategies include improved corridor lighting, high-visibility crosswalks, pedestrian hybrid beacons (PHBs), raised medians or refuge islands, curb extensions, leading pedestrian intervals, longer signal clearance times, and separated or protected bicycle facilities. Complementary education and outreach measures, such as refresher driving courses, vehicle-fit programs, and visibility awareness campaigns, along with targeted high-visibility enforcement focusing on failure-to-yield and distraction violations, are expected to enhance the effectiveness of engineering treatments.

In conclusion, this study provided a data-driven assessment of ORU safety in Louisiana, highlighting increasing crash frequency and severity amid rising exposure. The findings emphasize the need for targeted, context-specific countermeasures to mitigate crash risks and advance Louisiana's SHSP goals of creating a safer, more inclusive transportation system for the state's older population.

Recommendations

The combined statistical and spatial analyses identified behavioral, roadway, and environmental factors that consistently elevate risk for older drivers, pedestrians, and pedalcyclists. The results from this study provide a data-driven foundation for prioritizing safety investments, refining SHSP strategies, and implementing location-specific countermeasures aimed at reducing the frequency and severity of ORU crashes across Louisiana.

Acronyms, Abbreviations, and Symbols

Term	Description
AARP	All Older Americans *(formerly the American Association of Retired Persons)*
ADAS	Advanced Driver Assistance System
BC	Moderate or Complaint Injury
BTSCRP	Behavioral Traffic Safety Cooperative Research Program
CDRS	Certified Driver Rehabilitation Specialists
DOTD	Louisiana Department of Transportation and Development
FHWA	Federal Highway Administration
IIHS	Insurance Institute for Highway Safety
KA	Fatal or Severe Injury
LTRC	Louisiana Transportation Research Center
MCI	Mild Cognitive Impairment
MNL	Multinomial Logistic Regression
MS	Microsoft
NHTSA	National Highway Traffic Safety Administration
OR	Odds Ratio
ORUs	Older Road Users
PDO	Property Damage Only
RRFBs	Rectangular Rapid Flashing Beacons
SHSP	Strategic Highway Safety Plan

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Appendix

Appendix 1: Potential Data Sources for Future Systemic Safety Analysis

Appendix 1 summarizes the availability of key data elements required to support a future systemic safety analysis for older road users (ORUs) at intersections and roadway segments. The following table categorizes each data variable by user group and identifies its availability based on existing Louisiana Department of Transportation and Development (DOTD) and publicly accessible data sources.

Data related to roadway geometry, traffic control, and operational features, such as traffic volume, number of lanes, turn lanes, medians, speed limits, and intersection control types, are largely available through the DOTD Open Data Portal, MS2 Traffic Count Database, and Microsoft Access Crash Database. These datasets provide a solid foundation for driver-focused analyses and partial coverage for pedestrian and pedal-cyclist evaluations.

However, substantial data gaps exist for pedestrian- and cyclist-related infrastructure attributes essential for systemic safety analysis. Elements such as crosswalk length and markings, ADA-accessible curb ramps, leading pedestrian intervals (LPIs), pedestrian hybrid beacons (PHBs), rectangular rapid-flashing beacons (RRFBs), and mid-block crossings are not currently available in statewide datasets. Similarly, transit activity measures, land use classifications, and alcohol-vending establishment locations remain absent, limiting comprehensive contextual and behavioral analyses.

Environmental and demographic data, including population, employment density, household characteristics, and vehicle ownership, are accessible from the U.S. Census Bureau, while information on schools and universities is available through the National Center for Education Statistics. Roadway attributes such as functional class and slope/grade can be obtained from the DOTD Open Data Portal.

In summary, Appendix 1 highlights Louisiana's strong foundation in roadway and operational data while emphasizing the need to expand pedestrian, cyclist, and contextual datasets to enable a more complete and equitable systemic safety analysis for older road users statewide.

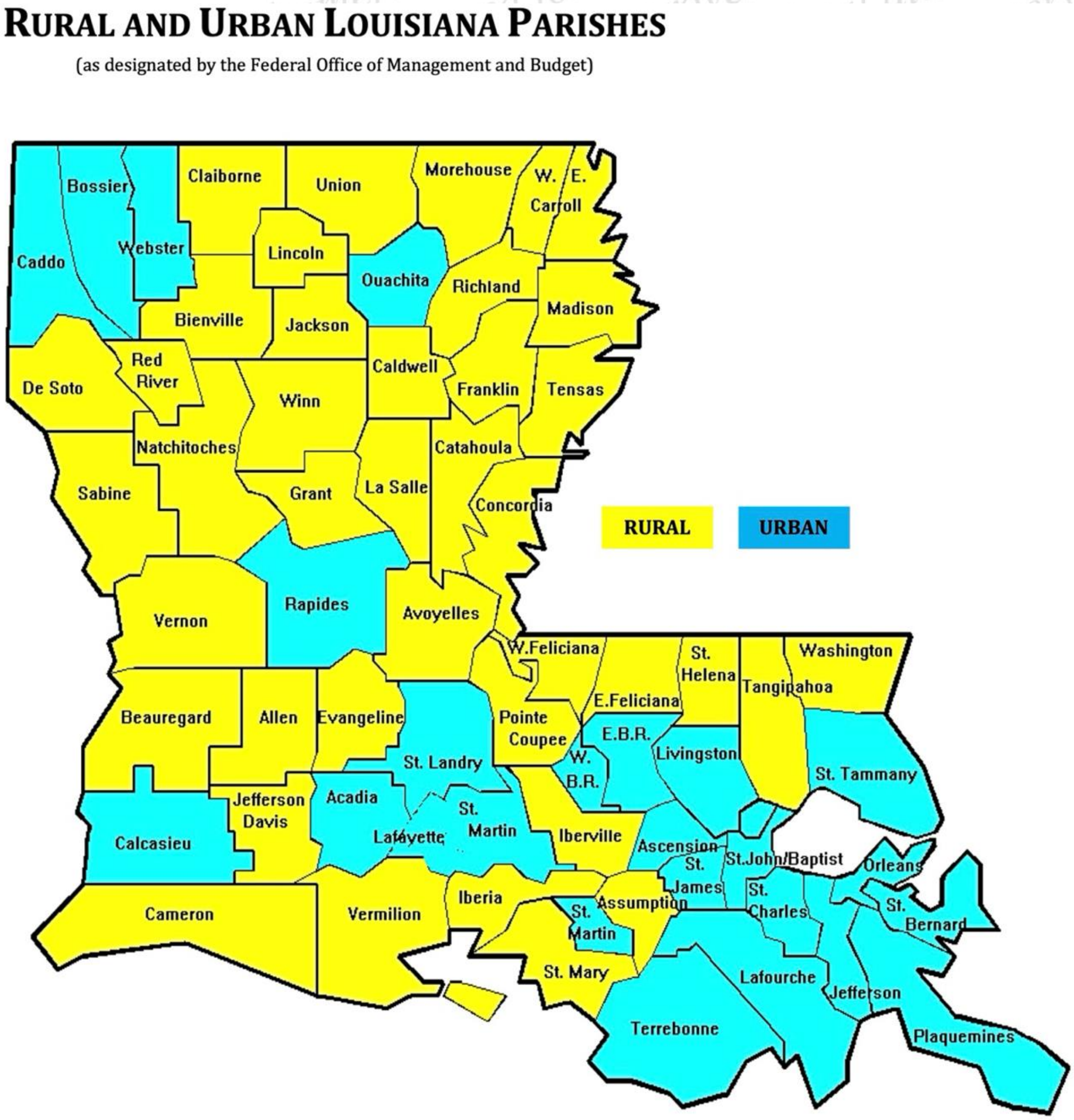
Data	Availability			Source
	Driver	Pedestrian	Pedal-Cyclist	
Intersection-Related				
Volume	✓	-	-	DOTD Traffic Count Data *(MS2)*
Transit Stops	✓	✓	✓	Statewide data is not available, Open Data BR, Ride New Orleans *(under construction)*
Number Of Traffic Lanes	✓	✓	✓	DOTD Open Data Portal *(number of lanes)*
Number Of Intersection Legs	✓	✓	✓	DOTD Microsoft (MS) Access Crash Database *(2016 onward)*
Crosswalk Length	-	-	-	-
Traffic Control Type	✓	✓	✓	DOTD Open Data Portal *(intersections control type)*
On-Street Parking	✓	✓	✓	DOTD Open Data Portal *(parking)*
Commercial Driveways	-	-	-	-
Leading Pedestrian Interval	-	-	-	-
Pedestrian Signals and Detection	✓	✓	✓	DOTD Open Data Portal *(intersections control type)*
Unrestricted/Restricted Turn Phasing	✓	✓	✓	DOTD MS Access Crash Database
Turning Lanes	✓	✓	✓	DOTD Open Data Portal *(turn lanes left and turn lanes right)*
Speed Limit	✓	✓	✓	DOTD Open Data Portal *(speed limit signs)* and MS Access Crash Database
Intersection Skew (Angle > 90°)	-	-	-	-
Crosswalk Markings and Type	-	-	-	-

Data	Availability			Source
	Driver	Pedestrian	Pedal-Cyclist	
Sidewalk Coverage	✓	✓	✓	DOTD Open Data Portal *(sidewalk outside and sidewalk inside)*
ADA-Accessible Curb Ramps	-	-	-	-
Segment-Related				
Volume	✓	-	-	DOTD Traffic Count Data *(MS2)*
Transit Stops	-	-	-	Statewide data is not available, Open Data BR, Ride New Orleans *(under construction)*
Total Through Lanes	✓	✓	✓	DOTD Open Data Portal *(number of lanes)*
Median With/Without Crossing Facilities	✓	✓	✓	DOTD Open Data Portal *(medians)*
Mid-Block Crosswalks	-	-	-	-
On-Street Parking	✓	✓	✓	DOTD Open Data Portal *(parking)*
Pedestrian Hybrid Beacon Or PHB	-	-	-	-
Rectangular Rapid Flashing Beacon	-	-	-	-
High Visibility Crosswalk Markings	-	-	-	-
Advance Stop/Yield Markings and Signs	-	-	-	-
Speed Limit	✓	✓	✓	DOTD Open Data Portal *(speed limit signs)* and MS Access Crash Database
Segment Length	✓	✓	✓	DOTD Open Data Portal *(Louisiana roadways)*

Data	Availability			Source
	Driver	Pedestrian	Pedal-Cyclist	
Sidewalk Coverage	✓	✓	✓	DOTD Open Data Portal *(sidewalk outside and sidewalk inside)*
Distance to Nearest Signalized Crossing or Activated Beacon Along Same Road	-	-	-	-
Right- or Left-Turn Lanes at Adjacent Intersections	✓	✓	✓	DOTD Open Data Portal *(turn lanes left and turn lanes right)*
Signals at Adjacent Intersections	✓	✓	✓	DOTD Open Data Portal *(intersections control type)*
Any Location Type				
Roadway Functional Class	✓	✓	✓	DOTD Open Data Portal *(Louisiana roadways)*
Transit Activity Measures	-	-	-	-
Commercial Land Uses; Mixed, Residential Land Use	-	-	-	-
Area Population	✓	✓	✓	U.S. Census Bureau
Employment Density	✓	✓	✓	U.S. Census Bureau
Household Density	✓	✓	✓	U.S. Census Bureau
Area Population Income	✓	✓	✓	U.S. Census Bureau
Area Population Age Groups	✓	✓	✓	U.S. Census Bureau
Area Population Vehicle Ownership and/or Mode Share Percentages	✓	✓	✓	U.S. Census Bureau
Other Urban Density Measures	✓	✓	✓	U.S. Census Bureau

Data	Availability			Source
	Driver	Pedestrian	Pedal-Cyclist	
Alcohol Vending Establishments	-	-	-	-
Universities/Schools	✓	✓	✓	National Center for Education Statistics
Slope/Grade	✓	✓	✓	DOTD Open Data Portal *(Louisiana roadways)*

Appendix 2: Classification of Parishes
by Federal Office of Management and Budget



Appendix 3. Older Driver KA Injury MNL Model Results

Reference	Variable	Coefficient	Odds Ratio	z-value	p-value
65 to 69	Driver.Age.Group → 70 to 74	0.16	1.18	2.71	0.01
12:00 p.m. – 6:00 p.m.	Crash.Time → 6:00 p.m. – 12:00 a.m.	0.21	1.23	2.28	0.02
Daylight	Lighting.Condition → Dark with No Streetlights	0.23	1.25	2.14	0.03
No Violations	Violations → Careless Operation	0.23	1.25	2.68	0.01
65 to 69	Driver.Age.Group → 75 to 79	0.24	1.26	3.45	<0.01
Low-Speed Roadway (< 40 mph)	Roadway.Type.by.Speed → High-Speed Roadway (> 40 mph)	0.27	1.31	4.43	<0.01
65 to 69	Driver.Age.Group → 80 to 84	0.28	1.32	3.52	<0.01
Weekday	Day.of.the.Week → Weekend	0.29	1.34	5.47	<0.01
Passenger Car	Vehicle.Type → Light Truck	0.30	1.35	4.74	<0.01
Passenger Car	Vehicle.Type → Van	0.33	1.39	2.99	<0.01
Proceeding Straight Ahead	Prior.Movement → Ran Off Road	0.34	1.41	4.04	<0.01
Normal	Driver.Condition → Fatigued/Asleep/ Blackout	0.37	1.44	2.27	0.02
No Violations	Violations → Driver Condition	0.42	1.53	3.38	<0.01
Rural Two-Lane	Area.Highway.Type → Rural.Multi-Lane	0.61	1.85	4.30	<0.01
No Violations	Violations → Failure to Yield	0.65	1.91	5.97	<0.01
65 to 69	Driver.Age.Group → 85+	0.67	1.96	8.03	<0.01

Reference	Variable	Coefficient	Odds Ratio	z-value	p-value
No Violations	Violations → Disregarded Traffic Control	0.89	2.44	6.33	<0.01
Proceeding Straight Ahead	Prior.Movement → Crossed Centerline/Median	1.19	3.30	10.28	<0.01
Normal	Driver.Condition → Illness	2.49	12.12	19.06	<0.01
Passenger Car	Vehicle.Type → Motorcycle	4.21	67.20	24.86	<0.01

Appendix 4: Older Driver BC Injury MNL Model Results

Reference	Variable	Coefficient	Odds Ratio	z-value	p-value
Male	Driver.Gender → Female	0.04	1.04	2.90	<0.01
No Violations	Violations → Careless Operation	0.08	1.08	3.10	<0.01
FALSE	Intersection → TRUE	0.08	1.09	5.92	<0.01
Passenger Car	Vehicle.Type → Van	0.09	1.10	3.44	<0.01
Daylight	Lighting.Condition → Dark with Streetlights	0.11	1.11	3.84	<0.01
65 to 69	Driver.Age.Group → 85+	0.11	1.11	4.66	<0.01
Low-Speed Roadway (<40 mph)	Roadway.Type.by.Speed → High-Speed Roadway (> 40 mph)	0.13	1.14	8.83	<0.01
Rural Two-Lane	Area.Highway.Type → Rural.Multi-Lane	0.13	1.14	2.51	0.01
Weekday	Day.of.the.Week → Weekend	0.14	1.15	9.10	<0.01
Single Vehicle Crash	Collision.Manner → Right Angle	0.18	1.20	6.15	0.00
Normal	Driver.Condition → Impaired (Drug/Alcohol)	0.20	1.22	3.29	<0.01
Daylight	Lighting.Condition → Dawn/Dusk	0.21	1.23	4.81	<0.01
Proceeding Straight Ahead	Prior.Movement → Ran Off Road	0.25	1.29	6.92	<0.01
No Violations	Violations → Driver Condition	0.31	1.36	6.79	<0.01
No Violations	Violations → Failure to Yield	0.37	1.45	12.75	<0.01
Proceeding Straight Ahead	Prior.Movement → Crossed Centerline/Median	0.40	1.49	8.13	<0.01
Single Vehicle Crash	Collision.Manner → Head On	0.47	1.60	9.31	<0.01
No Violations	Violations → Disregarded Traffic Control	0.52	1.69	14.07	<0.01

Reference	Variable	Coefficient	Odds Ratio	z-value	p-value
Normal	Driver.Condition → Fatigued/Asleep/Blackout	1.17	3.21	22.62	<0.01
Normal	Driver.Condition → Illness	2.07	7.94	31.25	<0.01
Passenger Car	Vehicle.Type → Motorcycle	2.59	13.27	19.67	<0.01

Appendix 5: Older Driver Crash Statistics by Parishes

Parish	Older Population in Parish *(2020 Census)*	All Older Driver Crashes *(2010-2021)*	Average Crashes per 1,000 Older Population*	Fatal and Severe Crashes *(2010-2021)*	Fatal/Severe Crashes per 1,000 Older Population*	Area Characteristics *(Urban or Rural)*
Acadia	9,965	1,707	14.3	26	2.6	Urban
Allen	3,555	513	12.0	16	4.5	Rural
Ascension	15,925	3,506	18.3	35	2.2	Urban
Assumption	4,057	430	8.8	12	3.0	Rural
Avoyelles	7,326	1,046	11.9	12	1.6	Rural
Beauregard	6,109	965	13.2	23	3.8	Rural
Bienville	2,761	248	7.5	6	2.2	Rural
Bossier	19,091	4,541	19.8	63	3.3	Urban
Caddo	43,434	11,726	22.5	173	4.0	Urban
Calcasieu	33,809	7,816	19.3	84	2.5	Urban
Caldwell	1,819	113	5.2	7	3.8	Rural
Cameron	956	101	8.8	3	3.1	Rural
Catahoula	1,798	104	4.8	4	2.2	Rural
Claiborne	3,007	295	8.2	14	4.7	Rural
Concordia	3,505	437	10.4	10	2.9	Rural
Desoto	5,008	754	12.5	20	4.0	Rural
East Baton Rouge	69,353	19,129	23.0	170	2.5	Urban
East Carroll	1,106	129	9.7	8	7.2	Rural
East Feliciana	3,987	105	2.2	13	3.3	Rural
Evangeline	5,729	1,047	15.2	6	1.0	Rural
Franklin	3,787	289	6.4	11	2.9	Rural
Grant	3,504	151	3.6	12	3.4	Rural
Iberia	11,549	2,654	19.2	30	2.6	Rural
Iberville	5,453	957	14.6	17	3.1	Rural
Jackson	3,159	230	6.1	11	3.5	Rural
Jefferson	78,936	18,565	19.6	85	1.1	Urban
Jefferson Davis	5,608	1,025	15.2	19	3.4	Rural
Lafayette	35,034	10,382	24.7	76	2.2	Urban
Lafourche	15,633	2,742	14.6	39	2.5	Urban
Lasalle	2,556	212	6.9	6	2.3	Rural

Parish	Older Population in Parish *(2020 Census)*	All Older Driver Crashes *(2010-2021)*	Average Crashes per 1,000 Older Population*	Fatal and Severe Crashes *(2010-2021)*	Fatal/Severe Crashes per 1,000 Older Population*	Area Characteristics *(Urban or Rural)*
Lincoln	6,849	1,565	19.0	24	3.5	Rural
Livingston	19,572	3,494	14.9	50	2.6	Urban
Madison	1,732	284	13.7	12	6.9	Rural
Morehouse	5,245	845	13.4	22	4.2	Rural
Natchitoches	6,627	1,357	17.1	31	4.7	Rural
Orleans	56,453	12,356	18.2	204	3.6	Urban
Ouachita	24,876	6,568	22.0	69	2.8	Urban
Plaquemines	3,169	429	11.3	8	2.5	Urban
Pointe Coupee	4,463	422	7.9	23	5.2	Rural
Rapides	22,857	5,847	21.3	51	2.2	Urban
Red River	1,460	185	10.6	9	6.2	Rural
Richland	3,604	363	8.4	17	4.7	Rural
Sabine	4,848	382	6.6	15	3.1	Rural
St. Bernard	5,273	1,016	16.1	11	2.1	Urban
St. Charles	7,746	1,247	13.4	18	2.3	Urban
St. Helena	2,138	176	6.9	12	5.6	Rural
St. James	3,751	588	13.1	8	2.1	Urban
St. John the Baptist	6,861	1,231	15.0	17	2.5	Urban
St. Landry	14,882	3,054	17.1	33	2.2	Urban
St. Martin	8,858	1,633	15.4	17	1.9	Urban
St. Mary	8,564	1,460	14.2	25	2.9	Rural
St. Tammany	48,528	8,185	14.1	80	1.6	Urban
Tangipahoa	20,911	4,493	17.9	55	2.6	Rural
Tensas	1,020	56	4.6	2	2.0	Rural
Terrebonne	16,969	3,848	18.9	19	1.1	Urban
Union	4,555	406	7.4	12	2.6	Rural
Vermilion	9,715	1,637	14.0	21	2.2	Rural
Vernon	6,375	907	11.9	19	3.0	Rural
Washington	8,801	1,172	11.1	25	2.8	Rural
Webster	7,793	1,465	15.7	27	3.5	Urban
West Baton Rouge	3,906	1,165	24.9	23	5.9	Urban
West Carroll	2,202	202	7.6	3	1.4	Rural

Parish	Older Population in Parish *(2020 Census)*	All Older Driver Crashes *(2010-2021)*	Average Crashes per 1,000 Older Population*	Fatal and Severe Crashes *(2010-2021)*	Fatal/Severe Crashes per 1,000 Older Population*	Area Characteristics *(Urban or Rural)*
West Feliciana	2,449	169	5.8	9	3.7	Rural
Winn	2,572	223	7.2	5	1.9	Rural
Mean: 13.04, Median: 13.42, Standard Deviation: 5.6, Minimum: 2.19, Maximum: 24.85						
* = [(Avg. Yearly Older Crashes in 12 years / Older Population) * 1,000]						

Appendix 6: Older Pedestrian KA Injury Binary Logistic Regression Model Results

Reference	Category	Coefficient	Odds Ratio	z-value	p-value
One-Way Road	Road Type → Two-Way Road with a Physical Separation	0.58	1.79	1.99	0.05
Passenger Car	Vehicle Type → SUV	0.66	1.93	3.06	<0.01
Clear	Weather Condition → Rain	0.72	2.06	2.21	0.03
Passenger Car	Vehicle Type → Light Truck	0.74	2.09	3.60	<0.01
65 to 69	Pedestrian Age Group → 85+	0.77	2.15	2.33	0.02
65 to 69	Pedestrian Age Group → 80 to 84	0.87	2.38	2.96	<0.01
Daylight	Lighting Condition → Dark with No Streetlights	0.89	2.43	2.62	0.01
No Violations	Violations → Driver Condition	1.14	3.13	2.64	0.01
Passenger Car	Vehicle Type → Truck/Tractor	1.15	3.17	2.03	0.04

Appendix 7: Older Driver Crash Statistics by Louisiana Parish

Parish	Older Population in Parish *(2020 Census)*	All Older Pedestrian Crashes (2010-2021)	Average Crashes per 1,000 Older Population*	Area Characteristics (Urban or Rural)
Acadia	9,965	9	0.9	Urban
Allen	3,555	5	1.4	Rural
Ascension	15,925	14	0.9	Urban
Assumption	4,057	2	0.5	Rural
Avoyelles	7,326	3	0.4	Rural
Bienville	2,761	2	0.7	Rural
Bossier	19,091	14	0.7	Urban
Caddo	43,434	70	1.6	Urban
Calcasieu	33,809	54	1.6	Urban
Cameron	956	3	3.1	Rural
Claiborne	3,007	1	0.3	Rural
Concordia	3,505	3	0.9	Rural
Desoto	5,008	1	0.2	Rural
East Baton Rouge	69,353	122	1.8	Urban
East Feliciana	3,987	2	0.5	Rural
Franklin	3,787	4	1.1	Rural
Grant	3,504	2	0.6	Rural
Iberia	11,549	16	1.4	Rural
Iberville	5,453	4	0.7	Rural
Jackson	3,159	2	0.6	Rural
Jefferson	78,936	153	1.9	Urban
Jefferson Davis	5,608	7	1.2	Rural
Lafayette	35,034	40	1.1	Urban
Lafourche	15,633	16	1.0	Urban
Lincoln	6,849	7	1.0	Rural
Livingston	19,572	10	0.5	Urban
Madison	1,732	3	1.7	Rural
Morehouse	5,245	4	0.8	Rural
Natchitoches	6,627	15	2.3	Rural
Orleans	56,453	350	6.2	Urban
Ouachita	24,876	27	1.1	Urban
Plaquemines	3,169	2	0.6	Urban
Pointe Coupee	4,463	2	0.4	Rural

Parish	Older Population in Parish *(2020 Census)*	All Older Pedestrian Crashes (2010-2021)	Average Crashes per 1,000 Older Population*	Area Characteristics (Urban or Rural)
Rapides	22,857	32	1.4	Urban
Red River	1,460	1	0.7	Rural
St. Bernard	5,273	9	1.7	Urban
St. Charles	7,746	5	0.6	Urban
St. Helena	2,138	1	0.5	Rural
St. James	3,751	8	2.1	Urban
St. John The Baptist	6,861	6	0.9	Urban
St. Landry	14,882	22	1.5	Urban
St. Martin	8,858	17	1.9	Urban
St. Mary	8,564	12	1.4	Rural
St. Tammany	48,528	30	0.6	Urban
Tangipahoa	20,911	27	1.3	Rural
Terrebonne	16,969	23	1.4	Urban
Union	4,555	5	1.1	Rural
Vermilion	9,715	7	0.7	Rural
Vernon	6,375	7	1.1	Rural
Washington	8,801	12	1.4	Rural
Webster	7,793	9	1.2	Urban
West Baton Rouge	3,906	9	2.3	Urban
Winn	2,572	1	0.4	Rural
Mean: 0.1, Median: 0.09, Standard Deviation: 0.08, Minimum: 0.02, Maximum: 0.52				
* = *[(Avg. Yearly Older Crashes in 12 years / Older Population) * 1,000]*				

Appendix 8: Top 10 Parishes in Louisiana with Elevated Older Pedal-Cyclist Crash Risk

Parish	Total Crashes (2010-2021)	Older Population (2020)	Average Crashes per 1,000 Older Population*	Area Characteristics (Urban or Rural)
Orleans	50	56,453	0.074	Urban
St. John The Baptist	5	6,861	0.061	Urban
Iberia	7	11,549	0.051	Rural
Madison	1	1,732	0.048	Rural
Terrebonne	9	16,969	0.044	Urban
St. Charles	4	7,746	0.043	Urban
Lafayette	17	35,034	0.040	Urban
St. Bernard	2	5,273	0.032	Urban
Jefferson	29	78,936	0.031	Urban
Bienville	1	2,761	0.030	Rural
Mean: 0.025, Median: 0.021, Standard Deviation: 0.016, Minimum: 0.006, Maximum: 0.074				
* = *[(Avg. Yearly Older Crashes in 12 years / Older Population) * 100,000]*				