Jacksonville State University
JSU Digital Commons

Theses | Theses, Dissertations & Graduate Projects

Spring 2025

Enhancing Pedestrian Safety around Jacksonville State University: A GIS-Based Perception and Crash Analysis

Husain O. Alegimenlen
Jacksonville State University, halegimenlen@stu.jsu.edu

Follow this and additional works at: https://digitalcommons.jsu.edu/etds_theses

Part of the Urban, Community and Regional Planning Commons

Recommended Citation
Alegimenlen, Husain O., "Enhancing Pedestrian Safety around Jacksonville State University: A GIS-Based Perception and Crash Analysis" (2025). *Theses*. 81.
https://digitalcommons.jsu.edu/etds_theses/81

This Thesis is brought to you for free and open access by the Theses, Dissertations & Graduate Projects at JSU Digital Commons. It has been accepted for inclusion in Theses by an authorized administrator of JSU Digital Commons. For more information, please contact digitalcommons@jsu.edu.

Enhancing Pedestrian Safety around Jacksonville State University: A GIS-Based Perception and Crash Analysis

A Thesis Submitted to the

Graduate Faculty of Jacksonville State University

in Partial Fulfillment of the

Requirements for the Degree of

Master of Science

with a Major in Geographic Information Systems and Technology

By

Husain Obianjulu Alegimenlen

Jacksonville, Alabama

May 2, 2025

Copyright 2025

All Rights Reserved

Husain Obianjulu Alegimenlen May 2, 2025

Abstract

This study uses a Geographic Information Systems (GIS) based approach to assess pedestrian safety around Jacksonville State University (JSU) by combining vehicle crash data with perception surveys from 111 pedestrians and 97 drivers. The research identifies high-risk areas, explores contributing factors, and recommends targeted safety improvements.

A total of 209 geocoded crash records (2021 to 2024) were analyzed using Kernel Density Estimation (KDE) and hotspot analysis in ArcGIS Pro. Crash clusters appeared along Pelham Road North and Mountain Street, marking key vehicular risk zones. Three major pedestrian danger areas were found: (1) Nisbet Street NW and Cardinal Lane NW, (2) University Circle and Trustee Street near Houston Cole Library, and (3) the parking lot behind Martin Hall. These locations were frequently reported as unsafe by both survey groups, reinforcing the GIS findings.

To strengthen the analysis, the study included socioeconomic, behavioral, and temporal survey data. Most respondents were students aged 18 to 24. Frequent device use, walking patterns, and time of day (morning and afternoon) influenced safety perceptions. Driver concerns were also higher during these periods, and near-miss experiences were linked to lower safety perceptions.

A composite KDE overlay combined crash, driver, and pedestrian density surfaces. This revealed spatial overlaps at key campus locations, including the AL 204 and AL 21 crosswalk and the AL 21 and Nisbet Street NW intersection. These locations were jointly identified as high-risk by both groups, though not confirmed in crash records.

The study presents a multi-dimensional GIS framework that combines spatial, behavioral, and temporal data to support safety planning and guide future interventions at JSU.

Acknowledgments

I would like to express my gratitude to the Department of Chemistry and Geosciences and the Graduate Studies Office at Jacksonville State University for their academic support throughout my program.

I would also like to thank my mentor and major professor, Dr. Sean Chenoweth, for his guidance, encouragement, and invaluable support throughout this research. His dedication and mentorship made all the difference.

Also, to my committee members, Dr. Ross Martin and Dr. Saeideh Gharehchahci, for their feedback and contributions to this project. Dr. Gharehchahci's steady support for students across the department has been greatly appreciated.

I extend my sincere appreciation to the University Police Department (UPD) at Jacksonville State University for their support, especially in providing crash data and helping to distribute the survey link.

Special thanks to my family and friends for their prayers, support, and encouragement throughout this journey, especially my late mother, whose memory and tragic loss in a hit-and-run incident inspired and motivated this research project.

Alegimenlen Husain Obianjulu

Table of Contents

List of Figures

Introduction

Jacksonville State University (JSU) is experiencing a period of significant growth, characterized by a rising student population that includes a growing number of international students (ALDOT, 2024). This influx is creating a more vibrant campus environment, but it also presents new challenges, particularly regarding pedestrian safety.

This project utilizes Geographic Information Systems (GIS) technology to analyze pedestrian movement patterns and identify potential safety risks focusing specifically on JSU and its surroundings. By collaborating with the right authorities and gathering community input, this research seeks to identify and mitigate safety risks effectively. The recent surge in student enrollment, with a specific emphasis on the record-breaking international student intake for Spring 2024, necessitates a proactive approach to ensuring a safe and navigable environment for all pedestrians (ALDOT, 2024).

Pedestrian safety has emerged as a major public health concern, especially in urban settings across the United States. According to the National Highway Traffic Safety Administration (2020), 6,301 pedestrians died in traffic crashes nationwide in 2020, representing over 17% of all traffic fatalities for that year. Additionally, projections indicate that pedestrian deaths rose by 21% during the first half of 2021 compared to the same period in 2020 (Casale, 2022). Retting (2017) highlights that pedestrian fatalities vary significantly by state, with urban areas experiencing disproportionately higher pedestrian crash rates, underscoring the need for targeted safety interventions at the state and local levels**.** More recent data from the NHTSA (2021) highlights a continued rise in pedestrian fatalities, emphasizing the need for data-driven interventions and proactive safety measures. This spike has been attributed to increased distracted driving as well as larger vehicles on roadways, which can result in more severe pedestrian injuries in crashes (Ruiz et al., 2018). Urban areas tend to have higher pedestrian fatality rates, highlighting the need for interventions to protect pedestrian safety, specifically in cities (Park & Bae, 2020). One county that has seen an increase in pedestrian crashes is Calhoun County, Alabama, home to the city of Jacksonville. As pedestrian safety risks continue to climb in Jacksonville and other urban areas of Calhoun County, targeted research is required to develop effective solutions tailored to the needs of these local communities.

GIS enables complex integration and visualization of diverse location-based datasets to uncover spatial relationships and patterns. By combining crash records, infrastructure maps, demographics, land use information and other urban planning data sources into a GIS, researchers can better understand the factors contributing to pedestrian crashes and pinpoint high-risk areas in need of safety improvements (Pulugurtha & Sambhara, 2011). Analysis of crash records from 2006 to 2015 revealed that 48% of all pedestrian collisions in Alabama occurred within four counties containing the largest cities, namely Jefferson, Mobile, Madison, and Montgomery (Alabama Department of Transportation, 2017). More recent statewide data from the NHTSA (2021) indicated a 34% increase in pedestrian fatalities across Alabama from 2019 to 2020. These statewide trends highlight the importance of conducting localized studies, such as in Calhoun County, home to Jacksonville State University, to develop targeted and effective solutions tailored specifically to local community needs.

GIS approaches have immense potential to analyze built environments systematically, identify risk factors, and guide appropriate interventions related to pedestrian safety (Stankov et al., 2020). GIS enables complex integration and visualization of diverse location-based datasets to uncover spatial relationships and patterns. By combining crash records, infrastructure maps, demographics, land use information and other urban planning data sources into a GIS, researchers can better understand the factors contributing to pedestrian crashes and pinpoint high-risk areas in need of safety improvements (Pulugurtha & Sambhara, 2011). Equipped with these geospatial evidence-based insights, transportation planners and decision-makers can implement well-informed countermeasures, education campaigns, and policies aimed at enhancing pedestrian safety (Fu, 2019).

Past studies have demonstrated promising applications of GIS analysis techniques for improving pedestrian safety outcomes. GIS-based examination of environmental attributes around schools further enabled recommendations for educational programs and infrastructure changes enhancing protection of child pedestrians (Rothman et al., 2019). Additionally, spatial modelling has helped predict future pedestrian crash locations to proactively direct prevention resources (Ha & Thill, 2011). Though most existing research has focused specifically on individual cities, GIS methodologies could be invaluable when customized to the built environments, demographics, crash profiles and community priorities of local urban areas across Alabama.

In recent advancements, studies have emphasized the integration of socioeconomic data such as income level, car access, and neighborhood disadvantage using GIS spatial joins to understand risk exposure more holistically (Cottrill & Thakuriah, 2010).

Likewise, temporal dimensions such as time of day, which influence walking patterns and pedestrian-driver conflict likelihoods, are now routinely modeled to better understand safety risks and peak incident windows (Xu et al., 2023). Furthermore, layered spatial overlays combining multiple kernel density estimations (KDE) from crashes, perceptions and near-miss experiences provide a novel lens to uncover compound high risk zones, as shown in this study.

Objectives

This research examines the use of Geographic Information Systems (GIS), spatial analysis, and perception-based data to assess pedestrian safety risks around Jacksonville State University (JSU). By leveraging vehicle crash data and community-reported pedestrian and driver surveys, the study aims to identify high-risk locations and explore contributing behavioral and socioeconomic factors influencing safety concerns.

To achieve this, the study is guided by the following objectives:

1. Apply GIS mapping and Kernel Density Estimation (KDE) techniques to analyze 209 geocoded vehicle crash records (2021–2024) and 208 combined pedestrian and driver survey responses within a 1.5-mile radius of JSU to identify spatial clusters of pedestrian safety risks.

2. Perform a KDE overlay and visual comparison of crash data with pedestrian and driver perception maps to detect spatial coincidence and uncover areas where perceived and recorded risks align, highlighting critical safety hotspots.

3. Incorporate socioeconomic, behavioral, and temporal survey variables such as age, occupation, device use, walking frequency, and time of day to better understand factors influencing perceived pedestrian safety.

By addressing these objectives, this study provides evidence-based insights that support targeted interventions to improve pedestrian safety, guide urban planning decisions, and enhance mobility around JSU.

Research Question

1. How effectively can GIS-based spatial analysis, including Kernel Density Estimation (KDE), identify high-risk pedestrian zones within a 1.5-mile radius of Jacksonville State University?

2. What key pedestrian safety concerns were reported by pedestrians and drivers, and how do these perceptions align or differ from the spatial distribution of crash incidents?

3. In what ways do socioeconomic, behavioral, and temporal factors influence reported perceptions of pedestrian safety, and how can these insights support targeted safety planning around JSU?

Scope

This GIS-based study focused on identifying high-risk pedestrian areas and proposing targeted safety improvements within a 1.5-mile radius of Jacksonville State University (JSU) in Jacksonville, Alabama. The analysis integrated 209 geocoded vehicle crash records (2021–2024) with perception surveys from 111 pedestrians and 97 drivers, collected using ArcGIS Survey123, to build a spatial evidence base for assessing pedestrian safety concerns.

Kernel Density Estimation (KDE) was applied in ArcGIS Pro to conduct hotspot analyses on crash and perception data. A composite KDE overlay was also performed to reveal spatial coincidences between crash zones and areas frequently flagged in both pedestrian and driver surveys. This approach helped to highlight locations where recorded incidents and perceived risks align, reinforcing their classification as critical safety hotspots.

The study further incorporated socioeconomic, behavioral, and temporal factors, such as age, occupation, walking frequency, time of day, and device use, to better understand the context behind reported safety concerns. These variables added depth to the spatial analysis and clarified the underlying conditions influencing perceived and actual pedestrian risks.

By combining crash data with perception-based insights, the study captured both documented and unreported (or near-miss) safety challenges. The results support data-informed safety recommendations, including improvements to crosswalk visibility, lighting, signage, and enforcement around campus. The methodology and findings are transferable to other university environments aiming to enhance pedestrian safety and mobility through GIS-based planning.

Literature Review

Pedestrian safety in urban environments has developed into a major public health concern due to rising trends in pedestrian injuries and fatalities (Casale, 2022). In 2020, over 17% of all US traffic deaths were in pedestrians, with 6,301 killed, reflecting the largest number since 1990 (National Highway Traffic Safety Administration, 2020). These alarming statistics have prompted research into evidence-based interventions to protect vulnerable road users through infrastructure improvements, law enforcement, and education programs (Iroz-Elardo et al., 2020). Within this domain, geographic information systems (GIS) have demonstrated immense promise in enabling data-driven decision-making to enhance pedestrian safety outcomes in communities (Stankov et al., 2020).

GIS Approaches for Analyzing Pedestrian Safety

These techniques provide geospatial intelligence to guide targeted improvements (Rothman et al., 2019). With pedestrian injuries concentrated in urban counties across many states like Alabama, GIS methodologies hold immense potential to inform localized solutions when applied within specific city contexts (Alabama Department of Transportation, 2017).

Pinpointing Hazardous Locations

A crucial advantage of GIS for pedestrian safety planning is enabling data-driven prioritization of the highest-risk areas in need of urgent attention. Hot spot analysis can be utilized to map past pedestrian crash clusters and corridors in Jacksonville down to the street-segment level (Iroz-Elardo et al., 2020). This technique would highlight priority high-injury zones within the city to focus on enforcement and infrastructure improvements.

Additionally, spatial modelling facilitates the prediction of hazardous pedestrian crash locations in Calhoun County. By integrating vehicle volumes, speed limits and pedestrian exposure estimates, models like the pedestrian crash potential index (PCPI) can identify probable future collision sites in urban areas of the county, including Jacksonville (Ha & Thill, 2011). This approach would enable a shift from reactive to proactive interventions to maximize prevention potential.

Researchers could also combine spatial modelling with cluster analysis to differentiate types of hot spots in Jacksonville based on environmental attributes, directing customized solutions to address underlying risk factors, whether infrastructure-related or behavioral (Pulugurtha & Sambhara, 2011). Hot spot analysis and spatial modelling enabled by GIS provide data-driven methods to pinpoint current and predict future high-risk pedestrian crash locations specific to Jacksonville and Calhoun County for targeted safety planning.

Assessing Contributory Factors

Beyond locating high-risk areas, GIS tools can assess the multifactorial conditions and elements contributing to pedestrian crashes across spatial contexts. Studies have evaluated built environment factors, including street width, traffic control devices, land use patterns, and pedestrian exposure measures derived through GIS analysis of routes and destinations (Pucher, 2023). For instance, the examination of urban form attributes such as street layout, intersection design, sidewalk quality, land use patterns, and pedestrian route connectivity around schools guided tailored infrastructure improvements to better protect child pedestrians (Rothman et al., 2019). In addition, GPS tracking has emerged as an innovative data source, enabling the quantification of pedestrian volumes and risk exposure levels across the street network through integration with roadway data in GIS (Jankowska, Schipperijn, & Kerr, 2015).

Demographic characteristics linked to elevated pedestrian crash risk have been analyzed using spatially coded census data. Socioeconomic attributes, such as lower household income or limited vehicle access, can contribute to increased pedestrian exposure, as residents might rely more heavily on walking or public transit, thus elevating their likelihood of collisions. Such insights help direct education and enforcement activities toward disadvantaged neighborhoods (Cottrill & Thakuriah, 2010). Research has also shown that neighborhood context, including factors such as crime rates, socioeconomic status, availability and quality of pedestrian infrastructure, and community engagement, significantly influences community safety and infrastructure quality. These factors collectively shape mobility and accessibility, thereby affecting pedestrian safety in urban settings (Ruiz, McMahon, & Jason, 2018). Recent studies also emphasize the role of behavioral and temporal patterns such as device usage while walking, and time-of-day variations in traffic exposure in shaping pedestrian risk perception and crash likelihood (Hatfield & Murphy, 2007).

Guiding Interventions

Leveraging GIS pedestrian crash analyses, researchers have developed location-specific countermeasures and multifaceted intervention plans tailored to community contexts across the country. In New Jersey, individually prioritized infrastructure strategies for high-crash intersections incorporated treatments such as pedestrian hybrid beacons, reader-activated warning signage, refuge islands, and pavement markings (Zegeer et al., 2017). Child pedestrian safety programs guided by spatial modelling around schools have encompassed enforcement activities, educational workshops with parents, and infrastructure enhancements for designated safe routes (Rothman et al., 2019). Additionally, comprehensive plans integrate land use policy changes, complete street redesigns, targeted law enforcement stings, and public awareness campaigns (Xu et al., 2023).

To enable participatory decision-making and to build community buy-in, geospatial pedestrian safety tools have engaged residents through interactive maps and safety audits of high-crash neighborhoods (Hosking et al., 2013). Public health researchers have mapped sociodemographic factors to identify disadvantaged groups for inclusion in educational interventions (Grise, 2015). Furthermore, the integration of pedestrian volume data with equity metrics using hot spot tools has ensured equitable prioritization for planning improvements (Griffin et al., 2019). The use of composite KDE overlay maps where crash data and community-reported survey surfaces intersect has recently emerged as a method to identify spatial agreement between perceived and recorded safety risks, helping planners prioritize critical zones for interventions (Pulugurtha & Sambhara, 2011). As GIS-based pedestrian safety research translates into real-world implementation, these community-focused approaches promote justice and generate a wide-ranging impact.

Future Research Directions

While substantial progress has occurred in applying GIS to pedestrian safety, additional research can enhance analytical capabilities and intervention delivery. As cities release open data on new mobility options, GIS systems incorporating e-scooter routes, bike share practices, and ride-hailing activity could reveal emerging risk patterns (Hoseinzadeh et al., 2020). Real-time data integration presents new possibilities to identify short-term crash factors like weather, special events, and construction projects (Ha, & Thill, 2011). Exploring predictive risk algorithms and interactive dashboards as decision support systems may further assist professionals in selecting and placing countermeasures (Fu, et al., 2019). Integrating spatial overlays with behavioral and temporal datasets is another emerging direction that enables nuanced analysis of when and why perceived risks intensify in specific zones (Ahola, Virrantaus, Krisp, & Hunter, 2007). Qualitative GIS techniques also offer promises for capturing community preferences, travel behaviors and perceived risk insights to guide socially responsible policies (Xu et al., 2023). Advancing and customizing geospatial tools can empower even more localized, equitable and effective pedestrian safety planning.

As pedestrian fatalities climb nationwide, GIS techniques have become invaluable for uncovering multifactorial spatial patterns, strategically allocating limited resources, and developing evidence-based solutions tailored to community contexts (Casale, 2022). By enabling data integration, hot spot analysis, spatial modelling and inclusive participatory planning, GIS provides a powerful framework for promoting pedestrian safety (Pucher, 2023). Continued research should build on documented successes in translating geospatial intelligence into infrastructure changes, enforcement activities, educational programs and holistic prevention initiatives that reverse troubling trends and work towards eliminating traffic-related pedestrian injuries and fatalities.

Methodology

This study employs a Geographic Information Systems (GIS)-based approach to analyze pedestrian safety risks around Jacksonville State University (JSU). By integrating geocoded vehicle crash data, pedestrian and driver perception surveys, and spatial analysis techniques, this research identifies high-risk pedestrian locations and informs targeted safety improvements. The methodology consists of data collection, spatial analysis, and risk assessment using ArcGIS Pro.

Collaboration with Authorities

Collaboration with the JSU Police Department facilitated access to geocoded vehicle crash records from 2021 to 2024. These records were incorporated into ArcGIS Pro for spatial hotspot analysis, enabling the identification of locations with high pedestrian-vehicle incidents.

Survey Approach

To supplement crash data, perception surveys were designed and distributed using ArcGIS Survey123 to collect responses from 111 pedestrians and 97 drivers, totaling 208 responses. The dissemination of the survey was facilitated through collaboration with the University Police Department and the Department of Public Safety, which helped distribute the survey link to students, faculty, and staff with parking permits or decals, as well as individuals commuting within the university vicinity. Additionally, professors assisted by sharing the survey link with their networks, and the researcher also reached out to friends and community members to further expand data collection.

Institutional Review Board (IRB) Approval:

Institutional Review Board (IRB) approval was sought and granted by Jacksonville State University before beginning this study. The researcher and supervisor completed mandatory IRB certification training courses on Social and Behavioral Research and Responsible Conduct of Research involving human subjects. Following training completion, all required documentation, including certification certificates, was submitted to JSU's IRB committee. After a comprehensive review process, formal approval was granted, allowing the official commencement of data collection in January 2025.

The survey aimed at capturing:

- Locations where respondents felt unsafe as pedestrians or drivers.
- The specific reasons for these concerns, such as poor lighting, speeding vehicles, inadequate crosswalks, or unclear signage.
- Socioeconomic, behavioral, and temporal variables including age, occupation, walking frequency, device use, and time of day.

Survey responses were geocoded and analyzed in ArcGIS Pro to map perceived pedestrian risk areas and assess trends in pedestrian and driver safety concerns. In addition, bar charts were generated to interpret and visualize these perception-based variables (Figures 9–14).

Data Collection and Analysis

Pedestrian Crash Data

- A total of 209 police-reported vehicle crash records (2021–2024) were collected from JSU authorities.
- Figure 1 illustrates the Kernel Density Estimation (KDE) analysis of geocoded crash incidents, highlighting statistically significant high-risk locations
- The results highlighted areas with frequent pedestrian-vehicle interactions, supporting a spatial understanding of pedestrian risks.

Survey Data

- Survey responses were geocoded and analyzed using KDE in ArcGIS Pro to determine high-risk areas as identified by pedestrians and drivers. KDE was applied to the perception survey data to identify high-density pedestrian safety concern zones for both pedestrians and drivers, as shown in Figures 2 and 3.
- The findings highlight locations where pedestrians and drivers frequently reported safety concerns.
- A KDE overlay was conducted to detect spatial coincidences where both pedestrian and driver perceptions aligned in the same high-risk zones. This helped identify critical overlapping hotspots.

GIS Analysis

Hotspot Identification

- KDE was used to generate spatial risk maps highlighting pedestrian safety hotspots.
- High-risk areas were identified, focusing on zones with the highest crash frequencies and locations were respondents frequently reported feeling unsafe.

Perceived Safety Risks

- Pedestrian and driver perception survey hotspots were mapped to visualize areas where respondents consistently reported pedestrian risks.
- This approach provides insights into community-reported safety concerns independent of officially recorded crash data, as shown in Figure 4.

- An interpolation overlay map (Figure 7) was created to visualize the convergence of risk perceptions between drivers and pedestrians using a color-coded scheme (green, Purple, red/yellow). Locations where both datasets overlapped were classified as shared concern zones.

Perception Based Chart Analysis

- Pie charts were generated to analyze and interpret behavioral and socioeconomic factors contributing to pedestrian safety perceptions. Charts analyzed crossing behavior, occupation, age group, device use, walking frequency, and time of day (Figures 9–13).
- The most prominent insights include a high perception of safety among daily walkers and students aged 18–24 and increased perceived safety during the morning and afternoon hours.
- Additional insights from Figure 14 examine driver-reported near-miss experiences with pedestrians, offering context to how past interactions may influence safety perception. This behavioral dimension provides critical input into understanding driver attentiveness and risk awareness in high-footfall areas.

Usage of GIS for the Study

This research utilizes ESRI ArcGIS Pro, a leading GIS software, to conduct a spatial analysis of pedestrian crash data and perception survey responses around Jacksonville, Alabama (ESRI, 2023). GIS enables data integration, visualization, modeling, and spatial analysis to uncover patterns, relationships, and trends in pedestrian safety (Mukherjee & Mitra, 2022).

Data Collection

This study integrates multiple data sources to analyze pedestrian safety around Jacksonville State University (JSU). Given the challenges in obtaining pedestrian crash records from law enforcement, the research methodology was adapted to incorporate vehicle crash data from police reports and a perception-based survey to assess pedestrian safety concerns (Pulugurtha & Sambhara, 2011).

Geocoded vehicle crash data from 2021 to 2024 were obtained from the Jacksonville State University Police Department, including information on the accident date and location/street. To supplement this data, perception surveys were conducted among pedestrians and drivers within a 1.5-mile radius of JSU. Prior to data collection, Institutional Review Board (IRB) approval was obtained from Jacksonville State University to ensure ethical compliance with human subject research protocols. A total of 111 pedestrians and 97 drivers participated in the survey, which was administered through the ArcGIS Survey123 mobile application. Survey questions focused on perceived safety risks and specific hazardous locations (Griffin & Jiao, 2019).

Both datasets were geocoded and analyzed in ArcGIS Pro to map subjective risk areas and compare them with crash data hotspots. This blended approach provides a comprehensive understanding of pedestrian safety concerns by combining officially reported crash incidents with user-reported experiences, ensuring a robust basis for spatial analysis and intervention planning.

Spatial Analysis

The hotspot analysis conducted in ArcGIS Pro revealed crash-prone locations based on official crash records, while the perception survey analysis provided insight into locations where pedestrians and drivers feel unsafe. Figure 6 provides a visual representation of one of the identified high-risk locations where vehicle crashes have been recorded. These findings highlight key high-risk areas, particularly near major intersections, high-traffic corridors, and campus access points as shown in figures 4 and 5. The interpolation map (Figure 7) further identifies locations where multiple datasets converge, signaling the most critical safety zones.

The spatial outputs serve as a foundation for prioritizing safety improvements in areas with documented crash histories and perceived pedestrian risk.

Further spatial relationships between crash data, infrastructure conditions, and survey responses will be explored in future analyses to assess how road design, speed limits, and lighting conditions contribute to pedestrian safety risks.

Significance of Study

This timely GIS research has the potential for considerable public impact through data-driven, localized pedestrian safety planning focused on Alabama's fastest-growing metropolitan area. Spatial analysis outcomes can provide a framework for community-supported infrastructure improvements, enforcement activities and educational initiatives associated with measurable reductions in pedestrian collisions. Context-specific recommendations moreover emphasize feasible, affordable solutions allowing rapid deployment to address urgent safety needs. By uniquely integrating objective-built environment data with participatory community insights, study findings aim to reverse adverse collision trends and eliminate preventable pedestrian fatalities in alignment with national Vision Zero goals (USDOT, 2022). Expanding collaborations across transportation agencies, first responders, research institutions, local leaders and neighborhood groups through participatory GIS techniques can further build momentum for sustainable change over the long term (Griffin et al., 2020). This investigation seeks to empower all stakeholders through geospatial intelligence, constructive dialogue, and purposeful coordination to advance pedestrian safety for Jacksonville and beyond. By combining pedestrian accident records with community input, this research aims to enhance pedestrian safety around

Jacksonville State University. The multi-approach GIS study will provide valuable insights to policymakers and engineers for implementing targeted interventions to mitigate safety risks and create safer environments for pedestrians. This revised project focuses specifically on JSU and its immediate surroundings, ensuring that interventions are tailored to the university's unique needs and challenges.

Results

Data Collection and Integration

This study integrates 209 geocoded vehicle crash records (2021–2024) and perception survey responses from 111 pedestrians and 97 drivers, for a total of 208 responses, to analyze pedestrian safety risks around Jacksonville State University (JSU). The vehicle crash data was obtained from the JSU Police Department, while perception survey responses were collected through ArcGIS Survey123 to identify locations where road users felt unsafe.

Both datasets were processed and mapped in ArcGIS Pro, using Kernel Density Estimation (KDE) to generate hotspot analyses for crash-prone locations and perception-based pedestrian risks. The KDE outputs visually highlight high-risk zones, which serve as the foundation for assessing pedestrian safety around JSU.

Hotspot Identification

The KDE analysis of vehicle crash data revealed three primary crash hotspots:

1. Pelham Road North & Jacksonville McDonald's Intersection (Figure 1)
2. Trustee Street & JSU Campus Area (Near New Dining Hall & Fitzpatrick Hall)

These areas exhibited the highest concentration of documented crash incidents, with Pelham Road North being the most affected corridor. The analysis showed that crashes were more concentrated near high-traffic intersections and roadways with frequent pedestrian movement. This is consistent with previous studies, which found that spatial epidemiology techniques, such as KDE, effectively identify high-risk pedestrian zones by analyzing hazard intensity in urban settings (Ha & Thill, 2011).

Similarly, the KDE analysis of perception survey responses identified areas where pedestrians and drivers frequently reported safety concerns. Pedestrian perception hotspots were observed at:

1. 4-Way Intersection at Nisbet St NW & Cardinal Ln NW (Figure 2)
2. Traffic Light at University Cir & Trustee St (Near Houston Cole Library)
3. Parking Lot behind Martin Hall

For the driver perception survey, the most critical pedestrian risk locations were:

1. Traffic Light at University Cir & Trustee St (Near Houston Cole Library) (Figure3)
2. 4-Way Intersection at Nisbet St NW & Cardinal Ln NW

Although pedestrian and driver perception hotspots partially aligned with police crash data hotspots, several additional locations emerged from the perception surveys where no reported crashes were documented. Notable examples include Trustee Circle near Mason Hall, behind Ayers Hall near Highway 204, in front of Merrill Hall, and the crosswalks leading to the basketball stadium. This highlights the value of perception-based data in capturing near-miss incidents and infrastructure concerns that are not represented in official police records.

Overlay of Combined Risk Zones

A composite KDE overlay (Figure 7) was created to visualize the spatial convergence of high-risk areas derived from all three data sources crash incidents, pedestrian surveys, and driver surveys. Two critical overlapping zones were identified:

- Zone 1 (JSU Main Pedestrian Crosswalk at the AL-204 and AL-21 Intersection): Identified as a Shared High-Risk Zone, this location was frequently noted by both pedestrians and drivers in the perception surveys as an area of concern, reflecting consistent reports of discomfort and perceived safety risks.

- Zone 2 (Crosswalk at University Circle and Trustee Street near Houston Cole Library): Also classified as a Shared High-Risk Zone, this crosswalk was commonly identified in both pedestrian and driver surveys as an area of elevated concern, indicating a strong overlap in perceived safety issues from multiple road users.

These zones were labeled on the composite map to emphasize convergence areas requiring immediate safety interventions.

Comparison of Crash Hotspots and Perception Based Risk Zones

The KDE results show both alignments and discrepancies between police crash data and perception-based safety concerns:

- Pelham Road North emerged as the highest-risk corridor in both crash data and pedestrian perceptions, indicating an urgent need for safety interventions.
- Perception-based hotspots at the 4-way intersection of Nisbet St NW & Cardinal Ln NW and University Cir & Trustee St (near Houston Cole Library) suggest safety concerns even though crash incidents were lower in these locations (Figures 4 and 5).
- Some crash-prone areas, such as William A. Meehan Hall & JSU Stadium, did not appear prominently in survey responses, suggesting that these locations may have sudden or unpredictable crash patterns rather than persistent pedestrian safety concerns.

These findings emphasize the need to incorporate both police crash records and perception survey insights to capture a comprehensive picture of pedestrian safety risks around JSU.

Spatial Analysis of Pedestrian Risk Zones

Using ArcGIS Pro, Kernel Density Estimation (KDE) was applied separately to both crash data and perception survey responses to understand pedestrian risk concentration patterns. The analysis highlights:

- High pedestrian risk zones near major intersections and pedestrian-heavy areas on campus.
- Variability in driver and pedestrian perceptions of safety risks, with drivers identifying locations where pedestrian visibility is low, while pedestrians focused on infrastructure concerns like inadequate crosswalks and high-speed vehicle traffic.

Further spatial analysis is needed to quantify infrastructure-related risk factors, such as road width, lighting, and crosswalk conditions, which will be explored in subsequent research.

Perception Based Socioeconomic, Behavioral, and Temporal Analysis

Figures 9–14 present pie charts exploring relationships between safety perceptions on behavioral, socioeconomic and temporal analysis:

- Age Group (Figure 9): Pedestrians aged 18–24 accounted for the largest share of safety perception at 75%, indicating a strong sense of safety among this younger group. Similarly, drivers within the 18–24 age group also dominated their category at 73%. Other age brackets (25–34, 35–44, 45 and above, and under 18) reported relatively lower safety perceptions in both surveys, with slight differences in distribution. This alignment suggests that younger individuals generally report higher perceived safety, whether walking or driving.
- Occupation (Figure 10): Students consistently reported the highest perception of safety across both groups, with 85% among pedestrians and 80% among drivers. Faculty

responses accounted for 11% in both pedestrian and driver surveys, while staff contributed 4% on the pedestrian side and 7% on the driver side. The close alignment highlights students as the most confident group regarding safety, possibly due to familiarity with the campus environment.

- Time of Day (Figure 11): For pedestrians, morning walks were perceived as safest (42%), followed by afternoon (26%), night (19%), and evening (13%). Among drivers, perception of safety peaked in the morning as well (50%), with afternoon close behind (48%), and a small drop at night (2%). This consistency across both groups suggests that visibility and traffic volume during morning hours may play a role in enhancing perceived safety.

- Figure 12: Perception of Safety by Device Use (Pedestrians) and Near-Miss Experience (Drivers): Figure 12 illustrates how safety perceptions vary among pedestrians based on device usage during walking, and among drivers based on their history of near-miss encounters. Among pedestrians, 48% reported frequently using a device while walking, followed by 24% who rarely used one, 16% occasionally, and 12% who never used any device. The prevalence of frequent device use suggests a potential distraction risk that could influence safety perception and actual behavior in traffic environments.

On the driver's side, the chart shows that 73% had not experienced a near-miss, while 27% had encountered one. This contrast reflects how personal experience can shape risk perception. Drivers without a near-miss may perceive their environment as safer, possibly underestimating hidden risks, whereas those with prior close calls may be more aware and cautious. Together, these insights reveal that both distraction among pedestrians and incident history among drivers play crucial roles in shaping perceived safety, emphasizing the need for targeted safety awareness efforts for each group.

Figure 13: Walking Frequency Distribution and Driver Safety Perception: The comparison of walking frequency between pedestrians and drivers reveals a shared dominance of daily walkers. Among pedestrians, 75% reported walking daily, followed by 22% who walk rarely, and 3% who walk occasionally. Similarly, on the driver side, 74% indicated they walk daily, 21% a few times a week, 2% occasionally, and 3% rarely. This similarity in walking habits suggests a strong overlap in the population that both walks and drives frequently, which may influence their perspectives on safety. While the pedestrian chart emphasizes the “rarely” category more distinctly than drivers, both groups largely comprise individuals with regular walking exposure, potentially making their safety concerns more informed by direct experience.

Figure 14: Perception of Pedestrian Safety by Crossing Behavior: Figure 14 presents pedestrian safety perception in relation to crossing behavior. A significant 63% of respondents indicated they crossed safely, while 28% selected “other,” suggesting ambiguity or alternative crossing patterns, and 9% reported not crossing safely.

This result emphasizes that although a majority perceive themselves as safe crossers, over one-third engage in unsafe or undefined crossing behaviors. The presence of 28% under “other” may point to irregular patterns such as jaywalking or crossing midblock, which potentially increases risk. These findings reinforce the need for targeted awareness campaigns and improved crossing infrastructure to encourage safer pedestrian practices.

Findings and Implications

The integration of hotspot analysis and perception-based assessments has helped identify key pedestrian safety risk zones around Jacksonville State University (JSU). These findings inform targeted interventions and underscore the importance of including both crash records and perception data for a comprehensive safety evaluation. Based on the spatial and survey results, the following recommendations are proposed:

- Pelham Road North Corridor: This remains the most prominent crash concentration zone, consistently identified through KDE and hotspot analysis. Recommended interventions include enhanced crosswalk visibility, pedestrian refuge islands, and potential speed limit enforcement during peak pedestrian hours.
- AL-204 & AL-21 Intersection (Main JSU Pedestrian Crosswalk): Identified as Zone 1 in the composite KDE overlay map, this area was consistently reported in both pedestrian and driver perception surveys as a high-risk crossing location. Though not reflected as a crash hotspot, its prominence in community feedback suggests a need for improved crossing design, such as flashing pedestrian beacons and extended signal times.
- University Circle & Trustee Street (Near Houston Cole Library): Marked as Zone 2, this crosswalk emerged as another high-perception risk area. Although it lacks significant crash history, its overlap in both driver and pedestrian datasets highlights the importance of proactive infrastructure upgrades, including lighting improvements and pedestrian right-of-way signage.
- Mountain Street & Church Avenue Area: Frequently mentioned in the perception surveys as a concern, this location did not register as a crash hotspot but reflects recurring near-miss experiences. Suggested improvements include pedestrian signage, road narrowing, and visibility enhancements.
- Forney Hall Vicinity (Across from JSU Stadium): Another perception-identified location with limited crash data but notable concern from survey respondents. Engineering

measures such as curb extensions or pavement markings may help reinforce pedestrian priority in this zone.

These findings demonstrate that perception-based data captures crucial near-miss incidents and infrastructure shortcomings often absent from official crash records. Integrating spatial and community-reported data supports more responsive, evidence-informed pedestrian safety planning at JSU.

Discussion

This study applied a GIS-based spatial analysis framework to evaluate pedestrian safety risks around Jacksonville State University (JSU), integrating 209 police-reported crash records (2021–2024) with 208 geocoded perception survey responses from both pedestrians and drivers. Kernel Density Estimation (KDE) in ArcGIS Pro was used to generate hotspot maps for both datasets, helping to identify spatially significant high-risk areas, as well as overlap zones where community-reported safety concerns coincided with recorded crash locations.

The findings illustrate both convergence and divergence between official crash records and user-reported experiences. While Pelham Road North emerged as a critical corridor in both datasets, other locations such as the 4-way intersection at Nisbet Street NW and Cardinal Lane NW and the traffic light near University Circle and Trustee Street were flagged more prominently in perception data. These discrepancies suggest that perceived danger is often rooted in near-miss incidents, infrastructure issues, or unrecorded encounters, emphasizing the need to incorporate perception data alongside historical crash reports. This observation reinforces previous research, which underscores the limitations of relying solely on police records for pedestrian safety assessments (Cottrill & Thakuriah, 2010).

Hotspot mapping also highlighted that risk zones often clustered near major intersections, corridors with high pedestrian traffic, and campus access points patterns that align with studies noting the relationship between pedestrian activity and crash intensity in areas with inadequate infrastructure (Pulugurtha & Sambhara, 2011). For instance, visibility-related complaints at crossings like University Circle and Trustee Street and speeding vehicles along Pelham Road North were frequently cited in the surveys. These align with literature emphasizing how infrastructure deficiencies such as poor lighting, lack of clear crosswalks, or unclear signage increase pedestrian vulnerability (Ziółkowski et al., 2024; Bullough et al., 2013).

An important advancement in this study was the incorporation of socioeconomic, behavioral, and temporal survey variables into the analysis. This included exploring how age, occupation, walking frequency, device use, and time of day influenced safety perceptions. Findings from this multi-dimensional dataset revealed that students aged 18–24 and individuals who walked daily perceived the highest risks. Notably, safety concerns peaked in the evening and nighttime hours when lighting conditions and visibility tend to decline—an important consideration for campus planning and traffic regulation.

The overlay analysis of pedestrian and driver KDE maps enabled the identification of converging zones where both groups flagged similar locations as unsafe. These intersections of perceived risk add a new layer of urgency and provide robust justification for targeted safety interventions in those areas. The qualitative data also supported this, with several respondents indicating repeated close calls, discomfort navigating specific intersections, or confusion regarding pedestrian right-of-way at signalized crossings. This level of convergence between datasets further validates the need for data-informed planning strategies (Mukherjee & Mitra, 2022).

Beyond spatial and behavioral insights, the study highlights the broader health and sustainability benefits of safe pedestrian infrastructure. Enhanced walkability contributes to improved public health, reduces dependence on automobiles, and supports more vibrant, connected urban communities (Pucher, 2023). These co-benefits make pedestrian safety an essential element of comprehensive urban and transportation planning.

Implementing GIS-based pedestrian safety assessments as demonstrated in this study allows for precision in prioritizing interventions, especially in environments with limited resources. The spatially explicit identification of high-risk zones supports the strategic allocation of infrastructure improvements and policy measures, particularly around schools, campuses, and residential neighborhoods.

While the research successfully mapped risk zones and revealed behavioral patterns, several limitations must be acknowledged. The analysis did not yet incorporate detailed built environment variables, such as road width, traffic control devices, and land use types, which are known to influence pedestrian crash risk (Chen & Shen, 2016). Integrating these elements could deepen the understanding of underlying causes and help develop even more targeted interventions.

Additionally, while overlay comparisons between crash data and perception maps were performed qualitatively, future analysis could benefit from quantitative statistical measures (e.g., spatial correlation coefficients) to better assess the degree of alignment. Further geostatistical modeling could help quantify how much perceptions predict crash densities or vice versa.

A broader geographic focus including areas beyond the 1.5-mile JSU radius and a longitudinal approach that assesses changes in pedestrian risk over time following interventions would offer valuable extensions of this work. Comparative studies across multiple campuses could also yield insights into how local design and policy contexts influence pedestrian safety outcomes.

Low-Cost Solutions

Short-term infrastructure improvements prioritized through this analysis can facilitate rapid safety enhancements for the most urgent hot spots. Based on similar implementations evaluated through the Federal Highway Administration's proven safety countermeasures initiative, potential treatments include high-visibility continental or ladder-style crosswalk markings, pedestrian crossing and yield signage, W11-2 in-street yield signs, pedestrian warning beacons, minor signal timing adjustments, lighting improvements, and targeted police enforcement efforts (FHWA, 2022). The 2023 FHWA update further emphasizes the importance of integrating pedestrian hybrid beacons, raised crosswalks, and leading pedestrian intervals as additional measures to reduce pedestrian-vehicle conflicts and improve pedestrian visibility at intersections (FHWA, 2023). These affordable, rapidly implementable treatments can facilitate immediate pedestrian crash reductions while longer-term capital improvement projects are planned.

Conclusion

This research evaluated pedestrian safety conditions around Jacksonville State University (JSU) through a combination of spatial analysis, crash data interpretation, and perception-based survey inputs. By integrating 209 officially reported crash incidents with 208 survey responses from pedestrians and drivers, the study used GIS tools to identify critical areas of safety concern and understand the underlying behavioral and infrastructural factors contributing to pedestrian vulnerability.

Spatial analysis using Kernel Density Estimation (KDE) revealed high concentrations of crash incidents along Pelham Road North, Trustee Street, and near Meehan Hall. These locations emerged as recurring sites of pedestrian-vehicle interaction and were supported by perception survey data that highlighted additional zones of discomfort and concern, such as the 4-way intersection at Nisbet Street NW and Cardinal Lane NW, and the traffic light at University Circle and Trustee Street by Houston Cole Library. These perception-based hotspots often extended beyond the zones captured in police data, suggesting that road users are aware of hazards not officially documented, including near misses and discomfort caused by design limitations.

In addition to spatial patterns, the study examined demographic and behavioral variables influencing perceived risk. Charts generated from survey responses indicated that individuals aged 18 to 24, frequent walkers, and those traveling during evening hours expressed heightened safety concerns. Crossing behaviors and device use patterns further clarified areas where pedestrians may be exposed to conflict with vehicular traffic. These insights add an important human dimension to the technical spatial analysis by highlighting who feels unsafe and when.

The overlay of crash KDE with pedestrian and driver perception maps allowed for the identification of shared hotspots, revealing specific locations where all three datasets aligned.

These overlapping areas, visually depicted through interpolation mapping, were classified as critical risk zones requiring immediate attention. Such convergence strengthens the case for targeted safety interventions in these zones.

The results suggest several practical responses. Measures like upgraded crosswalk markings, speed control features, and pedestrian-focused signage could be deployed to reduce conflict points. Collaboration between JSU, city planners, and transportation agencies is essential for the design and implementation of these improvements. In addition to addressing physical safety, the findings also support broader efforts to encourage walkability and support public health through safer mobility infrastructure.

While this research produced significant findings, it also presents opportunities for deeper investigation. Detailed infrastructure attributes such as lane width, lighting availability, signal phasing, and traffic volume were not included in this analysis but could provide valuable context for interpreting spatial risk patterns. Similarly, advanced statistical overlays and temporal studies could improve the precision of spatial alignment between perception-based and crash-based data.

Future research should extend to surrounding areas beyond the 1.5-mile radius and incorporate comparisons with similar university settings to generalize findings. Long-term monitoring could also help assess the impact of any implemented interventions and support the development of sustainable pedestrian safety plans.

In conclusion, this study offers a holistic framework for assessing pedestrian safety using GIS technology and community participation. The integration of crash records with survey-based insights enabled a more complete understanding of pedestrian safety concerns. These findings support the use of geospatial analysis in developing effective, context-sensitive strategies to reduce risk and improve pedestrian mobility around university campuses.

Future Research

Although this study provides a comprehensive spatial assessment of pedestrian safety around Jacksonville State University (JSU), several opportunities remain for expanding and deepening the analysis. By integrating crash data with perception-based insights and conducting spatial overlay through Kernel Density Estimation (KDE), this research highlights key areas of risk. However, the complexity of pedestrian safety calls for further exploration of the spatial, temporal, behavioral, and infrastructural dimensions influencing pedestrian vulnerability.

A critical next step involves refining the spatial comparison between crash locations and perception-based risk zones. While this research conducted an initial KDE overlay to visually examine alignment between datasets, future studies could apply statistical correlation techniques to measure the degree of spatial agreement. Quantifying where crash hotspots coincide with community-reported danger zones would help validate the importance of these locations and reinforce the urgency for intervention. In addition, further stratifying perception responses by time of day or season could shed light on when pedestrians feel most at risk, revealing patterns in safety perception that are not captured by crash records alone.

Future work should also incorporate roadway design and built environment attributes into the spatial analysis. Understanding how physical characteristics such as road width, crosswalk design, traffic signal timing, and lighting conditions influence crash likelihood and perception of risk could support more informed planning decisions. For example, assessing whether wider multilane roads without pedestrian refuge islands correlate with higher perception of risk or crash frequency would help isolate key infrastructural deficiencies. Nighttime visibility issues, especially at major intersections, should also be evaluated using lighting data or observational audits.

Another valuable direction lies in broadening the geographic scale of analysis. While this study focused on a 1.5 mile radius around JSU, pedestrian activity and risk extend into surrounding neighborhoods and commercial areas. Expanding the scope to include additional roads and intersections within Jacksonville could provide a fuller picture of pedestrian safety challenges across the city. Similarly, comparative research in other college towns of similar size could uncover shared challenges or unique risks that emerge in university centered environments. A longitudinal perspective, examining crash and perception trends over multiple years, would also help evaluate whether pedestrian safety is improving or deteriorating.

Further analysis of behavioral patterns is also warranted. This study introduced demographic and temporal variables through perception surveys but did not delve deeply into behaviors such as device use while walking, jaywalking, or compliance with crossing signals. On the driver side, future studies could explore behaviors like distracted driving, yielding habits, and speeding near campus zones. These insights could help explain the gap between perception and crash data, offering a more complete understanding of risk conditions from both road user perspectives.

Equally important is evaluating the effectiveness of safety interventions that may follow this study. Future research should conduct before and after assessments of crash counts and survey perceptions in areas where countermeasures are implemented. Observational studies could also monitor pedestrian and driver compliance with new infrastructure, such as crosswalk usage rates or reduced speeding. These evaluations will provide accountability and guide the refinement of future policies and investments.

Lastly, advancing participatory GIS tools for community engagement should be a core part of ongoing research. This study utilized ArcGIS Survey123 to collect pedestrian and driver perceptions, but future efforts could introduce real time, interactive tools that allow users to report hazards or near miss events directly onto digital maps. Community mapping workshops with local stakeholders including planners, students, faculty, and city officials could support collaborative analysis and decision making. Such participatory approaches ensure that safety strategies reflect both technical spatial data and lived pedestrian experiences.

As a whole, this research lays a strong foundation for understanding pedestrian safety at JSU. Future studies should continue to build upon these insights by incorporating additional data layers, engaging the community more deeply, and evaluating the impact of implemented interventions. Through continued spatial analysis, behavioral assessment, and participatory planning, meaningful improvements in pedestrian safety can be achieved not only at JSU but in similar urban university environments nationwide.

References

Alabama Department of Transportation. (2017). *Alabama statewide pedestrian safety study*. Alabama Department of Transportation. https://www.dot.state.al.us/programs/pdf/bicycleSafety/StatewidePlan.pdf

Ahola, T., Virrantaus, K., Krisp, J. M., & Hunter, G. J. (2007). A spatio-temporal population model to support risk assessment and damage analysis for decision-making. *International Journal of Geographical Information Science*, *21*(8), 935–953. https://doi.org/10.1080/13658810701349078

Bullough, J. D., Donnell, E. T., & Rea, M. S. (2013). *To illuminate or not to illuminate: Roadway lighting as it affects traffic safety at intersections.* Accident Analysis & Prevention, *53*, 65–77. https://www.sciencedirect.com/science/article/pii/S0001457512004514

Calhoun Journal. (2024, January 8). *ALDOT unveils pedestrian safety enhancements for Jacksonville State campus and downtown Jacksonville.* Calhoun Journal. Retrieved from https://calhounjournal.com/aldot-unveils-pedestrian-safety-enhancements-for-jacksonville-state-campus-and-downtown-jacksonville/

Casale, M., & U.S. Public Interest Research Group Education Fund. (2022). *Highway boondoggles 7.* https://publicinterestnetwork.org/wp-content/uploads/2022/09/Highway-Boondoggles-7.pdf

Chen, P., & Shen, Q. (2016). *Built environment effects on cyclist injury severity in automobile-involved bicycle crashes.* Accident Analysis & Prevention, *86*, 239–246. https://www.sciencedirect.com/science/article/pii/S0001457515301184

Cottrill, C. D., & Thakuriah, P. V. (2010). *Evaluating pedestrian crashes in areas with high low-income or minority populations.* Accident Analysis & Prevention, *42*(6), 1718–1728. https://www.sciencedirect.com/science/article/pii/S0001457510002173

Esri. (2023). *ArcGIS Pro: Features and capabilities*. Environmental Systems Research Institute. https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview

Federal Highway Administration (FHWA). (2022). *Proven safety countermeasures—Pedestrians.* U.S. Department of Transportation. https://safety.fhwa.dot.gov/provencountermeasures/

Federal Highway Administration (FHWA). (2023). *Proven safety countermeasures update memorandum.* U.S. Department of Transportation. https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa17100/psm_memo.cfm

Fu, T. (2019). *A novel approach to investigate pedestrian safety in non-signalized crosswalk environments and related treatments using trajectory data* (Master's thesis, McGill University, Canada). ProQuest Dissertations & Theses Global. https://search.proquest.com/openview/405853519e39f7b2992aff1677919fc9/1?pq-origsite=gscholar&cbl=44156

Griffin, G. P., & Jiao, J. (2019). *The geography and equity of crowdsourced public participation for active transportation planning.* Transportation Research Record, *2673*(1), 460–468. https://doi.org/10.1177/0361198118823498

Grise, E. (2015). *A spatial analysis of pedestrian injury in the city of Toronto* (Master's thesis, University of Toronto, Canada). ProQuest Dissertations & Theses Global.

https://search.proquest.com/openview/82fb2823c28a137daae95c6e354c21ec/1?pq-origsite=gscholar&cbl=18750

Ha, H. H., & Thill, J. C. (2011). *Analysis of traffic hazard intensity: A spatial epidemiology case study of urban pedestrians.* Computers, Environment and Urban Systems, *35*(3), 230–240. https://www.sciencedirect.com/science/article/pii/S0198971511000020

Hatfield, J., & Murphy, S. (2007). The effects of mobile phone use on pedestrian crossing behaviour at signalized and unsignalized intersections. *Accident Analysis & Prevention*, *39*(1), 197–205. https://doi.org/10.1016/j.aap.2006.07.001

Hoseinzadeh, N., Arvin, R., Khattak, A. J., & Han, L. D. (2020). Integrating safety and mobility for pathfinding using big data generated by connected vehicles. *Journal of Intelligent Transportation Systems*, *24*(4), 404–420. https://doi.org/10.1080/15472450.2019.1699077

Hosking, J., Ameratunga, S., Exeter, D., Stewart, J., & Bell, A. (2013). *Ethnic, socioeconomic and geographical inequalities in road traffic injury rates in the Auckland region. Australian and New Zealand Journal of Public Health*, *37*(2), 162–167. https://www.sciencedirect.com/science/article/pii/S1326020023005861

Iroz-Elardo, N., Schoner, J., Fox, E. H., Brookes, A., & Frank, L. D. (2020). *Active travel and social justice: Addressing disparities and promoting health equity through a novel approach to regional transportation planning. Social Science & Medicine*, *261*, 113211. https://www.sciencedirect.com/science/article/pii/S0277953620304305

Jankowska, M. M., Schipperijn, J., & Kerr, J. (2015). A framework for using GPS data in physical activity and sedentary behavior studies. *Exercise and Sport Sciences Reviews*, *43*(1), 48–56. https://doi.org/10.1249/JES.0000000000000035

King, M. R. (2000). *Calming New York City intersections.* In *Transportation Research Circular E-C019: Urban Street Symposium*. Transportation Research Board. https://onlinepubs.trb.org/Onlinepubs/circulars/ec019/Ec019_i3.pdf

Mukherjee, D., & Mitra, S. (2022). *Pedestrian safety analysis of urban intersections in Kolkata, India using a combined proactive and reactive approach.* Journal of Transportation Safety & Security, *14*(5), 754–795. https://doi.org/10.1080/19439962.2020.1818907

National Highway Traffic Safety Administration. (2020). *Pedestrians: 2019 data* (Traffic Safety Facts. Report No. DOT HS 813 024). U.S. Department of Transportation. https://crashstats.nhtsa.dot.gov/Api/Public/Publication/813079

National Highway Traffic Safety Administration. (2021). *CrashStats - NHTSA - DOT - Department of Transportation.* U.S. Department of Transportation. https://crashstats.nhtsa.dot.gov/

Park, S. H., & Bae, M. K. (2020). Exploring the determinants of the severity of pedestrian injuries by pedestrian age: A case study of Daegu Metropolitan City, South Korea. *International Journal of Environmental Research and Public Health*, *17*(7), 2358. https://doi.org/10.3390/ijerph17072358

Pucher, J. (2023). *Promoting safe walking and cycling to improve public health.* https://pdfs.semanticscholar.org/3858/84ff6acd0703e2304343249521a2f802b98e.pdf

Pulugurtha, S. S., & Sambhara, V. R. (2011). *Pedestrian crash estimation models for signalized intersections.* Accident Analysis & Prevention, *43*, 439–446. https://doi.org/10.1016/j.aap.2010.09.011

Retting, R. (2017). *Pedestrian traffic fatalities by state.* Governors Highway Safety Association. http://www.keepoaklandmoving.com/wp-content/uploads/2018/03/pedestrians_18.pdf

Rothman, L., Howard, A., Camden, A., & Macarthur, C. (2019). *Pedestrian crossing location influences injury severity in urban areas. Traffic Injury Prevention, 20*(4), 384–389. https://injuryprevention.bmj.com/content/18/6/365.short

Ruiz, L. D., McMahon, S. D., & Jason, L. A. (2018). *The role of neighborhood context and school climate in school-level academic achievement. American Journal of Community Psychology*, *61*(3–4), 296–309. https://onlinelibrary.wiley.com/doi/abs/10.1002/ajcp.12234

Stankov, I., Garcia, L. M., Mascolli, M. A., Montes, F., Meisel, J. D., Gouveia, N., … & Roux, A. V. D. (2020). *A systematic review of empirical and simulation studies evaluating the health impact of transportation interventions.* Environmental Research, *186*, 109519. https://doi.org/10.1016/j.envres.2020.109519

U.S. Department of Transportation. (2022). *National roadway safety strategy.* https://www.transportation.gov/NRSS

Xu, Z., Zheng, N., Logan, D. B., & Vu, H. L. (2023). *Assessing bicycle-vehicle conflicts at urban intersections utilizing a VR integrated simulation approach.* Accident Analysis & Prevention, *191*, 107194. https://doi.org/10.1016/j.aap.2023.107194

Zegeer, C. V., Sandt, L., Scully, M., Ronkin, M., Cynecki, M., & Lagerwey, P. (2017). *How to develop a pedestrian safety action plan* (Final report No. FHWA-SA-17-072). Federal Highway Administration. http://www.pedbikeinfo.org/pdf/webinar_psap_051811_3.pdf

Ziółkowski, R., Pérez-Acebo, H., Gonzalo-Orden, H., & Linares-Unamunzaga, A. (2024). *Changes in safety performance on single-carriageway roads after installation of additional lighting at pedestrian crossings.* Land, *13*(12), 2134. https://doi.org/10.3390/land13122134

Appendices

Figure 1: Kernel Density Analysis of Vehicle Crash Hotspot

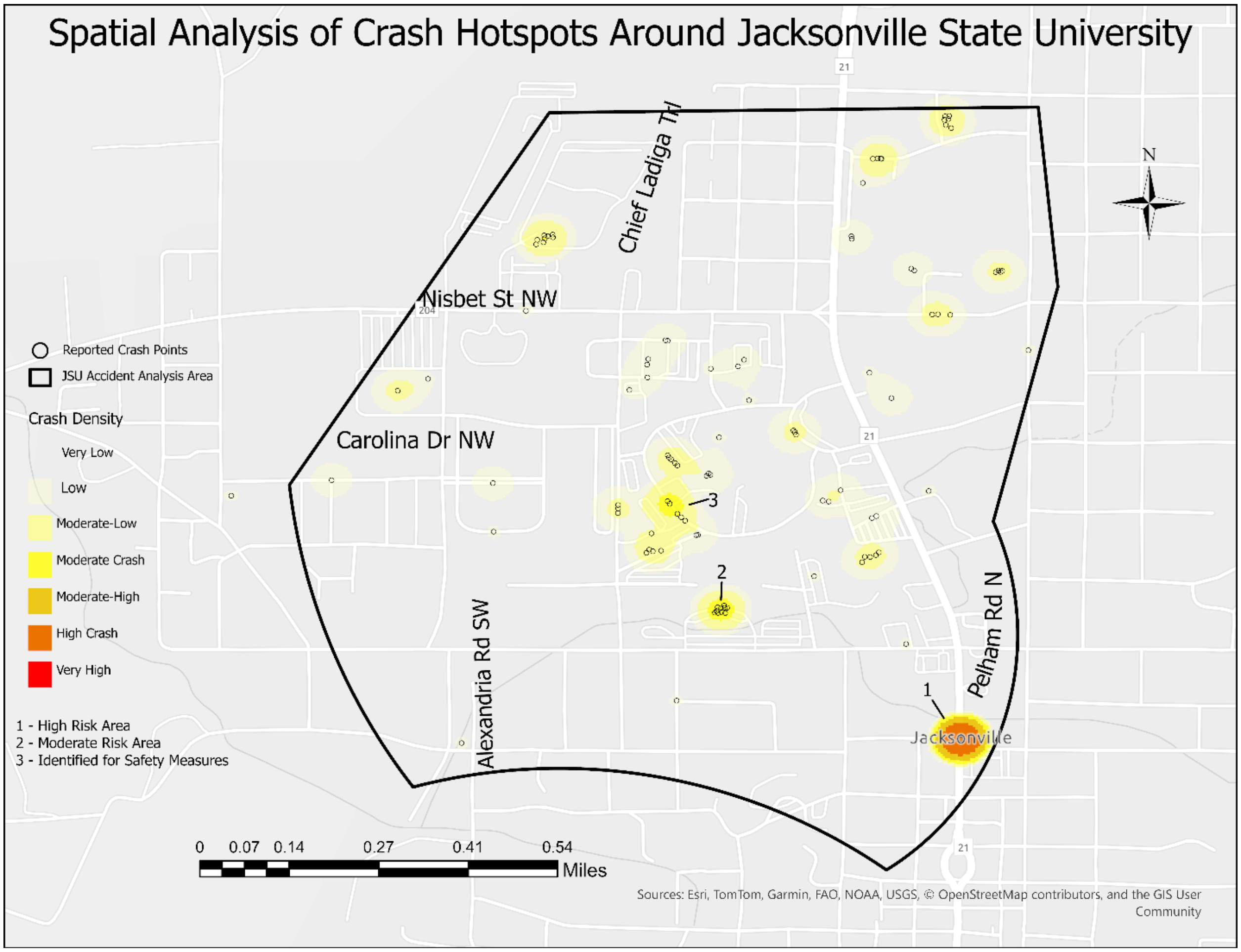


Figure 2: Pedestrian Perception Survey Heatmap

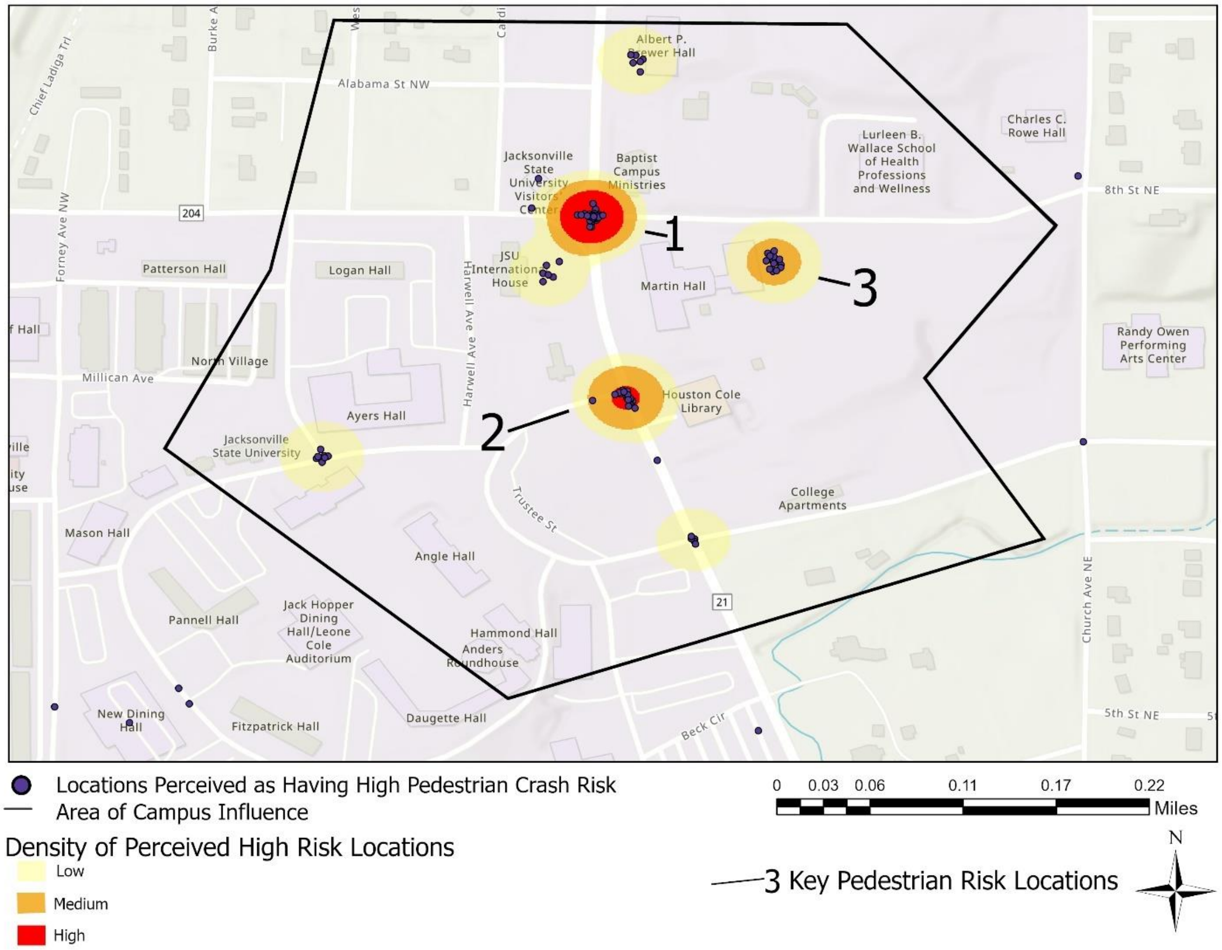


Figure 3: Driver Perception Survey Hotspot Map

Figure 4: Hotspot Location for Pedestrian Perception Survey

Nisbet Street NW & Cardinal Lane NW

Figure 5: Hotspot Locations for Driver Perception Survey

University Circle & Trustee Street (near Houston Cole Library)

Figure 6: Identified Location for Vehicle Crash Record

Pelham Road North AL 21

Figure 7: Overlay of KDE Surfaces from Crash, Pedestrian, and Driver Survey Data

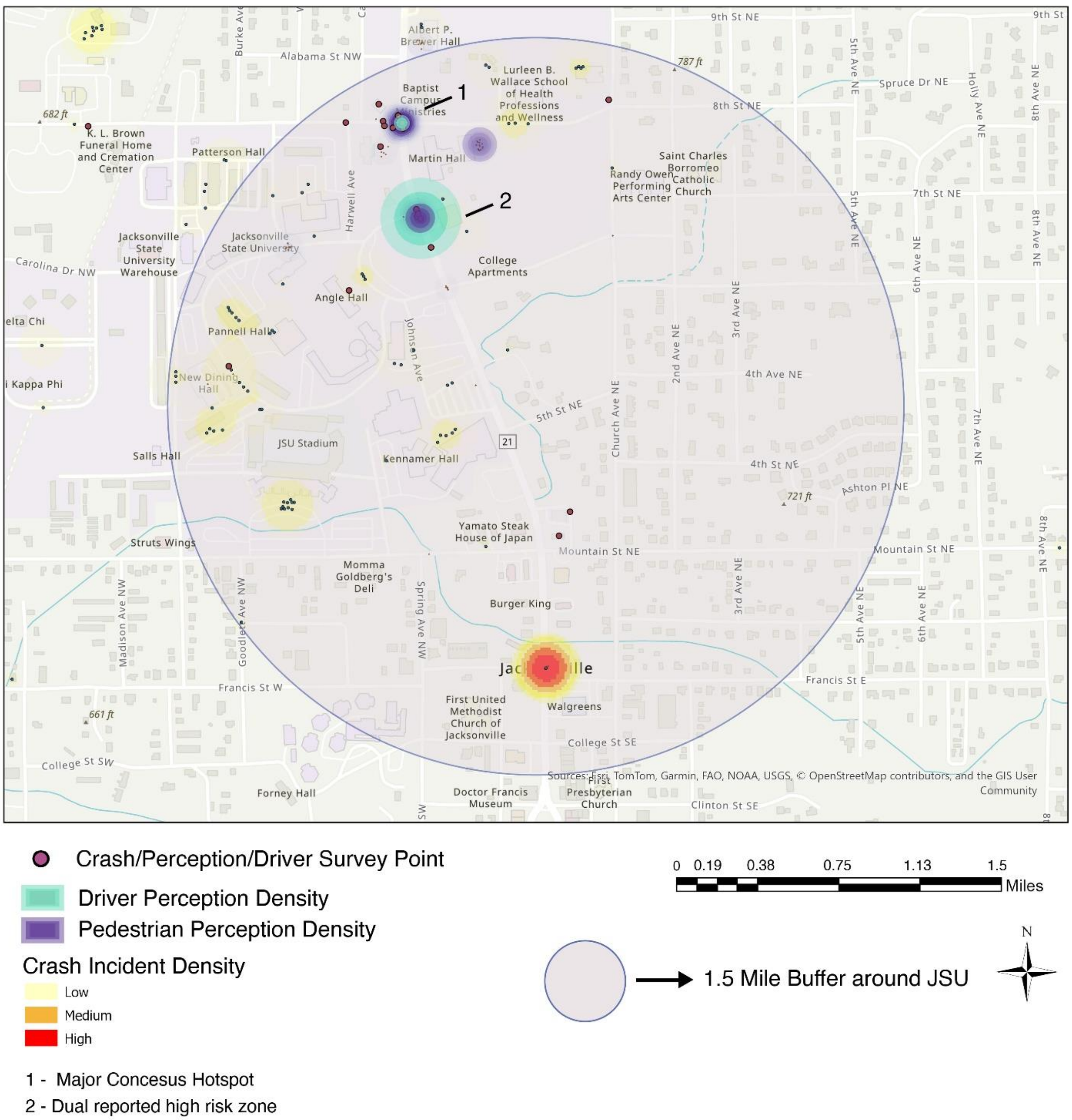
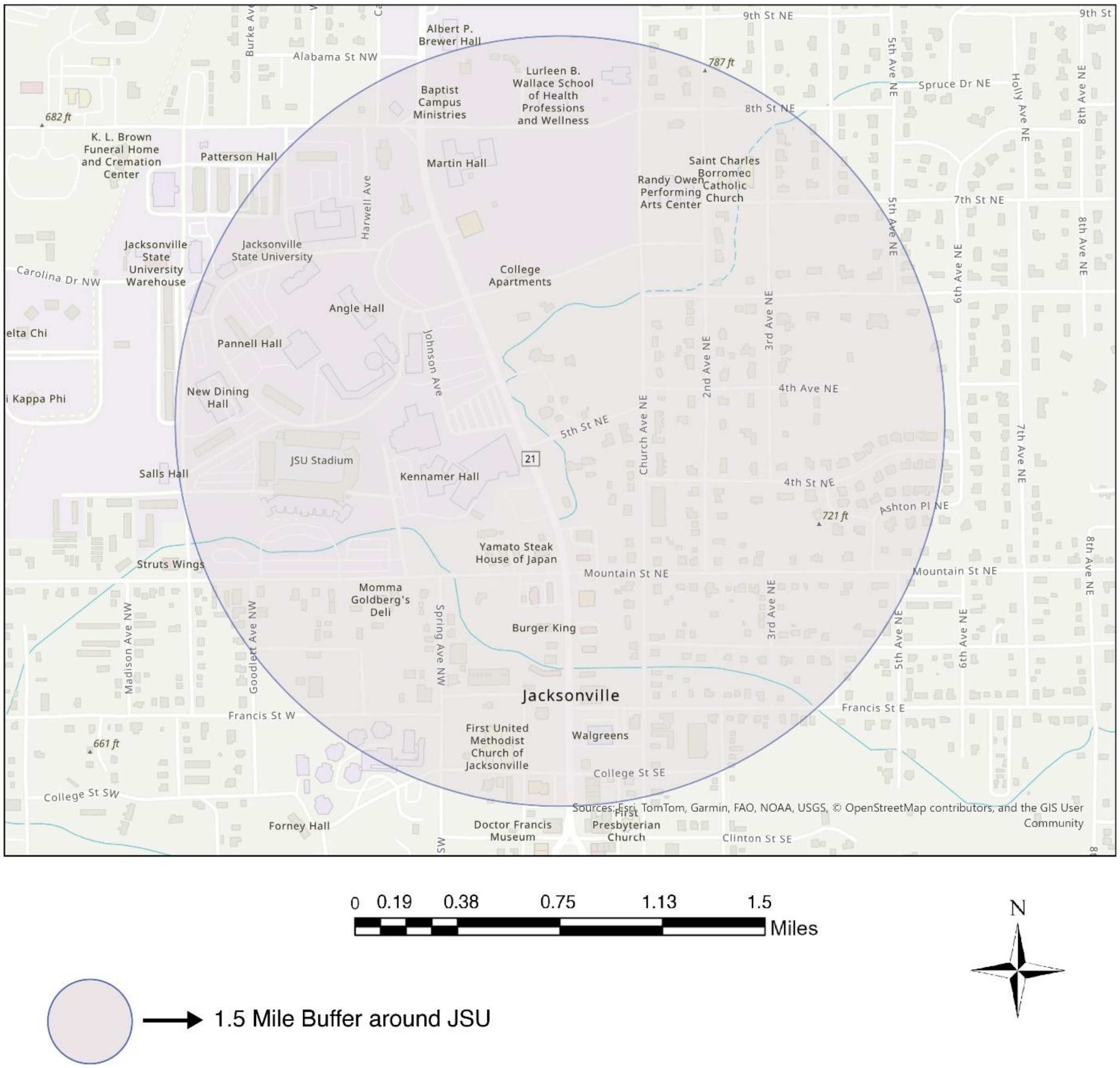
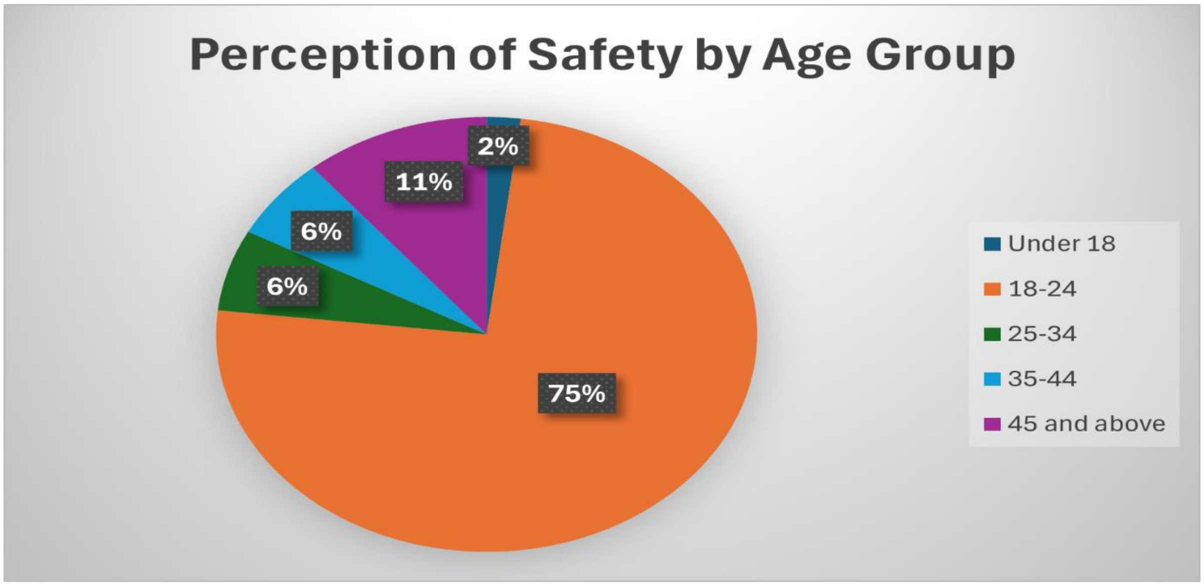


Figure 8: Study Area Map: 1.5-Mile Radius Around Jacksonville State University



Socioeconomic, Behavioral, and Temporal Analysis of Crash and Survey Data

Figure 9: Pedestrian and Driver Perception Survey for Age Group



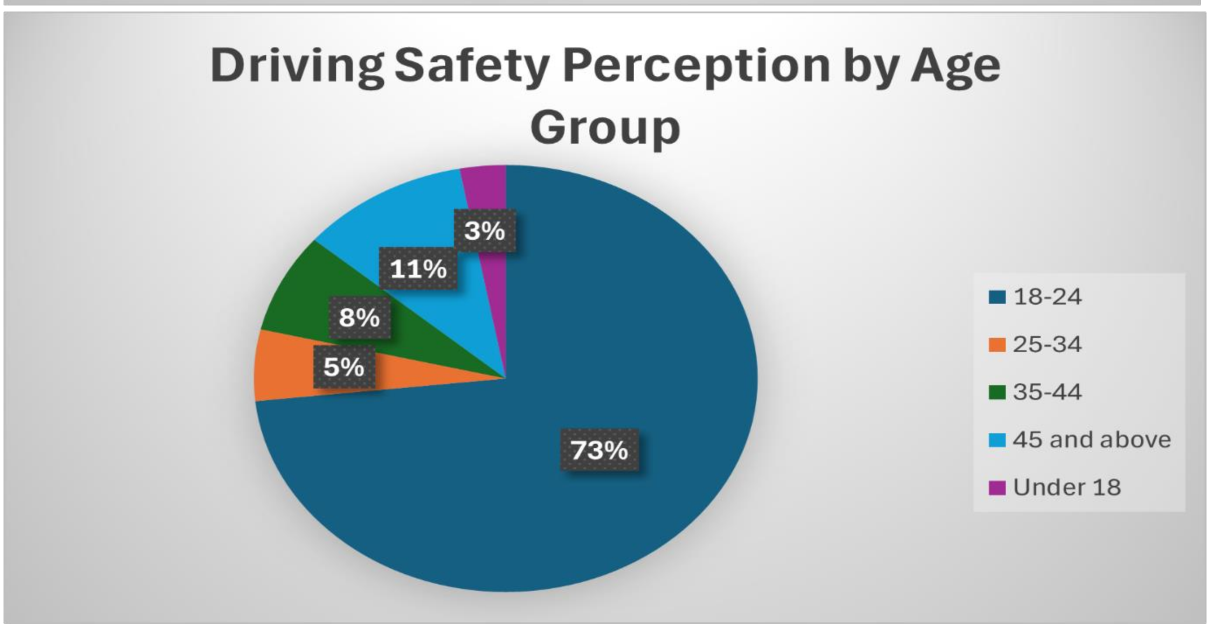
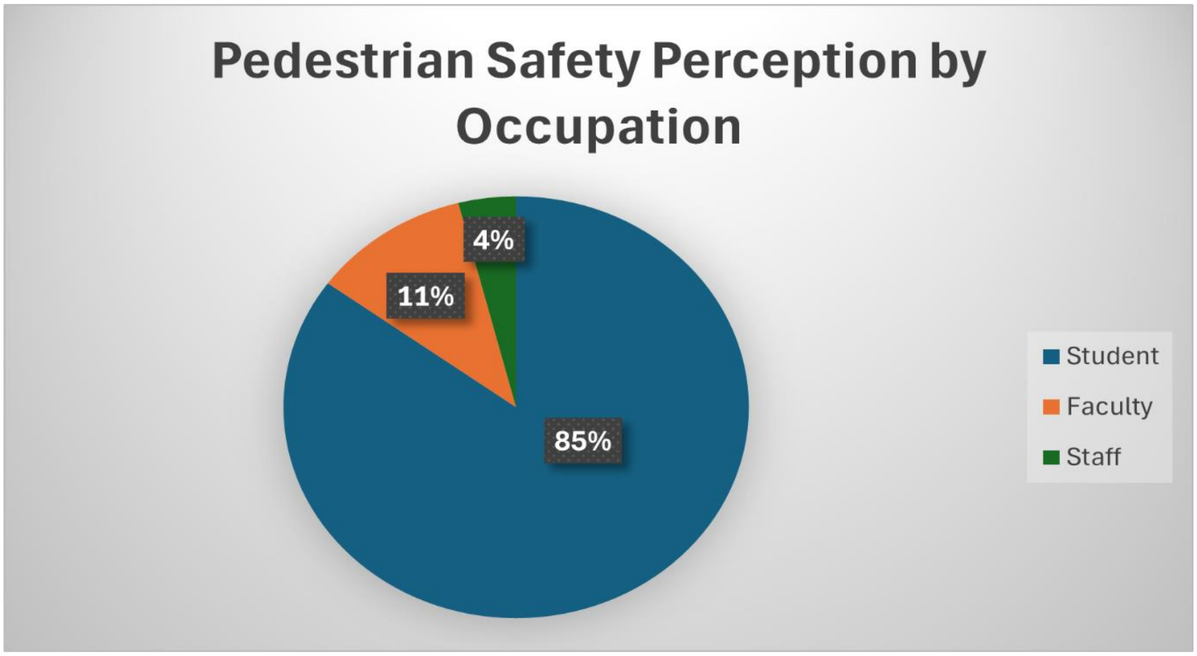


Figure 10: Pedestrian and Driver Safety Perception Chart for Occupation



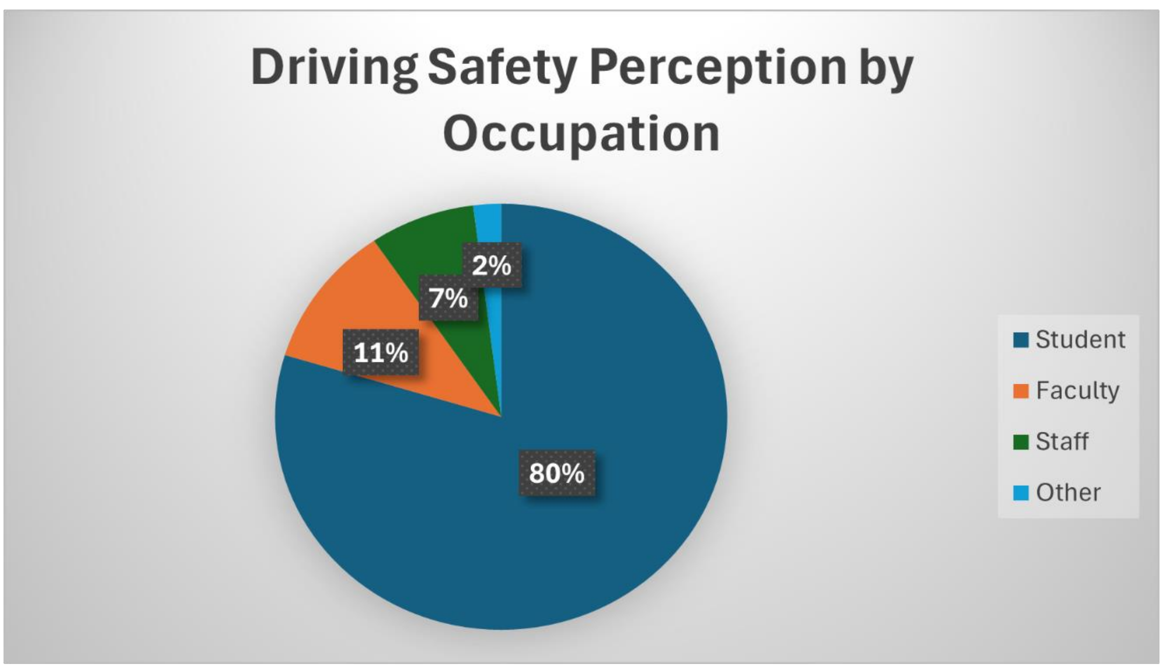
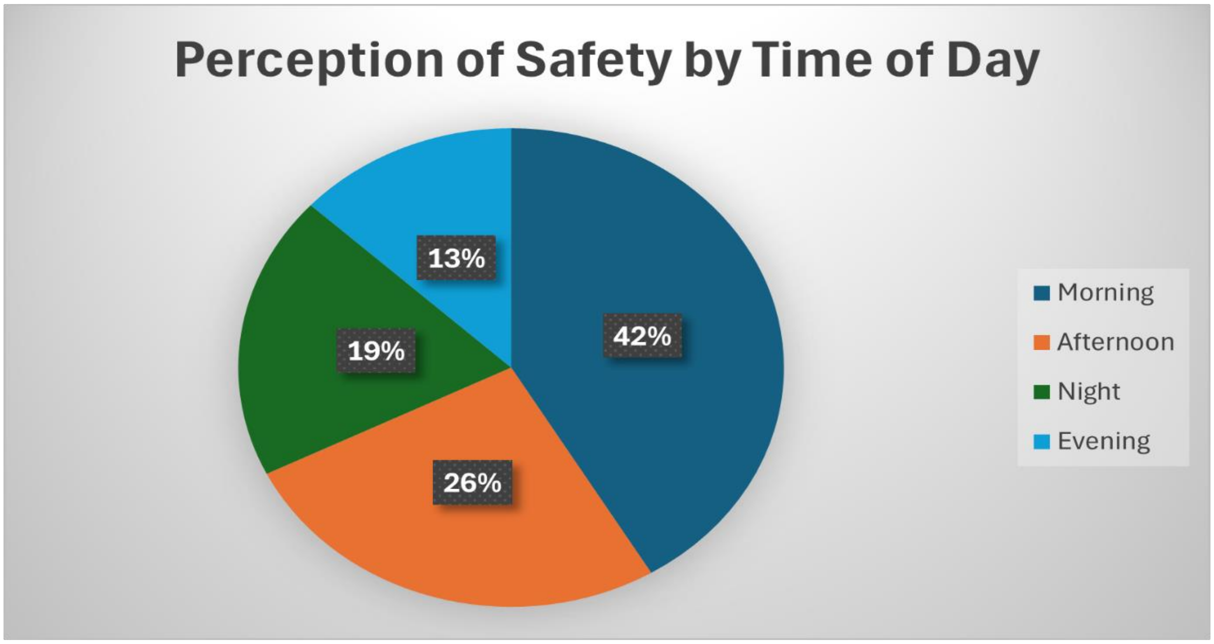


Figure 11: Pedestrian Safety Perception by Time of the Day



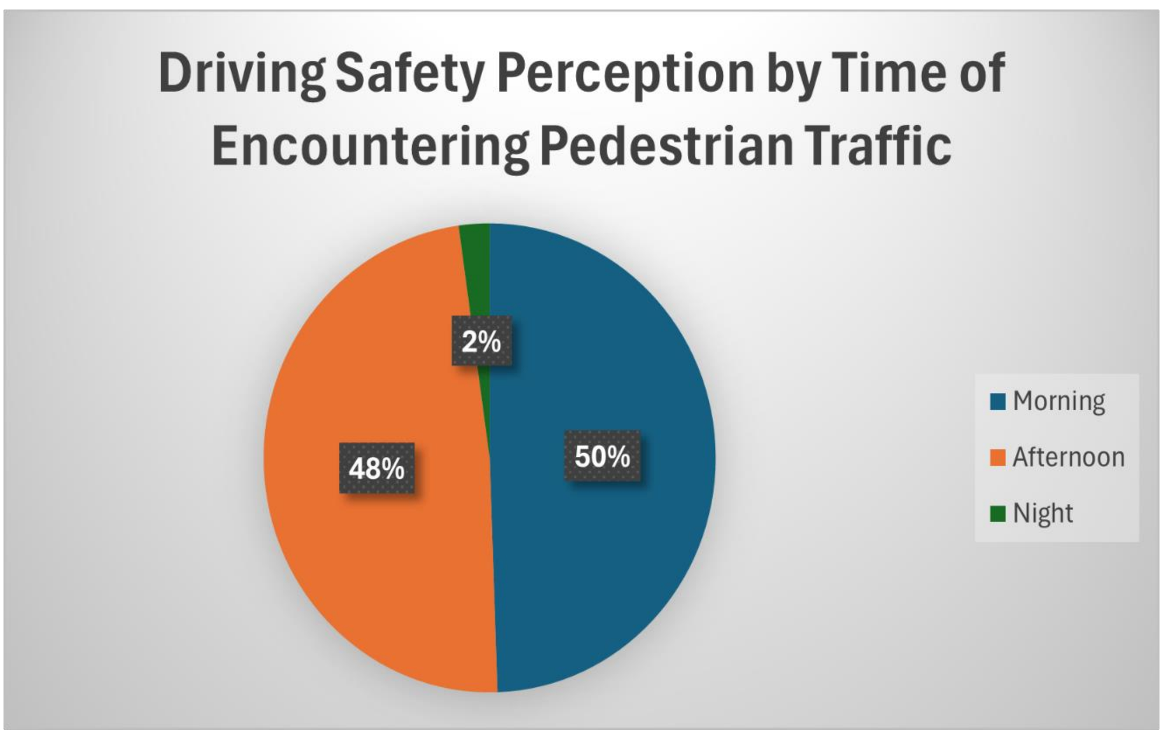
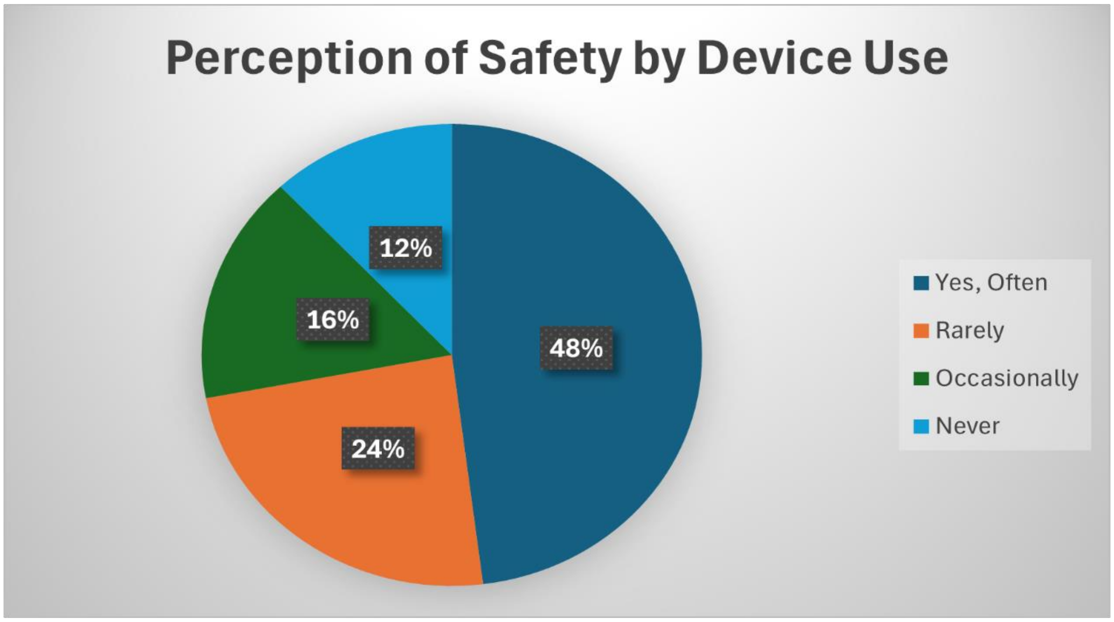


Figure 12: Perception of Safety by Device Use & Near Miss Experience



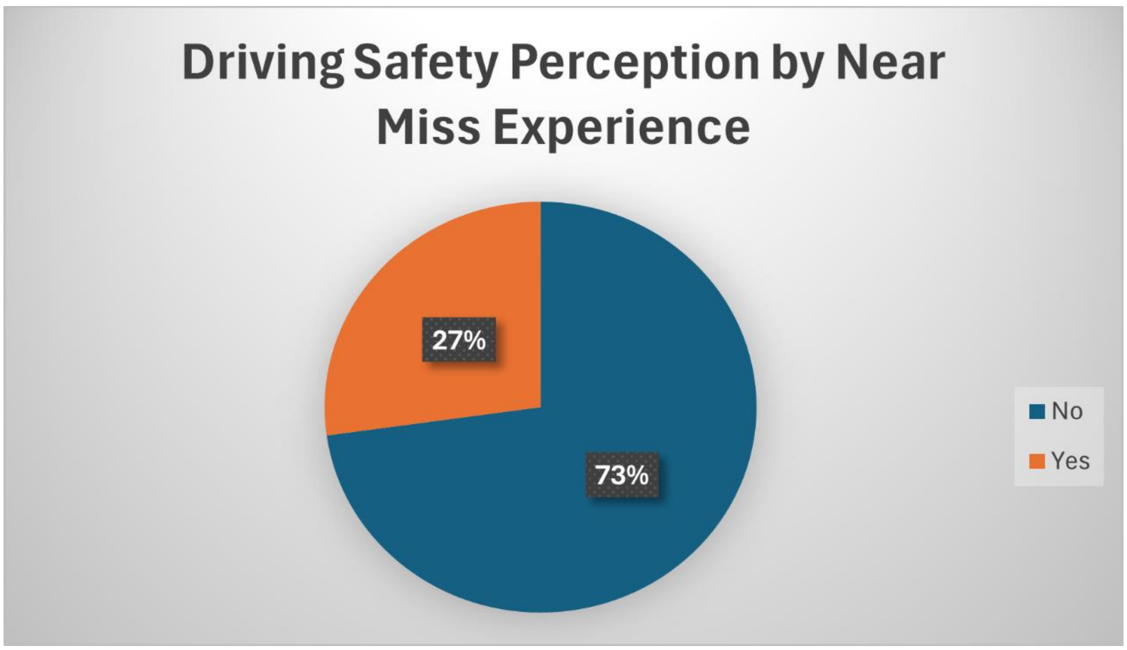
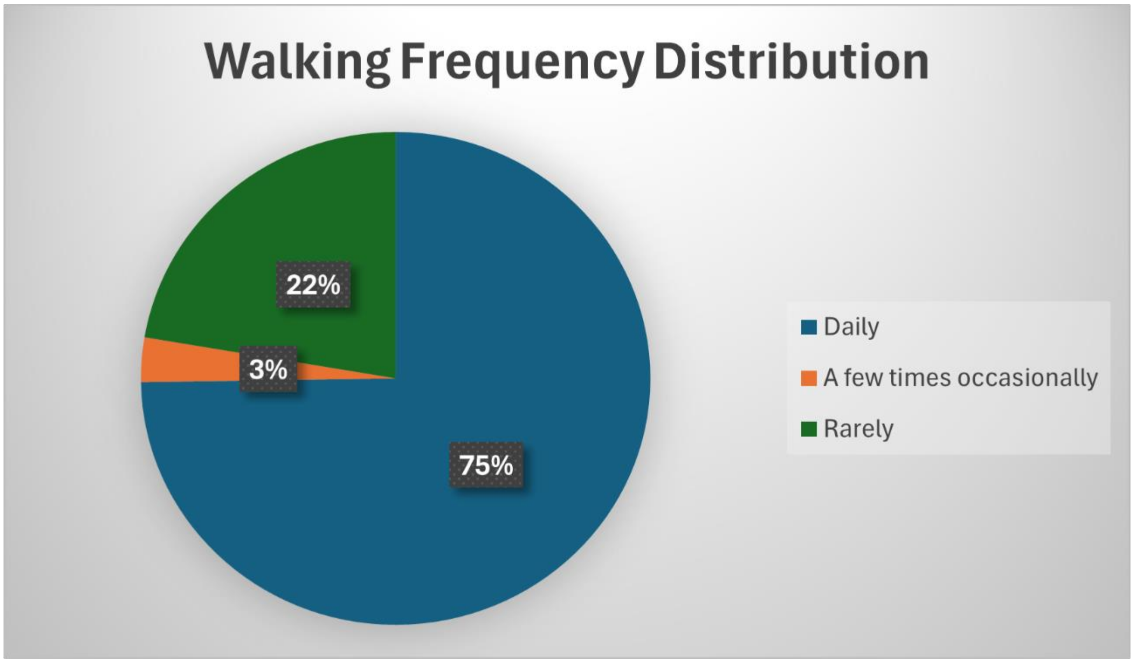


Figure 13: Walking Frequency Distribution and Driver Safety Perception



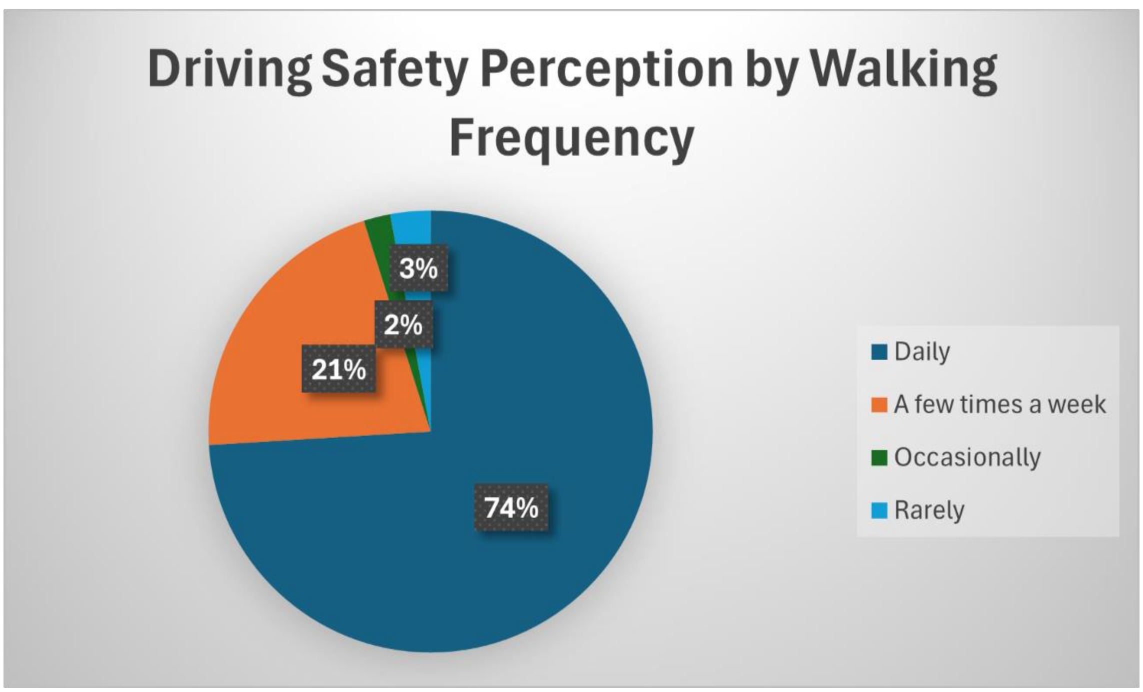
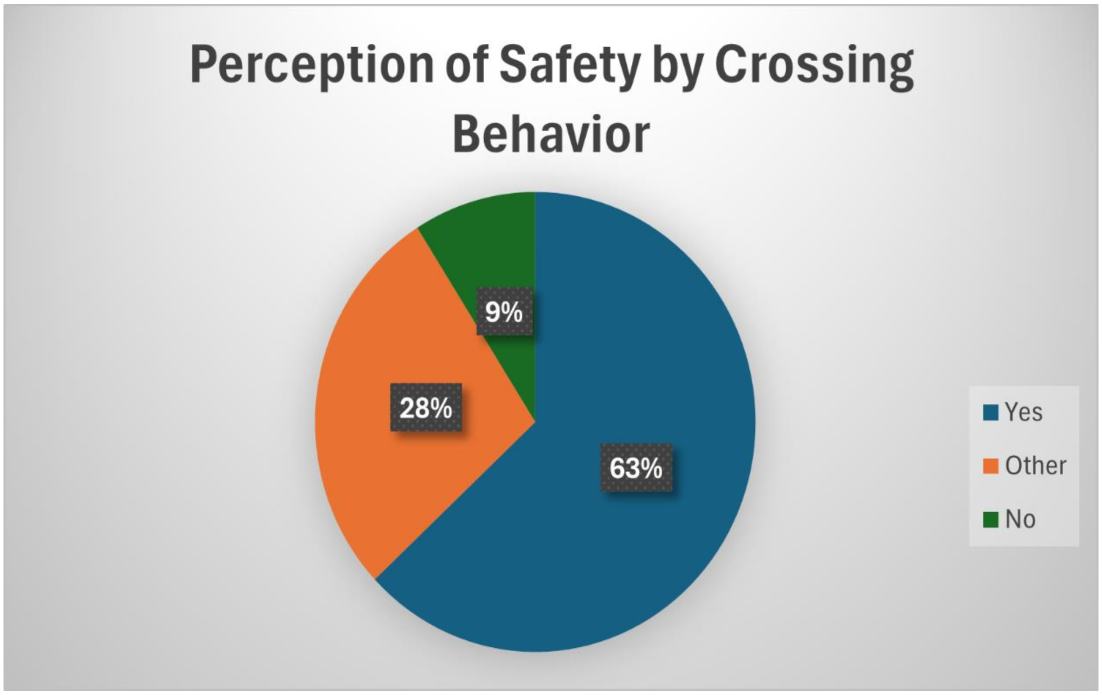


Figure 14: Perception of Pedestrian Safety by Crossing Behavior



ProQuest Number: 32053096

INFORMATION TO ALL USERS
The quality and completeness of this reproduction is dependent on the quality and completeness of the copy made available to ProQuest.

Distributed by
ProQuest LLC a part of Clarivate (2025).
Copyright of the Dissertation is held by the Author unless otherwise noted.

This work is protected against unauthorized copying under Title 17, United States Code and other applicable copyright laws.

This work may be used in accordance with the terms of the Creative Commons license or other rights statement, as indicated in the copyright statement or in the metadata associated with this work. Unless otherwise specified in the copyright statement or the metadata, all rights are reserved by the copyright holder.

ProQuest LLC
789 East Eisenhower Parkway
Ann Arbor, MI 48108 USA