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Crash Risk for Low-Income and Minority Populations: An Examination of At-risk Population Segments and Underlying Risk Factors

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16. Abstract

Socio-economic status (SES) is a well-known predictor of crash risk. Lower-income, minority, and less-educated persons are disproportionately likely to be injured or killed in a traffic accident. There has been a little substantive examination of the specific nature of the crash risk experienced by specific age and gender cohorts among the lower-income populations or how the daily activities of each of these cohorts may affect crash risk. In general, lower-income and minority populations are treated as monolithic groups, with little effort to identify specific population cohorts at disproportionate risk. This study examines pedestrian and cyclist crashes occurring in lower-income areas in Broward, Palm Beach, and Miami-Dade counties. This study is designed to address three specific objectives: (1) estimate the *relative risk* of pedestrian and cyclist crashes in lower-income communities, compared to their more affluent counterparts, to understand the nature of the pedestrian and cyclist crash risk in lower-income areas; (2) identify specific *at-risk population cohorts* within lower-income census block groups, stratified by age, gender, and the time of day to develop a profile of the unique characteristics of crashes experienced by pedestrians and cyclists in these areas; and (3) examine the effect of the commuting patterns on vehicle-pedestrian and vehicle-cyclist collisions. The Getis-Ord Gi* test statistic was used to identify spatial clustering patterns of vehicle-pedestrian and vehicle-cyclist collisions in low-income areas Broward, Palm Beach, and Miami-Dade counties, Florida.

Compared to more affluent block groups, pedestrians in lower-income areas are significantly more likely to be killed or severely injured. A notable finding of this study is that relatively few of the total crashes involve pedestrians (5.9%) and cyclists (2.6%) suspected of being under the influence of drugs and alcohol. Instead, the majority of the crashes involving specific cohorts can be understood in association with exposure resulting from expected daily activities typical for each cohort. Crashes involving pedestrians and bicyclists of different age groups are found to occur during the time periods when one would expect them to be most active. Based on an examination of the demographic and temporal distribution of pedestrian and bicycle collisions, we identified four discrete patterns of pedestrian risk: (1) s*chool trips and after-school activities:* pedestrians aged 14 and under, 6 am to 9 am and 3 pm to 9 pm, weekdays; (2) e*rrands during the early evening*: pedestrians aged 20 and older, 6 pm to 9 pm; (3) a*ctive older adults*: pedestrians aged 70 and older, 9 am to 9 pm; and (4) y*oung adults*: pedestrians aged 25-34, 6 pm to midnight.

The rate per thousand for vehicle-cyclist crashes in low-income neighborhoods is roughly 60% higher than that in more affluent areas. In comparison, the rate per thousand for the collisions which resulted in cyclists being killed or severely injured is 65% higher. Total and KSI collisions involving cyclists are twice as likely to occur in lower-income areas than more affluent ones. The overwhelming majority of cyclists struck in a collision (77.8%) are male and appear to be associated with the use of bicycles for utilitarian travel, with nearly all of these crashes (91%) occurring between 6 am and 9 pm. Neither alcohol nor drug use appears to be a major factor, with officers suspecting cyclists of alcohol use in only 2.3% of these collisions and drug use in only 0.4%. Based on an examination of the demographic and temporal distribution of these collisions, two at-risk populations are identified: (1) a*dult utilitarian bicycling*: cyclists aged 20-64, 6 am to 9 pm; and (2) a*fterschool activities*: cyclists 19 and under, 3 to 6 pm, weekdays. Child cyclists aged 14 and under are at a significantly higher risk of being killed or severely injured in lower-income communities than their counterparts living in more affluent areas. Except for the age cohorts 15-19 and 70 and older, male cyclists in all remaining age cohorts are at a significantly higher risk of being involved in a car accident than their more affluent counterparts.

This study identified environmental risk factors for lower-income block groups using negative binomial regression models. The dependent variables included the total number of pedestrians and bicyclists involved in a collision (regardless of crash severity) as well as the KSI crashes, defined as the number of fatal, incapacitating, and non-incapacitating injuries affecting a pedestrian or a bicyclist. The independent variables used in the analysis include demographic profile, transportation network characteristics, and land use composition. Our findings indicate that pedestrians are more likely to be involved in collisions in areas with higher concentrations of persons identifying as Black or Hispanic. The number of persons residing in a block group was not significantly associated with the increased incidence of bicycle collisions, though bicyclist crashes were influenced by the block group's racial composition. Shopping centers, supermarkets, and restaurants in lower-income communities were found to be statistically associated with increases in both pedestrian and bicycle collisions. Higher rates of both pedestrian and bicycle collisions at a block group level were positively statistically associated with a larger number of signalized intersections, intersections per 100 acres, and frequent bus stops. Pedestrian collisions were also found to increase with each mile of 5-or more lane street. Raised medians were associated with a significant reduction in crashes involving non-motorists, with each mile of raised median corresponding to an 83% and 69% decrease in pedestrian and bicycle collisions, respectively. For bicycle collisions, each increment of an increase in AADT by 1,000 vehicles was associated with a 0.9% increase in bicyclist collisions.

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Executive Summary

Socio-economic status (SES) is a well-known predictor of crash risk. Lower-income, minority, and less-educated persons are disproportionately likely to be injured or killed in a traffic accident. There has been little substantive examination of the specific nature of the crash risk experienced by specific age and gender cohorts among the lower-income populations or how the daily activities of each of these cohorts may affect crash risk. In general, lower-income and minority populations are treated as monolithic groups, with little effort to identify specific population cohorts at disproportionate risk. This study examines pedestrian and cyclist crashes occurring in lower-income areas in Broward, Palm Beach, and Miami-Dade counties. This study is designed to address three specific objectives: (1) estimate the *relative risk* of pedestrian and cyclist crashes in lower-income communities, compared to their more affluent counterparts to understand the nature of the pedestrian and cyclist crash risk in lower-income areas; (2) identify specific *at-risk population cohorts* within lower-income census block groups, stratified by age, gender, and the time of day to develop a profile of the unique characteristics of crashes experienced by pedestrians and cyclists in these areas; and (3) examine the effect of the commuting patterns on vehicle-pedestrian and vehicle-cyclist collisions. The Getis-Ord Gi* test statistic (Getis and Ord, 1992; Ord and Getis, 1995) was used to identify spatial clustering patterns of vehicle-pedestrian and vehicle-cyclist collisions in low-income areas Broward, Palm Beach, and Miami-Dade counties, Florida.

The study begins by identifying *at-risk cohorts* in lower-income areas, stratified by age and time of day. It then proceeds to examine *environmental risk factors* associated with the design and configuration of the built environment. While it may be the case that more crashes occur in lower-income and minority communities, one cannot ascertain that these crashes exclusively involve persons residing in the immediate area, nor that crashes involving lower-income populations occur exclusively, or even principally, in the communities in which they reside. In Miami-Dade, Broward, and Palm Beach counties, many concentrations of lower-income populations lie along arterial thoroughfares that function as commuter routes for persons traveling between suburban residences in the west to employment centers in the east. As such, it is almost certain that some portion of these crashes may be attributable to the increased exposure attributable to these commuting patterns.

At-Risk Cohorts

Lower-income communities reported 0.715 pedestrian crashes per 1,000 population per year, compared to 0.320 for higher-income block groups. The annual incidence rate of pedestrian fatalities or severe injuries per thousand is two times higher in the lower-income communities than in more affluent areas throughout the study period. Pedestrians in lower-income areas are 2.24 times more likely to be struck by a vehicle and 2.15 times as likely to be killed or severely injured. Persons 19 younger are at disproportionate risk as a share of the total population, though elevated risk levels are reported for all age cohorts except males between the ages of 20-24 and 25-34. For these age groups, the relative risk is almost equivalent in lower-income and higher-income areas. The largest concentration of these collisions (39.6%) occurred during the afternoon and early evening periods (3:00 pm to 9:00 pm). However, an examination of the data illustrates unique patterns of risk for different population cohorts. A notable finding of this study is that relatively few of the total crashes involve pedestrians (5.9%) and cyclists (2.6%) suspected of being under the influence of drugs and alcohol. Instead, the majority of the crashes involving specific cohorts can be understood, in large part, as a function of exposure related to daily activities. Based on an examination of the demographic and temporal distribution of pedestrian and bicycle collisions, we identified four discrete patterns of pedestrian risk:

1. *School trips and after-school activities:* pedestrians aged 14 and under, 6 am to 9 am and 3 pm to 9 pm, weekdays.

2. *Daily activities during the early evening*: pedestrians aged 20 and older, 6 pm to 9 pm.
3. *Active older adults*: pedestrians aged 70 and older, 9 am to 9 pm.
4. *Young adults*: pedestrians aged 25-34, 6 pm to midnight.

Except for males aged 20-24 and 25-34, all other cohorts are associated with a higher incidence of pedestrian collisions than their more affluent counterparts. The relative risk for child pedestrians and older adults, particularly in the age cohorts 55-64, 65-69, and 70 and older, is nearly three times higher in lower-income areas than in the areas with 120% AMI. Children aged 14 and under and older adults (mainly those 70 and over) are also over-represented in pedestrian-vehicle collisions resulting in fatalities or severe injuries in lower-income areas, compared to the same age and gender cohorts in more affluent communities.

Broward, Miami-Dade, and Palm Beach counties have reported 1,391 vehicle-cyclist collisions per year in lower-income communities, compared to 236 in higher-income areas during the study period. The rate per thousand for vehicle-cyclist crashes in low-income neighborhoods is roughly 62% higher than that in more affluent areas. In comparison, the rate per thousand for the collisions which resulted in cyclists being killed or severely injured is 65% higher. Total and KSI collisions involving cyclists are twice as likely to occur in lower-income areas than more affluent ones. The overwhelming majority of cyclists struck in a collision (80%) are male and appear to be associated with the use of bicycles for utilitarian travel, with nearly all of these crashes (91%) occurring between 6 am and 9 pm. Neither alcohol nor drug use appears to be a major factor, with officers suspecting cyclists of alcohol or drug use in only 2.6% of these collisions. Based on an examination of the demographic and temporal distribution of these collisions, two at-risk populations are identified:

1. *Adult utilitarian bicycling*: cyclists aged 20-64, 6 am to 9 pm.
2. *After-school activities*: cyclists 19 and under, 3 to 6 pm, weekdays.

Child cyclists aged 14 and under are at a significantly higher risk of being killed or severely injured in lower-income communities than their counterparts living in more affluent areas. Except for the age cohorts 15-19 and 70 and older, male cyclists in all remaining age cohorts are at a significantly higher risk of being involved in a car accident than their more affluent counterparts. While the overall risk is the highest for male cyclists aged 45-64, the risk of being killed or severely injured in a collision in lower-income areas is the highest among teenage male cyclists aged 15-19. The risk of being involved in a crash that results in a fatality or severe injury is higher for male cyclists of all age cohorts (except those 70 and older).

The analysis of the spatial clustering of pedestrian crashes indicates higher concentrations of collisions involving adult pedestrians along major corridors and near employment centers in low-income areas. Higher traffic volumes in the poorest census block groups increase the exposure of the local residents to motor vehicles and lead to a greater likelihood of vehicle-pedestrian and vehicle-cyclist collisions. Our analysis suggests that commuting patterns play an important role in increasing the exposure of the residents of lower-income communities to traffic flows. For a large portion of the pedestrian and bicycle crashes (71.3% and 68.0%, respectively), the driver who caused the crash did not reside in the same zip code as the pedestrian or cyclist involved in the collision. This finding indicates increased exposure of local residents to commuter traffic from suburban residences to various destination points in the tri-county area. The observed levels of traffic volumes and pedestrian and biking activities can be attributed to the density, scale, and design characteristics of the adjacent urban development, the employment characteristics of the area, and the socio-economic characteristics of the local population. The service super-sector, which dominates the local economy, is more likely to employ lower-income populations who are also more likely to walk or bike to work.

Environmental Risk Factors

Accident counts involving pedestrians and bicyclists in lower-income block groups are modeled using negative binomial regression. The dependent variables include the total number of pedestrians and bicyclists involved in a collision (regardless of crash severity) as well as the KSI crashes, defined as the number of fatal, incapacitating, and non-incapacitating injuries affecting a pedestrian or a bicyclist.

The independent variables used in the analysis fall into three general categories: demographic characteristics, transportation network properties, and land use composition. Our findings suggest that racial and ethnic dissimilarities increase the crash risk experienced by lower-income populations. The expected counts for both total and KSI collisions involving pedestrians and cyclists increase significantly in proportion to the percentage of Blacks and Hispanics in the population.

For lower-income communities, land use characteristics associated with common everyday destinations, such as supermarkets, shopping centers, and restaurants, are associated with an increase in the expected counts of crashes involving pedestrians and cyclists. Transportation network characteristics are also found to have statistically significant safety effects. Among the factors contributing the most to significant increases in the expected counts of pedestrian collisions are the length (in miles) of 5-or more lane streets, the number of signalized intersections, and the number of bus stops in each block group.

Conclusions and Recommendations

This study concludes by discussing the underlying causes of crashes occurring in lower-income areas, which appear to be principally the result of normal travel activities undertaken in poorly adapted environments to high levels of walking and bicycling. Much of the observed safety issues are not solely the result of deficiencies in the transportation system, but rather the product of inconsistencies between the design and operation of the transportation system and local land development policies, which result in *conflicts of use* and *errors of expectancy,* referred to as latent conditions. Addressing the resulting safety issues in a meaningful way requires more than ongoing modification of the transportation system aimed at mitigating problems as they emerge; local land development policies need to be aligned with the characteristics of the transportation system in order to prevent the ongoing creation of these problems.

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1. INTRODUCTION

Socio-economic status (SES) is a well-known predictor of crash risk, with lower-income, minority, and less-educated persons being disproportionately likely to be injured or killed in a traffic crash (Abdalla, Raeside, Barker, & McGuigan, 1997; Baker, Braver, Chen, Li, & Williams, 2002; Chichester, Gregan, Anderson, & Kerr, 1998; Centers for Disease Control, 2013; Cottrill & Thakuriah, 2010; Graham, Glaister, & Anderson, 2005; Hippisley-Cox, Groom, & Kendrick, 2002; Rifaat, Tay, & de Barros, 2010; Roberts & Powers, 1996; Valverde & Jovanis, 2006). Two related explanations are typically provided to explain this phenomenon. The first is that that lower-income residents are less likely to own cars, thus leading to higher rates of walking and bicycling, and thereby resulting in increased exposure for vulnerable road users (Blumenberg & Manville, 2004; King, Smart, & Manville, 2019; Murakami & Young, 1997). The second is that lower-income populations are more likely to engage in "unsafe" behaviors than their more affluent counterparts (Bachman, Johnston, & O'Malley, 1987; Charlton & White 1995; CDC, 1989; Neff & Burge, 1995; Petridou et al., 1997; Senf & Price, 1994). This has led to a prevailing view that such crashes can be understood as a product of the innate behaviors of lower-income populations, a view that is reflected in contemporary safety research, which treats race and income as control variables, or baseline conditions, that should, at best, be accounted for when examining other, more relevant variables. This perspective treats lower-income populations as a monolithic group and presumes that the crash risk experienced by these populations can be understood as a product of their behavior, rather than as an outcome of transportation system planning and design.

From the perspective of epidemiology, which is concerned with the incidence of risk across populations, such factors are regarded as *risk determinants*, or broader, population-level characteristics that make the incidence of a negative health outcome, such as traffic-related death or injury, more likely. While risk determinants are useful for identifying populations that are at risk of death or injury, they fail to elaborate on the precise nature of the risks experienced by this group, making it difficult to identify and implement meaningful interventions.

There has been little substantive examination of the specific nature of the crash risk experienced by lower-income populations. In general, lower-income and minority populations are treated as a monolithic group, with little effort to identify specific population cohorts that may be at disproportionate risk. In order to better develop our understanding of the crash risk experienced in lower-income areas, this study examines pedestrian and cyclist crashes occurring in lower-income areas in Broward, Palm Beach, and Miami-Dade counties. It begins by identifying *at-risk cohorts* in lower-income areas, stratified by age and time-of-day. It then proceeds to examine *environmental risk factors* associated with the design and configuration of the built environment and concludes by discussing planning and policy mechanisms that can be applied to help enhance pedestrian and cyclist safety in lower-income areas.

2.LITERATURE REVIEW

The literature on traffic safety has consistently found that lower-income and minority populations are disproportionately at risk of being injured or killed in a traffic crash, yet there has been little effort to understand whether specific demographic of ethnic subpopulations may be disproportionately at risk. Instead, studies typically speculate that the crash risk involving lower-income populations is attributable to higher rates of walking and cycling and the ownership of older, less crashworthy vehicles. While these are convenient explanations, neither transportation disadvantage nor vehicle age adequately explains the factors that place these populations at risk, nor do they lead to actionable safety interventions.

The existing literature treats lower-income and minority populations as a single population that lacks unique, distinguishing characteristics. Factors such as age, sex, and trip purpose likely influence risk exposure, and it is almost certainly true that specific combinations of these factors have a profound influence on crash risk for low-income and minority populations, just as they do for more affluent populations. To date, not a single study has sought to examine how specific demographic characteristics within the broad categorizations of "low-income" and "minority" influence crash risk. It can also not be assumed, as is currently done, that all "lower-income" and "minority" populations are the same.

There is a need to understand better the distribution of crash injury and severity among subgroupings of the target population broadly classified as "low income" and "minority," and begin defining the price risk factors that lead to adverse safety outcomes.

2.1 Risk Factors for Lower-income Populations

Research has consistently found that the areas in which lower-income populations reside experience an increased incidence of traffic-related crashes, injuries, and deaths (Abdalla, Raeside, Barker, & McGuigan, 1997; Baker, Braver, Chen, Li, & Williams, 2002; Chichester, Gregan, Anderson, & Kerr, 1998; Cottrill & Thakuriah, 2010; Graham, Glaister, & Anderson, 2005; Hippisley-Cox, Groom, & Kendrick, 2002; Rifaat, Tay, & de Barros, 2010; Roberts & Powers, 1996; Valverde & Jovanis, 2006). These areas typically have higher concentrations of female-led households, lower levels of educational attainment, lower rates of automobile ownership, and higher percentages of racial minorities. A common explanation as to why lower-income neighborhoods experience higher levels of traffic-related death and injury is that lower-income residents are less likely to own cars, leading to increased pedestrian exposure (Blumenberg & Manville, 2004; King, Smart, & Manville, 2019; Murakami & Young, 1997), and that the cars in use by lower-income households are often older (Blumenberg & Haas, 2002; County of Los Angeles, 2000; Murakami & Young, 1997; Ong & Houston, 2002), or in need of repair and maintenance (Cervero, Sandoval, & Landis, 2002). Further, a study of pedestrian mortality rates using patient records from the National Trauma Data Bank (NTDB) found that African Americans were 22% more likely to die following admission to a hospital following a pedestrian collision than were whites. In comparison, Hispanics were 33% more likely to die than white, non-Hispanics. Insurance status, which may influence the quality of care, appears to be a contributing factor, with uninsured patients reporting 77% greater odds of mortality than privately insured patients (Maybury et al., 2010).

2.2 At-risk Subpopulations and Behavioral Risk Factors

Research identified school-aged children, teenagers, seniors, and males as being populations particularly at risk of being involved in a crash event. In a study of six U.S. cities, Ferenchak and Marshall (2017) found that fatal crashes involving child pedestrians, defined as persons under the age of 18, concentrated near parks and schools. Pour et al. (2017) further found that crashes involving child pedestrians cluster around 8:00 AM and 3:00 PM, times usually associated with school travel.

Crashes involving teenagers are often attributed to risk-taking behaviors, manifested as speeding, racing, and driving while distracted. Such behaviors are especially prevalent among teenaged males, with the percentage of teenaged males in a community being positively associated with increased crash incidence (Evans, 2004; Hippisley-Cox et al., 2002; Rifaat et al., 2010). Behavioral factors associated with crashes involving adolescents have been well documented in psychological research, particularly driving while distracted.

Lower-income populations appear to engage in more risk-taking behaviors than more affluent populations, such the non-use of seat belts, riding with a drunk driver, and driving under the influence of drugs or alcohol (Petridou et al., 1997). This is consistent with the inequalities in morbidity and mortality by social class (Black, 1980; Syme & Berkman, 1976) and the concentration of various risk-taking behavior among underprivileged teens (Bachman, Johnston, & O'Malley, 1987; Charlton & White 1995; CDC, 1989; Neff & Burge, 1995; Senf & Price, 1994). However, in a study of self-reported safe driving behavior, which asked participants about seat belt use, speed limit compliance and abstaining from drinking and driving, the researchers found that there is no single high-risk group that consistently violates all three safety rules (Shinar, Schechtman, & Compton, 2001). Females were more likely than males to engage in all three safety behaviors, with educated women being particularly more likely to report the consistent use of seat belts. Most survey respondents indicated avoidance of drinking and driving, regardless of age, gender, education, and income differences. Interestingly, people with higher levels of income and educational attainment reported being less likely to observe speed limits than other cohorts, possibly because higher incomes reduce the financial and legal impacts of penalties associated with speeding.

For pedestrians, 60% of fatal crashes occur while pedestrians attempt to cross a street (NHTSA, 2003). Race and income appear to be associated with driver-yielding behaviors. Research has indicated that drivers of expensive cars are less likely to yield to pedestrians than those with lower-status cars (Piff et al., 2012). Yielding to pedestrians is often viewed by many drivers as a courtesy or privilege rather than compliance with established motor vehicle laws. Drivers are more likely to yield to disabled individuals (Harrell, 1992), women (Goddard, Kahn & Adkins, 2014), or people who are similar to their own age (Rosenbloom, Nemrodov & Eliyahu, 2006). A study conducted in Oregon found that many drivers do not yield to crossing pedestrians at unmarked intersections and that drivers are less likely to yield to Black male pedestrians than other cohorts (Goddard, Kahn & Adkins, 2014).

Older populations are disproportionately represented in fatal and injurious crashes, though not more total collisions. This appears to be the result of frailty, as older bodies are less able to absorb impact forces than younger ones. However, Kim et al. (2013) found greater heterogeneity of injury severity among older adults compared to the working-age group. The results from a mixed logit model suggested a higher probability of fatal injury for approximately half of the older adult sample but a lower probability for the other half compared to the working-age group. Older adults have been found to be generally more responsible than younger drivers when driving and far less likely than younger populations to be involved in crashes associated with irresponsible or reckless driving, such as single-vehicle, run-off-roadway crashes, crashes involving excessive speeds, or crashes involving a driver following another vehicle too closely (Hakamies-Blomqvist 2004; Federal Highway Administration 1993).

Nonetheless, safety problems for older adults, particularly as motorists, emerge at intersections. Declines in visual acuity associated with aging lead older adults to underestimate available gaps in oncoming traffic and thus to attempt turning maneuvers in front of oncoming vehicles (Hakamies-Blomqvist 2004; Hallmark and Mueller 2004; Smiley 2004; Straight 1997). The tendency to misjudge traffic gaps is further evidenced by police citations at crash locations, with drivers older than sixty-five being twice as likely to be cited for failing to yield to oncoming traffic than are younger drivers (Matthias, De Nicholas, and Thomas 1996). The problem with identifying safe gaps in oncoming traffic is exacerbated by higher vehicle operating speeds. Older drivers are generally able to identify safe gaps in traffic when oncoming vehicles are traveling at speeds of 30 miles per hour or less, but they have increasing difficulty doing so when vehicles are traveling at higher speeds (Chandraratna, Mitchell, and Stamatiadis 2002; Scialfa et al. 1991; Staplin 1995). Crashes involving pedestrians over the age of 65 tend to cluster at intersections and between the hours of 9:00 AM and 3:00 PM (Pour et al, 2017).

Lin et al. (2019) examined the pedestrian crash frequency and injury severity in low-income areas in District 4 of the Florida Department of Transportation, which includes Broward and Palm Beach counties.

The estimated parameters of the negative binomial model indicate that pedestrian crashes occur more frequently in census block groups with a lower proportion of older adults, higher public transit ridership, a higher proportion of commuters, a higher percentage of people with less than high school educational level, and a higher proportion of carless individuals. A logistic regression model indicated that dark-not lighted conditions, substance abuse, physical or mental impairment, and older age are significant predictors of crash severity (Lin et al., 2019). A study of the Melbourne metropolitan area found that most pedestrian crashes occur between the hours of 9:00 am and 3:00 PM, with males and females being equally likely to be involved during these periods. Nonetheless, crashes involving male pedestrians are significantly higher than those of females after 8:00 PM and on weekends (Pour et al., 2017). This is likely attributable to the increased likelihood of males walking under the influence (WUI) during this time period. Indeed, Hazeveh and Cherry (2018), in a study of WUI crashes in Tennessee, found that 78% of such crashes involved males, the majority (80%) occurred during evening hours, and 50% more likely to occur on weekends rather than weekdays. Such behavior appears to concentrate during middle-age, with the average age of a person walking under the influence being 42 years old. Pedestrian crashes occurring during the evening have been found to be more severe than those occurring during daylight hours (Doustmohammadi et al., 2018).

Although lower incomes are associated with lower rates of vehicle ownership, Koekemoer et al. (2017) suggest that other factors, such as inadequate road infrastructure and "negligent behavior" may also explain why lower-income areas tend to have higher crashes and injuries. "Negligent behavior" is a term used to imply that involved pedestrians have a limited understanding of safe crossing behavior. Inadequate infrastructure, unsafe cars, and/or "negligent behavior" might help explain the increased motorist casualties in New Jersey (Noland et al., 2013). A few other studies have explained why pedestrians, particularly young pedestrians in poor neighborhoods, are associated with increased injury risks (e.g., Lyons et al., 2008; Guyer, Talbot, & Pless, 1985). Risk is attributed to the lack of safe play spaces, housing in close proximity to busy traffic flows, immature cognitive behavior, higher crime rates, lower vehicle ownership rates, and greater physical, social, and psychological stress.

2.3 The Built Environment and Crash Risk

In addition to socioeconomic and behavioral characteristics, the built environment has an important role in crash incidence. A key factor is the presence of urban arterial roadways. More miles of arterial roadway has been associated with more total crashes (Alluri et al., 2017; Dumbaugh & Rae, 2009; Hadayeghi et al., 2007; Lovegrove & Sayed, 2006; Tasic & Porter, 2016; Wang, Jin, Abdel-Aty, Tremont, & Chen, 2012), more injury crashes (Alluri et al., 2017; Dumbaugh & Rae, 2009; Hadayeghi et al., 2007; Ladron de Guevara et al., 2004), and more fatal crashes (Alluri et al., 2017; Dumbaugh & Rae, 2009; Hadayeghi et al., 2007; Ladron de Guevara et al., 2004; Tasic & Porter, 2016). Pedestrian crashes have also been positively related to the preponderance of arterials (Eluru, Yasmin, Bhowmick, & Rahman, 2016; Tasic & Porter, 2016; Wang, Yang, Lee, Ji, & You, 2016). Other measures of arterial presence, such as arterial density (Huang et al., 2010), or percentage of the street network comprised of arterial roads (Jiang, Abdel-Aty, Hu, & Lee, 2016; Khondakar, Sayed, & Lovegrove, 2010; Osama & Sayed, 2017), have also been positively associated with crashes

Higher traffic volumes are found on freeways and arterial roads and in areas with higher population and employment densities. Therefore, certain types of land uses, such as commercial and office uses, often increase the traffic flow in an area. Traffic crashes in commercial areas often happen in parking lots, entrances, and intersections with sidewalks and/or bike lanes. Dumbaugh and Rae (2009) found that commercial land uses on arterial roads increase total, fatal, and injury crashes. Hadayeghi et al. (2007) found that the acreage of commercial, residential, and industrial land was positively correlated with total crashes and severe crashes. Likewise, Jermprapai and Srinivasan (2014) discovered a higher number of all levels of severity of pedestrian crashes in zones with a higher proportion of commercial or industrial land. Mohamed et al. (2014) found that both injury and fatal crashes increase with the percent of residential land and the percentage of commercial land in a city or township. Ukkusuri et al. (2011) likewise uncovered that zones with greater industrial, commercial, and open land have more pedestrian crashes. Wier et al. (2009) also find that pedestrian crashes increase with the presence of commercial uses.

The presence of sidewalks and bike lanes, while often presumed to be safety features, the presence of sidewalks and bike lanes has been found to have a mixed effect on crash incidence. Studies on pedestrian collisions revealed that more sidewalks are often positively associated with such crashes (Cai, Abdel-Aty, Lee, & Eluru, 2017; Eluru, Yasmin, Bhowmick, Rahman, et al., 2016; Nashad et al., 2016). This counterintuitive finding is likely attributable to the effects of exposure; areas with more sidewalks and bicycle facilities likely have more pedestrians and cyclists, and thus more opportunities for collisions, although few studies have meaningfully distinguished between pedestrian risk and pedestrian exposure (Merlin, Guerra, and Dumbaugh, 2020).

Intersections are often found to be a risk factor, as intersections are locations where multiple streams of traffic cross, creating traffic conflict and thus opportunities for traffic collisions. The number of intersections in an area is positively correlated with crashes in most, but not all, instances. The number of intersections is correlated with total, severe, peak-hour, pedestrian, and cyclist crashes (Abdel-Aty, Siddiqui, Huang, & Wang, 2011; Abdel-Aty et al., 2013; Jermprapai & Srinivasan, 2014; Siddiqui & Abdel-Aty, 2012; Ukkusuri, Miranda-Moreno, Ramadurai, & Isa-Tavarez, 2012; Yu and Zhu, 2016). Dumbaugh and Rae (2009) found that the number of four-or-more leg intersections in a block group is positively correlated with total and injury crashes, though they are negatively associated with fatal crashes. However, the number of three-leg intersections in a community was associated with lower crashes and injuries. Hadayeghi et al. (2007) report positive correlations between the number of intersections and both total and severe collisions. In a contrary finding, Ouyang and Beijeri (2014) found a negative relationship between intersection counts and total, pedestrian, cyclist, injury, and fatal crashes in Miami-Dade County.

Intersection density, which is the number of intersections in a community normalized by land area, is sometimes used in lieu of intersection counts. This variable reports mixed results, with some studies reporting a positive relationship with crash incidence (Huang, Abdel-Aty, & Darwiche, 2010; Nashad et al., 2016; Osama & Sayed, 2016), and others reporting a negative relationship (Jonsson, 2005; Quistberg et al., 2015). Regardless of the uncertain effects of intersections on crash incidence, their safety performance is influenced by factors such as approach speeds, the number of approach lanes, and the types of intersection control devices in use. When considered in aggregate over larger geographic areas, as in studies of the relationship between the built environment and crash incidence, variations in intersections' design and operation likely explain the divergence in the study results.

3. IDENTIFICATION OF AT-RISK COHORTS

While lower-income populations may be disproportionately likely to be injured and killed while walking or cycling, crash risk is unlikely to be distributed uniformly across these populations. Different cohorts are likely to experience different levels of risk based on travel behaviors associated with personal and lifestyle characteristics.

The study is designed to address three specific objectives: (1) estimate the *relative risk* of pedestrian and cyclist crashes in lower-income communities compared to their more affluent counterparts to understand the nature of the pedestrian and cyclist crash risk in lower-income areas; (2) identify specific *at-risk population cohorts* within lower-income census block groups, stratified by age, gender, and the time of day to develop a profile of the unique characteristics of crashes experienced by pedestrians and cyclists in these areas; and (3) examine the effect of the commuting patterns on vehicle-pedestrian and vehicle-cyclist collisions.

3.1 Data Development

Assembling the data used in this analysis entailed a two-tiered process. The first was to establish an operational definition of lower-income communities and a definition of a reference group for establishing relative risk. The second was to assemble the relevant data from disparate data sources to develop profiles of specific at-risk cohorts. These methods are detailed below.

Identification of Lower-income Areas and Higher-income Reference Groups

Information on income was derived from Census block groups, which provide information on area median income. We defined lower-income communities as those with poverty rates of greater than 15% or median household income less than 50% of the area median income (AMI). This definition is consistent with the Department of Housing and Urban Development's (HUD's) definition of "very low income" communities. For the purposes of this analysis, we used the 2018 income and rent limits defined by the Florida Housing and Finance Corporation (FHFC) for the State Housing Initiatives Partnership (SHIP) Program as a baseline (Table 1). This study uses the 50% AMI limit for a family of four.

Table 1: Selection Criteria for the Designation of Low-Income Areas

Criteria	County		
	Broward	Palm Beach	Miami-Dade
Median income	$65,700	$74,300	$52,300
50% AMI limits for a family of 4[a]	$40,400	$38,450	$39,350
120% AMI limits for a family of 4[a]	$96,960	$92,280	$94,440
Number of block groups with a poverty rate greater than 15%	362	273	816
Number of block groups with a poverty rate greater than 15% and/or HH income less than 50% AMI	434	342	905

Source: Florida Housing and Finance Corporation

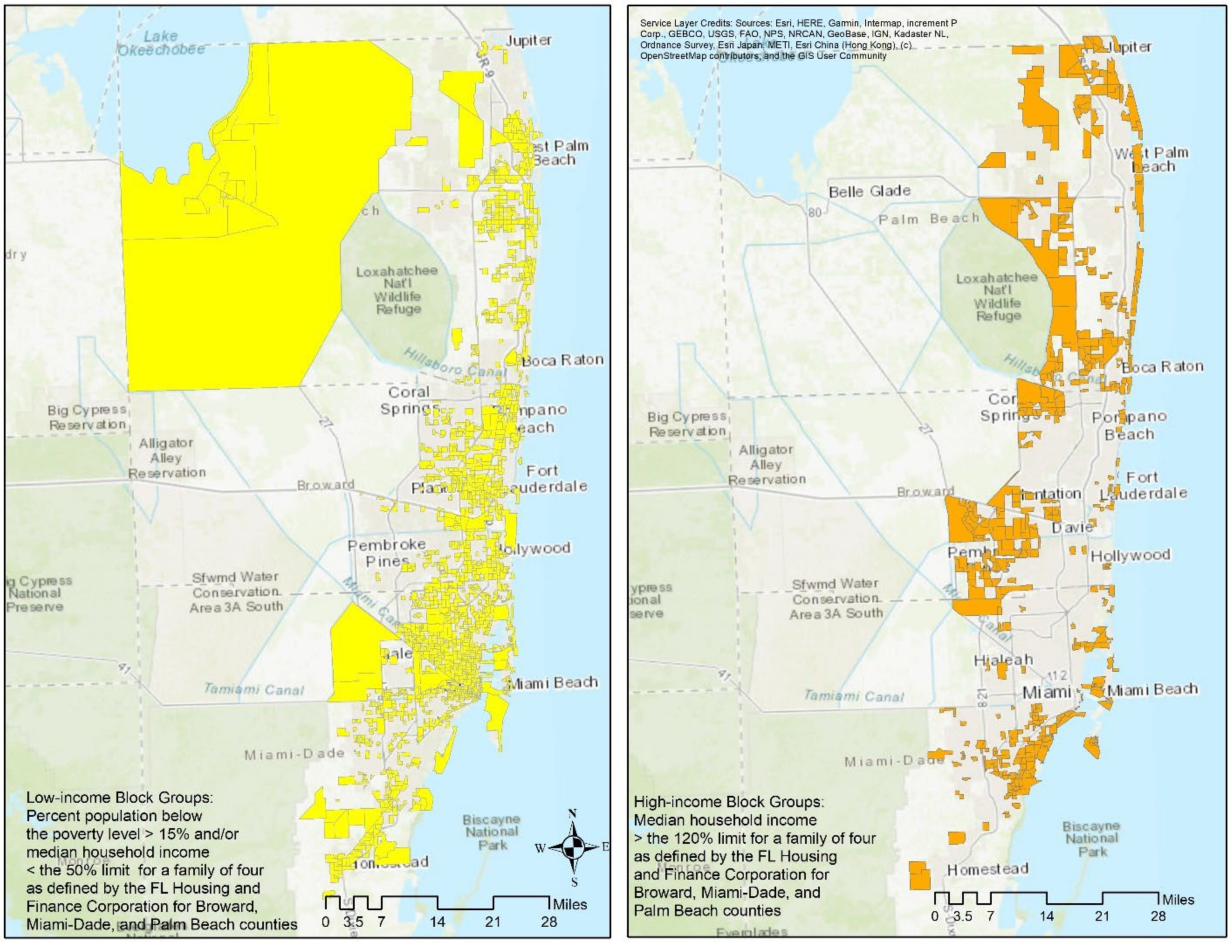

Figure 1. Spatial distribution of low-income and higher-income census block groups in Miami-Dade, Broward, and Palm Beach counties

Using 5-year estimates from the American Community Survey (2013-2017), we found that 362 census block groups in Broward County, 273 census block groups in Palm Beach County, and 816 census block groups in Miami-Dade County had poverty rates greater than 15%. Comparable to a previous FDOT study (Lin et al., 2019), we found that the census block groups with poverty rates greater than 15% do not completely overlap with the low-income census block groups identified using a second, household-based criterion. Based on poverty rates and the definition of the HUD for "very low-income areas," 434 census block groups were classified as low-income areas in Broward County, 342 census block groups were classified as low-income areas in Palm Beach County, and 905 in Miami Dade County for a total of 1,681 block groups.

The development of risk ratios requires identifying a reference group against which the crash incidence in lower-income areas can be compared. For this study, we used higher-income households as the reference group. HUD has established 120% of the area median income to delimit such households, a definition that is likewise used for this study.

Data Assembly

The study is based on three years (2015-2017) of crash data. Datasets of pedestrians and cyclists involved in a collision were obtained from the Florida State Safety Office (SSO). The datasets provides information about non-motorist age, sex, injury severity resulting from the crash, location during the crash, and suspected drug and alcohol use. These data do not, however, provide information on crash time, day, or crash location. Additional datasets were obtained from Signal Four Analytics (SFA) web portal maintained by the Geoplan Center of the University of Florida. A "query and join" operation was conducted to extract information about pedestrian and cyclist crashes that occurred in Miami-Dade, Broward, and Palm Beach counties during 2015-2017. The final data set consisted of crash time, date, and location information from the SFA crash data and non-motorist characteristics from the Florida SSO-supplied crash data. Based on crash locations, crashes were then separately mapped to high-income and low-income block groups. Table 2 provides a summary of crash data used in this study analysis, including the total number of pedestrian crashes, deaths, and serious injuries, defined as incapacitating or non-incapacitating injury. It also provides the sum of the pedestrians and cyclists killed or severely injured (KSI).

Several issues emerged in the assembly of this data. First, information on the race of the involved party was not available from these data, thus limiting the following analysis to age, sex, time-of-day, and day-of-week. Second, a large number of the records for Broward County failed to provide information on the demographic characteristics of persons involved in a traffic collision. This shortcoming appears to be attributable to the manner in which data are recorded rather than the result of any systematic bias, as discussed below. To help FDOT assess the effects of these practices, we have included county-specific information, as well as summaries of uncoded data, in Appendices A-F of this report.

Table 2: Summary of Crash Data

Crash Type	Description	Low-Income Block Groups	High-Income Block Groups
Pedestrians	*Number of crashes*	5,757	701
	Number of pedestrians involved	6,157	753
	Number of pedestrian fatalities	367	36
	Number of pedestrian injuries[a]	3,116	407
	Number killed or severely-injured	3,483	443
Cyclists	*Number of crashes*	4,131	694
	Number of cyclists involved	4,174	708
	Number of cyclist fatalities	72	14
	Number of cyclist injuries[a]	1,888	337
	Number killed or severely-injured	1,960	351

[a] *Injuries = Incapacitating + Non-incapacitating injuries*

Spatial clustering and identification of "hotspots"

The Getis-Ord Gi* test statistic (Getis and Ord, 1992; Ord and Getis, 1995) identifies patterns of spatial clustering of vehicle-pedestrian and vehicle-cyclist collisions in low-income areas in Broward, Palm Beach, and Miami-Dade counties, Florida. The Getis-Ord Gi* is a local measure of spatial association used to detect if a local pattern of an observed phenomenon is statistically significantly different from what is generally observed across the study area. The Getis-Ord Gi* statistic is calculated as the sum of the differences between the observed and average attribute values x_i for a feature j multiplied by the spatial weight w_{ij} defined by the distance between two or more features. The observed values of x_i for the unit of analysis and its neighbors are compared to the expected. A statistically significant positive Gi* value at a particular confidence level represents a 'hot spot,' indicating that there is a clustering of high values around an observed value of x_i. In this analysis, the attribute value of x_i is the crash count at the census block group level (Figure 2) and various combinations of age, gender, and time-of-day counts within a fixed distance band derived from peak z-score distances with threshold values between 2 and 5 miles (Figures 3 through 12).

3.2 Relative Risk: Lower-Income vs. Higher-Income Communities

Relative risk ratios compare the risk of an adverse event among a specific group with the risk of the same event in a comparison group. In this study, relative risk ratios were estimated based on the incidence proportions of vehicle-pedestrian and vehicle-cyclist collisions in lower-income and higher-income neighborhoods by age and gender. Specifically, relative risk ratios were calculated by dividing the number of per capita pedestrian or cyclist collisions in each age and gender cohort in lower-income block groups by the per capita rate of such collisions for the same age and gender cohorts in the higher income block groups. Relative risk ratios were estimated for both total and KSI (killed or severely injured) collisions involving pedestrians and cyclists.

A limitation of this study is the relatively high percentage of missing information on age and gender. While total crashes can be reliably reported, a selection bias may emerge as local police departments are less likely to record information on the age and sex of pedestrians and cyclists in lower-income areas than more affluent ones. The failure to record this information is principally due to the accident reporting practices employed in Broward County. While this does not affect the accuracy of the relative risk ratios for total and KSI collisions, it limits the accuracy of relative risk estimates for specific age cohorts.

Relative Risk: Pedestrians

As shown in Table 3 below, lower-income communities report 0.715 pedestrian crashes per 1,000 population per year, compared to 0.320 for higher-income block groups. The annual incidence rate of pedestrian fatalities or severe injuries per thousand is two times higher in the lower-income communities than in more affluent areas throughout the study period. Pedestrians in lower-income areas are 2.24 times more likely to be struck by a vehicle and 2.15 times more likely to be killed or severely injured.

Table 3: Pedestrian Collisions in Lower-Income and Higher-Income Block Groups

Pedestrians	**Total**		**KSI**	
	50 AMI	120 AMI	50 AMI	120 AMI
Pedestrian Collisions per Year	2052	251	653	117
Population (000s)	2,868	785	2,868	785
Rate per 1,000 Population	0.715	0.320	0.228	0.149
Relative Risk	2.237	0.447	2.148	0.466

As shown in Table 4, for all age and gender cohorts, the relative risk of pedestrian collisions in lower-income areas are higher compared to those in more affluent areas, except for males aged 20-24. The relative risk for child pedestrians and older adults, particularly in the age cohorts of 55-64, 65-69, and 70 and older, is nearly three times higher in lower-income areas than in the areas with 120% AMI. Much higher risk ratios for pedestrian-vehicle collisions resulting in fatalities or severe injuries are observed for children aged 14 and under and older adults (mainly those 65 and over) in lower-income areas, compared to the same age and gender cohorts in more affluent communities. Due to the reporting issues mentioned previously, we believe that the relative risk for at least some of these cohorts may be underestimated.

Table 4: Relative Risk of Pedestrian Collisions in Lower-Income Block Groups, by Age and Sex

	All Crashes			**KSI**		
Pedestrians	Male	Female	Total	Male	Female	Total
14 and Under	2.678	2.833	2.748	2.517	2.881	2.669
15-19	2.283	2.154	2.236	2.241	2.524	2.375
20-24	0.915	2.281	1.225	1.084	3.147	1.470
25-34	1.036	1.461	1.180	0.908	1.181	0.993
35-44	1.686	2.485	1.977	1.606	2.410	1.875
45-54	2.121	2.483	2.208	2.161	1.916	2.033
55-64	2.886	1.808	2.293	2.223	1.569	1.847
65-69	2.838	2.517	2.659	1.853	2.209	1.965
70 and Older	2.920	2.085	2.438	2.671	2.289	2.434
Total	1.956	2.132	2.237	1.778	1.992	2.148

Relative Risk: Cyclists

Broward, Miami-Dade, and Palm Beach counties have reported 1,391 vehicle-cyclist collisions per year in lower-income communities, compared to 236 in higher-income areas during the study period. The rate per thousand for vehicle-cyclist crashes in low-income neighborhoods is roughly 60% higher than in more affluent areas. Likewise, the rate per thousand for the collisions which resulted in cyclists being killed or severely injured is 65% higher (See Table 5).

Table 5: Bicycle Collisions in Lower-Income and Higher-Income Block Groups

Cyclists	**Total**		**KSI**	
	50 AMI	120 AMI	50 AMI	120 AMI
Bicycle Collisions per Year	1,391	236	653	117
Population (000s)	2,868	785	2,868	785
Rate per 1,000 Population	0.485	0.301	0.228	0.149
Relative Risk	1.613	0.620	1.528	0.654

Table 6 summarizes the relative risk ratios for cyclists involved in a collision by age, gender, and injury severity. Child cyclists aged 14 and under are at a significantly higher risk of being killed or severely injured in lower-income communities than their counterparts living in more affluent areas. Except for the age cohorts 15-19 and 70 and older, male cyclists in all remaining age cohorts are at a significantly higher risk of being involved in a car accident than their more affluent counterparts. While the overall risk is the highest for male cyclists aged 45-64, the risk of being killed or severely injured in a collision in lower-income areas is the highest among teenage male cyclists aged 20-24. The risk of being involved in a crash that results in a fatality or severe injury is higher for male cyclists of all age cohorts (except those 70 and older). The relative risk ratios are the highest for persons aged 20-24 and 45-64. Female cyclists aged 14 and under in lower-income neighborhoods are at a disproportionate risk compared to their counterparts in higher-income areas for both total and KSI collisions. Female cyclists aged 15-19 are at a lower risk in terms of total collisions in lower-income neighborhoods but at a higher risk of being killed or severely injured than their counterparts in more affluent areas. For female cyclists aged 20-24, the relative risk ratios for total collisions are equivalent in both lower- and higher-income areas but much higher for crashes resulting in death or severe injury in the impoverished neighborhoods. Older female cyclists (aged 55-64 and 70+) are also over-represented in lower-income neighborhoods.

Table 6: Relative Risk of Cyclist Collisions in Lower-Income Block Groups, by Age and Sex

	All Crashes			**KSI**		
Bicycle	Male	Female	Total	Male	Female	Total
14 and Under	1.212	1.514	1.248	1.103	1.499	1.154
15-19	0.957	0.526	0.849	1.532	1.212	1.462
20-24	1.311	0.985	1.228	2.242	1.494	2.046
25-34	1.806	1.316	1.695	1.266	0.743	1.106
35-44	1.701	0.805	1.464	1.261	0.494	1.074
45-54	2.428	0.859	1.922	1.804	1.002	1.629
55-64	2.128	1.243	1.840	1.840	1.783	1.724
65-69	1.082	0.649	0.901	1.171	0.227	0.851
70 and Older	0.826	1.478	0.878	0.718	0.608	0.634
Total	1.572	0.998	1.613	1.466	0.968	1.528

For all age cohorts, there are notable differences in exposure and crash outcomes between male and female cyclists. While for female cyclists, the rates of crash occurrences are somewhat similar in lower and higher-income areas, particularly in the age groups between 20 to 24 and 35-54, male cyclists of all age cohorts in lower-income communities are at a disproportionately high risk. Lower-income males are likely more reliant on bicycles to accomplish basic trip objectives, which have less route flexibility than recreational cycling.

The higher incidence of bicycle collisions in lower-income areas is also likely attributable, at least in part, to socio-economic distinctions in the nature of bicycle use. Culturally, cyclists in more affluent areas are more likely to cycle for health and recreational purposes rather than utilitarian ones. Recreational cycling among affluent populations is often accompanied by the use of protective equipment, such as helmets and other protective gear, which may further mitigate their overall risk of death and injury. Additionally, affluent populations would appear to be more likely to participate in a community of recreational cyclists, which likely leads to the diffusion of specific road safety behaviors, such as vehicular bicycling tactics, that may further reduce their overall levels of risk.

By contrast, lower-income populations are more likely to use bicycles for utilitarian purposes, rather than recreational ones. Their route choices are also more likely to be governed by shortest path considerations, rather than comfort or safety. It is further likely that economic or cultural issues may make members of this cohort less likely to purchase or use protective equipment (Macpherson et al. 2006), thus leading to the heightened incidence of severe crashes reported in these findings. At least some portion of this difference may be simply a function of lower rates of bicycle use in affluent areas, particularly among driver-age populations.

Figure 2 displays the results from the hotspot analysis using the Getis-Ord Gi* test statistic. Crash counts at the census block group level were used as the input value for the calculation of the Gi* test statistic and the associated standardized scores (z-scores) and p-values. The results highlight two particular areas of concern with a high level of clustering of crash counts. In Broward County, the highest concentration of vehicle-pedestrian and vehicle-cyclist collisions (hotspots at the 99% confidence level) is observed in Fort Lauderdale, Lauderhill, North Lauderdale, Oakland Park, and Wilton Manors. Additional clusters of crashes (hotspots at the 95% and 90% confidence levels) are found in Pompano Beach, Lauderdale Lakes, Davie, Plantation, West Park, and Dania Beach. In Miami-Dade County, low-income census block groups in the western part of the City of Miami, North Miami, Hialeah, Opa-Locka, and Sweetwater are associated with the highest concentration of crashes involving pedestrians and cyclists. While these results indicate a disproportionately high burden of pedestrian and bicycle crashes on population health in the low-income communities, they also suggest that the burden is not equally distributed across the more impoverished neighborhoods. The outcomes are associated with exposure to the risk of a crash. Morancy et al. (2012) suggest that risk exposure is driven by (1) the traffic volumes on streets and intersections in low-income areas, and (2) the number of pedestrians and cyclists exposed, and (3) environmental factors. Combined, these factors exert a strong influence on the likelihood of crash risk for pedestrians and cyclists in lower-income areas (Morancy et al., 2012). While the underlying risk factors for low-income and minority populations have drawn much attention, various groups' exposure warrants a stratified approach that can highlight the differences in relative risk by age, gender, or time of the day at specific locations.

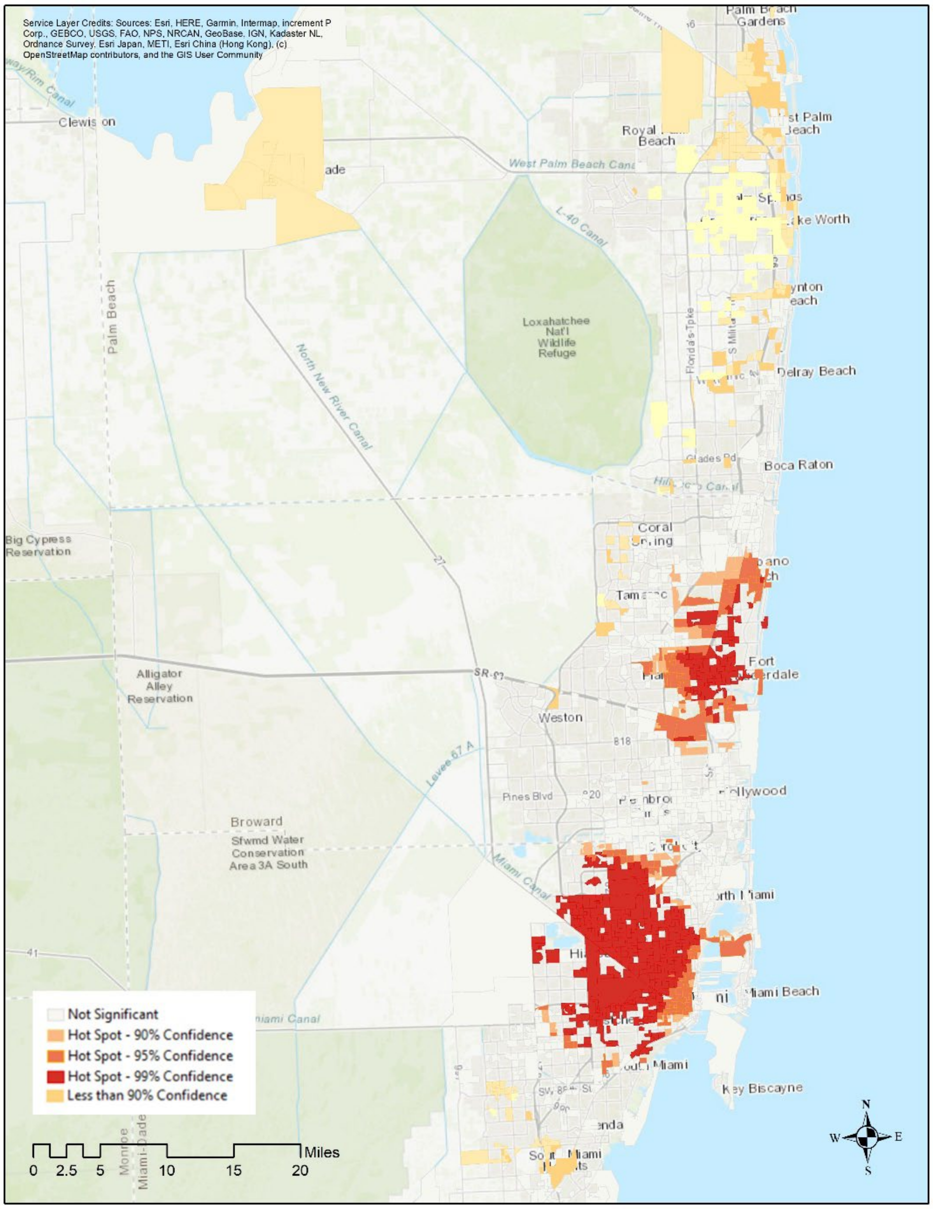

Figure 2. Hotspots of crash counts at the block group level involving pedestrians and cyclists in South Florida's low-income communities

3.3 At-Risk Pedestrian Cohorts in Lower-Income Areas

Over the study period (2015-2017), a total of 5,757 vehicle-pedestrian collisions are reported in lower-income communities, involving a total of 6,157 pedestrians (Table 2). Of these, 56.6% are killed or severely injured (3,116 severe injuries and 367 fatalities). Demographic information is available for 3,966 pedestrians involved in a collision and 3,322 pedestrians involved in an accident resulting in death or severe injury. Nearly 56% of all pedestrian collisions occurred in Miami-Dade County, followed by Broward County (29.5%) and Palm Beach County (14.7%) (Table A.29).

Table 7 summarizes the number of collisions involving pedestrians in lower-income areas, classified by time-of-collision and age. The largest number of pedestrians involved in a collision is associated with the age cohorts of 45-54 and 55-64, followed by those aged 25-34. Adults aged 25 to 64 are involved in approximately 59% of all collisions. These age cohorts also account for 37% of all pedestrians killed or injured in a car accident (Table 8). Across all age cohorts, the afternoon and early evening periods (3:00 PM – 9:00 PM) are associated with the highest number of pedestrians involved in a car crash. Pedestrians in the age group of 25-34 are involved in the highest number of vehicle-pedestrian collisions during the time interval from 9:00 PM to 3:00 AM.

Table 7: Pedestrians Involved in a Collision in Lower-Income Areas, by Age and Time-of-Day

Age Group	Time of Day								Total	Pct.
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
14 and under	5	1	51	23	48	97	89	14	328	8.30%
15-19	15	7	51	18	39	62	47	37	276	6.90%
20-24	25	21	29	31	43	54	60	41	304	7.70%
25-34	63	44	64	61	81	83	129	88	613	15.50%
35-44	28	22	51	58	75	81	104	70	489	12.30%
45-54	27	20	67	85	99	108	133	77	616	15.50%
55-64	21	17	59	81	103	113	155	75	624	15.70%
65-69	4	4	26	39	38	46	33	13	203	5.10%
70 and older	2	9	64	141	97	71	103	26	513	12.90%
Total	190	145	462	537	623	715	853	441	3966	
Pct.	4.80%	3.70%	11.70%	13.50%	15.70%	18.00%	21.50%	11.10%		
Unknown	93	76	278	268	302	393	477	304	2191	35.59%
Total	283	221	740	805	925	1108	1330	745	6157	
Pct.	4.60%	3.59%	12.02%	13.07%	15.02%	18.00%	21.60%	12.10%	100.00%	

Male pedestrians are more likely to be involved in a crash, accounting for 58.7% of the total collisions (Table A.34), while comprising 48.5% of the population of lower-income block groups. Unlike most other age cohorts, pedestrians 70 and older are more likely to be struck by a motor vehicle from 9:00 AM to noon (Table 7). This trend is present in the data for both collision totals and collisions resulting in death or severe injury (Table 8).

Table 8: Pedestrians Killed or Seriously Injured in Lower-Income Areas, by Time-of-Day and Age

Age Group	Time of Day								Total	Pct.
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
14 and under	3	1	23	10	28	46	47	11	169	5.1%
15-19	10	4	26	7	18	34	24	30	153	4.6%
20-24	17	17	11	17	23	32	36	30	183	5.5%
25-34	44	31	35	23	43	33	64	53	326	9.8%
35-44	18	9	26	19	35	41	64	40	252	7.6%
45-54	16	10	35	40	48	50	77	41	317	9.5%
55-64	13	12	31	45	48	53	92	43	337	10.1%
65-69	3	4	13	21	15	24	17	7	104	3.1%
70 and older	1	6	39	86	43	45	72	15	307	9.2%
Total	185	145	370	399	438	539	778	468	3322	100.0%
Pct.	5.6%	4.4%	11.1%	12.0%	13.2%	16.2%	23.4%	14.1%	100.0%	

Based on an examination of the demographic and temporal distribution of pedestrian and bicycle collisions, we identified four discrete patterns of pedestrian risk:

(1) *school trips and after-school activities:* pedestrians aged 14 and under, 6 am to 9 am and 3 pm to 9 pm, weekdays;

(2) daily activities *during the early evening*: pedestrians aged 20 and older, 6 pm to 9 pm;

(3) *active older adults*: pedestrians aged 70 and older, 9 am to 9 pm; and

(4) *young adults*: pedestrians aged 25-34, 6 pm to midnight

Each is discussed in detail below. Our findings suggest that pedestrian use of alcohol or drugs is not a major factor in these collisions, an issue that is examined in further detail later in this report.

School Trips and After-School Activities (Children Aged 14 and Under, Mornings, Afternoons, and Early Evening)

During the study period, a total of 328 children pedestrians aged 14 and under, or 8.3% of the total, are involved in a traffic collision. Of these, 140 resulted in a serious injury, and 11 resulted in a fatality. Most of the collisions occur at the beginning of the school day (6:00 AM to 9:00 AM), at the end of the school day (3:00 PM to 6:00 PM), and in the early evening hours (6:00 PM to 9:00 PM). Specific clusters of vehicle-pedestrian collisions affecting children 14 and younger are found in the afternoon hours (3:00 PM to 6:00 PM) on Fridays and Saturdays (see Table 9).

Table 9: Pedestrians Aged 14 and Under Involved in a Collision in Lower-Income Areas, by Time-of-Day and Day-of-Week

	Time of Day								Total	Pct.
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
Monday	0	1	1	0	7	10	6	3	28	8.5%
Tuesday	0	0	3	6	2	15	12	3	41	12.5%
Wednesday	2	0	14	5	4	7	12	2	46	14.0%
Thursday	0	0	13	3	12	14	12	0	54	16.5%
Friday	0	0	11	1	8	20	16	1	57	17.4%
Saturday	0	0	8	2	7	20	17	3	57	17.4%
Sunday	3	0	1	6	8	11	14	2	45	13.7%
Total	5	1	51	23	48	97	89	14	328	100.0%
Pct.	1.5%	0.3%	15.5%	7.0%	14.6%	29.6%	27.1%	4.3%	100.0%	

Among school-aged children, 59.5% of the vehicle-pedestrian collisions involve males, and 39.9% involve females (see Table 10). Male pedestrians aged 14 and under are particularly at risk from 3:00 PM to 9:00 PM. During this time interval, vehicle-pedestrian collisions affected 113 (60.1%) male pedestrians compared to 72 (38.7%) female pedestrians. Crashes involving pedestrians aged 14 and under appear to be clustered at the beginning and end of the school day. There is also a pattern of clustering associated with after-school activities undertaken in the late afternoon and early evening.

Table 10: Pedestrians Aged 14 and Under Involved in a Collision in Lower-Income Areas, by Sex and Time-of-Day

Time of Day	Male	Female	Total	Pct.
Midnight to 3 am	4	1	5	1.5%
3 am to 6 am	0	1	1	0.3%
6 am to 9 am	31	20	51	15.5%
9 am to noon	13	10	23	7.0%
Noon to 3 pm	26	21	48	14.6%
3 pm to 6 pm	57	39	97	29.6%
6 pm to 9 pm	56	33	89	27.1%
9 pm to midnight	8	6	14	4.3%
Total	195	131	328	100.0%
Pct.	59.5%	39.9%	100.0%	

Figure 3 displays hotspot locations for vehicle-pedestrian collisions involving persons aged 14 and under. The hotspots are predominantly clustered in the northern part of Miami-Dade County, including the cities of Miami, North Miami, Hialeah, and Hialeah Gardens. In Broward County, hotspots of vehicle-pedestrian collisions involving child pedestrians aged 14 and under are primarily found in Lauderhill and the western parts of Fort Lauderdale.

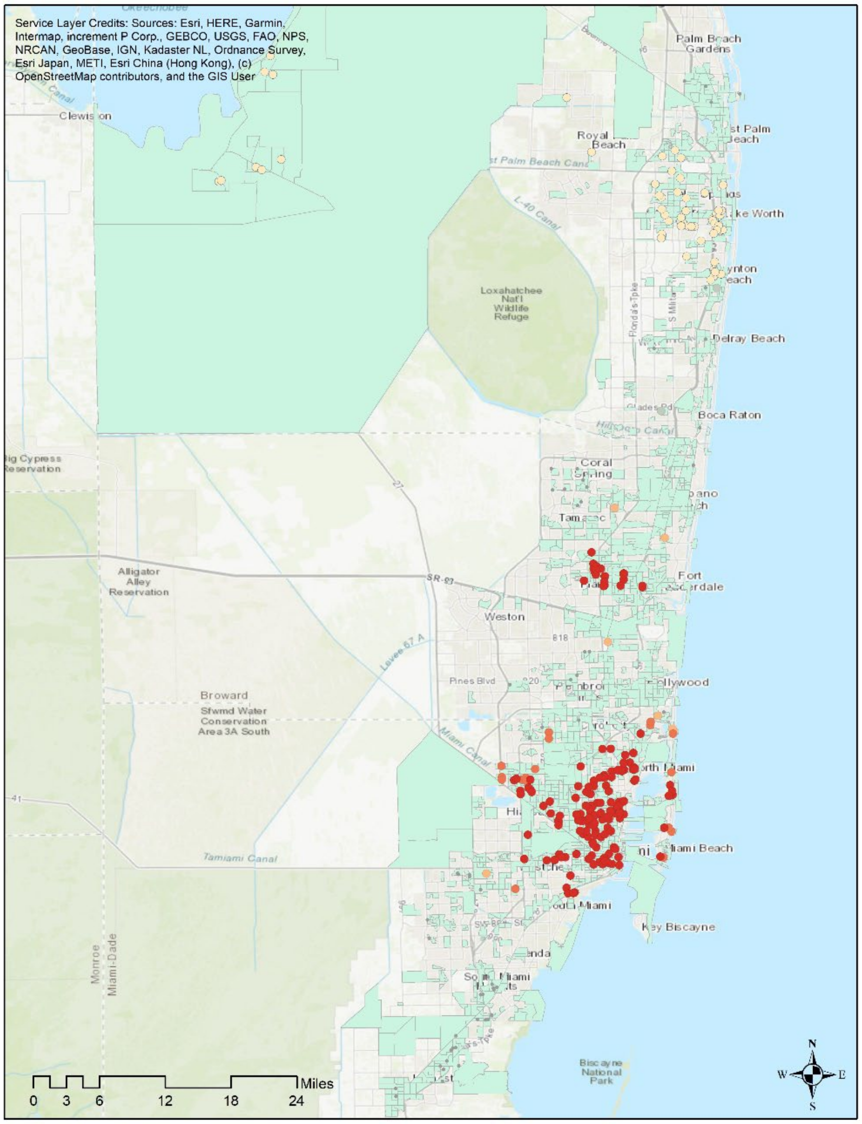

Figure 3. Hotspots of vehicle-pedestrian collisions involving child pedestrians aged 14 and under

Errands During the Early Evening (20 and Older, 6:00 PM – 9:00 PM)

Nearly 68.0% of all collisions involving pedestrians in lower-income areas occur during the active hours of the day, from 9:00 AM to 9:00 PM. As shown in Table 7, nearly 40% of all pedestrian collisions occur during the time interval from 3:00 PM to 9:00 PM. A considerable number of collisions (28.1%) occur between 9:00 AM and 3:00 PM. The time period between 6:00 PM and 9:00 PM is also of concern as 21.6% of all vehicle-pedestrian collisions occur during this time period. The numbers of pedestrian deaths and serious injuries for each age group and time period, shown in Table 8, also indicate that the largest number of severe injuries and fatalities occur during the time period from 6:00 PM to 9:00 PM (23.4% of the total).

Our data do not support the assumption that drugs or alcohol play a role in these collisions. Of the 1,108 pedestrians involved in a crash during the time period from 3:00 PM to 6:00 PM, only 24 (2.2%) are believed to be under the influence of drugs or alcohol (See Table 12 under *Drugs and Alcohol*, below). Out of 1,330 pedestrians involved in a collision during the active dining hours between 6:00 PM and 9:00 PM, only 84 (6.3%) are suspected of being under the influence of drugs and alcohol. These results suggest that the increased incidence of pedestrian collisions during the early evening period is most likely attributable to routine travel behaviors rather than drug and alcohol use.

Spatial clustering patterns of pedestrian crashes involving individuals over the age of 20 are shown in Figure 4. The highest concentrations of collisions involving adult pedestrians are found along major corridors and near employment centers in the low-income areas in the northern and central parts of Miami-Dade County and the central and southern parts of Broward County. Figure 5 shows that pedestrian crashes during the peak time interval from 3:00 PM to 6:00 PM exhibit a similar pattern. These travel behaviors coincide with the tail end of the PM peak period and most likely entail travel to household-supporting destinations, such as groceries, restaurants, shopping, or services. The observed levels of pedestrian activity can be attributed to the density, scale, and design characteristics of the adjacent urban development, the employment characteristics of the area, and the socio-economic characteristics of the local population. The service super-sector, which dominates the local economy, is more likely to employ lower-income populations who are also more likely to walk or bike to work. This phenomenon is further explored as part of the examination of environmental risk factors, below.

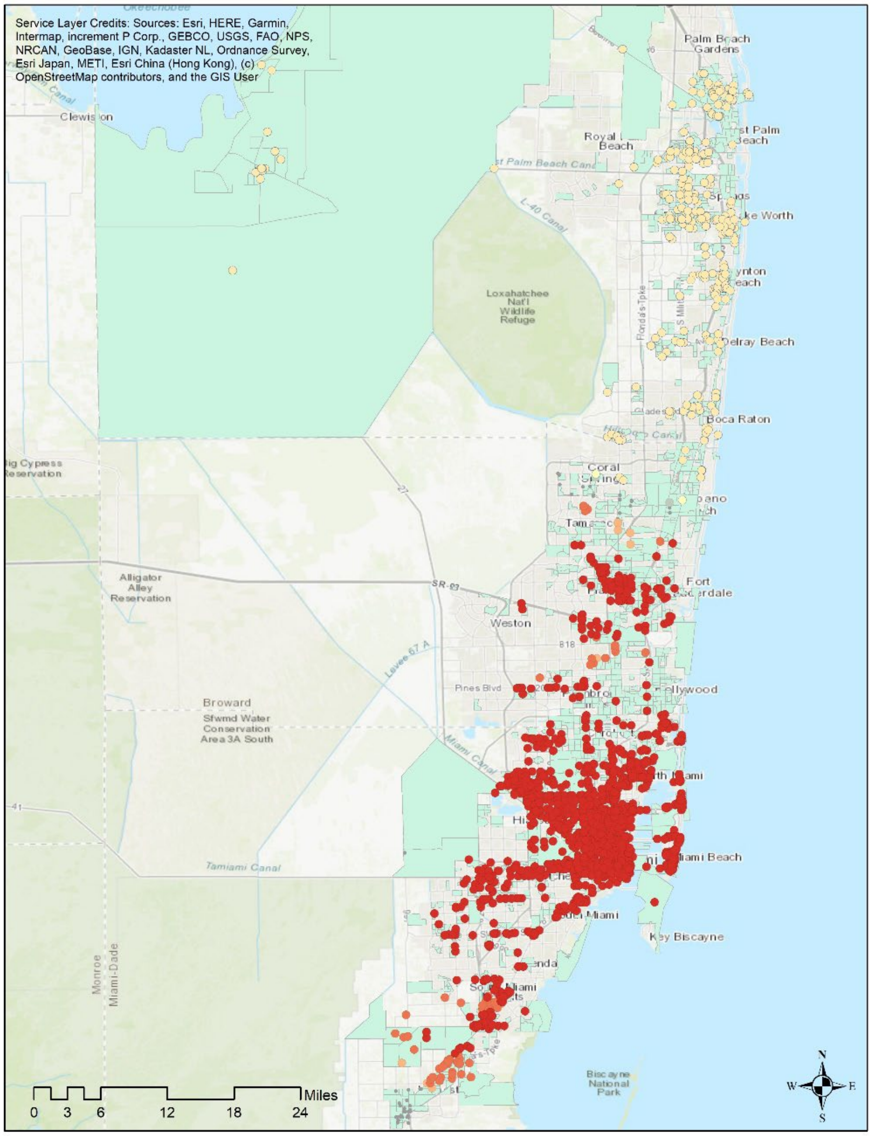

Figure 4. Hotspots of vehicle-pedestrian collisions involving adult pedestrians (aged 20+)

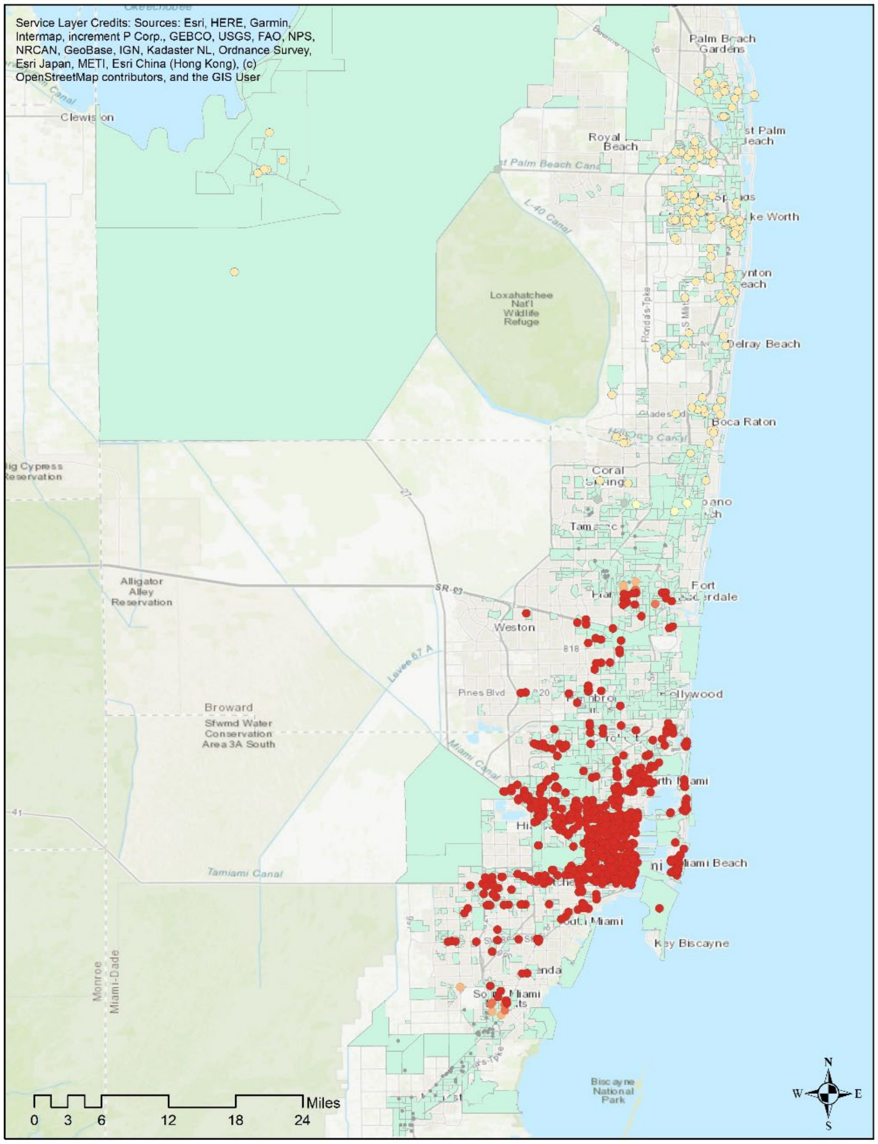

Figure 5. Hotspots of vehicle-pedestrian collisions involving adult pedestrians (aged 20+) between 3 pm and 6 pm

Active Older Adults (55-64 and 70 and Older, Midday and Early Evening)

Older adults aged 70 and over are involved in 12.9% of all pedestrian collisions, with 9.2% of these collisions resulting in death or severe injury. Pedestrians aged 70 and older are also associated with the highest ratio of the total number of pedestrian collisions to the number of killed and severely injured except those aged 20-24. Several factors may have contributed to these outcomes. Older adults are at a higher risk of injury as a result of increased frailty associated with aging (O'Hern et al., 2015; Niebuhr et al., 2016). Moreover, present-day older adults tend to maintain mobility and remain physically active later in life relative to their counterparts a decade or two ago (O'Hern et al., 2015). These two factors – higher levels of activity and frailty associated with aging, make older pedestrians uniquely vulnerable in a crash event. As shown in Tables 7 and 8, collisions involving older pedestrians largely occur during the hours that follow the AM and PM peak periods (9:00 AM to noon and 6:00 PM to 9:00 PM), though total and KSI crashes increase notably during the late afternoon and early evening periods (3:00 PM to 9:00 PM). The age cohorts of 45-54 and 55-64 account for the largest number of pedestrian collisions for both the total number of collisions and collisions resulting in a fatality or severe injury. The highest number of vehicle-pedestrian collisions in these age groups occurs during the time period from 6:00 PM to 9:00 PM. The afternoon hours are more critical for adults aged 45-64 than the morning hours, with 56.3% of all KSI collisions occurring between noon and 9 pm. Figures 6 and 7 show the results from the hotspot analysis for the locational characteristics of the vehicle-pedestrian collisions involving older adults.

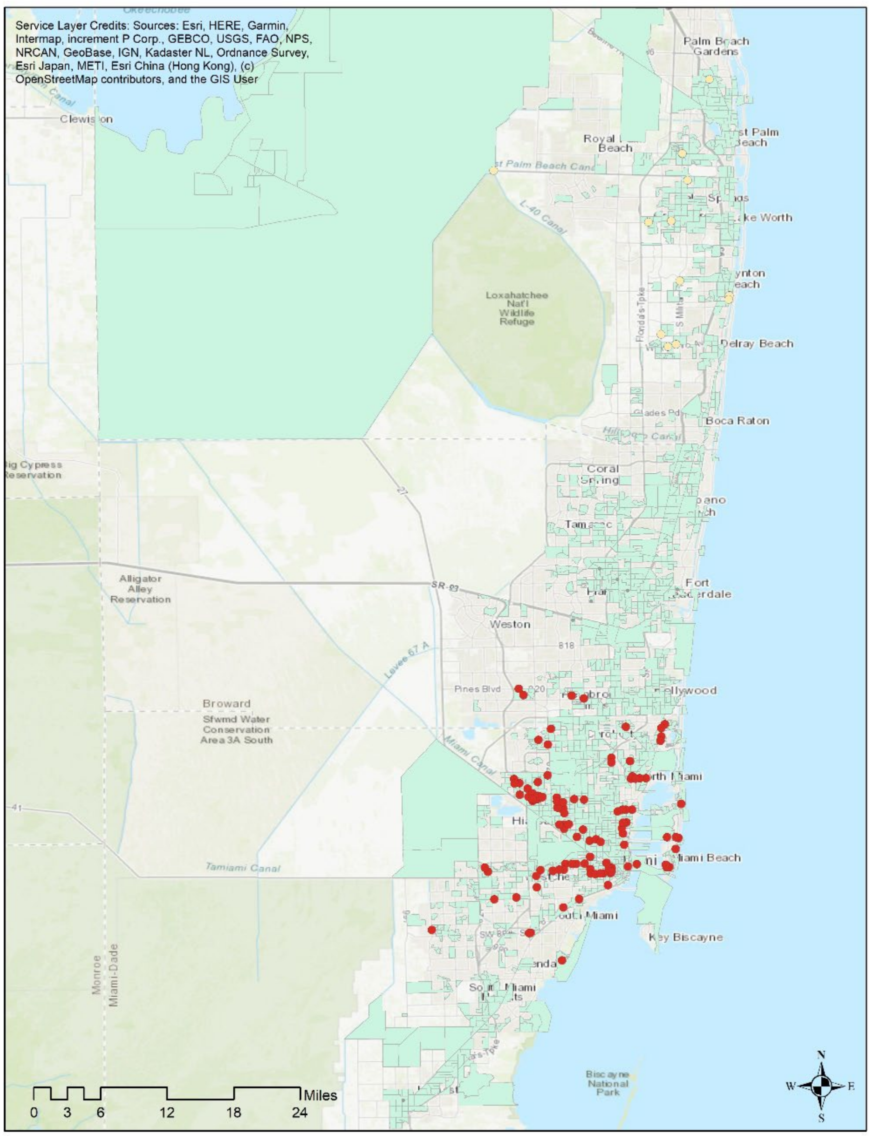

Figure 6. Hotspots of vehicle-pedestrian collisions involving older pedestrians (aged 70+) between 9 am and noon

Figure 6 shows hotspots of vehicle-pedestrian collisions involving older adults aged 70 and older between 9 am and noon. The highest concentrations of these crashes are found in Miami, Miami Beach, Hialeah, Opa-Locka, and Hialeah Gardens. Figure 7 displays crash hotspots for pedestrians aged 55 and older during the time interval from 3 pm to 9 pm. The pattern is consistent with the observed hotspots for all other age groups (20+), with the highest number of collisions occurring in Miami, Miami Beach, North Miami Beach, and Hialeah.

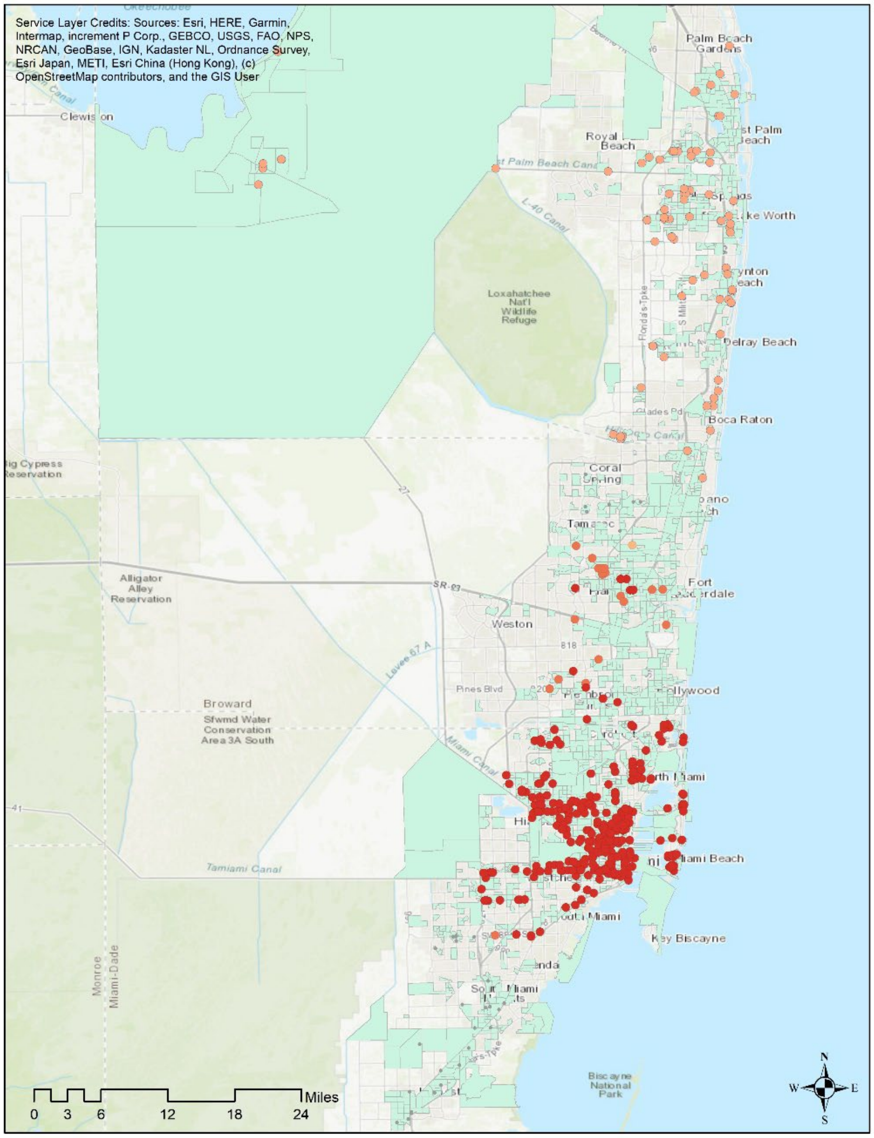

Figure 7. Hotspots of vehicle-pedestrian collisions involving older pedestrians (aged 55-69 and 70+) between 3 pm and 9 pm

Differences have been observed in the dynamics of temporal risk distribution across adults aged 45-64 and those who are 70 and older. Nearly 46.4% of all pedestrian collisions involving active adults aged 70 and older, or 238 out of 513, occur between 9:00 AM and 3:00 PM. Approximately 34% of these collisions occur between 3:00 PM and 9:00 PM. Similarly, older adults are most at risk of being involved in an accident resulting in a fatality or severe injury during the time intervals from 9:00 AM to noon and 6:00 PM to 9:00 PM. Both time intervals account for 51.5% of all collisions in which adults 70 and older are killed or severely injured. The time period between noon and 6 pm accounts for 28.7% of all collisions associated with a fatality or a severe injury of pedestrians aged 70 and older.

Young Adults (Persons Aged 25-34, 6:00 PM to Midnight)

Adults between the ages of 25-34 are twice as likely to be struck by a vehicle than those aged 20-24 and 1.3 times more likely to be involved in a pedestrian crash than those between the ages of 35 and 44. The largest number of pedestrians in this age group involved in a collision occurs during the evening hours (6:00 PM to midnight), accounting for 35.4% of all vehicle-pedestrian collisions in this age group. The age group is also over-represented in pedestrian collisions occurring between 9:00 PM and 3:00 AM. Almost half of all pedestrian collisions involving younger adults aged 25-34 result in a fatality or severe injury. The prevalence of pedestrian crashes involving this cohort is likely attributable to increased exposure associated with social and recreational activities, particularly for unmarried adults without children.

While fewer female pedestrians of this age cohort are involved in collisions (41.6%), their numbers are equal to that of males during the 6:00 AM to 9:00 PM period (see Table 11). The data suggest that male pedestrians are more active in the late evening than females. The use of alcohol or drugs does not appear to be a significant contributing factor. The proportion of pedestrians suspected to be under the influence of drugs or alcohol is similar to, or slightly less than, other adult age cohorts. Out of a total of 613 pedestrians struck by a vehicle in the 25-34 age group, 47 (7.7%) are suspected of using drugs or alcohol. Most of these are found in the late evening hours. Only five pedestrians between the ages of 25-34 are suspected of using drugs or alcohol during the 6:00 PM to 9:00 PM period (see Table 12).

Table 11: Pedestrians Aged 25-34 Involved in a Collision, by Time-of-Day and Sex

Time of Day	Male	Female	Total	Pct.
Midnight to 3 am	46	17	63	10.3%
3 am to 6 am	36	8	44	7.2%
6 am to 9 am	33	31	64	10.4%
9 am to noon	35	26	61	10.0%
Noon to 3 pm	39	41	81	13.2%
3 pm to 6 pm	46	37	83	13.5%
6 pm to 9 pm	62	67	129	21.0%
9 pm to midnight	60	28	88	14.4%
Total	357	255	613	100.0%
Pct.	58.2%	41.6%	100.0%	

Spatial clustering patterns of vehicle-pedestrian collisions involving young adults aged 25-34 between 6 pm and midnight are shown in Figure 8. The spatial distribution of crashes indicates higher frequencies along the arterial thoroughfare and in and around commercial land uses. We aggregated commercial parcels to a block group level and intersected with the crash data records in the age cohort of 25-34. The results validated our assumption that the majority of these crashes occurred nearby commercial land uses.

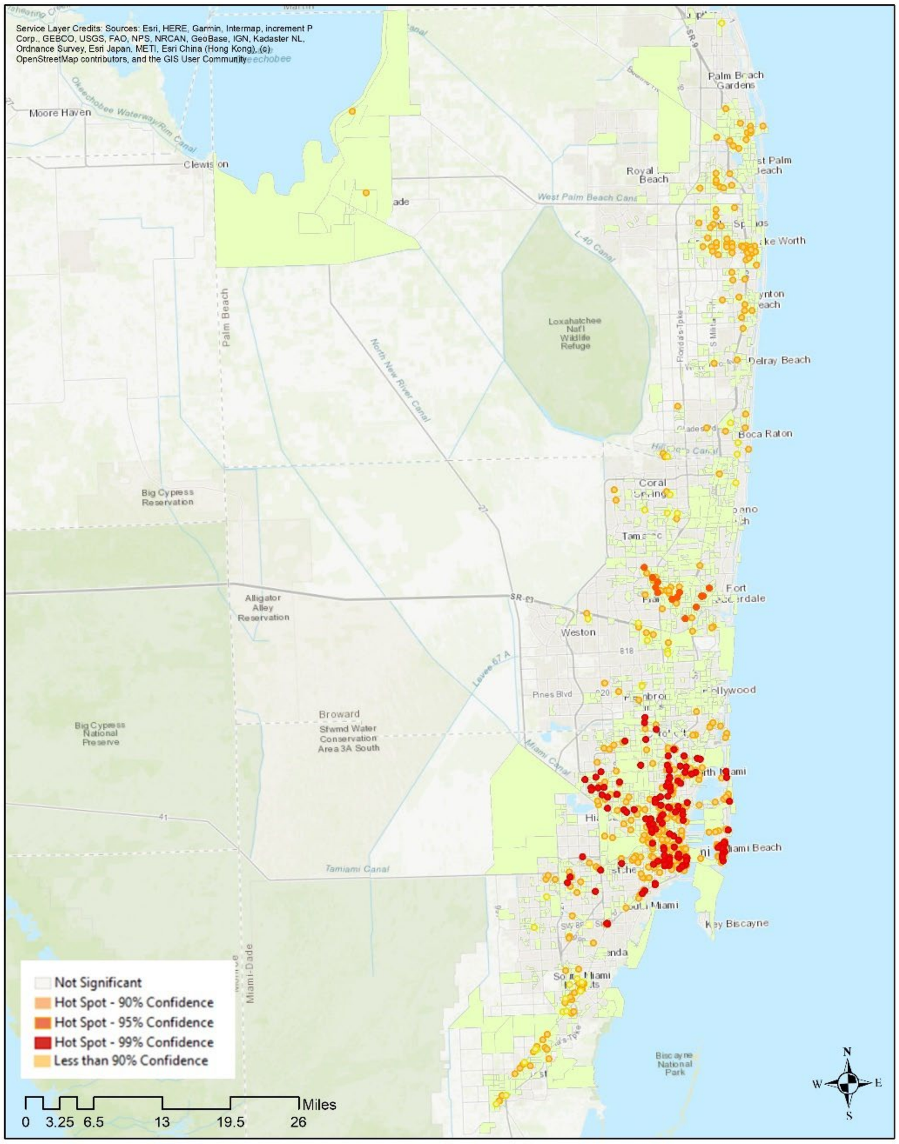

Figure 8. Hotspots of vehicle-pedestrian collisions involving younger adults (aged 24-35) between 6 pm and midnight)

Reconsidering the Role of Drugs and Alcohol on Pedestrian Crash Incidence

A common misconception is that drugs and alcohol are major contributing factors to the increased risk of pedestrian crashes in lower-income areas. Our findings do not support this assumption. We examined officer-reported suspected use of drugs or alcohol in 6,157 records. Of these, 319 included a reference of alcohol use or 5.2% of the total, and 42 were reported as involving drug use, or 0.7% of the total. Only 5.9% of the total number of pedestrians involved in a collision were suspected of being under the influence of drugs or alcohol. Table 12 below summarizes the data on pedestrians suspected of using drugs and alcohol at the time of the crash in lower-income areas. The percentages shown in Table 12 are derived from the frequencies shown in Table 7.

Table 12: Number and Percentage of Pedestrians Involved in a Collision Suspected of Being under the Influence of Drugs or Alcohol, by Age and Time-of-Day

Age Group	Time of Day								Total
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight	
14 and under	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
15-19	4 (26.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (8.1%)	7 (2.5%)
20-24	6 (24.0%)	6 (28.6%)	1 (3.4%)	1 (3.2%)	0 (0.0%)	0 (0.0%)	3 (5.0%)	6 (14.6%)	23 (7.6%)
25-34	16 (25.4%)	9 (20.5%)	5 (7.8%)	0 (0.0%)	1 (1.2%)	0 (0.0%)	5 (3.9%)	11 (12.5%)	47 (7.7%)
35-44	2 (7.1%)	4 (18.2%)	2 (5.9%)	3 (5.2%)	2 (2.7%)	4 (4.9%)	8 (7.7%)	9 (12.9%)	33 (7.2%)
45-54	4 (14.8%)	1 (5.0%)	3 (3.0%)	3 (3.5%)	5 (5.1%)	4 (3.7%)	10 (7.5%)	15 (19.5%)	44 (7.1%)
55-64	4 (19.0%)	3 (17.6%)	0 (0.0%)	2 (2.5%)	4 (3.9%)	6 (5.3%)	7 (4.5%)	16 (21.3%)	42 (6.7%)
65-69	0 (0.0%)	0 (0.0%)	1 (3.8%)	0 (0.0%)	0 (0.0%)	1 (2.2%)	3 (9.1%)	2 (15.4%)	7 (3.4%)
70 and older	1 (50.0%)	0 (0.0%)	1 (1.6%)	1 (0.7%)	0 (0.0%)	1 (1.4%)	8 (7.8%)	3 (11.5%)	15 (2.9%)
Unknown	14 (15.1%)	10 (13.2%)	7 (2.5%)	3 (1.1%)	8 (2.6%)	8 (2.0%)	40 (8.4%)	51 (16.8%)	141 (6.4%)
Total	51	33	20	13	20	24	84	116	361
Pct.	18.0%	14.9%	2.7%	1.6%	2.2%	2.2%	6.3%	15.6%	5.9%

Most of the crashes in which a pedestrian is suspected of being under the influence of drugs or alcohol occur between 9:00 PM and 6:00 AM. Of all pedestrians involved in a crash during the evening hours (9:00 PM to midnight), 116 or 15.6% of the total number of pedestrians struck during this time period are suspected of being under the influence of drugs or alcohol. Additionally, 84 pedestrians (51 during the time period from midnight to 3:00 AM and 33 during the 3:00 AM to 6:00 AM period) or 32.9% (18.0% + 14.9%) of those involved in collisions between midnight and 6:00 AM were suspected of being under the influence of alcohol or drugs. In the evening hours from 6:00 PM to 9:00 PM, 84 or 6.3% of the pedestrians struck by a vehicle were suspected of being under the influence of drugs and alcohol. It should be noted that there are relatively fewer pedestrian collisions during the 6:00 AM to 6:00 PM time period. The incidence of alcohol and drug use resulting in pedestrian collisions is the highest among the adult population aged 25 to 64. Even among those groups, the incidence of drugs and alcohol during the 6:00 AM to 6:00 PM time period is relatively low. These results suggest that interventions aimed at reducing impaired driving, although beneficial, may not have a noticeable effect on changing pedestrian behaviors that result in increased crash risk.

3.4 At-Risk Cohorts: Cyclists

A total of 4,174 cyclists are involved in collisions in lower-income communities between 2015 and 2017. Of these,1960, or 46.9%, result in a fatality or severe injury (1,888 serious injuries and 72 fatalities). The incident proportions for age and gender cohorts were established using 2,426 records for which police accident reports provide demographic information. Information on cyclists that are killed or severely injured is shown in Table 14.

The overwhelming majority of cyclists involved in a collision in lower-income areas are male (84.4%) (Table A.56). Nearly all of these crashes (88.7%) occur between 6:00 AM and 9:00 PM. This finding suggests that these crashes are most likely associated with males using bicycles for work-related trips or utilitarian purposes, such as trips to groceries and shopping centers. Suspected use of alcohol or drugs is reported in only 62 of the 2,426 records, or 2.6% of the total crashes for which demographic information is provided. Therefore, neither alcohol nor drug use appears to be a significant contributing factor to the incidence of these crashes. Cyclists between the ages of 25 to 34 are at disproportionate risk of being involved in a collision or being killed or injured. Adults between the ages of 25 and 64 constitute 65.6% of all vehicle-cyclist crashes. Across all age cohorts, including children 14 and under, the highest number of collisions occurs between 3:00 PM and 6:00 PM (~25% of the total). For all age groups, the time period between 3:00 PM and 9:00 PM remains the most critical, with almost half of all collisions occurring during that time of the day. The same trend is observed with the vehicle-cyclist collisions resulting in a fatality or severe injury.

Table 13: Cyclists Involved in a Collision in Lower-Income Areas, by Age and Time-of-Day

Age Group	Time of Day								Total	Pct.
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
14 and under	1	0	14	17	17	65	38	2	154	6.30%
15-19	6	0	21	22	45	77	55	14	240	9.90%
20-24	9	3	29	33	47	71	47	22	261	10.80%
25-34	14	12	48	50	83	96	96	52	451	18.60%
35-44	7	8	63	44	54	77	69	23	345	14.20%
45-54	7	12	62	49	57	109	76	26	398	16.40%
55-64	15	6	47	68	75	91	73	24	399	16.40%
65-69	2	1	10	15	18	22	12	5	85	3.50%
70 and older	2	2	17	27	12	20	10	3	93	3.80%
Unknown	27	25	238	246	331	420	318	143	1748	41.88%
Total	90	69	549	571	739	1048	794	314	4174	100.00%
Pct.	2.16%	1.65%	13.15%	13.68%	17.70%	25.11%	19.02%	7.52%	100.00%	

Table 14: Cyclists Killed or Seriously Injured in Lower-Income Areas, by Time-of-Day and Age

Age Group	Time of Day								Total	Pct.
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
14 and under	1	0	12	11	16	58	34	0	132	6.60%
15-19	5	0	17	22	35	70	50	14	213	10.60%
20-24	8	3	27	29	39	59	42	17	224	11.10%
25-34	11	11	39	41	67	75	76	45	365	18.10%
35-44	6	7	49	35	49	57	59	18	280	13.90%
45-54	5	10	49	44	43	84	66	20	321	15.90%
55-64	12	5	42	57	55	73	65	16	325	16.10%
65-69	2	1	9	12	15	20	10	5	74	3.70%
70 and older	2	2	17	22	10	15	8	3	79	3.90%
Total	52	39	261	273	329	511	410	138	2013	100.0%
Pct.	2.60%	1.90%	13.00%	13.60%	16.30%	25.40%	20.40%	6.90%	100.0%	

Two at-risk populations are identified based on the demographic and temporal distribution of these collisions:

1. *After-school activities*: cyclists 19 and under, 3 to 6 pm, weekdays.
2. *Adult utilitarian bicycling*: cyclists aged 20-64, 6 am to 9 pm.

Afterschool Activity (Persons Aged 19 and Under, 3:00 PM to 6:00 PM)

The proportion of bicycle crashes involving persons aged 19 and younger is about 16.2% of the total number of bicycle crashes. This percentage is lower than their percentage representation within the population as persons aged 19 and younger comprise 23.4% of the total population in the lower-income block groups of the tri-county area. The time period between 3:00 PM and 6:00 PM accounts for 36% of all bicycle crashes involving persons aged 19 and younger. Notably, 90.2% of all cyclists involved in a collision in this age group result in a fatality or severe injury (212 out of 235).

Table 15 shows the distribution of the number of cyclists struck by a vehicle among persons aged 19 and under by time of the day and day of the week. The majority of the cyclists involved in a collision in this age group are struck by a vehicle on Wednesdays, Thursdays, and Fridays. Bicycle collisions over these three days account for nearly half of all records specific for this age cohort. Wednesdays are associated with the highest number of crashes compared to all other days of the week. Nearly 60% of all cyclists in this age group are struck between 3:00 PM and 9:00 PM.

Table 16 shows that 80.5% of all cyclists aged 19 and under who are involved in a collision are male, with female cyclists accounting for only 19.5%. Male cyclists of this age cohort are over-represented in all time intervals, with the highest risk occurring between 3:00 PM and 9:00 PM. Figure 9 presents the hotspots of vehicle-cyclist collisions involving persons aged 19 and younger. The spatial patterns suggest an almost even distribution across the tri-county area with multiple small clusters scattered near major arterial roads.

Table 15: Cyclists Aged 19 and Under Involved in a Collision in Lower-Income Areas, by Time-of-Day and Day of the Week

	Time of Day							Total	Pct.	
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
Monday	0	0	0	3	9	11	19	2	44	11.2%
Tuesday	0	0	2	5	7	25	14	5	58	14.7%
Wednesday	2	0	9	5	8	26	19	1	70	17.8%
Thursday	1	0	9	5	10	21	9	5	60	15.2%
Friday	1	0	8	5	7	22	12	1	56	14.2%
Saturday	1	0	3	5	12	21	13	0	55	14.0%
Sunday	2	0	4	11	9	16	7	2	51	12.9%
Total	7	0	35	39	62	142	93	16	394	100.00%
Pct.	1.8%	0.00%	8.9%	9.9%	15.7%	36.0%	23.6%	4.1%	100.00%	

Table 16: Cyclists 19 and Under Involved in a Collision in Lower-Income Areas, by Sex and Time-of-Day

Time of Day	Male	Female	Total	Pct.
Midnight to 3 am	6	1	7	0.6%
6 am to 9 am	28	7	35	9.1%
9 am to noon	33	6	39	11.0%
Noon to 3 pm	55	7	62	11.0%
3 pm to 6 pm	115	27	142	42.2%
6 pm to 9 pm	78	15	93	24.7%
9 pm to midnight	12	4	16	1.3%
Total	326	67	394	100.0%
Pct.	80.5%	19.5%	100.0%	

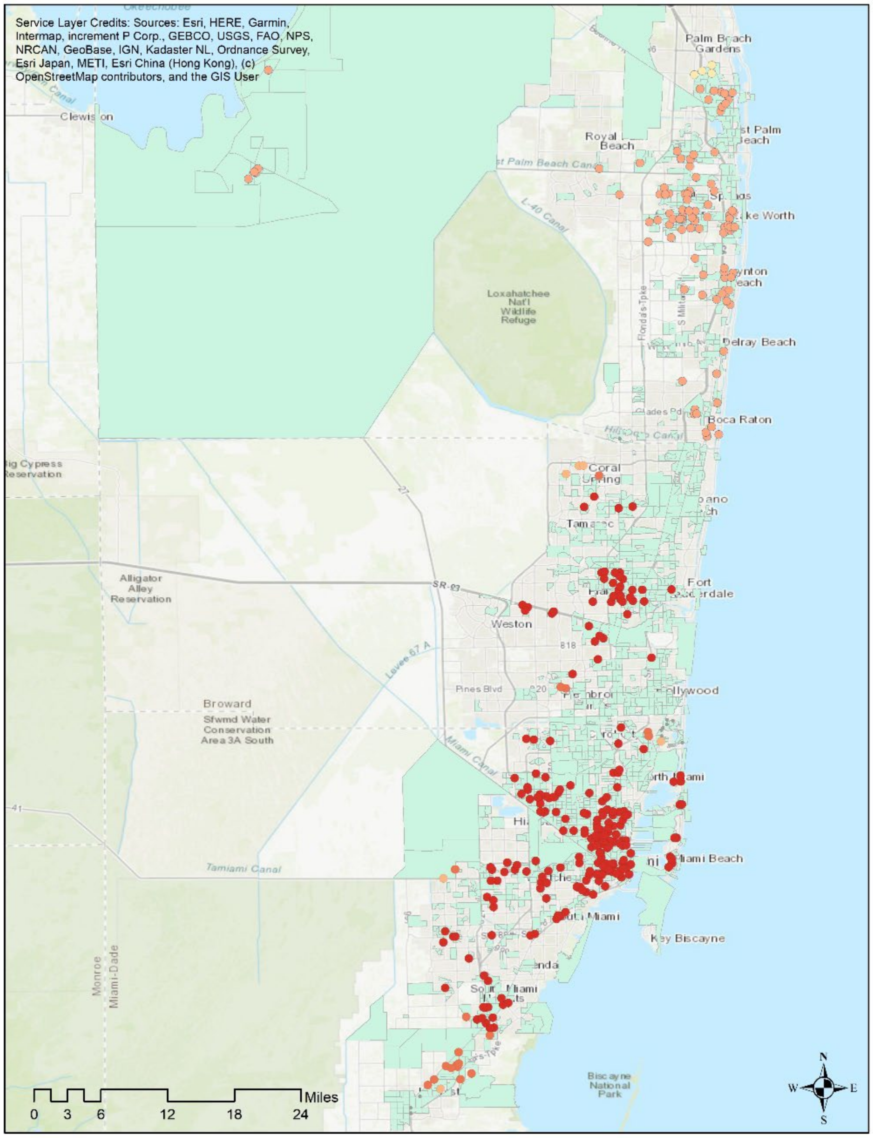

Figure 9. Hotspots of vehicle-cyclist collisions involving persons aged 19 and under

Adult Utilitarian Bicycling

Bicycle crashes are distributed uniformly across the working-age populations between 6:00 AM and midnight (Table 13). Male cyclists comprise 87.6% of all vehicle-cyclist collisions in low-income areas (Table 18). As Table 17 indicates, male cyclists aged 25-34 are at disproportionately high risk, particularly between 3:00 PM and 9:00 PM. The increased number of collisions appears to be associated with exposure to the evening rush hour traffic. The effect of this exposure seems to be amplified by secondary trip ends most likely associated with short trips to nearby destinations such as groceries, restaurants, or shopping venues.

Table 17: Cyclists Aged 25-34 Involved in a Collision, by Time-of-Day and Sex

Time of Day	Male	Female	Total	Pct.
Midnight to 3 am	13	1	14	3.1%
3 am to 6 am	12	0	12	2.7%
6 am to 9 am	35	13	48	10.6%
9 am to noon	38	12	50	11.1%
Noon to 3 pm	61	21	83	18.4%
3 pm to 6 pm	77	19	96	21.3%
6 pm to 9 pm	68	27	96	21.3%
9 pm to midnight	47	5	52	11.5%
Total	351	98	451	100.0%
Pct.	77.8%	21.7%	100.0%	

Table 18: Cyclists Aged 35-64 Involved in a Collision, by Time-of-Day and Sex

Time of Day	Male	Female	Total	Pct.
Midnight to 3 am	27	2	29	2.5%
3 am to 6 am	25	0	26	2.3%
6 am to 9 am	156	16	172	15.1%
9 am to noon	135	26	161	14.1%
Noon to 3 pm	160	26	186	16.3%
3 pm to 6 pm	240	36	277	24.3%
6 pm to 9 pm	191	27	218	19.1%
9 pm to midnight	66	6	73	6.4%
Total	1000	139	1142	100.0%
Pct.	87.6%	12.2%	100.0%	

Figures 10 and 11 show hotspots of vehicle-cyclist collisions involving persons aged 25-64 based on the total number of such crashes and those that occur between 3:00 PM and 9:00 PM. The spatial clustering patterns are consistent with the observed patterns for vehicle-pedestrian collisions. The observed levels of walking and biking activities can be attributed to the density, design, and employment characteristics of the adjacent urban areas, which increase the exposure of non-motorists to incoming traffic. The temporal distribution of the bicycle crashes is consistent with lower-income populations being employed in the service sector, where working hours begin and end later than conventional commuting periods. The increased frequency of bicycle crashes occurring in lower-income communities most likely involves the use of bicycles for utilitarian purposes, especially by male residents.

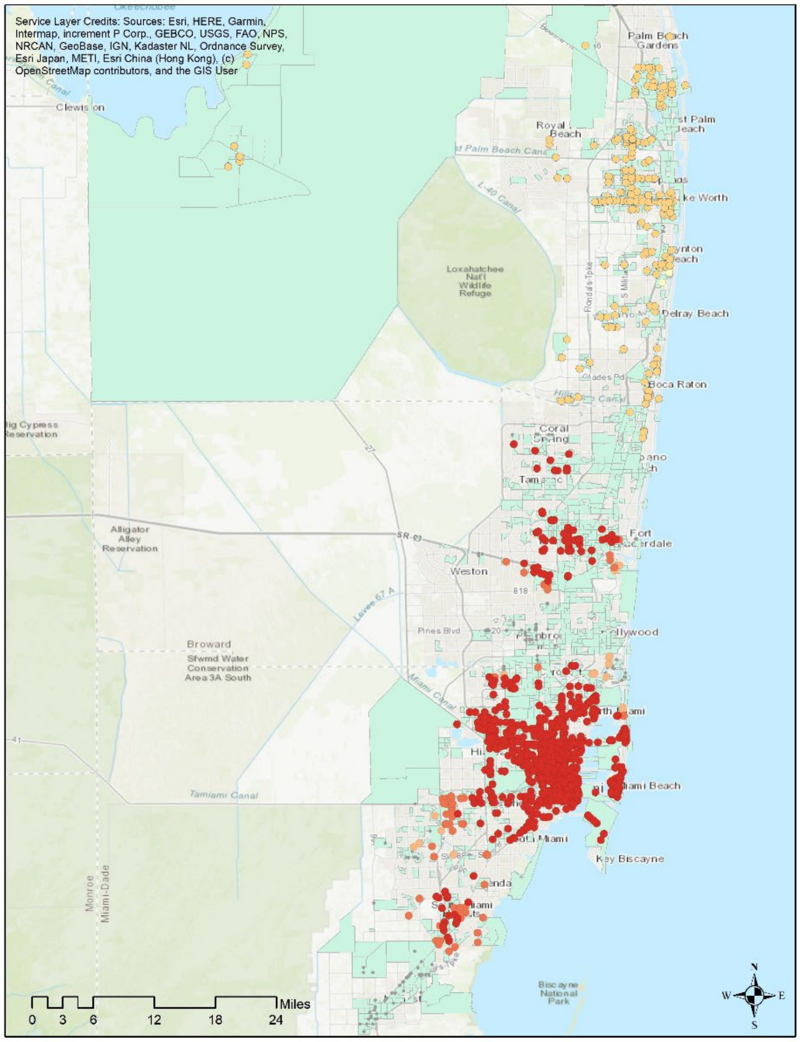

Figure 10. Hotspots of vehicle-cyclist collisions involving persons aged 25 to 64

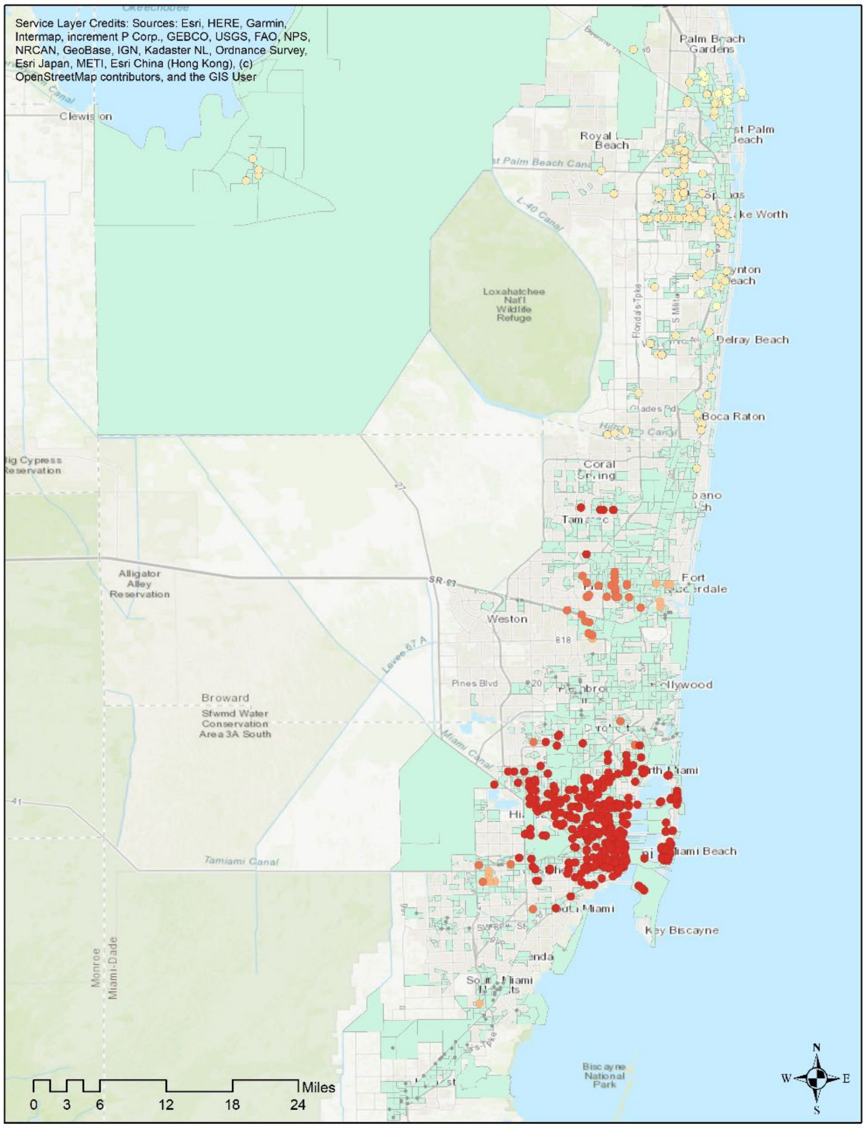

Figure 11. Hotspots of vehicle-cyclist collisions involving persons aged 25 to 64 between 3 pm to 9 pm

Role of Drugs and Alcohol in Cyclist Crash Incidence

Suspected use of drugs and alcohol is examined for all 4,174 records of vehicle-cyclist collisions in lower-income communities during the study period. Of these, 107 records, or 2.6% of the total, included suspected drug and alcohol use. Demographic information is reported for 65 of these records, while 45 are missing such information. Table 19 below summarizes the available information on the number of cyclists suspected of being under the influence of drugs and alcohol by age by the time of the day. The percentages are calculated using the baseline data presented in Table 13. Of all vehicle-cyclist collisions (N = 4,147), demographic information was available for 2,426 records (as shown in Table 13).

Of all vehicle-cyclist collisions occurring during the morning, afternoon, and early evening hours (6:00 AM to 9:00 PM), only 1.92% are suspected of using drugs or alcohol. Such collisions are the highest among adult cyclists between the ages of 25 and 54. However, they account for about 3.6% of all vehicle-cyclist crashes in these age cohorts. The highest number of such collisions occur during the evening hours (6:00 PM to midnight). Notably, 52 or 12.0% of all cyclists struck by a vehicle during the evening hours are suspected of being under the influence of drugs or alcohol.

Table 19: Number and Percentage of Cyclists Involved in a Collision Suspected of Being under the Influence of Drugs or Alcohol, by Age and Time-of-Day

Age Group	Time of Day								Total
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight	
14 and under	0 (0.0%)	0 (0.0%)	1 (7.1%)	0 (0.0%)	0 (0.0%)	1 (1.5%)	0 (0.0%)	0 (0.0%)	2 (1.3%)
15-19	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.3%)	3 (5.5%)	0 (0.0%)	4 (1.7%)
20-24	0 (0.0%)	0 (0.0%)	1 (3.4%)	0 (0.0%)	0 (0.0%)	1 (1.4%)	0 (0.0%)	0 (0.0%)	2 (0.8%)
25-34	2 (14.3%)	2 (16.7%)	1 (2.1%)	2 (4.0%)	1 (1.2%)	0 (0.0%)	2 (2.1%)	4 (7.7%)	14 (3.1%)
35-44	1 (14.3%)	2 (25.0%)	2 (3.2%)	2 (4.5%)	1 (1.9%)	2 (3.9%)	3 (2.9%)	3 (13.0%)	16 (3.8%)
45-54	0 (0.0%)	1 (8.3%)	2 (3.2%)	0 (0.0%)	3 (5.3%)	3 (2.8%)	4 (5.3%)	3 (11.5%)	16 (4.0%)
55-64	0 (0.0%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	1 (1.3%)	1 (1.1%)	1 (1.4%)	3 (12.5%)	7 (1.8%)
65-69	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
70 and older	0 (0.0%)	1 (50.0%)	0 (0.0%)	2 (7.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (33.3%)	4 (4.3%)
Unknown	0 (0.0%)	1 (4.0%)	1 (0.4%)	4 (1.6%)	8 (2.4%)	6 (1.4%)	10 (3.1%)	15 (10.5%)	45 (2.6%)
Total	3	7	9	10	14	15	23	29	110
Pct.	3.33%	10.14%	1.64%	1.75%	1.89%	1.43%	2.90%	9.24%	2.64%

4. EXPOSURE OF PEDESTRIANS AND CYCLISTS TO COMMUTER TRAFFIC PATTERNS IN LOW-INCOME COMMUNITIES

Similar to previous studies, we found that more crashes occur in lower-income and minority communities than their more affluent counterparts. While it is highly probable that the pedestrians and bicyclists involved in a collision are local residents, it is unclear whether or not the motorists involved in these collisions are local residents or are striking local residents while traveling through the lower-income communities to other destinations.

In Miami-Dade, Broward, and Palm Beach counties, many concentrations of lower-income populations lie along arterial thoroughfares that function as commuter routes. It is likely that some portion of these crashes may be attributable to the increased exposure attributable to these commuting patterns. Similarly, these areas often lack meaningful employment options, suggesting that at least some of the deaths and injuries involving lower-income and minority populations leave their communities. Understanding the nature of these collisions and the broader regional traffic patterns that influence them will greatly advance the development of safety interventions targeting specific risk behaviors. In this section, we develop a profile of the spatial exposure of pedestrians and cyclists in lower-income communities to commuting patterns that influence traffic-related injury and death occurring in lower-income communities.

4.1 Data Processing

The exposure of pedestrians and cyclists involved in a collision to local and/or commuter traffic patterns is evaluated using a combination of three datasets: (i) 2015-2017 data on pedestrians and cyclists involved in a collision obtained from the Florida State Safety Office (SSO), as discussed in Section 3.1; (ii) 2015-2017 crash location data including vehicle and driver information obtained from the Florida State Safety Office (SSO); and (iii) 2010 Census ZIP Code Tabulation Areas (ZCTAs), which approximate area representations of U.S. Postal Service (USPS) ZIP Code service areas created by the Census Bureau to present statistical data. The crash location data with the vehicle and occupant information comprises both Off-System (Roadways not maintained by the Florida Department of Transportation that are city or county-owned) and On-System (Mainline roadways maintained by the FL Department of Transportation) for Long-Form-reported crashes within the state of Florida. The layer is created by merging 2015, 2016, and 2017 on-system and off-system road crash data.

The 2015-2017 crash location data containing vehicle and driver information and the 2015-2017 data on pedestrians and cyclists involved in a collision are joined using the crash ID, creating a combined dataset, in which the driver's demographic information is linked to the non-motorists demographic profile, including home zip code. The intersect tool in ArcGIS is used to overlay the crash locations contained in the combined dataset with the Census ZIP Code Tabulation Areas (ZCTAs), thus adding a new field to the dataset that specifies the zip code in which the crash occurred. This leads to the compilation of two new datasets (for pedestrians and cyclists, respectively), which provide baseline information to understand the broader regional traffic patterns that influence the spatial distribution of the vehicle-pedestrian and vehicle-cyclist collisions. Since arterials often occur on the boundary of zip codes, it is likely that many of these involve pedestrians who live in one block group crossing the arterial and getting hit in the adjacent one. To address these boundary issues (i.e., to account for collisions occurring within walking distance from the boundary separating adjacent zip codes), a buffer of 0.25 miles is created around each crash., The crashes occurring within the buffers are identified using the ZCTAs boundary files.

A number of records failed to provide information on the home zip code of the drivers and non-motorists involved in a traffic collision. Home zip code information was not available for 201 pedestrians and 128 cyclists involved in a crash in low-income areas. Home zip code information was missing for 795 drivers involved in vehicle-bicycle collisions and 1,713 drivers involved in a vehicle-pedestrian crash.

4.2 Effect of Commuting Patterns on Non-Motorist Collisions

As shown in Table 20, 1,664 pedestrians, or 41.1% of all pedestrians involved in a collision, are struck in their home zip code. Similarly, 1,375 cyclists, or 44.0% percent of the total, are struck in their home zip code. Pedestrian and bicyclist trips are sensitive to distance, and the majority of these trips originate from home. The data suggest that in approximately 17% of both vehicle-pedestrian and vehicle-cyclist collisions, the home zip code of the driver involved in the crash match the home zip code of the pedestrian struck in that collision. These patterns are consistent with local travel, most likely associated with household-supporting trips or short work-related commutes.

Table 20: Number and percentage of non-motorists struck by a vehicle in their home zip code.

Category	Frequency	Pct.
Pedestrians Struck in Home Zip Code	1,664	41.1%
Bicyclists struck in Home Zip Code	1,375	44.0%

A second issue entails the residential location of the drivers that are involved in these collisions. Are these local residents, or are these motorists traveling through lower-income areas from other locations? Tables 21 and 22 show the residential locations of motorists, pedestrians, and bicyclists involved in a collision. In 675 of the reported cases of vehicle-pedestrian collisions (or16.6%), the home zip code of the driver involved in the collision coincides with the home zip code of the pedestrian struck in that collision. The motorist's zip code matches the cyclist's home zip code in 535 reported cases, or 17.1% of the total. In 12% of the reported cases of vehicle-pedestrian collisions and nearly 15% of the reported cases of vehicle-cyclist collisions, the crash event occurred in the home zip code of the motorist. In these cases, the home zip code of the non-motorists involved in the crash does not match the motorist's zip code. A proximity analysis using 0.25 miles buffer around each crash location indicated that approximately 22% of the crashes occur within walking distance from the zip code boundary line. Given this result, it is possible that some pedestrians and cyclists may have crossed the zip code boundary line making short-distance trips to nearby destinations. A trip undertaken by a pedestrian using an alternative means of transportation such as public transit could also explain this finding. These patterns are consistent with localized traffic where trips originate and end in or near motorists, pedestrians, and cyclists' home zip codes.

Overall, 2,885 pedestrians (or 71.3% of the total) are struck by motorists who do not live near the crash location. Additionally, 2,125 cyclists (or 68% of the total) are involved in a collision caused by a motorist who does not live in the zip code where the crash occurred. Of these, roughly 47% of all pedestrian collisions and 41.2% of the bicycle collisions occur in a zip code that does not match the driver's home zip code nor the home zip code of the non-motorist. As shown in Table 21, 989 pedestrians involved in an accident in their home zip code are struck by motorists who live elsewhere (24.5% of the total). Similarly, 840 or nearly 27% of the cyclists involved in a crash in their home zip code are struck by motorists who live in a different zip code. These results are consistent with commuter traffic patterns. They suggest that increased exposure to commuter traffic is a key contributing factor to the increased risk of vehicle-pedestrian and vehicle-cyclist crashes in low-income areas.

Table 21: Residential Locations of Pedestrians and Motorists Involved in a Vehicle-Pedestrian Collision

	Pedestrian lives in crash location?		
Motorist lives in crash location?	Yes	No	Total
Yes	675 (16.6%)	485 (12.0%)	1160 (28.7%)
No	989 (24.5%)	1896 (46.9)	2885 (71.3%)
Total	1664 (41.1%)	2381 (58.9%)	4045 (100.0%)

Table 22: Residential Locations of Bicyclists and Motorists Involved in a Vehicle-Bicyclist Collision

	Bicyclist lives in crash location?		
Motorist lives in crash location?	Yes	No	Total
Yes	535 (17.1%)	463 (14.8%)	998 (32.0%)
No	840 (26.9%)	1285 (41.2%)	2125 (68.0%)
Total	1375 (44.0%)	1748 (56.0%)	3123 (100.0%)

The data for which demographic information is available indicate that a relatively small number of pedestrians struck by a vehicle (~5.3%) reside outside the tri-county area. We assume that these are most likely tourists or visitors who do not live permanently in South Florida. Additionally, a small number of cyclists involved in a collision (159 or 5.1% of the total) report a home address outside the tri-county area, suggesting that these cyclists are most likely tourists or visitors who do not reside permanently in southeast Florida.

5. IDENTIFICATION OF ENVIRONMENTAL RISK FACTORS

In addition to identifying specific pedestrian and bicyclist cohorts who may be at disproportionate risk, this study further sought to identify environmental risk factors that may contribute to this risk. The sections below detail the construction of the database used to identify environmental risk factors and present negative binomial regression models that identify those factors that influence the incidence of pedestrian and bicyclist crashes in lower-income areas.

5.1 Data and Methods

To identify the environmental risk factors that may be contributing to the incidence of crashes involving pedestrians and bicyclists in lower-income communities, the population level database, detailed above, was combined with census data and information on land use and street characteristics obtained from Florida Geographic Data Library (FGDL). Parcel-level land use information was captured by counting those uses located within the block group boundaries. Streets and intersections proved a more complicated matter, as block group boundaries are often delimited by the presence of major streets. Nonetheless, the hazards posed by such facilities affect both adjacent block groups. To address streets located along block group boundaries, we ran a 200-ft buffer around each block group and assigned the streets located within the buffer to each adjacent block group.

Dependent Variables and Model Development

Four dependent variables were examined. The first was the total number of pedestrians and bicyclists involved in a collision, regardless of crash severity. As casualty crashes may have different characteristics than total collisions, this study further examined KSI crashes, defined as the number of fatal, incapacitating, and non-incapacitating injuries affecting a pedestrian or a bicyclist.

Because the dependent variables are count data that are overdispersed (i.e., the variance is greater than the mean—see Table 21), this study used negative binomial models for the following analyses. While this study initially sought to analyze the environmental factors that affected crash incidence involving specific sub-populations, the limited number of observations in most age and temporal categories prevented the development of meaningful statistical models. As such, this study used total and KSI for all pedestrians and bicyclists rather than the specific cohorts identified above.

Table 23: Dispersion Statistics of Crash Frequency at the Census Block Group Level (3-Year Counts)

Variable	Minimum	Maximum	Mean	Variance
Total Pedestrian	0	28	2.34	11.60
Pedestrian KSI	0	17	1.23	3.77
Total Bicyclists	0	18	1.43	5.06
Bicyclist KSI	0	11	0.68	1.56

Independent Variables

The independent variables used in this analysis were developed to capture the effects of population characteristics, transportation system characteristics, and land use characteristics on pedestrian and bicyclist crashes in lower-income communities. Descriptive statistics for the independent variables used in this study are presented in Table 24 and described below.

Table 24: Descriptive Statistics for Lower Income Block Groups

Variable	Minimum	Maximum	Mean	Std. Dev.
population	0	6,401	1,706.21	941.09
% Black	0	100	27.68	30.78
% Hispanic	0	100	46.71	32.85
aadt	0	68,000	22,118	10,800
miles of 5 or more lane streets	0	10	0.39	0.67
miles of raised medians	0	4	0.17	0.30
Intersections per 100 acres	0	101	14.11	18.71
# signalized intersections	0	34	3.38	3.11
# bus stops	0	65	5.50	5.33
# shopping centers	0	25	0.26	0.92
# supermarkets	0	3	0.08	0.30
# restaurants	0	12	0.75	1.34
# schools/colleges	0	27	0.89	1.73

Demographic Characteristics

Areas with more people would be expected to generate more street activity and thus higher overall levels of exposure. As such, population was included as a control measure in our models. Concentrations of non-white populations, most notably persons identifying as Black and Hispanic in the US census, are often included in safety models as a risk factor. It remains unclear, however, whether race is a risk factor independent of income. As such, we included the percentage of census-identified Blacks and Hispanics in our models. The modeled variables are:

- *Population (thousands).* This is the count of total persons residing in the block group. The total population was then divided by 1,000 to ease the interpretation of the model coefficients.
- *% Black.*
- *% Hispanic.*

System Characteristics

While streets classified as "arterials" are a known risk factor for pedestrians, bicyclists, and motorists alike, it is important to observe that it is not the classification of a street as an arterial thoroughfare that results in crash risk, but instead the attributes commonly associated with such streets, which include higher traffic volumes, multiple travel lanes, higher operating speeds, and complex intersections (Dumbaugh and Rae, 2009; Dumbaugh and Li, 2011; Dumbaugh et. al., 2013; Dumbaugh et. al., 2020). The risk associated with this street class can be moderated through the use of raised medians, which serve to channelize traffic away from high-conflict locations and, as a safety benefit to pedestrians, serve as a refuge island (FDOT, 2014; Gan et. al., 2005).

For this study, we sought to disaggregate the characteristics of the surface transportation system to identify those elements that may have a disproportionate influence on crash risk. Specifically sought were measures capturing vehicle speeds and the production, or management, of traffic conflicts. Interestingly, none of the speed variables proved to be meaningfully related to pedestrian and bicyclist crash incidence and were omitted from the final models (we discuss the likely reasons for this in the sections below).

- *AADT (thousands).* The average annual daily traffic occurring in the block group. This data was provided by the Florida Department of Transportation.
- *Miles of streets with 5 or more lanes.* This variable is the sum of the miles of streets that have five or more lanes within a block group.
- *Miles of streets with a raised median.* This variable represents the total mileage of streets with a raised median.
- *Percentage of 2-lane streets.* This is the percentage of the total lane mileage in the street network comprised of streets with 2 lanes.
- *# of signalized intersections.* Traffic signals are used to manage complex movements at intersections. This is the count of signalized intersections in the block group.
- *Intersection density.* Intersections are locations where conflicting streams of traffic cross and are thus locations where one would expect to observe higher crash incidence. Nonetheless, the findings for intersections are mixed, with some studies funding them to increase crashes (Dumbaugh and Li, 2011; Dumbaugh, Li, and Joh, 2013), while others found higher intersection densities to decrease crashes (Marshall and Garrick, 2010). Intersection density is measured as the number of intersections per 100 acres.
- *# of bus stops.* Bus stops are locations that serve as a point of origin and destination for pedestrians. As such, the presence of bus stops may have the potential to create clusters of pedestrian activity that increase crash incidence.

Land Use Characteristics

The location and configuration of land uses determine the origins and destinations of travel, as can create conditions that make crashes more or less likely to occur. Retail and commercial uses, in particular, have been identified as a potential risk factor, particularly when they take an auto-oriented form that includes driveways and unprotected ingress and egress. The data contained in the FGDL allow these uses to be disaggregated into a finer level of detail to ascertain whether different types of commercial and retail uses are associated with different levels of risk. The following variables were specifically analyzed:

- *# supermarkets*
- *# of restaurants*
- *# of shopping centers*
- *# of schools/colleges*

5.2 Environmental Risk Factors for Pedestrians in Lower Income Areas

Total Pedestrian Collisions

Table 23 below, shows the model results for total pedestrian crashes. While the number of people residing in a block group did not prove to be meaningfully associated with pedestrian collisions, the block group's racial composition did. Pedestrians are more likely to be involved in collisions in areas with higher concentrations of persons identifying as Black or Hispanic. Each 1% increase in the percentage of persons identifying as Black in a block group was associated with a 1.2% increase in pedestrian collisions, while each 1% increase in the percentage of persons identifying as Hispanic was associated with a 1.5% increase in pedestrian collisions.

Table 25: Total Pedestrian Collisions in Lower-Income Block Groups

	coeff.	std. error	z	p	95% conf. interval	
population (thousands)	0.0111	0.0352	0.310	0.753	-0.0579	0.0801
% Black	0.0121	0.0015	8.210	0.000	0.0092	0.0149
% Hispanic	0.0145	0.0014	10.690	0.000	0.0118	0.0172
aadt (thousands)	0.0101	0.0033	3.090	0.002	0.0037	0.0165
miles of five-or-more lane streets	0.0938	0.0598	1.570	0.117	-0.0233	0.2109
miles of raised medians	-0.8265	0.1365	-6.050	0.000	-1.0941	-0.5590
intersection density	0.0062	0.0018	3.530	0.000	0.0027	0.0096
# signalized intersections	0.1002	0.0122	8.220	0.000	0.0763	0.1241
# bus stops	0.0292	0.0079	3.680	0.000	0.0136	0.0447
# shopping centers	0.1760	0.0399	4.410	0.000	0.0978	0.2541
# supermarkets	0.2571	0.1009	2.550	0.011	0.0594	0.4548
# restaurants	0.0833	0.0242	3.450	0.001	0.0360	0.1307
# schools/colleges	0.0397	0.0175	2.260	0.024	0.0053	0.0740
constant	-1.2998	0.1347	-9.650	0.000	-1.5638	-1.0359

log likelihood = -3139.84

n = 1651

Of the transportation system variables, pedestrian crashes increased by 1% for every 1,000 increase in average annual daily traffic volumes. Each mile of 5-or more lane street was associated with a 9.4% increase in pedestrian collisions, though this variable entered the model at slightly less than the 0.1 level of statistical confidence. Each additional signalized intersection in the block group was associated with a 10% increase in pedestrian collisions, and each additional bus stop was associated with a 2.9% increase. Increases in intersection density were likewise associated with more pedestrian collisions, with a 1% increase in intersection density, measured as intersections per 100 acres, corresponding to a 0.6% increase in pedestrian collisions. Raised medians were associated with a significant reduction in pedestrian collisions, with each mile of raised median corresponding to an 83% decrease in pedestrian collisions. Land use characteristics appear to matter as well. Each commercial shopping center located within a block group was associated with an 18% increase in pedestrian collisions, while each additional supermarket, restaurant, and school was associated with a 25%, 8%, and 4% increase, respectively.

KSI Pedestrian Collisions

Given the likelihood that pedestrian collisions often result in a serious injury, it is perhaps unsurprising that the model results for KSI collisions largely mirror those for total collisions (Table 24). Areas with higher concentrations of Blacks and Hispanics experience higher numbers of pedestrians being killed or seriously injured, as do areas with more signalized intersections, higher intersection densities, and more bus stops. Raised medians were associated with significant reductions in pedestrian death and injury. While the mileage of 5-or-more lane streets entered the model with the expected sign, it did not enter at conventional levels of statistical significance. Shopping centers, supermarkets, restaurants, and schools were again significantly associated with increased pedestrian death and injury.

Table 26: KSI Pedestrian Collisions in Lower-income Block Groups

	coeff.	std. error	z	p	95% conf. interval	
population (thousands)	0.0416	0.0386	1.080	0.282	-0.0341	0.1173
% Black	0.0119	0.0017	7.060	0.000	0.0086	0.0152
% Hispanic	0.0141	0.0016	9.010	0.000	0.0111	0.0172
aadt (thousands)	0.0109	0.0037	2.960	0.003	0.0037	0.0182
miles of five-or-more lane streets	0.0798	0.0717	1.110	0.266	-0.0607	0.2202
miles of raised medians	-0.7977	0.1551	-5.140	0.000	-1.1017	-0.4937
intersection density	0.0054	0.0019	2.800	0.005	0.0016	0.0092
# signalized intersections	0.0998	0.0130	7.660	0.000	0.0743	0.1253
# bus stops	0.0255	0.0086	2.980	0.003	0.0087	0.0423
# shopping centers	0.1718	0.0416	4.130	0.000	0.0902	0.2534
# supermarkets	0.1936	0.1071	1.810	0.071	-0.0163	0.4035
# restaurants	0.0903	0.0255	3.540	0.000	0.0403	0.1403
# schools/colleges	0.0409	0.0180	2.270	0.023	0.0056	0.0762
constant	-1.9480	0.1565	-12.450	0.000	-2.2547	-1.6413

log likelihood = -2630.18

n = 1651

Total Bicycle Collisions

Table 25 presents the results of the model for total bicycle collisions. The number of persons residing in a block group was not significantly associated with the increased incidence of bicycle collisions, though bicyclist crashes were influenced by the block group's racial composition. A 1% increase in the percentage of persons identifying as Black was associated with a 0.27% increase in bicyclist collisions, while a 1% increase in Hispanics was associated with a 0.5% increase in these collisions. Of the transportation network characteristics, an increase in AADT of 1,000 vehicles was associated with a 0.9%

increase in bicyclist collisions. Increases in the number of signalized intersections, number of intersections per 100 acres, and numbers of bus stops were associated with 7%, 0.6%, and 3.7% increase in bicycle collisions, respectively. Raised medians were associated with significantly fewer bicycle collisions, with each mile of raised median corresponding to a 69% decrease in these collisions. Shopping centers, supermarkets, and restaurants were significantly associated with 16%, 31%, and 12% increases in bicycle collisions, respectively.

Table 27: Total Bicycle Collisions in Lower-Income Block Groups

	coeff.	std. error	z	p	95% conf. interval	
population (thousands)	-0.0008	0.0406	-0.020	0.984	-0.0805	0.0789
% Black	0.0027	0.0016	1.670	0.096	-0.0005	0.0058
% Hispanic	0.0052	0.0015	3.500	0.000	0.0023	0.0081
aadt (thousands)	0.0086	0.0038	2.260	0.024	0.0012	0.0160
miles of five-or-more lane streets	0.0828	0.0784	1.060	0.291	-0.0708	0.2365
miles of raised medians	-0.6876	0.1603	-4.290	0.000	-1.0019	-0.3733
intersection density	0.0063	0.0020	3.170	0.002	0.0024	0.0101
# signalized intersections	0.0707	0.0134	5.290	0.000	0.0445	0.0969
# bus stops	0.0372	0.0087	4.300	0.000	0.0203	0.0542
# shopping centers	0.1592	0.0427	3.730	0.000	0.0755	0.2429
# supermarkets	0.3143	0.1066	2.950	0.003	0.1054	0.5231
# restaurants	0.1169	0.0263	4.440	0.000	0.0653	0.1685
# schools/colleges	0.0256	0.0196	1.300	0.193	-0.0129	0.0641
constant	-0.9372	0.1455	-6.440	0.000	-1.2223	-0.6521

log likelihood = -2594.05

n = 1651

KSI Bicycle Collisions

Of the demographic variables, only the percentage of Hispanics was associated with a significant increase in bicyclist death or injury. KSI bicycle collisions were found to increase with the number of signalized intersections and the number of bus stops. While intersection density was again associated with increases in bicyclist death and injury, it entered the model just outside of the conventional 0.1 level of statistical significance. Each mile of raised median was associated with a 75% reduction in KSI bicyclist collisions. Each shopping center in a block group was associated with a 15% increase in bicyclist death and injury, while each grocery and restaurant was associated with a 25% and 10% increase in these crashes, respectively (See Table 26).

Table 28: KSI Bicycle Collisions in Lower-income Block Groups

	coeff.	std. error	z	p	95% conf. interval	
population (thousands)	0.0058	0.0474	0.120	0.902	-0.0871	0.0988

% Black	0.0011	0.0019	0.580	0.563	-0.0026	0.0048
% Hispanic	0.0031	0.0018	1.730	0.084	-0.0004	0.0065
aadt (thousands)	0.0114	0.0045	2.560	0.011	0.0027	0.0202
miles of five-or-more lane streets	0.1133	0.0890	1.270	0.203	-0.0612	0.2878
miles of raised medians	-0.7519	0.1852	-4.060	0.000	-1.1149	-0.3889
intersection density	0.0038	0.0024	1.610	0.108	-0.0008	0.0085
# signalized intersections	0.0751	0.0155	4.850	0.000	0.0447	0.1055
# bus stops	0.0373	0.0100	3.710	0.000	0.0176	0.0569
# shopping centers	0.1368	0.0474	2.890	0.004	0.0440	0.2296
# supermarkets	0.2453	0.1213	2.020	0.043	0.0075	0.4831
# restaurants	0.0998	0.0295	3.380	0.001	0.0419	0.1578
# schools/colleges	0.0310	0.0221	1.410	0.160	-0.0122	0.0742
constant	-1.5516	0.1739	-8.920	0.000	-1.8923	-1.2108

log likelihood = -1799.84

n = 1651

5.3 Discussion: Environmental Risk Factors and the Production of Latent Error

Mitigating environmental risk factors requires an understanding of how the built environment influences crash risk. Doing so requires us to move beyond the identification of so-called "critical factors," or the behaviors in which a road user was engaged immediately prior to a crash event, and to instead understand how the environment may have contributed to, or prevented, the occurrence of these behaviors. From an organizational systems safety perspective, traffic crashes are not simply the result of random, idiosyncratic behaviors, such as inattention, but instead often the result of a mismatch between the transportation system's design and its actual use. Where such mismatches exist, they create *latent conditions* that can result in predictable and preventable deaths and injuries (Reason, 1997).

It is thus important to distinguish between *random error* and *latent error*. Random error is the result of ordinary human fallibility, such as inattention and distraction, that can lead to a crash event. Random errors are a product of individual patterns of behavior and may occur at any time or location. Because they are innate to individuals, it is impossible to eliminate random error completely, thus leading to the need for "forgiving" design solutions to compensate for these errors when they inevitably occur. Traffic volumes are often a good proxy for random error, as they can be expected to occur at relatively fixed rates across a population rather than clustering at specific locations (Dumbaugh et. al., 2018).

For this study, average annual daily traffic volumes serve as a rough proxy for random error; in all four models, pedestrian and bicyclist increase at a relatively consistent rate of about 1% per 1,000 AADT. Nonetheless, AADT did not prove to have a particularly strong effect on crash frequency when compared against other system characteristics. To illustrate using expected values from the models, doubling the AADT in a typical block group would be expected to increase the number of expected crashes from 0.66 per year to only 0.82. This is less than the addition of a single supermarket into the same block group, which alone increases the expected number of pedestrian crashes from 0.66 to 0.84.

The effects that minor changes in system characteristics can have on crash incidence highlight the importance of understanding the critical role that latent error has on road safety. Latent error is not inevitable but instead occurs when the environment leads people to engage in context-specific behaviors that increase their likelihood of being injured or killed. The presence of latent error can be observed when crashes cluster at specific locations or in the presence of specific features, such as a grocery store. These errors are an outcome of system configurations that, when combined with ordinary patterns of human behavior, result in preventable deaths and injuries. The features identified in this study as environmental risk factors should be understood as features that lead to latent error. These emerge as the result of two related issues that may be addressed through design: conflicts of use and errors of expectancy.

Use Conflicts and Errors of Expectancy

In urban environments, latent conditions that lead to pedestrian and bicyclist crashes take two primary forms. The first is the creation of *use conflicts*. In the case of the crashes considered in this study, these are observable at locations that generate high levels of pedestrian and bicyclist activity, but which lack the necessary infrastructure to separate these vulnerable road users from vehicular traffic.

The second is the creation of *errors of expectancy.* These are errors of cognition that occur when the design of the transportation system creates incorrect expectations about the risk associated with specific behaviors. While driving is a superficially mundane activity, the driving task requires individuals to process large volumes of sensory information and rapidly translate that information into specific operating actions. Because drivers have the inability to process the diverse array of information present in their environment (Gigerenzer and Brighton 2009; Kahneman 2011), they instead infer an overall sense of a roadway based on their comfort levels and existing experience with similar "types" of roadways. This results in the establishment of specific behavioral scripts, as well as expectations regarding the types of elements likely to be present in the environment, referred to by psychologists as "schema." These, in turn, are organized into behavioral routines, called "scripts" that road users employ when navigating the environments. The use of scripts and schema allow individuals to simplify and automate the driving task through largely intuitive, pre-cognitive processes (Perez et al. 2015; Van Elslande and Faucher-Alberton 1997).

While these processes are cognitively efficient, safety problems emerge when the scripts and schema used by drivers do not align with the actual hazards present in an environment, a mismatch that results in a phenomenon known as "inattentional blindness," or a failure to observe a hazard that is, in fact, present (Chabris and Simons, 2011; Mack and Rock 1998). In the case of road safety, inattentional blindness results in a crash type categorized as "looked-but-failed-to-see," a crash type that typically involves pedestrians, bicyclists, and motorcyclists, and which has been estimated to account for 10 percent of all fatal crashes (Brown 2002). *Errors of expectancy* compound the hazards associated with *conflicts of use* because they result in drivers being cognitively unprepared to quickly respond to the unanticipated traffic conflicts, such as a pedestrian or bicyclist entering the vehicle's path (Dumbaugh, Saha, and Merlin, 2020).

Environmental Factors Leading to Conflicts of Use and Errors of Expectancy

For the lower income populations examined in this study, latent errors appear to concentrate in the presence of auto-oriented commercial uses, such a commercial shopping centers, supermarkets, and restaurants. While responsibility for addressing traffic safety problems is ordinarily viewed as being the responsibility of agencies tasked with the design and operation of the transportation system, it should be noted that many of the environmental risk factors with conflicts of use and errors of expectancy are the result of seemingly unrelated decisions relating to the location and configuration of new development. These decisions can transform an otherwise safe environment into a hazardous one.

This problem is best illustrated through example. As shown in figure 12, below, a largely unremarkable rural roadway is transformed into a high-crash location through the land use practices of local governments. This roadway's initial design was well-adapted to providing interregional mobility in a rural context, and between 1999 and 2005, the roadway's geometry hardly changed at all. What has changed is the roadway's developmental context, which did not occur through any action on the part of those responsible for the street's initial design and operation, but instead through local development decisions relating to the siting and configuration of new development. The result is a misalignment between the initial design and subsequent use of the street or, in other words, the establishment of latent error.

Figure 12: An Example of Safety Issues Generated by Land Development - US 441, St Cloud, 1999 (top left), 2005 (top right), and Present (bottom)

Attempts to meaningfully address these safety problems require a more comprehensive understanding of how they are established. Figure 13, below, presents the chain of decisions that can lead to the safety outcomes observed in this study, as well as the pathway leading to the production of latent error. 3E programs and engineering countermeasures can address negative safety outcomes, but it is important to recognize that they are the last links in the causal chain and serve principally to mitigate safety problems that have already been established through transportation decisions and policies that direct the siting and configuration of new development, decisions that may occur years in advance of an actual crash event. Road safety can be greatly advanced by taking advantage of the upstream planning and design decisions that are responsible for the creation of high-crash environments, providing additional layers of defense.

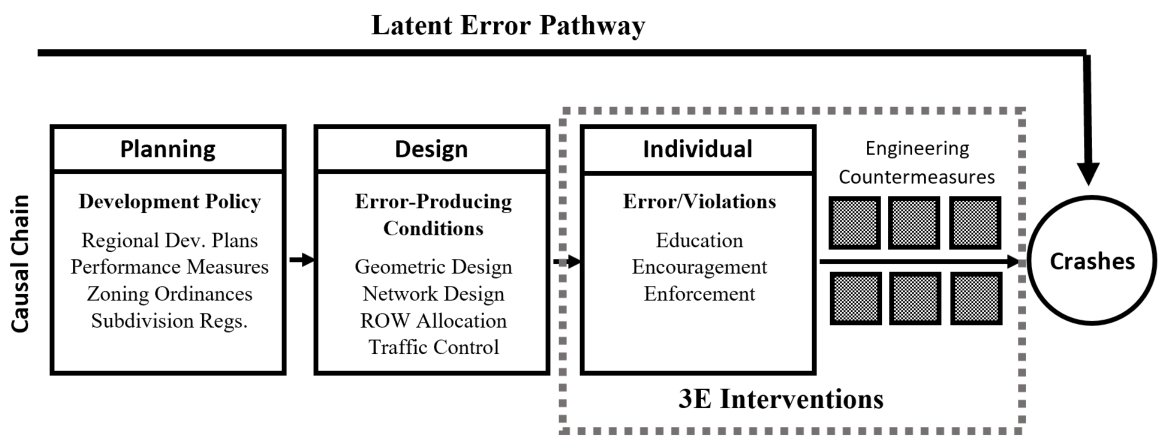

Figure 13. A Comprehensive View of Road Safety and the Production of Latent Error (Source: Dumbaugh et. al., 2018)

The framework shown in Figure 13 is useful for understanding the role played by the environmental risk factors identified in this study, which can be defined as belonging to three general categories: background conditions, transportation system characteristics, and development characteristics. Background conditions, including population and traffic volumes, are measures of the total number of road users, and thus relate to the incidence of random error. Transportation and developmental characteristics, on the other hand, relate to the design and configuration of the environment and may thus relate to the establishment of conditions that lead to preventable crashes, injuries, and deaths.

Population Characteristics

The number of people living in a block group was not significantly related to pedestrian or bicyclist crashes. The racial composition of a block group, however, had a profound effect on crash incidence, with the percentage of Black and Hispanic residents being strongly associated with crash increases, particularly for pedestrians. Stated another way, crash risk increases as minority populations become increasingly concentrated. This study is unable to ascertain the extent to which this risk may be the result of population-level characteristics, such as minority populations being more likely to walk or bicycle or to engage in particular behaviors that may increase risk, or whether they are attributable to environmental factors that are unique to areas with high concentrations of minority populations. One study, for example, found that motorists were twice as likely to yield for white pedestrian than Black ones (Goddard et. al., 2015). It is likely that a combination of behavioral and environmental factors influence the increased risk experienced by non-white populations. While further study is needed to better understand why race exacerbates risk beyond that attributable to income, the findings nevertheless suggest that safety interventions may be most beneficial in areas with concentrations of racial minorities.

Transportation System: Arterials, Medians, and Network Characteristics

It has been well-established that urban arterials pose safety problems for pedestrians and bicyclists. This is often attributed to three factors. The first is higher traffic volumes, which may increase overall exposure. The second is the presence of multiple lanes, which increases the number of traffic conflicts encountered by pedestrians and bicyclists as they attempt to crass these streets. The third is that arterials are often accompanied by higher traffic speeds, which increases crash severity. Higher speeds may also increase crash incidence through errors of expectancy, described above, and through increases in stopping sight distance, making motorists less able to stop in response to a pedestrian of bicyclists entering the travel way.

Rather than examining arterials as a simple road class, this study disaggregated these effects by modeling traffic volumes, the number of lanes, and posted speeds as separate variables. Traffic volumes had a positive, though very slight, effect on the incidence of pedestrian and bicyclist crashes. Speed, measured here in terms of posted speed limits, did not prove to be significantly related to total or injurious pedestrian and bicyclist crashes after accounting for a community's developmental characteristics. Likewise, the presence of five-or-more-lane streets had a generally negative effect on pedestrian and bicycle crashes, though this variable failed to enter significantly in any of the models. Instead, it is not multi-streets themselves, but instead multi-lane streets combined with other developmental characteristics that creates safety problems.

This conclusion is further supported by the observed safety benefits of raised medians, which were associated with significant reductions in pedestrian and bicyclist crashes alike. As has been long recognized by FDOT, the safety benefit is that medians provide a midblock refuge for pedestrians and bicyclists, allowing them to divide a potential hazardous crossing into two stages (see Figure 14). Given that much of the crossings observed in these areas occur at unprotected midblock locations, the ability to stage crossings along a raised median is clearly beneficial.

Figure 14: Medians Used for Staged Crossings

Developmental Characteristics

While it is tempting to view road safety as principally a matter of street design, the relative safety of any particular street is, in large part, a function of the relationship between the street and its surrounding environment. The presence of supermarkets, shopping centers, and restaurants were all found to be risk factors for crashes involving pedestrians and bicyclists in lower-income areas. These uses are major trip attractors, particularly during the late afternoon and early evening periods, which when roughly half of all pedestrian and bicyclist collisions occur.

Yet, the problem is likely not so much the presence of these uses themselves as it is their location and configuration. In the areas examined in this study, these uses are located along major arterials, thereby directing pedestrian and bicyclist traffic to these high-volume, high-traffic facilities, and largely take the form of auto-oriented strip development, a known risk factor for pedestrians and bicyclists (Dumbaugh and Li, 2011; Dumbaugh, Li, and Joh, 2013). These often have direct driveway connections to the arterial network, many with obstructed sightlines, that create conflicts between pedestrians and bicyclists[1] using the sidewalk (see Figure 15).

[1] Field observations revealed that bicyclists generally chose to ride along sidewalks, rather than using bicycle lanes or travel lanes.

Figure 15. Unconsolidated Driveways, Restaurants, and Strip Commercial Uses

When these uses are located on highways designed for higher-speed mobility functions, they create safety problems that often result in calls for modifications to the design and operation of the system, such as reductions in the number or width of travel lanes, the adoption of design or enforcement strategies targeting speed reduction, or modifications to intersections and traffic control devices. While all of these strategies may be beneficial in specific developmental contexts, this safety problem emerges when local development decisions are not meaningfully linked to the characteristics of the transportation system that it uses.

6. FINDINGS

This study, like much of the prevailing road safety research, has found that crashes involving pedestrians and bicyclists are more common in lower-income areas than more affluent ones. While higher rates of exposure due to lower rates of automobile ownership undoubtedly contribute to the increased incidence of pedestrian and bicyclist crashes in lower-income areas, there has been little detailed examination into the specific nature of the risk experienced by lower-income populations. This study has sought to fill a critical gap in our understanding of pedestrian and bicyclist crashes in lower-income areas by identifying the characteristics of specific at-risk cohorts, as well as the environmental risk factors that may exacerbate this risk.

It is commonly implied that drug and alcohol use is a major contributing factor to the high rates of pedestrian and bicyclist crashes observed in lower-income communities. This study does not support this assertion. Only 5.9% of pedestrians involved in a collision, and 2.6% of bicyclists, were suspected of being under the influence of drugs or alcohol. As might be expected, these tended to occur during the late-night/early morning hours (midnight to 6 AM); they nonetheless comprise an extremely small share of the total pedestrian and bicyclist crashes that occur.

Our data suggest that the majority of the crashes involving specific cohorts are a function of exposure resulting from routine daily activities typical for pedestrians and bicyclists of different age groups during time periods when they are expected to be most active. The analysis of the spatial clustering of pedestrian crashes indicates higher concentrations of collisions involving adult pedestrians along major corridors and near employment centers in low-income areas. Higher traffic volumes in the poorest census block groups increase the local residents' exposure to motor vehicles and lead to a greater likelihood of vehicle-pedestrian and vehicle-cyclist collisions. Our analysis suggests that commuting patterns play an important role in increasing the exposure of the residents of lower-income communities to traffic flows. For a large portion of the pedestrian and bicycle crashes (71.3% and 68.0%, respectively), the driver who caused the crash did not reside in the same zip code as the pedestrian or cyclist involved in the collision. This finding indicates increased exposure of local residents to commuter routes from suburban residences to various destination points across the tri-county area. The observed levels of traffic volumes and pedestrian and biking activities can be attributed to the density, scale, and design characteristics of the adjacent urban development, the employment characteristics of the area, and the socio-economic characteristics of the local population. The service super-sector, which dominates the local economy, is more likely to employ lower-income populations who are also more likely to walk or bike to work.

Among the lower-income populations, higher-risk groups include four specific pedestrian cohorts and two bicyclist cohorts, as discussed below.

Pedestrians

1. *School trips and after-school activities:* pedestrians aged 14 and under, 6 am to 9 am and 3 pm to 9 pm, weekdays.
2. *Errands during the early evening:* pedestrians aged 20 and older, 6 pm to 9 pm.
3. *Active older adults:* pedestrians aged 70 and older, 9 am to 9 pm.
4. *Young adults:* pedestrians aged 25-34, 6 pm to midnight.

Approximately 70% of all collisions involving pedestrians in lower-income areas occur during the active hours of the day, from 9:00 AM to 9:00 PM. More pedestrians are involved in a crash between 6:00 PM and 9:00 PM than any other time period, comprising 21.5% of the total. A significant number of collisions (nearly 30%) also occur between 9:00 AM and 3:00 PM. Male pedestrians are more likely to be involved in a crash, accounting for 59.9% of the total collisions, while comprising only 48.5% of the population of lower-income block groups. Children aged 14 and under comprise 8.3% of all pedestrians involved in a traffic collision. These collisions cluster in the morning (6:00 AM to 9:00 AM) and afternoon/early evening periods (3:00 PM to 9:00 PM). Among school-aged children, male pedestrians are at higher risk of being involved in an accident. Male pedestrians aged 14 and under are particularly at risk from 3:00 PM to 9:00 PM.

Pedestrians aged 70 and older are also associated with the highest ratio of the total number of pedestrian collisions to the number of killed and severely injured except those aged 20-24. Two factors – higher levels of activity and frailty associated with aging, make older pedestrians uniquely vulnerable in a crash event. Adults between the ages of 25-34 are twice as likely to be struck by a vehicle than those aged 20-24 and 1.3 times more likely to be involved in a pedestrian crash than those between the ages of 35 and 44. This age group is over-represented in pedestrian collisions occurring between 9:00 PM and 3:00 AM. Almost half of all pedestrian collisions involving younger adults aged 25-34 result in a fatality or severe injury. The prevalence of pedestrian crashes involving this cohort is likely attributable to increased exposure associated with social and recreational activities, particularly for unmarried adults without children.

Bicyclists

1. *Adult utilitarian bicycling:* bicyclists aged 20-64, 6 am to 9 pm.
2. *Afterschool activities:* bicyclists 19 and under, 3 to 6 pm, weekdays.

The proportion of bicycle crashes involving persons aged 19 and younger is about 16.2% of the total number of bicycle crashes. This percentage is slightly less than their representation within the population as persons aged 19 and younger comprise 23.4% of total population in lower-income block groups. Overall, 21.3% of the crashes involving this cohort, and 23% of the injuries and deaths, occur between 3:00 PM and 9:00 PM. Notably, 90.2% of all cyclists involved in a collision in this age group result in a fatality or severe injury (212 out of 235).

A large share of the bicycle crashes occurring in lower-income communities involve the use of bicycles by male residents for utilitarian purposes, such as work commutes and household-supporting travel. Lower-income populations are likely to be employed in service sector jobs, which have time periods that begin and end later than conventional commuting periods. Male cyclists aged 35-64 comprise 87.6% of all vehicle-cyclist collisions in this age cohort in low-income areas. Crashes increase during the late afternoon and early evening periods (3:00 PM – 9:00 PM), which would appear to correspond with evening commutes and secondary trip ends most likely associated with household-related travel to groceries, restaurants, or nearby shopping venues.

Environmental Factors

Accident counts involving pedestrians and bicyclists in lower-income block groups are modeled using negative binomial regression. The dependent variables include the total number of pedestrians and bicyclists involved in a collision (regardless of crash severity) as well as the KSI crashes, defined as the number of fatal, incapacitating, and non-incapacitating injuries affecting a pedestrian or a bicyclist.

The independent variables used in the analysis fall into three general categories: demographic characteristics, transportation network properties, and land use composition. Our findings suggest that racial dissimilarities increase the crash risk associated experienced by lower-income populations. The expected counts for both total and KSI collisions involving pedestrians and cyclists increase significantly in proportion to the percentage of Blacks and Hispanics in the population. Higher concentrations of persons identifying as Black or Hispanic are shown to be a significant predictor for the expected counts of pedestrian collisions. The block group total population is not found to be significantly associated with the increased incidence of bicycle collisions. However, the block group's racial composition has a statistically significant effect on the expected counts of bicycle crashes. For example, a 1% increase in the percentage of persons identifying as Black or Hispanic is associated with a slight increase in bicyclist collisions.

For lower-income communities, land use characteristics associated with common everyday destinations, such as supermarkets, shopping centers, and restaurants, are associated with an increase in the expected counts of crashes involving pedestrians and cyclists. Each supermarket located in a block group is associated with a 25% increase in the expected counts of pedestrian collisions, while each commercial shopping center is associated with an 18% increase in pedestrian collisions. Similar trends in expected counts are observed with respect to restaurants (8% increase) and schools (4% increase), respectively. The model results for KSI pedestrian collisions largely follow those for total collisions. Likewise, shopping centers, supermarkets, and restaurants are significantly associated with increases in the expected counts of bicycle collisions.

Transportation network characteristics are also found to have statistically significant safety effects. Among the factors most contributing to substantial increases in the expected total counts of pedestrian collisions are the length (in miles) of 5-or more lane streets, the number of signalized intersections and the number of bus stops in each block group. The mileage of 5-or-more lane streets was also associated with increased KSI collisions involving pedestrians and cyclists. Intersection density (measured as intersections per 100 acres) and AADT are also associated with increases in the expected counts of pedestrian and bicycle collisions but to a lesser extent. Raised medians proved to provide safety benefits for pedestrians and cyclists alike, undoubtedly due to their ability to serve as a midblock refuge for pedestrians and cyclists attempting to cross multi-lane streets. Each mile of raised median corresponds to an 83% decrease in pedestrian collisions and a 69% decrease in bicycle collisions, respectively.

The identification of at-risk cohorts by age and gender provides unique opportunities to inform the development of comprehensive programs that can address local safety needs. A brief summary of the implications of these findings is provided below:

- School-aged pedestrians and bicyclists were identified as being disproportionately at-risk, particularly during the afterschool period. Our findings suggest that the safety problem lies not so much in the journey-to-school trip as with more general afterschool activities. School safety and education programs addressing these issues can result in spillover neighborhood effects as educational programs on safe street use, developed in concert with local schools, can result in better safety outcomes not only in the areas where school-aged children walk and bike but also throughout the adjacent walking and biking networks (National Center for Safe Routes to School, 2019).
- The incidence of alcohol and drug use resulting in pedestrian or bicycle collisions was not found to be a major contributing factor to the increased frequency of vehicle-pedestrian and vehicle-cyclist collisions. In fact, these were very low. These results suggest that interventions aimed at reducing impaired driving, although beneficial, may not have a noticeable effect on changing pedestrian behaviors that result in increased crash risk.
- The higher incidence of bicycle collisions in lower-income areas is likely attributable, at least in part, to cultural and socio-economic differences in the nature of bicycle use. Culturally, cyclists in more affluent areas are more likely to cycle for health and recreational purposes rather than utilitarian ones. By contrast, lower-income populations are more likely to use bicycles for utilitarian purposes, rather than recreational ones. It is further likely that economic or cultural issues may make members of this cohort less likely to purchase or use protective equipment, thus leading to the heightened incidence of severe crashes reported in these findings.

- Higher levels of commuter traffic from suburban residences to various destination points in the tri-county area increase the exposure of local residents to safety risk factors.
- A neighborhood's racial and demographic profile, proximity to frequently traveled destinations, and the characteristics of the transportation network were found to have significant effects on the expected counts of both total collisions and those that result in a fatality or severe injury.
- Since commuters from surrounding areas are found to be at least partially responsible to pedestrian and bicycle crashes in lower income communities, "a paradigm shift in favor of more sustainable transportation that would reduce traffic volumes and prioritize public transit" (Morency et al. 2012, p. 1118). Preventative strategies focusing on traffic volume reduction and safer roadway design may also contribute to lower crash risk in poorer neighborhoods (Morency et al. 2012).

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Appendix A: Characteristics of Pedestrians Involved in a Crash in Lower-income Block Groups

Table A.29: Characteristics of Pedestrians involved in a Crash, by Severity

Severity Level	County			Total	Pct
	Broward	Miami-Dade	Palm Beach		
None	261	655	120	1036	16.8%
Possible Injury	529	1030	229	1788	29.0%
Non-incapacitating injury	595	1024	292	1911	31.0%
Incapacitating injury	290	509	137	936	15.2%
Fatal	109	170	57	336	5.5%
Non-traffic	6	14	2	22	0.4%
Total	1819	3435	903	6157	100.0%
Pct.	29.5%	55.8%	14.7%	100.0%	

Table A.30: Characteristics of Pedestrians involved in a Crash, by Time of Day

	County				
Time of Day	Broward	Miami-Dade	Palm Beach	Total	Pct
Midnight to 3 am	81	158	44	283	4.6%
3 am to 6 am	62	127	32	221	3.6%
6 am to 9 am	247	388	105	740	12.0%
9 am to noon	198	512	95	805	13.1%
Noon to 3 pm	252	563	110	925	15.0%
3 pm to 6 pm	330	616	162	1108	18.0%
6 pm to 9 pm	408	694	228	1330	21.6%
9 pm to midnight	241	377	127	745	12.1%
Total	1819	3435	903	6157	100.0%
Pct.	29.5%	55.8%	14.7%	100.0%	

Table A.31: Characteristics of Pedestrians involved in a Crash, by Age

Age Group	County			Total	Pct.
	Broward	Miami-Dade	Palm Beach		
14 and under	40	208	80	328	8.3%
15-19	28	190	58	276	7.0%
20-24	30	219	55	304	7.7%
25-34	67	461	85	613	15.5%
35-44	36	382	71	489	12.3%
45-54	47	493	76	616	15.5%
55-64	55	485	84	624	15.7%
65-69	12	164	27	203	5.1%
70 and older	54	395	64	513	12.9%
Total	369	2997	600	3966	100.0%
Pct.	9.3%	75.6%	15.1%	100.0%	

Table A.32: Characteristics of Pedestrians involved in a Crash, by Time and Age

Age Group	Time of Day								Total	Pct.
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
14 and under	5	1	51	23	48	97	89	14	328	8.3%
15-19	15	7	51	18	39	62	47	37	276	7.0%
20-24	25	21	29	31	43	54	60	41	304	7.7%
25-34	63	44	64	61	81	83	129	88	613	15.5%
35-44	28	22	51	58	75	81	104	70	489	12.3%
45-54	27	20	67	85	99	108	133	77	616	15.5%
55-64	21	17	59	81	103	113	155	75	624	15.7%
65-69	4	4	26	39	38	46	33	13	203	5.1%
70 and older	2	9	64	141	97	71	103	26	513	12.9%
Total	190	145	462	537	623	715	853	441	3966	100.0%
Pct.	4.8%	3.7%	11.6%	13.5%	15.7%	18.0%	21.5%	11.1%	100.0%	

Table A.33: Characteristics of Pedestrians involved in a Crash, by Time, Age, County of Incidence

County	Age Group	Time of Day - Total								Total	Pct.
		Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
Broward	14 and under	1	0	8	3	7	13	8	0	40	10.8%
	15-19	0	0	7	2	2	6	5	6	28	7.6%
	20-24	6	4	1	1	3	5	5	5	30	8.1%
	25-34	4	4	7	6	11	7	18	10	67	18.2%
	35-44	2	4	9	3	4	5	3	6	36	9.8%
	45-54	2	3	7	7	4	9	13	2	47	12.7%
	55-64	3	2	6	6	9	9	13	7	55	14.9%
	65-69	0	0	2	0	4	3	3	0	12	3.3%
	70 and older	0	2	4	11	11	7	12	7	54	14.6%
	Total	18	19	51	39	55	64	80	43	369	100.0%
	Pct.	4.9%	5.1%	13.8%	10.6%	14.9%	17.3%	21.7%	11.7%	100.0%	
Miami-Dade	14 and under	2	1	30	14	36	60	55	10	208	6.9%
	15-19	13	7	29	10	29	47	32	23	190	6.3%
	20-24	17	15	24	29	32	39	41	22	219	7.3%
	25-34	48	37	42	50	66	62	93	63	461	15.4%
	35-44	23	11	39	51	59	64	82	53	382	12.7%
	45-54	22	15	52	66	85	87	102	64	493	16.4%
	55-64	15	10	48	68	81	87	118	58	485	16.2%
	65-69	4	3	19	31	32	39	25	11	164	5.5%
	70 and older	1	7	56	118	77	50	71	15	395	13.2%
	Total	145	106	339	437	497	535	619	319	2997	100.0%
	Pct.	4.8%	3.5%	11.3%	14.6%	16.6%	17.9%	20.7%	10.6%	100.0%	
	14 and under	2	0	13	6	5	24	26	4	80	13.3%

Palm Beach County	15-19	2	0	15	6	8	9	10	8	58	9.7%
	20-24	2	2	4	1	8	10	14	14	55	9.2%
	25-34	11	3	15	5	4	14	18	15	85	14.2%
	35-44	3	7	3	4	12	12	19	11	71	11.8%
	45-54	3	2	8	12	10	12	18	11	76	12.7%
	55-64	3	5	5	7	13	17	24	10	84	14.0%
	65-69	0	1	5	8	2	4	5	2	27	4.5%
	70 and older	1	0	4	12	9	14	20	4	64	10.7%
	Total	27	20	72	61	71	116	154	79	600	100.0%
	Pct.	4.5%	3.3%	12.0%	10.2%	11.8%	19.3%	25.7%	13.2%	100.0%	

Table A.34: Characteristics of Pedestrians involved in a Crash, by Sex

	County				
Sex	Broward	Miami-Dade	Palm Beach	Total	Pct.
Male	203	1775	400	2378	58.7%
Female	168	1292	214	1674	41.3%
Total	371	3067	614	4052	100.0%
Pct.	9.2%	75.7%	15.2%	100.0%	

Table A.35: Characteristics of Pedestrians involved in a Crash, by Time of Day and Day of Week

Weekday	Time of Day								Total	Pct.
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
Monday	84	39	47	61	97	125	162	116	731	11.9%
Tuesday	26	25	114	117	134	163	192	85	856	13.9%
Wednesday	29	18	152	144	123	153	188	77	884	14.4%
Thursday	13	23	143	127	149	170	202	100	927	15.1%
Friday	32	31	94	107	150	195	179	78	866	14.1%
Saturday	28	21	128	137	149	188	216	141	1008	16.4%
Sunday	71	64	62	112	123	114	191	148	885	14.4%
Total	283	221	740	805	925	1108	1330	745	6157	100.0%
Pct.	4.6%	3.6%	12.0%	13.1%	15.0%	18.0%	21.6%	12.1%	100.0%	

Table A.36: Characteristics of Pedestrians involved in a Crash, by Time of Day, Day of Week, and Sex

		Time of Day									
Sex	Weekday	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight	Total	Pct.
Male	Monday	41	18	19	24	34	51	70	45	302	12.7%
	Tuesday	12	11	45	54	56	56	70	33	337	14.2%
	Wednesday	14	9	54	58	44	53	73	32	337	14.2%
	Thursday	3	12	56	47	54	58	74	43	347	14.6%
	Friday	12	18	36	48	53	71	73	22	333	14.0%
	Saturday	13	12	35	39	48	69	83	64	363	15.3%
	Sunday	33	32	30	41	42	49	69	63	359	15.1%
	Total	128	112	275	311	331	407	512	302	2378	100.0%
	Pct.	5.4%	4.7%	11.6%	13.1%	13.9%	17.1%	21.5%	12.7%	100.0%	
Female	Monday	21	6	15	19	29	30	30	27	177	10.6%
	Tuesday	8	5	24	27	33	52	50	17	216	12.9%
	Wednesday	5	3	43	48	45	46	54	17	261	15.6%
	Thursday	7	5	40	36	52	48	58	15	261	15.6%
	Friday	6	7	26	31	51	62	50	10	243	14.5%
	Saturday	3	3	35	42	53	55	64	35	290	17.3%
	Sunday	15	13	11	38	41	32	52	24	226	13.5%
	Total	65	42	194	241	304	325	358	145	1674	100.0%
	Pct.	3.9%	2.5%	11.6%	14.4%	18.2%	19.4%	21.4%	8.7%	100.0%	

Appendix B: Characteristics of Severely-injured Pedestrians in Lower-Income Areas (Incapacitating and non-Incapacitating, Non-Fatal Injuries)

Table B.37: Characteristics of Seriously-injured Pedestrians by Time of Day

Time of Day	Frequency	Percent	Valid Percent	Cumulative Percent
Midnight to 3 am	185	5.6%	5.6%	5.6%
3 am to 6 am	145	4.4%	4.4%	9.9%
6 am to 9 am	370	11.1%	11.1%	21.1%
9 am to noon	399	12.0%	12.0%	33.1%
Noon to 3 pm	438	13.2%	13.2%	46.3%
3 pm to 6 pm	539	16.2%	16.2%	62.5%
6 pm to 9 pm	778	23.4%	23.4%	85.9%
9 pm to midnight	468	14.1%	14.1%	100.0%
Total	3322	100.0%	100.0%	

Table B.38: Characteristics of Seriously-injured Pedestrians, by Age and County of Incidence

Age Group	County			Total	Pct.
	Broward	Miami-Dade	Palm Beach		
14 and under	22	105	42	169	7.9%
15-19	17	102	34	153	7.1%
20-24	21	122	40	183	8.5%
25-34	40	239	47	326	15.2%
35-44	16	193	43	252	11.7%
45-54	24	248	45	317	14.8%
55-64	38	252	47	337	15.7%
65-69	6	84	14	104	4.8%
70 and older	31	235	41	307	14.3%
Total	215	1580	353	2148	100.0%
Pct.	10.0%	73.6%	16.4%	100.0%	

Table B.39: Characteristics of Seriously-injured Pedestrians, by Time and Age

Age Group	Time of Day								Total	Pct.
	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
14 and under	3	1	23	10	28	46	47	11	169	7.9%
15-19	10	4	26	7	18	34	24	30	153	7.1%
20-24	17	17	11	17	23	32	36	30	183	8.5%
25-34	44	31	35	23	43	33	64	53	326	15.2%
35-44	18	9	26	19	35	41	64	40	252	11.7%
45-54	16	10	35	40	48	50	77	41	317	14.8%
55-64	13	12	31	45	48	53	92	43	337	15.7%
65-69	3	4	13	21	15	24	17	7	104	4.8%
70 and older	1	6	39	86	43	45	72	15	307	14.3%
Total	125	94	239	268	301	358	493	270	2148	100.0%
Pct.	5.8%	4.4%	11.1%	12.5%	14.0%	16.7%	23.0%	12.6%	100.0%	

Table B.40: Characteristics of Seriously-injured Pedestrians, by Time and Age, by County

County	Age Group	Time of Day								Total	Pct.
		Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Broward	14 and Under	1	0	4	2	4	5	2	0	18	2.0%
	15 - 19	0	0	3	1	0	2	4	3	13	1.5%
	20 - 24	4	4	0	0	1	4	3	4	20	2.3%
	25 - 34	2	1	4	2	6	3	12	4	34	3.9%
	35 - 44	0	1	6	1	3	1	1	2	15	1.7%
	45 - 54	0	1	1	3	2	6	5	0	18	2.0%
	55 - 64	2	1	3	2	4	2	7	1	22	2.5%
	65-69	0	0	1	0	2	0	2	0	5	0.6%
	70 and Older	0	1	3	7	6	4	4	2	27	3.1%
	Not Coded	38	23	88	72	89	115	182	101	708	80.5%
	Total	47	32	113	90	117	142	222	117	880	100%
Palm Beach	14 and Under	0	0	1	2	3	13	16	2	37	8.6%
	15 - 19	2	0	5	3	4	9	5	5	33	7.7%
	20 - 24	0	1	1	1	7	8	9	9	36	8.4%
	25 - 34	4	1	5	2	2	7	11	8	40	9.3%
	35 - 44	2	2	2	3	3	8	13	5	38	8.9%
	45 - 54	0	0	4	6	4	7	11	3	35	8.2%
	55 - 64	2	1	2	4	10	8	9	4	40	9.3%
	65-69	0	0	2	3	1	4	1	0	11	2.6%
	70 and Older	0	0	3	4	3	9	14	2	35	8.2%
	Not Coded	10	3	6	14	15	18	34	23	123	28.7%

	Total	20	8	31	42	52	91	123	61	428	100%
Miami-Dade	14 and Under	2	1	17	6	18	26	28	7	105	6.2%
	15 - 19	7	3	19	3	14	24	14	18	102	6.0%
	20 - 24	9	14	10	16	14	19	25	16	123	7.3%
	25 - 34	32	28	25	19	32	21	37	36	230	13.6%
	35 - 44	13	4	15	16	28	34	48	32	190	11.2%
	45 - 54	12	4	26	29	43	40	55	28	237	14.0%
	55 - 64	8	6	27	36	31	40	62	28	238	14.0%
	65-69	2	2	9	17	12	23	11	4	80	4.7%
	70 and Older	0	3	23	69	32	27	39	6	199	11.7%
	Not Coded	3	17	22	31	21	32	30	36	192	11.3%
	Total	88	82	193	242	245	286	349	211	1696	100.0%

Table B.41: Characteristics of Seriously-injured Pedestrians, by Sex

Gender	County			Total	Pct.
	Broward	Miami-Dade	Palm Beach		
Not Coded	708	114	122	944	38.80%
Male	96	534	209	839	34.48%
Female	77	477	97	651	26.76%
Total	880	1125	428	2433	100%

Table B.42: Characteristics of Seriously-injured Pedestrians, by Time of Day and Day of Week

Weekday	Time of Day								Total	Pct.
	Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Monday	30	15	16	21	35	42	62	32	253	12.13%
Tuesday	8	7	42	33	50	67	75	35	317	15.20%
Wednesday	9	2	50	47	34	52	66	33	293	14.05%
Thursday	1	14	48	47	54	55	68	29	316	15.15%
Friday	7	10	24	35	55	78	77	29	315	15.10%
Saturday	4	5	28	46	52	70	70	43	318	15.24%
Sunday	29	19	20	40	36	29	58	43	274	13.14%
Total	88	72	228	269	316	393	476	244	2086	100.00%

Table B.43: Characteristics of Seriously-injured Pedestrians, by Time of Day, Day of Week, and Sex

Sex	Weekday	Time of Day								Total	Pct.
		Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Male	Monday	15	7	8	8	11	19	23	11	102	13.49%
	Tuesday	3	3	15	12	20	19	30	14	116	15.34%
	Wednesday	4	2	19	11	15	20	23	10	104	13.76%
	Thursday	0	8	18	18	22	19	21	9	115	15.21%
	Friday	3	4	9	15	18	25	33	7	114	15.08%
	Saturday	2	4	8	11	16	27	24	15	107	14.15%
	Sunday	16	10	9	9	10	13	17	14	98	12.96%
	Total	43	38	86	84	112	142	171	80	756	100.00%
Female	Monday	5	4	5	7	10	7	12	9	59	9.53%
	Tuesday	3	1	8	8	14	26	21	9	90	14.54%
	Wednesday	2	0	14	21	10	19	22	11	99	15.99%
	Thursday	0	4	14	14	22	18	24	5	101	16.32%
	Friday	1	4	6	11	21	28	25	5	101	16.32%
	Saturday	1	0	9	13	17	21	19	13	93	15.02%
	Sunday	4	5	5	14	16	6	17	9	76	12.28%
	Total	16	18	61	88	110	125	140	61	619	100.00%

Appendix C: Characteristics of Pedestrians Killed In Lower Income Block Groups

Table C.44: Pedestrians Killed in a Crash, by Time of Day

Time of Day	Frequency	Pct.
Midnight to 2:59 am	33	9.0
3 am to 5:59 am	35	9.5
6 am to 8:59 am	36	9.8
9 am to 11:59 am	38	10.4
Noon to 2:59 pm	24	6.5
3 pm to 5:59 pm	34	9.3
6 pm to 8:59 pm	88	24.0
9 pm to 11:59 pm	79	21.5
Total	367	100%

Table C.45: F Characteristics of Pedestrians Killed in a Fatal Crash. by Age and County of Incidence

Age Group	County			Total	Pct.
	Broward	Miami-Dade	Palm Beach		
14 and Under	0	7	3	11	3.00%
15-19	2	9	1	12	3.27%
20-24	0	9	3	14	3.81%
25-34	4	24	5	33	8.99%
35-44	1	16	4	21	5.72%
45-54	6	24	9	38	10.35%
55-64	16	26	6	48	13.08%
65-69	1	8	2	10	2.72%
70 an Older	6	44	9	56	15.26%
Not Coded	79	18	17	124	33.79%
Total	115	185	59	367	100.00%

Table C.46: Characteristics of Pedestrians Killed in a Fatal Crash, by Time and Age

Age Group	Time of Day								Total	Pct.
	Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
14 and Under	0	0	1	1	1	3	3	2	11	3.00%
15 - 19	1	1	4	0	0	1	1	4	12	3.27%
20 - 24	4	3	0	0	1	2	2	2	14	3.81%
25 - 34	6	7	2	1	3	3	5	6	33	8.99%
35 - 44	4	3	3	1	0	2	5	3	21	5.72%
45 - 54	4	4	4	3	3	2	6	12	38	10.35%
55 - 64	2	3	2	5	4	5	17	10	48	13.08%
65-69	1	2	0	1	0	0	3	3	10	2.72%
70 and Older	1	2	10	11	4	7	17	4	56	15.26%
Not Coded	10	10	10	15	8	9	29	33	124	33.79%
Total	33	35	36	38	24	34	88	79	367	100.00%
Pct.	8.99%	9.54%	9.81%	10.35%	6.54%	9.26%	23.98%	21.53%	100.00%	

Table C.47: Characteristics of Pedestrians Killed in a Fatal Crash, by Time, Age, and County of Incidence

County	Age Group	Time of Day								Total	Pct.
		Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Broward	14 and Under	0	0	0	1	0	0	0	0	1	0.82%
	15 - 19	0	0	1	0	0	0	0	1	2	1.64%
	20 - 24	1	0	0	0	0	0	0	0	1	0.82%
	25 - 34	2	0	1	0	1	0	0	0	4	3.28%
	35 - 44	1	0	0	0	0	0	0	0	1	0.82%
	45 - 54	1	0	0	0	1	0	2	2	6	4.92%
	55 - 64	1	0	1	2	3	1	4	4	16	13.11%
	65-69	0	0	0	0	0	0	0	0	0	0.00%
	70 and Older	0	0	0	0	0	0	3	2	5	4.10%
	Not Coded	10	6	7	7	8	6	22	20	86	70.49%
	Total	16	6	10	10	13	7	31	29	122	100.00%
Miami-Dade	14 and Under	0	0	0	0	1	3	2	1	7	3.78%
	15 - 19	1	1	3	0	0	1	1	2	9	4.86%
	20 - 24	2	3	0	0	1	1	2	0	9	4.86%
	25 - 34	4	6	1	1	2	3	5	2	24	12.97%
	35 - 44	2	3	3	1	0	2	3	2	16	8.65%
	45 - 54	3	3	4	3	2	2	3	4	24	12.97%
	55 - 64	1	1	0	2	1	3	13	5	26	14.05%
	65-69	1	1	0	1	0	0	3	2	8	4.32%
	70 and Older	0	2	10	10	4	5	11	2	44	23.78%
	Not Coded	0	2	2	4	0	2	3	5	18	9.73%
	Total	14	22	23	22	11	22	46	25	185	100.00%
Palm Beach	14 and Under	0	0	1	0	0	0	1	1	3	5.00%
	15 - 19	0	0	0	0	0	0	0	1	1	1.67%
	20 - 24	1	0	0	0	0	1	0	2	4	6.67%
	25 - 34	0	1	0	0	0	0	0	4	5	8.33%
	35 - 44	1	0	0	0	0	0	2	1	4	6.67%
	45 - 54	0	1	0	0	0	0	1	6	8	13.33%
	55 - 64	0	2	1	1	0	1	0	1	6	10.00%
	65-69	0	1	0	0	0	0	0	1	2	3.33%
	70 and Older	1	0	0	1	2	2	3	0	7	11.67%

Not Coded	0	2	1	2	0	1	4	8	20	33.33%
Total	3	7	3	4	2	5	11	25	60	100.00%

Table C.48: Characteristics of Pedestrians Killed in a Fatal Crash, by Sex

Gender	County			Total	Pct.
	Broward	Miami-Dade	Palm Beach		
Male	21	116	27	164	44.69%
Female	13	55	14	82	22.34%
Not Coded	88	14	19	121	32.97%
Total	115	185	60	367	100%

Table C.49: Characteristics of Pedestrians Killed in a Fatal Crash, by Time of Day and Day of Week

Weekday	Time of Day								Total	Pct.
	Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Monday	14	9	5	2	2	6	14	14	66	17.98%
Tuesday	0	0	3	7	7	3	10	4	34	9.26%
Wednesday	3	7	9	12	0	4	12	8	55	14.99%
Thursday	2	3	4	5	3	4	14	13	48	13.08%
Friday	7	4	7	4	6	6	10	5	49	13.35%
Saturday	1	3	1	6	3	7	15	17	53	14.44%
Sunday	6	9	7	2	3	4	13	18	62	16.89%
Total	33	35	36	38	24	34	88	79	367	100.00%
Pct.	8.99%	9.54%	9.81%	10.35%	6.54%	9.26%	23.98%	21.53%	100.00%	

Table C.50: Characteristics of Pedestrians Killed in a Fatal Crash, Time of Day, Day of Week, and Sex

Sex	Weekday	Time of Day								Total	Pct.
		Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Male	Monday	6	5	2	2	0	4	5	6	30	18.29%
	Tuesday	0	0	3	4	1	2	5	1	16	9.76%
	Wednesday	3	5	2	5	0	2	5	5	27	16.46%
	Thursday	1	1	1	0	3	2	5	5	18	10.98%
	Friday	2	2	5	2	1	0	6	1	19	11.59%
	Saturday	0	2	1	4	2	4	6	7	26	15.85%
	Sunday	4	1	6	1	0	1	7	8	28	17.07%
	Total	16	16	20	18	7	15	39	33	164	100.00%
Female	Monday	5	2	2	0	2	0	3	3	17	20.73%
	Tuesday	0	0	0	1	2	0	1	1	5	6.10%
	Wednesday	0	0	3	2	0	0	3	1	9	10.98%
	Thursday	1	2	1	1	0	2	4	4	15	18.29%
	Friday	1	2	1	0	3	5	3	0	15	18.29%
	Saturday	0	0	0	2	1	2	3	3	11	13.41%
	Sunday	0	4	0	0	1	1	3	1	10	12.20%
	Total	7	10	7	6	9	10	20	13	82	100.00%
Unknown	Monday	3	2	1	0	0	2	6	5	19	15.70%
	Tuesday	0	0	0	2	4	1	4	2	13	10.74%
	Wednesday	0	2	4	5	0	2	4	2	19	15.70%
	Thursday	0	0	2	4	0	0	5	4	15	12.40%

Friday	4	0	1	2	2	1	1	4	15	12.40%
Saturday	1	1	0	0	0	1	6	7	16	13.22%
Sunday	2	4	1	1	2	2	3	9	24	19.83%
Total	10	9	9	14	8	9	29	33	121	100.00%

Appendix D: Characteristics of Cyclists Involved in a Crash in Lower-income Block Groups

Table D.51: Cyclist Crashes by Severity

	County				
Severity Level	Broward	Miami-Dade	Palm Beach	Total	Pct.
None	15	19	6	40	1.2%
Possible injury	507	646	281	1434	43.4%
Non-incapacitating injury	513	645	309	1467	44.4%
Incapacitating injury	120	156	78	354	10.7%
Fatal	5	5	1	11	0.3%
Non-traffic	1	0	0	1	0.0%
Total	1161	1471	675	3307	100.0%
Pct.	35.1%	44.5%	20.4%	100.0%	

Table D.52: Characteristics of Cyclists involved in a Crash, by Time of Day and County of Incidence

	County				
Time of Day	Broward	Miami-Dade	Palm Beach	Total	Pct.
Midnight to 3 am	22	58	10	90	2.2%
3 am to 6 am	23	35	11	69	1.7%
6 am to 9 am	209	231	109	549	13.2%
9 am to noon	195	246	130	571	13.7%
Noon to 3 pm	246	328	165	739	17.7%
3 pm to 6 pm	338	467	243	1048	25.1%
6 pm to 9 pm	274	372	148	794	19.0%
9 pm to midnight	113	145	56	314	7.5%
Total	1420	1882	872	4174	100.0%
Pct.	34.0%	45.1%	20.9%	100.0%	

Table D.53. Characteristics of Cyclists involved in a Crash, by Age and County of Incidence

	County				
Age Group	Broward	Miami-Dade	Palm Beach	Total	Pct.
14 and under	24	75	55	154	6.3%
15-19	23	150	67	240	9.9%
20-24	30	164	67	261	10.8%
25-34	35	309	107	451	18.6%
35-44	31	241	73	345	14.2%
45-54	38	279	81	398	16.4%
55-64	36	279	84	399	16.4%
65-69	9	52	24	85	3.5%
70 and older	10	64	19	93	3.8%
Total	236	1613	577	2426	100.0%
Pct.	9.7%	66.5%	23.8%	100.0%	

Table D.54: Characteristics of Cyclists involved in a Crash, by Time and Age

	Time of Day									
Age Group	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight	Total	Pct.
14 and under	1	0	14	17	17	65	38	2	154	6.3%
15-19	6	0	21	22	45	77	55	14	240	9.9%
20-24	9	3	29	33	47	71	47	22	261	10.8%
25-34	14	12	48	50	83	96	96	52	451	18.6%
35-44	7	8	63	44	54	77	69	23	345	14.2%
45-54	7	12	62	49	57	109	76	26	398	16.4%
55-64	15	6	47	68	75	91	73	24	399	16.4%
65-69	2	1	10	15	18	22	12	5	85	3.5%
70 and older	2	2	17	27	12	20	10	3	93	3.8%
Total	63	44	311	325	408	628	476	171	2426	100.0%
Pct.	2.6%	1.8%	12.8%	13.4%	16.8%	25.9%	19.6%	7.0%	100.0%	

Table D.55: Characteristics of Cyclists involved in a Crash, by Time, Age, and County of Incidence

County	Age Group	Time of Day - Total								Total	Pct.
		Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight		
Broward	14 and under	0	0	2	2	0	10	9	1	24	10.2%
	15-19	0	0	1	3	5	8	5	1	23	9.7%
	20-24	0	1	5	3	2	12	4	3	30	12.7%
	25-34	1	1	6	4	4	5	11	3	35	14.8%
	35-44	1	0	5	6	3	8	7	1	31	13.1%
	45-54	0	3	6	6	5	7	8	3	38	16.1%
	55-64	0	0	3	6	11	10	5	1	36	15.3%
	65-69	0	0	3	3	1	2	0	0	9	3.8%
	70 and older	0	0	3	1	1	2	2	1	10	4.2%
	Total	2	5	34	34	32	64	51	14	236	100.0%
	Pct.	0.8%	2.1%	14.4%	14.4%	13.6%	27.1%	21.6%	5.9%	100.0%	
Miami-Dade	14 and under	1	0	4	8	12	29	20	1	75	4.6%
	15-19	5	0	11	11	30	49	34	10	150	9.3%
	20-24	9	2	16	19	29	39	34	16	164	10.2%
	25-34	11	7	36	34	60	65	62	34	309	19.2%
	35-44	5	6	50	25	39	53	45	18	241	14.9%
	45-54	5	6	40	30	42	85	50	21	279	17.3%
	55-64	15	5	36	48	46	58	53	18	279	17.3%
	65-69	2	1	4	8	13	12	9	3	52	3.2%
	70 and older	2	2	7	21	9	16	5	2	64	4.0%
	Total	55	29	204	204	280	406	312	123	1613	100.0%

	Pct.	3.4%	1.8%	12.6%	12.6%	17.4%	25.2%	19.3%	7.6%	100.0%	
Palm Beach County	14 and under	1	0	14	17	17	65	38	2	154	6.3%
	15-19	6	0	21	22	45	77	55	14	240	9.9%
	20-24	9	3	29	33	47	71	47	22	261	10.8%
	25-34	14	12	48	50	83	96	96	52	451	18.6%
	35-44	7	8	63	44	54	77	69	23	345	14.2%
	45-54	7	12	62	49	57	109	76	26	398	16.4%
	55-64	15	6	47	68	75	91	73	24	399	16.4%
	65-69	2	1	10	15	18	22	12	5	85	3.5%
	70 and older	2	2	17	27	12	20	10	3	93	3.8%
	Total	63	44	311	325	408	628	476	171	2426	100.0%
	Pct.	2.6%	1.8%	12.8%	13.4%	16.8%	25.9%	19.6%	7.0%	100.0%	

Table D.56: Characteristics of Cyclists involved in a Crash, by Sex

	County				
Sex	Broward	Miami-Dade	Palm Beach	Total	Pct.
Male	196	1436	471	2103	84.4%
Female	48	222	120	390	15.6%
Total	244	1658	591	2493	100.0%
Pct.	9.8%	66.5%	23.7%	100.0%	

Table D.57: Characteristics of Cyclists involved in a Crash, by Time of Day and Day of Week

	Time of Day									
Weekday	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight	Total	Pct.
Monday	21	9	28	74	83	88	90	41	434	10.4%
Tuesday	11	7	68	82	125	181	118	34	626	15.0%
Wednesday	11	11	94	83	105	186	129	31	650	15.6%
Thursday	8	12	120	79	106	149	125	54	653	15.6%
Friday	8	11	104	86	110	152	103	49	623	14.9%
Saturday	10	9	87	70	101	171	138	56	642	15.4%
Sunday	21	10	48	97	109	121	91	49	546	13.1%
Total	90	69	549	571	739	1048	794	314	4174	100.0%
Pct.	2.2%	1.7%	13.2%	13.7%	17.7%	25.1%	19.0%	7.5%	100.0%	

Table D.58: Characteristics of Cyclists involved in a Crash, by Time of Day, Day of Week, and Sex

		Time of Day									
Sex	Weekday	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight	Total	Pct.
Male	Monday	10	8	14	31	40	48	43	22	216	10.3%
	Tuesday	7	3	31	43	53	93	60	18	308	14.6%
	Wednesday	5	9	51	41	43	97	75	14	335	15.9%
	Thursday	8	7	61	42	57	73	57	27	332	15.8%
	Friday	8	6	54	39	44	75	45	27	298	14.2%
	Saturday	6	6	29	30	57	92	72	25	317	15.1%
	Sunday	14	5	28	53	60	63	48	26	297	14.1%
	Total	58	44	268	279	354	541	400	159	2103	100.0%
	Pct.	2.8%	2.1%	12.7%	13.3%	16.8%	25.7%	19.0%	7.6%	100.0%	
Female	Monday	2	0	4	9	11	6	11	2	45	11.5%
	Tuesday	1	0	5	6	11	21	12	3	59	15.1%
	Wednesday	2	0	11	11	12	14	12	0	62	15.9%
	Thursday	0	0	14	4	14	14	22	4	72	18.5%
	Friday	0	2	8	16	8	18	12	3	67	17.2%
	Saturday	2	0	8	5	5	14	13	2	49	12.6%
	Sunday	0	0	4	7	8	11	4	2	36	9.2%
	Total	7	2	54	58	69	98	86	16	390	100.0%
	Pct.	1.8%	0.5%	13.8%	14.9%	17.7%	25.1%	22.1%	4.1%	100.0%	

Appendix E: Characteristics of Severely-injured Cyclists in Lower-Income Areas (Incapacitating and non-Incapacitating, Non-Fatal Injuries)

Table E.59: Characteristics of Seriously-injured Cyclists, by Time of Day

Time of Day	Frequency	Percent	Valid Percent	Cumulative Percent
Midnight to 3 am	71	2.1	2.1	2.1
3 am to 6 am	59	1.8	1.8	3.9
6 am to 9 am	453	13.7	13.7	17.6
9 am to noon	457	13.8	13.8	31.4
Noon to 3 pm	551	16.7	16.7	48.1
3 pm to 6 pm	813	24.6	24.6	72.7
6 pm to 9 pm	650	19.6	19.6	92.3
9 pm to midnight	255	7.7	7.7	100.0
Total	3309	100.0	100.0	

Table E.60: Characteristics of Seriously-injured Cyclists, by Age

	County				
Age Group	Broward	Miami-Dade	Palm Beach	Total	Pct.
14 and under	20	61	51	132	6.6%
15-19	21	129	63	213	10.6%
20-24	28	137	59	224	11.1%
25-34	29	239	97	365	18.1%
35-44	26	187	67	280	13.9%
45-54	32	217	72	321	15.9%
55-64	28	224	73	325	16.1%
65-69	8	44	22	74	3.7%
70 and older	8	53	18	79	3.9%
Total	200	1291	522	2013	100.0%
Pct.	9.9%	64.1%	25.9%	100.0%	

Table E.61: Characteristics of Seriously-injured Cyclists, by Time and Age

	Time of Day									
Age Group	Midnight to 3 am	3 am to 6 am	6 am to 9 am	9 am to noon	Noon to 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to midnight	Total	Pct.
14 and under	1	0	12	11	16	58	34	0	132	6.6%
15-19	5	0	17	22	35	70	50	14	213	10.6%
20-24	8	3	27	29	39	59	42	17	224	11.1%
25-34	11	11	39	41	67	75	76	45	365	18.1%
35-44	6	7	49	35	49	57	59	18	280	13.9%
45-54	5	10	49	44	43	84	66	20	321	15.9%
55-64	12	5	42	57	55	73	65	16	325	16.1%
65-69	2	1	9	12	15	20	10	5	74	3.7%
70 and older	2	2	17	22	10	15	8	3	79	3.9%
Total	52	39	261	273	329	511	410	138	2013	100.0%
Pct.	2.6%	1.9%	13.0%	13.6%	16.3%	25.4%	20.4%	6.9%	100.0%	

Table E.62: Characteristics of Seriously-injured Cyclists, By Age, Time, and County of Incidence

County	Age Group	Time of Day								Total	Pct.
		Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Broward	14 and Under	0	0	1	1	0	5	5	0	12	1.9%
	15 - 19	0	0	1	2	4	4	2	1	14	2.2%
	20 - 24	0	1	4	3	0	4	3	1	16	2.5%
	25 - 34	1	0	2	1	2	2	5	1	14	2.2%
	35 - 44	0	0	1	2	1	5	5	0	14	2.2%
	45 - 54	0	2	3	4	1	3	6	1	20	3.2%
	55 - 64	0	0	2	0	4	4	2	0	12	1.9%
	65-69	0	0	2	1	0	2	0	0	5	0.8%
	70 and Older	0	0	1	1	0	0	2	0	4	0.6%
	Not Coded	9	11	86	77	78	105	109	44	519	82.4%
	Total	10	14	103	92	90	134	139	48	630	100%
Palm Beach	14 and Under	0	0	3	3	2	15	5	0	28	7.3%
	15 - 19	1	0	5	6	3	10	6	1	32	8.3%
	20 - 24	0	0	4	6	5	10	5	3	33	8.5%
	25 - 34	2	2	3	5	7	10	15	10	54	14.0%
	35 - 44	0	2	4	6	9	5	7	2	35	9.1%
	45 - 54	1	1	9	6	6	7	10	1	41	10.6%
	55 - 64	0	1	5	6	5	11	9	2	39	10.1%
	65-69	0	0	1	1	1	6	1	1	11	2.8%
	70 and Older	0	0	4	3	1	1	2	0	11	2.8%

	Not Coded	4	0	11	16	15	34	10	12	102	26.4%
	Total	8	6	49	58	54	109	70	32	386	100%
Miami-Dade	14 and Under	0	0	2	3	4	13	15	0	37	4.44%
	15 - 19	2	0	5	5	10	23	12	8	65	7.79%
	20 - 24	5	3	11	7	15	17	16	9	83	9.95%
	25 - 34	6	5	19	17	28	28	24	15	142	17.03%
	35 - 44	2	3	22	12	22	19	14	8	102	12.23%
	45 - 54	2	4	17	16	17	33	26	13	128	15.35%
	55 - 64	10	4	16	22	20	26	31	9	138	16.55%
	65-69	1	1	1	2	4	3	6	1	19	2.28%
	70 and Older	0	1	5	8	6	7	1	2	30	3.60%
	Not Coded	0	9	12	13	12	21	15	8	90	10.79%
	Total	28	30	110	105	138	190	160	73	834	100.00%

Table E.63: Characteristics of Seriously-injured Cyclists, by Sex and County of Incidence

Sex	County			Total	Pct.
	Broward	Miami-Dade	Palm Beach		
Male	92	645	231	968	49.39%
Female	20	110	56	186	9.49%
Unknown	518	189	99	806	41.12%
Total	630	834	386	1960	100%

Table E.64: Characteristics of Seriously-injured Cyclists, by Time of Day and Day of Week

Weekday	Time of Day								Total	Pct.
	Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Monday	14	6	17	36	41	51	49	25	239	12.66%
Tuesday	4	3	30	41	42	80	54	13	267	14.14%
Wednesday	3	4	42	30	35	74	59	13	260	13.77%
Thursday	2	7	54	40	38	67	69	35	312	16.53%
Friday	5	17	52	41	48	62	44	19	288	15.25%
Saturday	8	5	47	32	46	59	64	27	288	15.25%
Sunday	11	10	23	38	35	53	37	27	234	12.39%
Total	47	52	265	258	285	446	376	159	1888	100.00%
Pct.	2.49%	2.75%	14.04%	13.67%	15.10%	23.62%	19.92%	8.42%	100.00%	

Table E.65: Characteristics of Seriously-injured Cyclists, by Time of Day, Day of Week, and Sex

Sex	Weekday	Time of Day								Total	Pct.
		Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Male	Monday	11	9	7	14	20	25	22	11	119	12.53%
	Tuesday	2	1	17	21	19	41	24	9	134	14.11%
	Wednesday	4	7	24	15	11	38	29	11	139	14.63%
	Thursday	3	3	21	16	20	30	35	20	148	15.58%
	Friday	7	8	28	23	18	25	24	9	142	14.95%
	Saturday	5	6	16	16	22	29	34	15	143	15.05%
	Sunday	10	2	14	15	19	25	18	22	125	13.16%
	Total	42	36	127	120	129	213	186	97	950	100.00%
	Pct.	4.42%	3.79%	13.37%	12.63%	13.58%	22.42%	19.58%	10.21%	100.00%	
Female	Monday	7	2	4	3	7	4	11	4	42	17.57%
	Tuesday	1	0	2	1	4	10	8	1	27	11.30%
	Wednesday	1	0	6	4	5	6	7	1	30	12.55%
	Thursday	1	2	8	2	7	6	12	6	44	18.41%
	Friday	1	4	3	6	6	12	9	1	42	17.57%
	Saturday	1	0	6	4	2	6	6	3	28	11.72%
	Sunday	0	4	1	4	4	7	4	2	26	10.88%
	Total	12	12	30	24	35	51	57	18	239	100.00%
	Pct.	5.02%	5.02%	12.55%	10.04%	14.64%	21.34%	23.85%	7.53%	100.00%	

Appendix F: Characteristics of Cyclists Killed In Lower Income Block Groups

Table F.66: Fatal Cyclist Crashes by Time of Day

Time of Day	County			Total	Pct.
	Broward	Miami-Dade	Palm Beach		
Midnight to 2:59 am	3	3	0	6	8.11%
3 am to 5:59 am	2	4	1	7	9.46%
6 am to 8:59 am	3	2	1	6	8.11%
9 am to 11:59 am	2	2	2	6	8.11%
Noon to 2:59 pm	0	0	1	1	1.35%
3 pm to 5:59 pm	5	6	0	11	14.86%
6 pm to 8:59 pm	3	10	5	18	24.32%
9 pm to 11:59 pm	8	6	5	19	25.68%
Total	26	33	15	74	100.00%

Table F.67: Characteristics of Cyclists Killed in a Fatal Crash, by Age

Age Group	County			Total	Pct.
	Broward	Miami-Dade	Palm Beach		
14 and Under	0	0	0	0	0.00%
15-19	0	0	0	0	0.00%
20-24	0	0	0	0	0.00%
25-34	2	4	2	8	10.81%
35-44	1	5	2	8	10.81%
45-54	3	6	3	12	16.22%
55-64	1	10	4	15	20.27%
65-69	0	1	2	3	4.05%
70 and Older	1	1	0	2	2.70%
Not Coded	18	6	2	26	35.14%
Total	26	33	15	74	100.00%

Table F.68: Characteristics of Cyclists Killed in a Fatal Crash, by Time and Age

Age Group	Time of Day								Total	Pct.
	Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
14 and Under	0	0	0	0	0	0	0	0	0	0.0%
15 - 19	0	0	0	0	0	0	0	0	0	0.0%
20 - 24	0	0	0	0	0	0	0	0	0	0.0%
25 - 34	0	1	1	1	0	0	3	1	7	9.46%
35 - 44	1	1	1	0	0	1	2	2	8	10.81%
45 - 54	0	3	2	0	0	2	2	3	12	16.22%
55 - 64	3	0	0	1	1	1	4	5	15	20.27%
65-69	0	1	0	1	0	0	1	0	3	4.05%
70 and Older	0	0	0	1	0	2	0	0	3	4.05%
Not Coded	2	1	2	2	0	5	7	7	26	35.14%
Total	6	7	6	6	1	11	19	18	74	100.00%
Pct.	8.11%	9.46%	8.11%	8.11%	1.35%	14.86%	25.68%	24.32%	100.00%	

Table F.69: Characteristics of Cyclists Killed in a Fatal Crash, by Time, Age and County of Incidence

County	Age Group	Time of Day								Total	Pct.
		Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Broward	14 and Under	0	0	0	0	0	0	0	0	0	0.0%
	15 - 19	0	0	0	0	0	0	0	0	0	0.0%
	20 - 24	0	0	0	0	0	0	0	0	0	0.0%
	25 - 34	0	1	0	0	0	0	0	1	2	7.7%
	35 - 44	1	0	0	0	0	0	0	0	1	3.8%
	45 - 54	0	0	1	0	0	0	0	2	3	11.5%
	55 - 64	0	0	0	0	0	1	0	0	1	3.8%
	65-69	0	0	0	0	0	0	0	0	0	0.0%
	70 and Older	0	0	1	0	0	0	0	0	1	3.8%
	Not Coded	2	1	1	2	0	4	3	5	18	69.2%
	Total	3	2	3	2	0	5	3	8	26	100%
Palm Beach	14 and Under	0	0	0	0	0	0	0	0	0	0.0%
	15 - 19	0	0	0	0	0	0	0	0	0	0.0%
	20 - 24	0	0	0	0	0	0	0	0	0	0.0%
	25 - 34	0	0	1	0	0	0	1	0	2	13.3%
	35 - 44	0	0	0	0	0	0	1	1	2	13.3%
	45 - 54	0	1	0	0	0	0	1	1	3	20.0%
	55 - 64	0	0	0	0	1	0	0	3	4	26.7%
	65-69	0	0	0	1	0	0	1	0	2	13.3%
	70 and Older	0	0	0	0	0	0	0	0	0	0.0%
	Not Coded	0	0	0	1	0	0	1	0	2	13.3%
	Total	0	1	1	2	1	0	5	5	15	100%

	14 and Under	0	0	0	0	0	0	0	0	0	0.0%
	15 - 19	0	0	0	0	0	0	0	0	0	0.0%
	20 - 24	0	0	0	0	0	0	0	0	0	0.0%
	25 - 34	0	0	0	0	0	2	2	2	6	18.18%
	35 - 44	0	0	0	1	0	0	2	1	4	12.12%
Miami-Dade	45 - 54	0	1	1	0	0	1	1	1	5	15.15%
	55 - 64	0	2	1	0	0	2	1	0	6	18.18%
	65-69	3	0	0	1	0	0	4	2	10	30.30%
	70 and Older	0	1	0	0	0	0	0	0	1	3.03%
	Not Coded	0	0	0	0	0	1	0	0	1	3.03%
	Total	3	4	2	2	0	6	10	6	33	100%

Table F.70: Characteristics of Cyclists Killed in a Fatal Crash, by Sex

Gender	County			Total	Pct.
	Broward	Miami-Dade	Palm Beach		
Male	9	28	14	51	68.92%
Female	0	1	0	1	1.35%
Unknown	17	4	1	22	29.73%
Total	26		15	74	100%

Table F.71: Characteristics of Cyclists Killed in a Fatal Crash, by Time of Day and Day of Week

Weekday	Time of Day								Total	Pct.
	Midnight to 2:59 am	3 am to 5:59 am	6 am to 8:59 am	9 am to 11:59 am	Noon to 2:59 pm	3 pm to 5:59 pm	6 pm to 8:59 pm	9 pm to 11:59 pm		
Monday	0	1	0	1	0	2	4	5	13	17.57%
Tuesday	0	1	1	1	0	1	2	3	9	12.16%
Wednesday	0	3	0	1	0	2	4	1	11	14.86%
Thursday	2	2	1	1	1	1	2	0	10	13.51%
Friday	1	0	1	1	0	2	2	1	8	10.81%
Saturday	0	0	1	1	0	2	1	5	10	13.51%
Sunday	3	0	2	0	0	1	4	3	13	17.57%
Total	6	7	6	5	1	10	19	18	74	100.00%
Pct.	8.11%	9.46%	8.11%	6.76%	1.35%	13.51%	25.68%	24.32%	100.00%	

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