PEDESTRIAN AND BICYCLIST CRASH RISK IN LOW INCOME AND MINORITY AREAS:

An Examination of At-Risk Population Segments and Environmental Risk Factors

Final Report

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Prepared for:

Florida Department of Transportation

Mark Plass, P.E., Project Manager

Prepared by:

Florida Atlantic University

Eric Dumbaugh, Ph.D.

Diana Mitsova, Ph.D.

Dibakar Saha, Ph.D.

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16. Abstract

Socioeconomic status (SES) is a well-known predictor of crash risk, with lower income and minority populations being disproportionately likely to be injured or killed in a traffic crash. There has been little substantive examination of the specific nature of the crash risk experienced by lower income populations. This study examines the characteristics of pedestrians and bicyclists involved in crashes in lower income areas in Broward and Palm Beach County, as well as the environmental factors that contribute to their risk. It finds that very few of the pedestrians and bicyclists struck, injured, or killed in lower income areas were under the influence of drugs and alcohol. Instead, the majority of these crashes appear to involve individuals engaging in ordinary activities, particularly during the late afternoon and early evening. This study identifies four pedestrian and two bicycle cohorts at disproportionate risk, risk that increases in the presence of restaurants, shopping centers, and 5-or-more lane streets, and which decreases in the presence of raised medians and the higher levels of intersection density. This study concludes by discussing the nature of this risk, most notably conflicts of use and errors of expectancy, and by outlining potential engineering, education, and enforcement countermeasures that may best address it.

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EXECUTIVE SUMMARY

Socioeconomic 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. 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 bicyclist crashes occurring in lower income areas in Broward and Palm Beach 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 bicyclist safety in lower income areas.

At-Risk Cohorts

Compared to more affluent block groups, pedestrians in lower income areas are between two and three times more likely to be killed or severely injured. Persons 19 and 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 25-34. The largest concentration of these collisions (43%) occurred during the afternoon and early evening periods (3:00 pm to 9:00 pm), though 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 (6%) involve pedestrians suspected of being under the influence of drugs and alcohol. 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 street play:* 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. *Emerging adulthood*: pedestrians aged 25-34, 6 pm to midnight

Total collisions and killed or severely-injury (KSI) collisions involving bicyclists are twice as likely to occur in lower income areas than more affluent ones. The overwhelming majority of bicyclists 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 or drug use appears to be a major factor, with officers suspecting bicyclists 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. *Adult utilitarian bicycling*: bicyclists aged 20-64, 6 am to 9 pm
2. *Afterschool activities*: bicyclists 19 and under, 3 to 6 pm, weekdays

Environmental Risk Factors

This study identified environmental risk factors for lower income block groups using negative binomial regression models. The independent variables used in this analysis fall into three general categories: background conditions, transportation network characteristics, and land use composition. With respect to background conditions, what is most notable is that total and KSI crashes involving pedestrian and bicyclists increase significantly in proportion to the percentage of blacks and Hispanics in the population. This study is unable to distinguish the extent to which this finding may be attributable to behavioral differences, or whether it is a function of differences in the design and configuration of the built environment. In either event, it is clear that racial disparities increase the crash risk experienced by lower income populations, warranting greater consideration to the unique needs of these populations.

The second group of variables sought to capture the safety effects of transportation network characteristics. The mileage of 5-or-more lane streets was associated with the increased incidence of total and KSI collisions involving pedestrians and bicyclists, and significantly so for all except pedestrian KSI collisions. On the other hand, raised medians proved to provide safety benefits for pedestrians and bicyclists alike, undoubtedly due to their ability to serve as a midblock refuge for pedestrians and bicyclists attempting to cross multi-lane streets. Yet what is perhaps most notable is the important role played by intersection density, which was found to lead to consistent reductions in crashes involving pedestrians and bicyclists alike. As we have discussed, this is likely attributable to the ability of well-connected street networks to provide pedestrians and bicyclists with routes that not only reduce their overall travel distances, and thus exposure, but which also provide them with multiple route choices to their destination ends, providing potential options for avoiding potentially hazardous routes. We should further note that in early model runs, we tested variables that accounted for the percentage of streets with posted speeds of 25 mph or less and 35 mph or less. Neither variable proved to have a statistically meaningful effect on pedestrian or bicyclist crash incidence.

Finally, we included variables that accounted for land use characteristics. For lower income communities, variables associated with everyday activities, such as supermarkets, shopping centers, and restaurants, were associated with increased incidence of crashes involving pedestrians and bicyclists. This is markedly different than the land uses associated with collision in the affluent sections of Palm Beach County, which were associated with the presence of "mixed-use" buildings, which are a characteristic of social and recreational destinations, rather than utilitarian ones. The number of bars and nightclubs were additionally included as a variable to confirm the finding that few pedestrians or bicyclists involved in a crash in lower income areas were impaired. Not only were bars and nightclubs not significantly related to the incidence of pedestrians and bicyclists involved in a collision, the coefficients in all four models were negative.

Table ES-1: Environmental Features Associated with Pedestrian and Bicyclist Crash Involvement in Lower Income Block Groups

	Pedestrians		**Bicyclists**	
	Total	KSI	Total	KSI
population (thousands)	0.073Ψ	0.073	0.029	-0.010
dvmt (thousands)	0.005**	0.005*	0.005Ψ	0.004
% black	0.014***	0.014***	0.007**	0.007*
% Hispanic	0.013***	0.016***	0.011**	0.012**
miles of 5-or-more lane streets	0.264Ψ	0.164	0.293Ψ	0.314Ψ
miles of raised medians	-0.724***	-0.657**	-0.663**	-0.499Ψ
intersection density	-4.091***	-3.832***	-4.648***	-4.982***
# supermarkets	0.284	0.179	0.483**	0.474**
# shopping centers	0.099*	0.096*	0.105Ψ	0.075
# restaurants	0.165***	0.199***	0.180***	0.175***
# schools/colleges	0.023	0.027	-0.012	0.020
# bars and nightclubs	-0.139	-0.077	-0.199	-0.227

Ψ $p < .10$
* $p < .05$
** $p < .01$
*** $p < .001$

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 environments that are poorly adapted to high levels of walking and bicycling. Many 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 (see Figure ES-1).

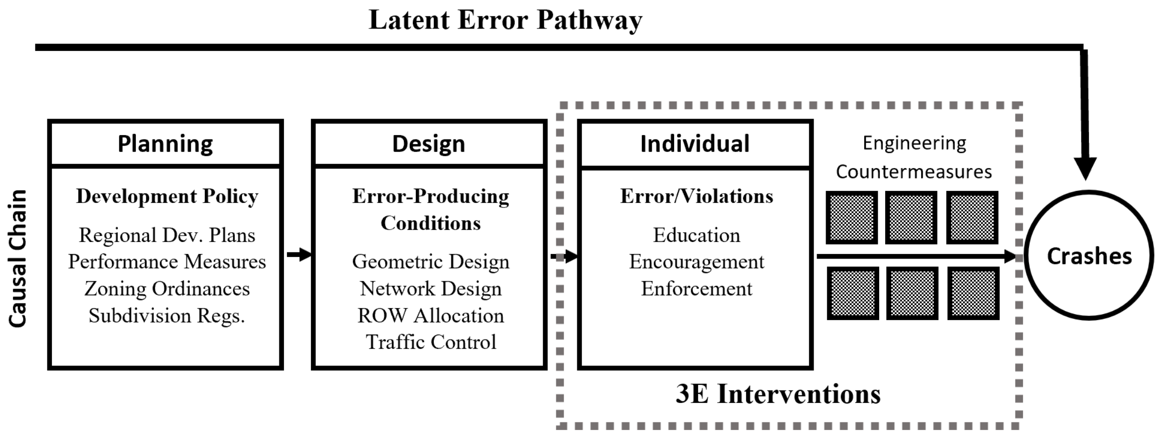

Figure ES-1: A Comprehensive Approach to Road Safety and the Production of Latent Error

Based on the findings from at-risk population segments and environmental risk factors, six recommendations are presented that direct educational and enforcement programs towards at-risk population cohorts, and which seek to address safety issues resulting from mismatches in the transportation system and local land development practice. Specifically sought were strategies that can be applied preventively to minimize the need for future capital investments aimed at mitigating the hazards created through local land development practices. These recommendations are:

1. Safety education in local schools
2. Targeted educational and information campaigns
3. Community policing during the afternoon and early evening
4. Refining FDOT context classifications based on road user characteristics
5. Linking traffic safety to state consistency and concurrency requirements
6. Access management plans for urban redevelopment.

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An Examination of At-risk Population Segments and Underlying Risk Factors

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 et. al., 1998; Centers for Disease Control, 2013; Cottrill & Thakuriah, 2010; Graham et. al., 2005; Hippisley-Cox et. al., 2002; Rifaat et. al., 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, thus leading to increased exposure for vulnerable road users (Blumenberg & Manville, 2004; King et. al., 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 et. al., 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 all 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 bicyclist crashes occurring in lower income areas in Broward and Palm Beach 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 bicyclist safety in lower income areas.

2. IDENTIFICATION OF AT-RISK COHORTS

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

To understand the nature of the pedestrian and bicyclist crash risk in lower income areas, this study begins by estimating the *relative risk* of pedestrian and bicyclist crashes in lower income areas, compared to their more affluent counterparts. It then proceeds to identify specific *at-risk population cohorts* within lower income areas, stratified by age and time of day, in order to develop a profile of the unique characteristics of crashes experienced by pedestrians and bicyclists in lower income areas.

2.1 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, as well as a definition of a reference group for establishing relative risk. The second was to assemble the relevant data from disparate data sources in order 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 provides information on area median income. We defined lower income communities as those with poverty rates of greater than 15% or median household incomes that are 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 2-1). Since the average family size in Broward and Palm Beach was 3.68 and 3.7, respectively, this study uses the 50% AMI limit for a family of four.

Using 5-year estimates from the American Community Survey (2013-2017), we found that 362 census block groups in Broward County and 273 census block groups in Palm Beach 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, and 342 census block groups were classified as low income areas in Palm Beach County, for a total of 776 block groups.

Table 2-1: Selection Criteria for the Designation of Low Income Areas

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

[a]*Source*: Florida Housing and Finance Corporation

The development of risk ratios requires the identification of 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

This study uses three years (2015-2017) of crash data for its analysis. Information on pedestrians and bicyclists involved in a collision were collected from crash data obtained from the Florida State Safety Office (SSO). The dataset provides information about non-motorist age, sex, injury severity resulting from the crash, location during the crash, and suspected drug and alcohol use. This data does not, however, provide information on crash time, day, or crash location. To obtain this for Broward and Palm Beach Counties, we extracted the relevant data from the Signal Four Analytics (SFA) web portal. SFA, maintained by the Geoplan Center of the University of Florida, archives mapped crash data received from the Florida Department of Highway Safety and Motor Vehicles (DHSMV). A “query and join” operation was done to extract information about pedestrian and bicyclist crashes that occurred in 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 2-2 provides a summary of crash data used in this study analysis, including the total number of pedestrian crashes, deaths, and serious injuries, defined as a capacitating or non-incapacitating injury. It also provides the sum of the pedestrians and bicyclists that are killed or severely injured (KSI), defined as the sum of number of pedestrians or bicyclists that were killed or severely injured.

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 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 B-G of this report.

Table 2-2: Summary of Crash Data

Crash Type	Description	Low Income Block Groups	High Income Block Groups
Pedestrians	*Number of crashes*	2,531	360
	Number of pedestrians involved	2,612	394
	Number of pedestrian fatalities	174	26
	Number of pedestrian injuries[a]	1,308	183
	Number killed or severely-injured	1,482	209
Bicyclists	*Number of crashes*	2,104	408
	Number of bicyclists involved	2,127	417
	Number of bicyclist fatalities	41	8
	Number of bicyclist injuries[a]	1,016	216
	Number killed or severely-injured	1,057	224

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

2.2 Relative Risk: Lower Income vs. Higher Income Communities

Relative risk ratios were developed to determine the extent to which pedestrians and bicyclists in lower income areas may be at disproportionate risk, when compared against similar cohorts in more affluent areas. Relative risk ratios are calculated as the number of per capita pedestrian or bicyclist collisions in lower income block groups, divided by the per capita rate of such collisions in the block groups classified as being higher income. These are examined both in terms of total and KSI (killed or severely injured) collisions involving pedestrians and bicyclists, as well as the incidence of such crashes affecting specific cohorts, stratified by age and sex.

While total crashes can be reliably reported, an issue that emerges in the development of relative risk ratios is that local police departments are less likely to record information on the age and sex of pedestrians and bicyclists in lower income areas than more affluent ones. As shown inAppendices B-G, 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 does limit the accuracy of estimates of relative risk for specific age cohorts. For lower income areas in FDOT District 4, 63% of the total cases do not provide information on the demographic characteristics of pedestrians involved in a collision, compared to 50% for the incidence of these events in 120 AMI block groups. For bicyclists, 62% of crashes in lower income block groups lack demographic information, compared to 45% for 120 AMI block groups.

Although the failure to record demographic information does not affect the relative risk ratios for the total incidence of pedestrians and bicyclists involved in a collision, it does limit the accuracy of relative risk ratios developed for population-level cohorts. To allow cohort-level risk to be evaluated, we identified the magnitude of the undercount for lower income populations (13% for pedestrians, and 17% for bicyclists) and adjusted the number of crashes for each cohort accordingly. This approach allows for a more accurate estimate of risk for individual demographics, though it must be acknowledged that it presumes that there is no systematic bias in the reporting agency's decision to record this information based on the age or sex of the involved party.

Relative Risk: Pedestrians

As shown in Table 2-3, below, lower income communities reported 0.65 pedestrian crashes per 1,000 population per year, compared to 0.24 for higher income block groups. On a comparative basis, pedestrians in lower income areas are 2.8 times more likely to be struck by a vehicle, and nearly 3 times as likely to be killed or severely-injured.

Table 2-3: Pedestrian Collisions in Lower Income and Higher Income Block Groups

	Total		**KSI**	
Pedestrians	50 AMI	120 AMI	50 AMI	120 AMI
Pedestrian Collisions per Year	871	131	491	69
Population (000s)	1,334	557	1,334	557
Rate per 1,000 Population	0.65	0.24	0.37	0.12
Relative Risk	2.78	0.36	2.97	0.34

Table 2-4 shows relative risk ratios pedestrians in lower income areas, stratified by age and sex. With the exception of males aged 25-34, all other cohorts report a higher incidence of pedestrian collisions then their more affluent counterparts. Child pedestrians are particularly over-represented in lower income areas, with these areas reporting 3-6 times more crashes involving persons under the age of 19 than their more affluent counterparts. Given the magnitude of the differences in relative risk ratios for the population as a whole (Table 2-3) and individual cohorts (Table 2-4), we believe that the relative risk for at least some of these cohorts may be underestimated, despite our attempt to adjust the data for coding discrepancies, most particularly for collisions involving male pedestrians aged 25-34.

Table 2-4: 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	5.91	2.93	4.30	3.60	2.93	2.47
15-19	4.11	3.28	3.71	4.03	3.28	4.58
20-24	1.44	1.86	1.59	3.43	1.86	5.24
25-34	0.95	1.56	1.13	0.98	1.56	1.13
35-44	1.76	1.97	1.87	2.27	1.97	2.68
45-54	2.29	2.38	2.30	2.42	2.38	2.10
55-64	4.05	1.42	2.32	3.28	1.42	1.84
65-69	1.38	3.27	1.89	0.81	3.27	1.30
70 and Older	3.40	2.56	2.92	3.77	2.56	2.90
Total	2.33	2.13	2.23	2.46	2.13	2.23

Relative Risk: Bicyclists

For Broward and Palm Beach Counties, twice as many bicyclists in lower income communities are involved in a collision than in higher income areas. For lower income areas, there are 0.53 bicyclists involved in a collision per year per capita, compared to 0.25 in more affluent areas (See Table 2-5).

The relative incidence of bicyclists involved in a collision is shown in Table 2-6, below. Unlike pedestrians, where risk was distributed somewhat evenly, there is a pronounced differentiation in cohort-level incidence in lower income areas. Most notably, males between the ages of 20 and 24 are four times more likely to be involved in a collision than their more affluent counterparts, and fully 13 times likely to be involved in a collision that results in serious injury or death.

Table 2-5: Bicycle Collisions in Lower Income and Higher Income Block Groups

Bicyclists	**Total**		**KSI**	
	50 AMI	120 AMI	50 AMI	120 AMI
Bicycle Collision per Year	709	139	352	74
Population (000s)	1,334	557	1,334	557
Rate per 1,000 Population	0.53	0.25	0.26	0.13
Relative Risk	2.13	0.47	1.99	0.50

Table 2-6: Relative Risk of Bicyclist Collisions in Lower Income Block Groups, by Age and Sex

	All Crashes			**KSI**		
Bicycle	Male	Female	Total	Male	Female	Total
14 and Under	1.57	1.37	1.52	1.62	1.37	1.50
15-19	1.67	0.87	1.41	1.79	0.87	1.67
20-24	4.30	2.44	3.57	13.09	2.44	6.01
25-34	2.10	1.54	1.87	2.00	1.54	1.82
35-44	1.66	2.04	1.79	1.59	2.04	1.66
45-54	2.33	1.10	1.96	2.03	1.10	1.74
55-64	1.89	3.01	1.89	1.48	3.01	1.54
65-69	1.68	0.89	1.43	1.60	0.89	1.13
70 and Older	0.60	2.93	0.65	0.53	2.93	0.55
Total	1.79	1.52	2.78	1.69	1.52	2.46

This is almost certainly reflective of a combination of social and economic factors emerging during this period, which correspond to diverging socio-economic status over individual lifetimes. Affluent males in this age cohort are more likely to own an automobile, attend college, and embark on professional careers, all factors that increase socio-economic status and reduce overall risk of traffic-related death and injury. Culturally, affluent males in this cohort 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. Further, affluent populations would appear to be more likely to participate in a community of recreational bicyclists, 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.

It should be observed that per capita rates of crash incidence do not account for differences in overall exposure; at least some portion of this difference may be simply a function of lower overall rates of bicycle use in affluent areas, particularly among driver-age populations. Lower income males are likely more reliant on bicycles to accomplish basic trip objectives, which have less route flexibility than recreational cycling. 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.

Another notable difference is the comparatively low incidence of crashes affecting lower income bicyclists aged 70 and older, relative to their more affluent counterparts. This is likely attributable to lifestyle factors making affluent males more likely than less-affluent ones to use bicyclists for health and recreational purposes. Indeed, we strongly suspect that for all age cohorts, the higher incidence of bicycle collisions is likely attributable, at least in part, to socio-economic distinctions in the nature of bicycle use, with lower income populations being more likely to use bicycles for utilitarian purposes, rather than recreational ones, with route choices governed by shortest path considerations, rather than comfort or safety.

2.3 At-Risk Pedestrian Cohorts in Lower Income Areas

Table 2-7 provides a statistical profile of pedestrians struck by a vehicle in lower income areas, classified by time-of-collision and age. Between 2015 and 2017, there were 2,612 pedestrians struck by a vehicle in lower income areas, with 56% resulting in a pedestrian death or severe injury (1,308 serious injuries and 166 fatalities). Of these, demographic information was available for 969 pedestrians, 56% of whom were killed or severely injured. These 969 cases for which demographic information is available provide the basis for the analysis below. Complete data, including cases for which demographic information was not available, are presented in Appendices B-G.

The largest number of pedestrians involved in a crash are struck during the afternoon and early evening periods (3:00 PM – 9:00 PM). The numbers of pedestrian deaths and serious injuries for each age group and time period, shown in Table 2-8, approximately mirror pedestrian collision totals. Male pedestrians are somewhat more likely to be involved in a collision, accounting for 61% of the total collisions, while comprising only 49% of the population of lower income block groups.

Table 2-7: Pedestrians Involved in a Collision in Lower Income Areas, by Age and Time of Day

Age Group	Time of Day: 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	3	0	21	9	12	37	33	4	119	12.28%
15 - 19	2	0	22	8	10	15	15	14	86	8.88%
20 - 24	8	6	5	2	11	15	19	19	85	8.77%
25 - 34	14	6	21	11	15	21	36	25	149	15.38%
35 - 44	5	11	11	7	16	17	22	16	105	10.84%
45 - 54	5	5	15	19	13	21	31	13	122	12.59%
55 - 64	6	7	11	13	22	26	37	17	139	14.34%
65-69	0	1	7	8	7	8	11	4	46	4.75%
70 and Older	1	2	7	24	23	22	30	9	118	12.18%
Total	44	38	120	101	129	182	234	121	969	100.00%
Pct.	4.54%	3.92%	12.38%	10.42%	13.31%	18.78%	24.15%	12.49%	100.00%	

Considered in aggregate, four specific at-risk cohorts are identified as being at unique risk, classified as: 1) school trips and street play; 2) errands during the early evening; 3) active older adults; 4) emerging adulthood. Each is detailed below. Surprisingly, we did not find that pedestrian use of alcohol or drugs were a major factor in these collisions, an issue that is examined in further detail later in this report.

Table 2-8: Pedestrians Killed or Seriously Injured in Lower Income Areas, by Time of Day 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	6	4	7	18	19	3	58	10.56%
15 - 19	2	0	9	4	4	11	9	10	49	8.93%
20 - 24	5	5	1	1	8	13	12	14	59	10.75%
25 - 34	8	3	10	4	8	10	23	17	83	15.12%
35 - 44	4	3	8	4	6	9	16	8	58	10.56%
45 - 54	1	2	5	9	6	13	19	11	66	12.02%
55 - 64	4	5	7	8	16	12	20	10	82	14.94%
65-69	0	1	3	3	3	4	4	1	19	3.56%
70 and Older	1	1	6	12	10	15	23	7	75	13.66%
Total	26	20	55	49	68	105	145	81	549	100.00%
Pct.	4.74%	3.64%	10.02%	8.93%	12.39%	19.13%	26.41%	14.75%	100.00%	

School Trips and Street Play (Children Aged 14 and Under, Mornings, Afternoons, and Early Evening)

Children aged 14 and under comprise 12% 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), and are more likely to occur on weekdays rather than weekends, with specific clusters occurring on Wednesdays, and Fridays (see Table 2-9). Of the 119 pedestrians under the age of 14 struck by a vehicle, 55 involved a serious injury, and 3 resulted in a fatality.

Table 2-9: Pedestrians Aged 14 and Under Involved in a Collision in Lower Income Areas, by Time of Day and Day of Week

	Time of Day								
	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
Monday	0	0	0	2	1	7	4	1	15
Tuesday	2	0	8	4	0	4	6	0	24
Wednesday	0	0	5	1	3	6	5	0	20
Thursday	0	0	3	0	0	6	5	0	14
Friday	0	0	4	0	2	9	5	1	21
Saturday	1	0	0	2	2	3	7	2	17
Sunday	0	0	1	0	4	2	1	0	8
Total	3	0	21	9	12	37	33	4	119

Male pedestrians are disproportionately represented among school-aged children, with 63% of these collisions involving males, and 37% involving females (see Table 2-10). While female pedestrians are less likely to be involved in a collision overall, the number of female pedestrians struck by a vehicle approaches that of males during the 3:00 PM to 6:00 PM period. Considered holistically, crashes involving pedestrians aged 14 and under appear to be strongly linked to school travel patterns for males and females, as well as street play undertaken by males in the late afternoon and early evening.

Table 2-10: 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
Midnight - 3 am	2	1	3
3 am – 6 am	0	0	0
6 am - 9 am	14	7	21
9 am - Noon	4	5	9
Noon – 3 pm	7	5	12
3 pm - 6 pm	21	16	37
6 pm – 9 pm	24	9	33
9 pm - Midnight	3	1	4
Total	75	44	119

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

As shown in Table 7, above, more pedestrians are involved in a crash between 6:00 PM and 9:00 PM than any other time period, comprising 24% of the total. This is the highest risk time period for all pedestrians over the age of 19, and is the period during which the largest number of severe injuries and fatalities occur, with this period producing 27% and 24% of totals, respectively. While it is tempting to infer that drugs or alcohol are a factor in these crashes, the data do not support this inference. Of the 234 pedestrians involved in a crash during this time period, officers suspected only 11 (4.7%) of being under the influence of drugs or alcohol (See Table 12 under *Drugs and Alcohol*, below). Instead, the increased incidence of pedestrian collisions appears to be attributable to ordinary travel behaviors that occur during the early evening period, a period that encompasses the tail end of the PM peak period and likely entails travel to household-supporting destinations, such as groceries, restaurants, shopping, or services. This phenomenon is further explored as part of the examination of environmental risk factors, below.

Active Older Adults (70 and Older, Midday and Early Evening)

Frailty associated with aging makes older pedestrians uniquely vulnerable in a crash event. An examination of the proportion of total crashes involving death or severe injury shows that pedestrians aged 70 and older are more likely be injured or killed than all other age cohorts except those aged 20-24. Yet what distinguishes elderly pedestrians is not so much the severity of their injuries, but their temporal distribution. As shown in Tables 2-7 and 2-8, collisions involving older pedestrians largely occur during the daylight hours that follow the AM peak period, though total and KSI crashes increase notably during the late afternoon and early evening periods (3:00 PM to 8:59 PM).

Emerging Adulthood (Persons Aged 25-34, 6:00 PM to Midnight)

In absolute terms, the largest number of pedestrians involved in a collision are between the ages of 25-34, particularly during the evening (6:00 PM – midnight). The high concentration 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 there are fewer female pedestrians of this age cohort involved in collisions overall, their numbers are equal to that of males during the 6:00 PM to 9:00 PM period (see Table 2-11), suggesting that male pedestrians are more active in the late evening than females. The use of alcohol or drugs does not appear to be a major contributing factor, with the proportion of pedestrians suspected to be under the influence of drugs or alcohol being similar to, or slightly less than, other adult age cohorts, both in aggregate and during the 6:00 PM to 9:00 PM period specifically (see Table 2-12).

Table 2-11: Pedestrians Aged 25-34 Involved in a Collision, by Time of Day and Sex

Time of Day	Male	Female	Total
Midnight – 3:00 am	11	3	14
3 am – 6:00 am	5	1	6
6 am – 9:00 am	11	10	21
9 am - Noon	6	5	11
Noon – 3:00 pm	11	4	15
3pm – 6 pm	12	9	21
6pm – 9 pm	18	18	36
9:00 pm - Midnight	19	6	25
Total	93	56	149

Reconsidering the Role of Drugs and Alcohol on Pedestrian Crash Incidence

While the use of drugs and alcohol are commonly regarded as a major contributing factor in pedestrian crashes, relatively few pedestrians in lower income areas were identified as being under the influence. As shown in Table 2-12, below, only 62 of the 969 pedestrians involved a collision were suspected by the office as being under the influence of drugs or alcohol, 6% of the total. Note that not all pedestrians had complete demographic data and thus were not included in the examination of demographic characteristics detailed above. To ensure that this was not simply a product of the manner in which crash data were reported, we examined officer-reported suspicion of drug or alcohol use for all 2,612 records. Of these, 153 reported officer suspicion of drug or alcohol use, or 5.8% of the total.

A relatively high percentage of pedestrians involved in a collision during the evening (9:00 PM to Midnight) and early morning periods (Midnight to 6:00 AM) appear to involve drug or alcohol use, as would be expected, though it should be observed that there are comparatively few pedestrian collisions during these time periods. While interventions aimed at addressing drug and alcohol use may be beneficial as a means of reducing impaired driving or advancing broader public health aims, such programs do not appear likely to have much of an effect on reducing pedestrian behaviors that result in increased crash risk.

Table 2-12: 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

	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
14 and Under	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
15 - 19	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (7%)	1 (1%)
20 - 24	3 (38%)	2 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (11%)	7 (8%)
25 - 34	4 (29%)	2 (33%)	2 (10)%	0 (0%)	0 (0%)	0 (0%)	2 (6%)	4 (16%)	14 (9%)
35 - 44	1 (20%)	3 (27%)	2 (18%)	1 (14)%	1 (6%)	1 (6%)	1 (5%)	3 (19%)	13 (12%)
45 - 54	1 (20%)	0 (0%)	0 (0%)	1 (5%)	1 (8%)	0 (0%)	4 (13%)	5 (38%)	12 (10%)
55 - 64	2 (33%)	2 (29%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (5%)	5 (29%)	11 (8%)
65 - 70	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (13%)	0 (0%)	0 (0%)	1 (2%)
Over 70	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (7%)	0 (0%)	3 (3%)
Total	12 (27%)	9 (24%)	4 (3%)	2 (2%)	2 (2%)	2 (1%)	11 (5%)	20 (17%)	62 (6%)

2.4 At Risk Cohorts: Bicyclists

Between 2015 and 2017, there were 2,127 collisions involving bicyclists in lower income communities, 49.6% of which resulted in a death or severe injury (1,055 serious injuries and 19 fatalities). Of these, police accident reports provided demographic information for 811, 51% of which resulted in a death or serious injury. These 811 cases for which demographic information are shown in Table 2-13, below, and information on bicyclists that were killed or severely injured is shown in Table 2-14. Complete data for Broward and Palm Beach Counties, including cases for which demographic information was not provided, are included in Appendices B-G.

Bicyclists involved in a collision in lower income areas are overwhelmingly male (80%). These crashes appear to be associated with males uses bicycles for utilitarian purposes, with nearly all of these crashes (91%) occurring between 6:00 AM and 8:59 PM. Neither alcohol nor drug use appears to be a major factor, with officers suspecting the bicyclist of alcohol use in only 20 of the 811 crashes for which demographic information is provided 2.5%). As with the findings for pedestrians, the low percentage of drug and alcohol use is reflected in the larger crash database. Of the 2,127 bicyclists involved in a collision, 48, or 2.3%, were suspected of being under the influence of either drugs or alcohol. Based on the descriptive results, the majority of bicycle crashes occurring in lower income areas can be categorized into two categories: 1) adult utilitarian bicycling and; 2) afterschool activities.

Table 2-13: Bicyclists Involved in a Collision in Lower Income Areas, by Age and Time of Day

	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	0	0	9	9	5	36	18	1	78	9.62%
15 - 19	1	0	10	11	15	28	21	4	90	11.10%
20 - 24	0	1	13	14	18	32	13	6	97	11.96%
25 - 34	3	5	12	16	23	31	34	18	142	17.51%
35 - 44	1	2	13	19	15	23	24	5	102	12.58%
45 - 54	2	6	22	19	15	24	26	5	119	14.67%
55 - 64	0	1	11	20	29	33	20	6	120	14.80%
65 - 69	0	0	6	7	5	10	3	2	33	4.07%
70 and Older	0	0	11	6	3	4	5	1	30	3.70%
Total	7	15	107	121	128	221	164	48	811	100.00%
Pct.	0.86%	1.85%	13.19%	14.92%	15.78%	27.25%	20.22%	5.92%	100.00%	

Adult Utilitarian Bicycling

The data strongly suggest that 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. Table 2-13 shows that bicycle crashes are distributed relatively evenly across the working-age population, though there are slightly higher numbers of collisions involving bicyclists aged 25-34 and 45-54. 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 that may be attempted at this time.

Table 2-14: Bicyclists Killed or Seriously Injured in Lower Income Areas, by Time of Day 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	0	0	4	4	2	20	10	0	40	9.64%
15 - 19	1	0	6	8	7	14	8	2	46	11.08%
20 - 24	0	1	8	9	5	14	8	4	49	11.81%
25 - 34	3	3	6	6	9	12	21	11	71	17.11%
35 - 44	1	2	5	8	10	10	13	3	52	12.53%
45 - 54	1	4	13	10	7	10	17	5	67	16.14%
55 - 64	0	1	7	6	10	16	11	5	56	13.49%
65 - 69	0	0	3	3	1	8	2	1	18	4.34%
70 and Older	0	0	6	4	1	1	4	0	16	3.86%
Total	6	11	58	58	52	105	94	31	415	100.00%
Pct.	1.45%	2.65%	13.98%	13.98%	12.53%	25.30%	22.65%	7.47%	100.00%	

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

Persons aged 19 and younger comprise 24% of total population in lower income block groups. The proportion of bicycle crashes involving this age cohort is slightly less than their representation within the population, with bicyclists aged 19 and younger involved in about 21% of total bicyclist crashes. Nonetheless, these crashes have a pronounced temporal profile, with 70% of the crashes involving this cohort, and 75% of the injuries and deaths, occurring between 3:00 PM and 9:00 PM.

3. 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. These are then compared against pedestrian and bicyclist crash incidence in affluent areas, allowing this study to identify those characteristics that are unique to lower income areas specifically.

3.1 Data and Methods

To identify the environmental risk factors that may be contributing to 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 3-1), 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 3-1: Dispersion Statistics of Crash Frequency at the Census Block Group Level

Variable	Minimum	Maximum	Mean	Variance
Total Pedestrian	0	21	1.24	4.83
Pedestrian KSI	0	12	0.71	1.86
Total Bicyclists	0	18	1.04	3.84
Bicyclist KSI	0	11	0.54	1.34

Independent Variables

The independent variables used in this analysis were developed to capture the effects of demographics, transportation network 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 3-2 and described below.

Table 3-2: Descriptive Statistics for Lower Income Block Groups

Variable	Minimum	Maximum	Mean	Std. Dev.
population	0	6,399	1,719	915
dvmt	0	516,794	47,015	43,529
% white	0	100%	59%	30%
% black	0	100%	33%	31%
% Hispanic	0	93%	26%	20%
miles of 5-or-more lane streets	0	9.00	0.56	0.73
miles of raised median	0	4.35	0.24	0.34
# of signalized intersections	0	19	3.00	2.60
intersection density	0	0.72	0.09	0.13
# supermarkets	0	3	0.10	0.35
# commercial shopping centers	0	25	0.30	1.20
# restaurants	0	11	0.85	1.45
# schools/colleges	0	15	0.95	1.72
# bars and nightclubs	0	4	0.13	0.44
# mixed-use buildings	0	46	1.24	3.24

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.*

Vehicle Miles Traveled

More automobile traffic can create more opportunities for collisions. To capture the effects of automobile travel on pedestrian and bicyclist crash incidence, this study used daily vehicle miles traveled (DVMT) as an independent variable. To calculate DVMT, we obtained AADT data from the Florida Department of Transportation (FDOT) and multiplied AADT by the length of each street segment in the block group.

- *DVMT (thousands).* The daily vehicle miles of travel in the block group. This variable was divided by 1,000 to simplify the interpretation of the model coefficients.

Street and Network 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 classification of a street as an arterial thoroughfare that results in crash risk, but instead the design attributes commonly associated with such streets, which include higher traffic volumes, multiple travel lanes, and higher operating speeds (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). After a preliminary series of models examining the effects of posted speed limits and the presence of signalized intersections, only two variables proved to have a significant relationship with crash incidence:

- *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.

In addition to these street characteristics, pedestrian and bicyclist safety may be enhanced by the configuration of the street network itself. Intersections are locations where conflicting streams of traffic meet. Nonetheless, the effect of intersections, at a network level, is uncertain; more intersections have been found to be associated with more pedestrian and bicyclist crashes (Dumbaugh and Li, 2011; Dumbaugh, Li, and Joh, 2013), while areas with higher concentrations of intersections have been found to be associated with reductions in crash incidence (Marshall and Garrick, 2010). More intersections would be expected to result in the increased incidence of crashes as the result of the increased production of traffic conflicts. Nonetheless, high concentrations of intersections provide alternate routes that may allow pedestrians and bicyclists to avoid high-volume streets and may thus be associated with reduction in crash incidence. To examine the subject, this study developed a series on models treating these two variables separately. Only intersection density proved to be significantly related to crash incidence and was thus the only variable included in the final models.

- *Intersection density.* This is the count of intersections in a block group, divided by block group acreage.

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*
- *# of bars, lounges, and nightclubs*

3.2 Environmental Risk Factors for Pedestrians in Lower Income Areas

Total Pedestrian Collisions

Table 3-3 presents the results for total crashes involving pedestrians, regardless of injury severity. As expected, more residents and higher levels of daily vehicle miles of travel (DVMT), both measures of exposure, were associated with increased pedestrian crash incidence. The racial composition of a block group was significantly related to the incidence of pedestrian crashes as well, with a 1% increase in the number of blacks associated with a 1.4% increase in pedestrian crashes, and a 1% increase in Hispanics being associated with a 1.4% increase in pedestrian crashes.[1]

Table 3-3: Total Pedestrian Collisions in Lower Income Block Groups

	coeff.	std. error	z	p	95% conf. interval	
population (thousands)	0.073	0.069	1.06	0.290	-0.062	0.209
dvmt (thousands)	0.005	0.002	2.33	0.020	0.001	0.010
% black	0.014	0.002	6.26	0.000	0.010	0.019
% white	0.013	0.003	3.95	0.000	0.006	0.019
miles of 5-or-more lane streets	0.264	0.143	1.85	0.065	-0.016	0.545
miles of raised medians	-0.724	0.223	-3.25	0.001	-1.161	-0.287
intersection density	-4.091	0.578	-7.08	0.000	-5.224	-2.959
# supermarkets	0.284	0.154	1.84	0.065	-0.018	0.586
# shopping centers	0.099	0.049	2.03	0.042	0.004	0.195
# restaurants	0.165	0.039	4.20	0.000	0.088	0.241
# schools/colleges	0.023	0.030	0.77	0.441	-0.036	0.082
# bars and nightclubs	-0.139	0.136	-1.02	0.308	-0.405	0.128
constant	-1.103	0.178	-6.20	0.000	-1.451	-0.754
Log Likelihood = -1070						
N = 776						

The presence of streets with 5-or-more lanes, a characteristic of arterial thoroughfares, was associated with a significant increase in total number of pedestrians struck by a vehicle. Each additional mile of such streets was associated with a 26% increase in pedestrian crash incidence. Each mile of raised medians was associated with a 72% reduction in the number of pedestrians involved in a crash event, undoubtedly due to the ability of medians to provide a midblock crossing refuge. It must be noted that while medians may moderate overall pedestrian crash risk, they do not eliminate the underlying hazards posed by multi-lane streets.

Intersection density, which is a measure of the connectedness of the street network, proved to have the highest level of statistical significance of all of the modeled variables (z = -7.08). This is an interesting finding. While intersections are associated with more traffic conflicts, and would be expected to result in the increased incidence of pedestrian crashes, preliminary model runs

[1] We additionally developed separate models that substituted % white for blacks and Hispanics, confirming that white populations are at less risk than non-white populations, even in lower-income areas. In this model the % white population reported a coefficient of -0.01 at the 0.000 level of significance. Stated another way, a 1% increase in the percentage of white, non-Hispanic residents is associated with a 1% reduction in crashes involving pedestrians.

found that the absolute number of intersections in a lower income block group had no significant association with pedestrian crash incidence. That intersection density proved to be highly significant strongly suggests that pedestrians in lower income communities make trip-routing decisions based on perceived estimates of risk; higher levels of intersection density are associated with greater route choice, allowing pedestrians to select routes that minimize their risk of death and injury. Dense networks of streets may further be associated with lower operating speeds as they may entail frequent vehicle stops.

Of the land uses considered in this analysis, those associated with food choices—supermarkets and restaurants—were both significantly associated with increased pedestrian crash risk. This is consistent with the findings from the examination of at-risk cohorts, which found that the greatest number of pedestrian crashes occurred during the period immediately following the PM peak. Supermarkets and restaurants are locations where trips during the PM peak period are likely to cluster. It should be further observed that many of the restaurants in lower income areas are fast-food restaurants, which are typically accompanied by both driveway access to the arterial system and drive-through windows. It is highly probable that the configuration of these restaurants contributes to the hazards posted by these uses. Shopping centers also emerged as a significant variable. This, we believe, is likely a result of the fact that commercial shopping centers have direct access and egress to the arterial system through dedicated driveways, creating conflict points for pedestrians using adjacent sidewalks.

We further included both the number of schools and the number of bars/nightclubs as independent variables in the model. Neither variable proved to have a statistically meaningful relationship with pedestrian crashes. For schools, this finding is notable because of the current safety emphasis placed on school trips, which often include the presence of school crossing guards and speed enforcement during periods when children are traveling to and from school. While the cohort-level analysis found that school-aged pedestrians were at risk during these periods, at least some portion of this risk in the vicinity of schools appears to be offset by the presence of school safety programs.

Bars and nightclubs were included as a variable in the model because of the prevailing belief that pedestrian safety can be understood as a product of the use of drugs or alcohol. Yet, as shown in the analysis of at-risk cohorts, only 6% of the total pedestrians involved in a collision were suspected of being under the influence of drugs or alcohol. This finding is corroborated by the results of this model, which not only finds that there is no statistically meaningful relationship between the presence of bars and pedestrian collisions, but that the general relationship is negative.

Environmental Factors Associated with KSI Pedestrian Crashes

Given that most crashes involving pedestrians are injurious, it is perhaps unsurprising that the results for the pedestrian KSI model mirrors that of total pedestrian collisions (see Table 3-4).

Race is again a significant predictor of crash risk, with areas reporting higher concentrations of blacks and Hispanics reporting a significant increase in KSI pedestrian crashes.

Table 3-4: KSI Pedestrian Collisions in Lower Income Block Groups

	coeff.	std. error	z	p	95% conf. interval	
population (thousands)	0.073	0.076	0.96	0.339	-0.076	0.221
dvmt (thousands)	0.005	0.002	2.24	0.025	0.001	0.010
% black	0.014	0.003	5.34	0.000	0.009	0.019
% Hispanic	0.016	0.004	4.32	0.000	0.009	0.023
miles of 5-or-more lane streets	0.164	0.152	1.08	0.281	-0.134	0.462
miles of raised medians	-0.657	0.243	-2.71	0.007	-1.133	-0.182
intersection density	-3.832	0.676	-5.67	0.000	-5.157	-2.508
# supermarkets	0.179	0.167	1.07	0.283	-0.148	0.506
# shopping centers	0.096	0.048	1.99	0.046	0.001	0.190
# restaurants	0.199	0.042	4.78	0.000	0.118	0.281
# schools/colleges	0.027	0.032	0.83	0.407	-0.037	0.090
# bars and nightclubs	-0.077	0.146	-0.53	0.597	-0.364	0.209
Constant	-1.737	0.207	-8.38	0.000	-2.143	-1.331

Log Likelihood = -810
N = 776

The mileage of 5-or-more lane streets ceased to be statistically significant after accounting for other features of the built environment, such as the presence of raised medians and intersection density. As discussed previously, we believe this is attributable to two factors. First, raised medians provide refuge islands for crossing pedestrians, which reduces their overall exposure when crossing multi-lane streets, while the presence of a connected network of streets provides pedestrians with the ability to route away from potentially hazardous streets. We should note that the overall effect of 5-or-more lane remains negative, however. Of the land use variables, both commercial shopping centers and restaurants are again associated with significant increases in pedestrian casualties, while bars and schools are not.

3.3 Environmental Risk Factors for Bicyclists in Lower Income Areas

Total Bicyclist Collisions

Table 3-5, below, shows the results of the model for total bicyclist collisions. DVMT is associated with increased bicyclist crashes, though population is not. The percentage of blacks and Hispanics residing in a block group was associated with significant increases in bicyclist collisions, with a 1% increase in the black population being associated with a 0.7% increase in bicycle crashes and a 1% increase in the Hispanic population being associated with a 1.1% increase in bicyclist crashes.

Table 3-5: Total Bicycle Collisions in Lower Income Block Groups

	coeff.	std. error	z	p	95% conf. interval	
population (thousands)	0.029	0.075	0.39	0.697	-0.118	0.177
dvmt (thousands)	0.005	0.003	1.91	0.056	0.000	0.011
% black	0.007	0.002	2.82	0.005	0.002	0.012
% Hispanic	0.011	0.003	3.06	0.002	0.004	0.017
miles of 5-or-more lane streets	0.293	0.154	1.90	0.057	-0.009	0.596
miles of raised medians	-0.663	0.253	-2.63	0.009	-1.158	-0.168
intersection density	-4.648	0.676	-6.87	0.000	-5.974	-3.322
# supermarkets	0.483	0.165	2.92	0.004	0.159	0.807
# shopping centers	0.105	0.057	1.85	0.065	-0.006	0.217
# restaurants	0.180	0.043	4.17	0.000	0.096	0.265
# schools/colleges	-0.012	0.036	-0.33	0.738	-0.084	0.059
# bars and nightclubs	-0.199	0.153	-1.30	0.195	-0.499	0.102
constant	-0.883	0.192	-4.60	0.000	-1.259	-0.507

Log Likelihood = -982

N = 776

Of the street network variables, each mile of 5-or-more lane streets was associated with a 29% increase in bicycle collisions, while each mile of raised median was associated with a 66% reduction in the incidence of such collisions. Higher levels of intersection density were associated with a reduction in bicyclist collisions. As with the models for pedestrians, we believe this is attributable to the manner in which such street networks are used; 5-or-more lane roads are innately hazardous, particularly for crossing bicyclists. Nonetheless, raised medians provide a midblock refuge for such crossings, and the presence of high levels of intersection density indicate the presence of a network of alternate routes that may allow bicyclists to their exposure by reducing trip distances and avoiding hazardous routes.

The land use variables associated with bicyclist collisions are identical to those that are hazardous to pedestrians: supermarkets, shopping centers, and restaurants. Given the use of sidewalks by bicyclists, we expect that the reasons are similar to those affecting pedestrians as well; namely, that the presence of driveways and their associated traffic creates high-conflict locations for bicyclists. Neither schools nor bars proved to be significantly associated with bicyclist collisions.

KSI Bicyclist Collisions

As shown in Table 3-6, the variables for bicyclists killed or seriously injured in a collision are largely identical to those for total bicyclists involved in a crash. A block group's racial characteristics are again an important predictor of crash risk, with higher concentrations of blacks and Hispanics being associated with higher numbers of bicyclists being killed or severely-injured. Intersection density again has a strong, negative effect on bicyclist KSI collisions, while these collisions again continue to increase in the presence of supermarkets and restaurants. Neither bars nor schools are associated with the death or serious injury of bicyclists.

Table 3-6: KSI Bicycle Collisions in Lower Income Block Groups

	coeff.	std. error	z	p	95% conf. interval	
population (thousands)	-0.010	0.087	-0.12	0.905	-0.181	0.160
dvmt (thousands)	0.004	0.003	1.51	0.130	-0.001	0.010
% black	0.007	0.003	2.27	0.023	0.001	0.013
% Hispanic	0.012	0.004	2.99	0.003	0.004	0.020
miles of 5-or-more lane streets	0.314	0.177	1.78	0.075	-0.032	0.660
miles of raised medians	-0.499	0.277	-1.80	0.072	-1.042	0.044
intersection density	-4.982	0.902	-5.53	0.000	-6.749	-3.215
# supermarkets	0.474	0.184	2.57	0.010	0.112	0.835
# shopping centers	0.075	0.062	1.20	0.231	-0.048	0.197
# restaurants	0.175	0.049	3.56	0.000	0.078	0.271
# schools/colleges	0.020	0.041	0.49	0.625	-0.060	0.100
# bars and nightclubs	-0.227	0.188	-1.21	0.228	-0.595	0.142
constant	-1.514	0.229	-6.61	0.000	-1.963	-1.065

Log Likelihood = -690

N = 776

3.4 Considering Pedestrian and Bicyclist Crashes in Affluent Environments

A major finding of the examination of at-risk cohorts was that much of the risk experienced by pedestrians and bicyclists in lower income areas is associated with utilitarian travel in hazardous environments, a finding that is corroborated by the model results shown in Table 3-6. To further examine this assertion, we sought to understand which environmental variables were associated with crashes in more affluent areas, defined for the purposes of this study as block groups with a median household income of 120% of the area median income. Tables 3-7 and 3-8 show the models for total pedestrian and bicyclist collisions.

Table 3-7: Total Pedestrian Collisions in Affluent Block Groups

	coeff.	std. error	z	p	95% conf. interval	
population (thousands)	0.064	0.070	0.92	0.360	-0.073	0.200
dvmt (thousands)	0.002	0.003	0.70	0.481	-0.004	0.008
% black	0.012	0.012	0.99	0.322	-0.012	0.035
% Hispanic	-0.002	0.007	-0.28	0.779	-0.016	0.012
miles of 5-or-more lane streets	0.233	0.142	1.64	0.102	-0.046	0.511
intersection density	-4.246	2.309	-1.84	0.066	-8.772	0.280
# of mixed-use buildings	0.072	0.031	2.32	0.021	0.011	0.134
constant	-0.874	0.195	-4.48	0.000	-1.257	-0.492

Log Likelihood = -308

N = 279

Table 3-8: Total Bicyclist Collisions in Affluent Block Groups

	coeff.	std. error	z	p	95% conf. interval	
population (thousands)	0.036	0.076	0.47	0.637	-0.113	0.184
dvmt (thousands)	0.004	0.003	1.21	0.227	-0.003	0.011
% black	0.001	0.012	0.07	0.945	-0.023	0.025
% Hispanic	-0.015	0.008	-2.01	0.044	-0.030	0.000
miles of 5-or-more lane streets	0.010	0.146	0.07	0.946	-0.276	0.296
intersection density	-7.433	3.021	-2.46	0.014	-13.355	-1.512
# mixed-use buildings	0.066	0.035	1.91	0.057	-0.002	0.134
# schools/colleges	0.114	0.066	1.73	0.084	-0.015	0.242
constant	-0.368	0.188	-1.96	0.050	-0.737	0.000

Log Likelihood = -333

N = 279

After controlling for population, dvmt, and race, few of the variables that proved to be significant in lower income areas proved to be significant in more affluent ones. Intersection density was again significantly associated with a reduction in both crash types. This, however, is where their similarities end. The mileage of 5-or-more lane streets ceased to be significantly related to either pedestrian or bicyclist collisions (though the coefficient for pedestrians approached the 0.1 level of statistical confidence), and none of the land use variables associated with collisions in lower income areas proved significant for crashes in affluent ones. Instead, the presence of mixed-use buildings, defined in the FGDL as buildings with two different uses within them, proved to be the only lane use variable associated with pedestrian and bicyclist collisions. Mixed-use buildings are concentrated in older, affluent areas, such as the block groups that include Atlantic Avenue in Delray, Las Olas Boulevard in Fort Lauderdale, and the Village of Palm Beach.

This strongly suggests that in more affluent areas, walking and bicycling are undertaken for social and recreational purposes, rather than the utilitarian ones found in lower income block groups. Affluent populations have far higher levels of automobile ownership (see Table 3-9) and thus have greater discretion on which trip purposes to pursue through walking or bicycling. This discretion likely also explains the findings for 5-or-more lane streets. Affluent populations have the ability to choose whether or not to walk or bicycle along these streets, and given this choice, apparently choose not to do so.

Table 3-9: Levels of Automobile Ownership in Lower Income and Higher Income Block Groups

	Lower Income	Higher Income
Avg. HH Size	2.8	2.9
Pct 0 car	11.6%	1.9%
Pct 1 car or less	59.7%	26.5%

Two additional differences are worth observing. This first is that schools are a risk factor for bicyclist collisions in affluent block groups (though not in lower income areas). We expect that this may be, in part, attributable to a combination of differences in baseline rates of exposure and underlying lifestyle factors. Affluent white populations are likely to encourage children to independently accomplish journey-to-school trips as a means of promoting adolescent independence Nonetheless, this finding should not be used to infer that children residing in more affluent areas are more at-risk of being injured or killed; bicyclists under the age of 15 are 50% more likely to be struck by a vehicle in lower income areas than in more affluent ones. Instead, it appears that, when compared to lower income areas, crashes involving child bicyclists appear to be clustered around school locations.

The second difference is that, unlike in lower income areas, the percentage of Hispanic residents proved to be associated with a significant *reduction* in total bicyclist collisions. This is likely attributable to the unique characteristics of the Hispanic population in South Florida, which includes a large number of affluent, highly-educated immigrants from South America, a population that has high levels of automobile ownership and which may have a cultural predisposition against bicycling for either recreational or utilitarian purposes. Considered on the whole, however, the findings of this study demonstrate that the environmental risk factors that affect lower income populations differ notably from those of more affluent populations, and that racial disparities appear to exacerbate the underlying risk encountered by lower income pedestrians and bicyclists.

4. FINDINGS AND FUTURE DIRECTIONS

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.

4.1 Identification of At-Risk Cohorts

To begin, it is important to dispense with the common view that drug or 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% of pedestrians involved in a collision, and 2% 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 6AM), they nonetheless comprise an extremely small share of the total pedestrian and bicyclist crashes that occur.

Instead, the majority of the crashes involving specific cohorts can be understood, in large part, as a function of their exposure; crashes involving pedestrians and bicyclists of different age groups can be expected to occur during the time periods when one would expect them to be most active. Four specific pedestrian cohorts, and two bicyclist cohorts, were specifically identified.

Pedestrians

- *School trips and street play:* pedestrians aged 14 and under, 6 am to 9 am and 3 pm to 9 pm, weekdays.
- *Errands during the early evening*: pedestrians aged 20 and older, 6 pm to 9 pm.
- *Active older adults*: pedestrians aged 70 and older, 9 am to 9 pm.
- *Emerging adulthood*: pedestrians aged 25-34, 6 pm to midnight.

Bicyclists

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

The identification of specific at-risk cohorts is useful for the development of targeted education and enforcement interventions. While the development of specific programs is beyond the scope of this project, its findings suggest several opportunity areas for partnering with education and enforcement professionals, as well as local stakeholders, to address local safety needs. These opportunity areas, as well as partners and local stakeholders, are briefly identified below, with the hope they will help inform the development of comprehensive safety programs.

Safety Education in Local Schools

The effectiveness of educational programs is contingent upon the program's ability to access its target populations. School-aged pedestrians and bicyclists were identified as being disproportionately at-risk, particularly during the afterschool period. Interestingly, the presence of a school did not emerge as a significant environmental risk factor for child pedestrian and bicyclists, suggesting that the safety problem lies not so much in the journey-to-school trip as with more general afterschool activities. This finding is likely attributable, at least in part, to the presence of school crossing guards and traffic enforcement near school locations. As such, the risk experienced by school-aged children appears to shift to areas that lack such services. Educational programs on safe street use, developed in concert with local schools, is likely to be beneficial to addressing the safety of school-aged children.

Targeted Educational and Information Programs

Significant portions of lower income communities have limited access to an automobile (see Table 23), leading to the more frequent use of public transportation and the clustering of vulnerable road users at bus stop locations (See Figure 4-1). At such locations, particularly those located in high-risk environments, messaging can be tailored towards the specific risk encountered at these locations which, in many cases, appears to entail crossing behaviors. Additional opportunities may exist through safety campaigns developed in partnership with local transit operators (Broward County Transit and PalmTran) and may include, for example, in-vehicle messaging along routes that serve vulnerable populations or fare incentives for participation in specific educational programs. Similarly, local social service providers, such as local health clinics, may serve as another outlet for accessing at-risk cohorts, both through targeted information campaigns as well as through participant recruitment into more comprehensive educational programs.

Community Policing During the Afternoon and Early Evening

For nearly every age cohort, the largest share of pedestrian and bicyclist crashes occurs during the late afternoon and early evening periods (3:00 PM to 9:00 PM). Law enforcement activities during this time period would yield the greatest overall results. Nonetheless, such activities should be sensitive to the unique experiences of these populations, who may have negative views on the motivations that underpin traffic enforcement. The implementation of such programs should be developed in concert with community leaders and local stakeholders to ensure that there is a shared understanding of the purpose and need. Similarly, such programs would likely be likely most beneficial if focused on providing community assistance, rather than the issuance of citations or other punitive enforcement activities; policing activities that assist with clearly-identified safety needs create opportunities for the development of constructive relationships with law enforcement personnel, relationships that may advance the development of local cultures of safety. It should further be observed that such programs need not necessarily entail law enforcement personnel; many of the practices already applied for school zones, such as advisory speeds and crossing guards, can be applied to address safety for the broader population during high-risk periods.

Figure 4-1: Clusters of Vulnerable Adults

Creating a Culture of Safety: Overcoming the Limitations of Education and Enforcement Programs

Crashes are infrequent events, and it should be openly acknowledged that programs targeting specific population segments during specific time periods are, independent of other factors, unlikely to yield noteworthy reductions in the total incidence of crashes, injuries, and deaths. For example, A program that successfully eliminated every death and injury involving a child pedestrian between 3:00 PM and 9:00 PM, the period during which this population is most likely to be injured or killed in a crash event, would only reduce the total pedestrian deaths and injuries in Broward and Palm Beach Counties by about 6.5%. Considered independently, such safety improvements do not appear promising.

Yet a comprehensive program that targets multiple at-risk population segments simultaneously may collectively generate substantial benefits, particularly if focused on a specific local community experiencing high numbers of traffic-related deaths and injuries. Considered more broadly, the most useful application of these results is likely not to achieve systemwide reductions in pedestrian and bicyclist crashes involving specific at-risk cohorts, but instead the development of a multi-faceted campaign that seeks to reduce crashes for multiple at-risk cohorts in a single, target community.

The benefit of doing so is threefold. First, and most directly, empowering local communities on the issue of traffic safety encourages ongoing engagement and can create the capacity for ongoing civic engagement on safety as well as other matters of community concern. Second, a multi-dimensional program accesses different population segments in the community simultaneously, which may both reinforce the overall program objectives and can lead to the diffusion of treatment across other members of the population. Finally, the implementation of a multidimensional program in a target community allows for the development of agency expertise in addressing safety in a comprehensive, interdisciplinary manner, expertise that can be used to inform and enhance the subsequent application of such programs in subsequent communities.

4.2 Environmental Risk Factors and the Production of Latent Error

In addition to identifying at-risk population cohorts, this study further sought to identify the environmental risk factors that may contribute to their overall levels of risk. Before doing so, it is important to note that safety should not be understood as principally behavioral problems to be remedied through education and enforcement programs. Humans are fallible and the transportation system is designed to account for ordinary, predictable patterns of human behavior (International Transport Forum, 2008; 2016).

Addressing environmental risk factors requires an understanding of how the built environment may influence crash risk. From an organizational systems safety perspective, on which the Safe Systems approach is based, road safety problems are not merely a matter of slips and lapses resulting from inattention or distraction, they may also occur when there is a discrepancy between the manner in which a system is designed and the manner in which it is actually used. 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. As such, they can be expected to occur at relatively fixed rates across the population, rather than being concentrated at any specific 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.

Latent error is different. 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 environmental features. These errors are not simply a product of human fallibility, but instead an outcome of designs that, when combined with ordinary human behavior, lead to preventable deaths and injuries. The features identified in this study aa 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 *conflicts of use*. 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, in large part, as a result of the means through which drivers perceive and adapt to the road environment. 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." The use of cognitive 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 emergence of a pedestrian of bicyclist in the vehicle's path.

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 multilane streets, and, in particular, along multilane streets where restaurants, groceries and shopping centers are located. They are less likely to occur where there are medians that divide road segments, as well as where there are high levels of intersection density that allow for shorter trips on lower-speed streets.

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 decisions relating to the location and configuration of new development, decisions over which transportation agencies often have little control.

The safety issues that result from local land use decisions can be readily illustrated through an example. Figure 4-2, below, shows the transformation of a largely unremarkable rural roadway into a high-crash location. 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 4-2: 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 4-3, 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.

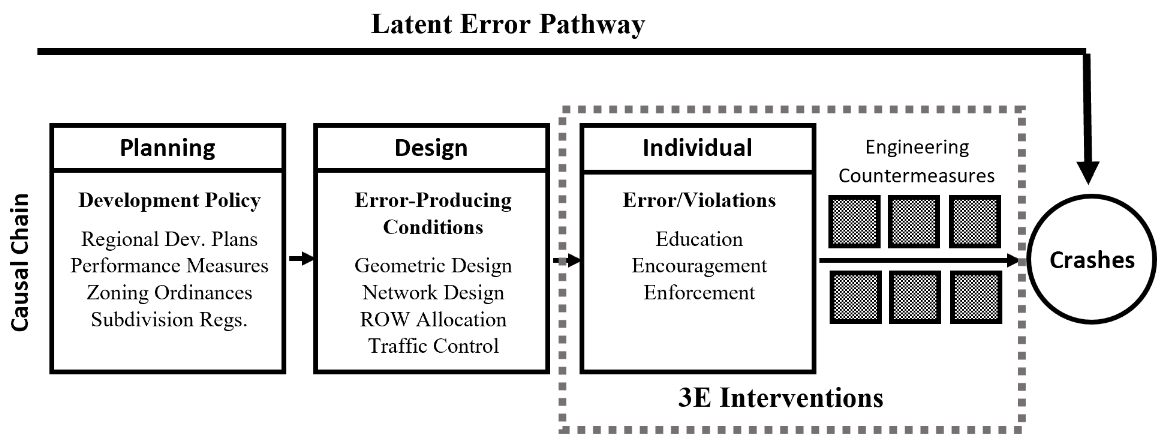

Figure 4-3: A Comprehensive View of Road Safety and the Production of Latent Error

The framework shown in Figure 4-3 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 latent error. Our findings for each of these categories is detailed below, followed by a discussion of their policy implications.

Background Conditions

Neither population nor VMT proved to be particularly meaningful as explanatory variables after accounting for the characteristics of the built environment. The number of people living in a block group was not significantly related to pedestrian or bicyclist crashes. VMT was associated with increases in total crashes in both categories, but the effect was quite weak, with a 1% increase in VMT corresponding to a 0.5% increase in pedestrian and bicyclist crashes. To put this number in perspective, doubling the VMT in a block group would not be expected to have much of an effect on overall crash incidence, increasing the expected number of crashes pedestrian crashes in a typical block group from 1.24 to 1.86, and increasing the number of bicyclist crashes from 1.04 to 1.56.

Considering Race

Race, on the other hand, proved to be a profoundly important risk factor, with the percentage of black and Hispanic residents being strongly associated with increases in pedestrian and bicyclist crashes. A 1% increase in the black or Hispanic population was associated with a 1.4% and 1.3% increase in pedestrian crashes, respectively, and a 0.7% and 1.1% increase in bicyclist crashes. 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 increase the number of traffic conflicts encountered by pedestrians and bicyclists as they attempt to crass these streets. The third factor 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 travelway.

Rather than examining arterials as a simple road class, this study disaggregated these effects by modelling traffic volumes, 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. The number of travel lanes, however, did emerge as an important risk factor, particularly for KSI crashes, with each mile of 5-or-more lane facilities associated with a roughly 30% increase in the expected number of pedestrian and bicyclist casualties. More travel lanes equate to increased crossing distances and thus more opportunities for a pedestrian and bicyclist to be struck by an oncoming vehicle, particularly when crossing at unprotected locations.

This conclusion is further supported by the observed safety benefits of raised medians, which was associated with significant reductions in pedestrian and bicyclist crashes alike. The safety benefit here, as has been long recognized by FDOT, is that medians provide a midblock refuge for pedestrians and bicyclists, allowing them to divide a potential hazardous crossing into two stages (see Figure 4-4). Given that much of the crossings observed in these areas occur at unprotected midblock locations, the ability to stage crossings is clearly beneficial.

The most noteworthy finding, however, is not that multi-lane facilities are hazardous, nor that medians moderate the risk they pose, but rather the significant reductions in crashes that occur in areas with high levels of intersection density. Intersection density is a measure of the connectedness of the street network, and would appear to reduce pedestrian and bicyclist crashes through two related mechanisms. The first is that areas with high concentrations of intersections likely reduce overall exposure. As detailed in the examination of at-risk cohorts, much of the pedestrian and bicyclist travel in lower income areas is likely utilitarian in nature, which is to say, it is undertaken not for exercise or recreational purposes, but instead to accomplish specific travel objectives, particularly when households have limited access to a personal automobile. High levels of intersection density can be expected to reduce overall exposure because they allow for more direct trip routing, thereby decreasing travel distances, and because they provide more route choices, allowing pedestrians and bicyclists to avoid higher-conflict locations. The result is a decrease in total and injurious pedestrian and bicyclist crashes.

Figure 4-4: 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[2] using the sidewalk (see Figure 4-5). Restaurants, which in lower income areas are often fast food chains with drive-through windows, are particularly problematic, with each restaurant associated with a roughly 20% increase in KSI collisions involving pedestrians and bicyclists.

Figure 4-5: 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 for calls for modifications to the deisgn 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

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

contexts, this safety problem emerges when local development decisions are not meaningfully linked to the characteristics of the transportation system that it uses.

4.3 Mitigation: Enhancing FDOT's Context Classification System to Address Environmental Risk Factors

Strategies for addressing environmental risk factors can be divided into two types. The first are mitigation strategies that seek to adapt the transportation system to the developmental context that surrounds it. The Florida Department of Transportation has made noteworthy strides in addressing these challenges through the *Context Classification Guide* and associated recommendations in the *Florida Design Manual*, which attempt to link street design to its developmental context. Much has been written on the subject of geometric design for urban streets in different developmental contexts, which cannot be summarized here (see Dumbaugh and King, 2018, for a review of this material). Instead, this study concludes by addressing the contextual factors that direct safety outcomes, many of which are made by local governments and are independent of those activities over which FDOT has control, and proposes enhancements that can strengthen and enhance the guidance outlined in the *Context Classification Guide*.

FDOT's context classification system, shown in Figure 4-6, is noteworthy for relating transportation system design to a street's environmental characteristics. One of the challenges of such an approach, however, is context is based principally on new urbanist notions of "ideal" urban forms, defined in terms of elements such as the concentration and configurations of buildings, rather than on actual patterns of use. Yet for lower income communities, walking and bicycling is often undertaken out of necessity, rather than choice, and is often independent of such idealized notions of appropriate urban form.[3] An examination of high-crash locations in Broward and Palm Beach Counties revealed that the majority of state roads are classified as C-4, Urban-General, a designation that is accompanied by a relatively wide range of design speeds, and thus permissible design outcomes.[4] For lower income communities, however, what matters most does not appear to be form, but use; crashes cluster in environments with concentrations of shopping and restaurants, much of which takes the form of strip commercial, a form that is not reflected in FDOT's context classification scheme and which warrants specific consideration.

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[3] The transect framework does appear to be useful for understanding pedestrian and bicyclist activity in affluent areas, shown in Tables 21 and 22 and discussed previously in this report.

[4] Contemporary urban street design guidance, including FDOT's Context Classification Criteria, focuses largely on design speeds as the controlling element of design, though it is important to acknowledge that a street's ultimate geometry is shaped by design volumes and design vehicles as well.

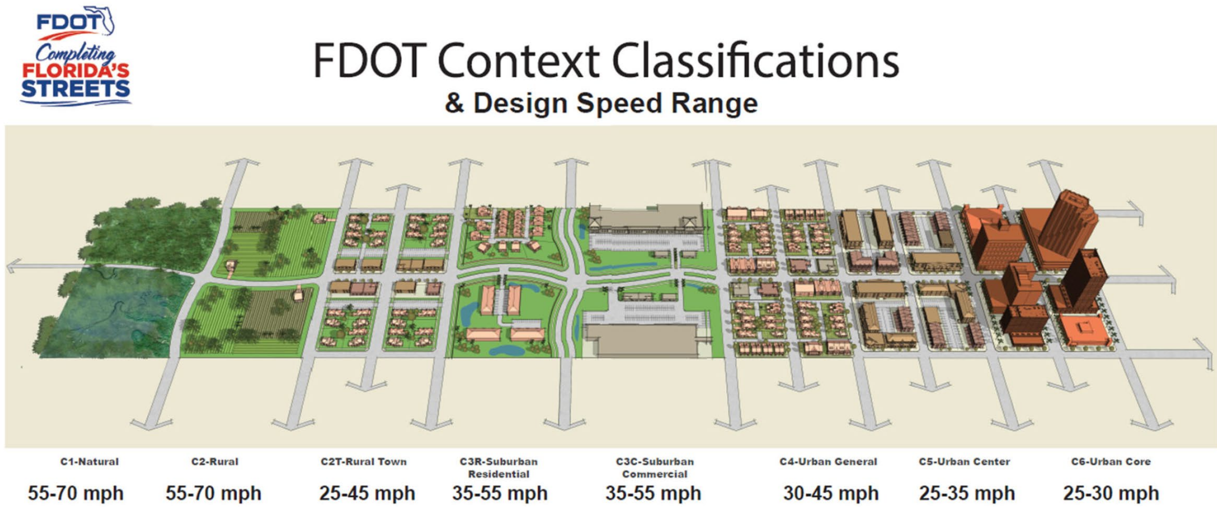

Figure 4-6: *FDOT Context Classification and Related Design Speeds*

Refining Context Definitions Based on Road User Characteristics

As a framework for directing practice, it would seem helpful to refine the state's context classification criteria to better account for use characteristics, particularly for thoroughfares classed as C3C (Suburban Commercial) and C4 (Urban General), which are likely to be the most problematic streets for lower income populations and the general public alike. A useful starting point for doing so is the functional classification system applied in Germany, which provides a more refined range of target speeds, and thus design outcomes,[5] based on a consideration of a street's mobility function and use characteristics. What is of specific note is that pedestrian use is explicitly considered as a determining criterion in the selection of a street's target speed. The inclusion of this consideration expressly calls attention to many of the safety issues observed in lower income areas, which is tension between the function and use of major thoroughfares. As shown in Figure 4-7, speeds are very tightly controlled in areas with active pedestrian uses, with targets speeds over 30 km/h (20 MPH) viewed as being problematic.

[5] ITE (2010) recommends that desired target speeds should be determined, and that a street's design speed, operating speed, and posted speed limits be adjusted to ensure that they are consistent.

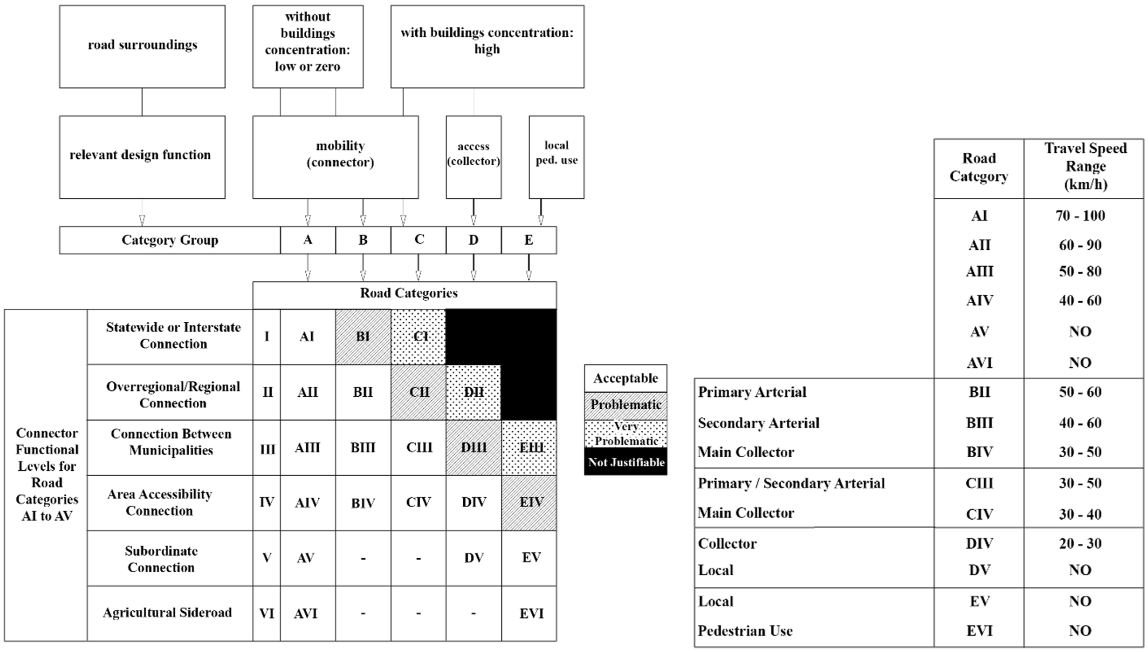

Figure 4-7: German Function Classification System

Such a framework is not inconsistent with FDOT's Context Classification guidance, which may be refined by establishing criteria for adopting different target speed ranges. Within C4 zones, for example, the adoption of speeds on the lower end of the recommended range may be desirable where there are high levels of pedestrian and bicyclist activity, concentrations of lower income populations, or clusters of commercial and retail uses. It should be observed, however, that the even the low end of C4 speeds (35-40 MPH) would nonetheless be flagged as problematic under the German Functional Classification System.

Implementation Approach: New Zealand's One Road Network Classification System

Widespread modifications to the transportation network's speed or operating characteristics can be impractical, both financially and politically, a consideration that likely explains the wide range of speed values for C3 and C4 classifications. New Zealand has sought to address these issues through its One Network Road Classification (ONRC) Programme (see Figure 4-8), which employs an incremental implementation approach.

Like the German Functional Classification System, ONRC links design speeds to use characteristics, paying particular attention to the unique needs of pedestrians and bicyclists. The range of target speeds are more consistent with current FDOT practices than those applied in Germany, though speeds of 50 km/h (30 MPH) are the highest desirable except in environments with few intersections and strict separations between motorists and other road users. Shared spaces, which are spaces where pedestrians and motorists can freely interact, are permissible at speeds of 10 km/h or less (6 MPH). The ONRC framework does not prevent the design of higher-speed, mobility-oriented thoroughfares. Instead, it establishes specific criteria to determine the conditions where such designs are safe and appropriate, based on International Roadway Assessment Programme (iRAP)[6] criteria, which estimate's a roadway's likely safety performance based on the geometric characteristics of the roadway, median presence, geometric alignment, topography, roadside conditions, and intersection frequency and design.

<table>
<tr><th>Classification</th><th>Straight open road /urban motorways</th><th>Curved open road</th><th>Winding open road</th><th>Urban (not motorway)</th></tr>
<tr><td>Class 1
High volume national</td><td>100–110km/h[4]
Depends on design and safety risk (e.g. divided 4–5 star, grade separated intersections, safety barriers) and factoring in enforcement thresholds</td><td rowspan="3"></td><td rowspan="4">60–80km/h</td><td></td></tr>
<tr><td>Class 2
National, Regional, Arterial</td><td rowspan="2">80–100km/h
Depends on safety risk and whether volumes justify investment to bring the road up to 3 star equivalent, also enforcement thresholds</td><td>50km/h
60–80km/h where safety risk allows, e.g. fewer intersections, mode separation for active users</td></tr>
<tr><td>Class 3 Primary and secondary collector</td><td rowspan="2">30–50km/h
30km/h if high volumes of cyclists/pedestrians
Recognise access and place
10km/h for Shared Spaces</td></tr>
<tr><td>Class 4
Access and low-volume access
All winding/tortuous</td><td colspan="2">60–80km/h
Depending on roadside development, pedestrian and cyclist volumes, whether sealed or not</td></tr>
</table>

Figure 4-8: One Road Network Classification System

The implementation of the ONRC is accompanied by a systemwide speed management plan that seeks to gradually align the existing system with the recommended criteria, and may serve as a useful guide for the adaptation of Florida's system (see Figure 4-9). New Zealand has adopted a gradual approach, examining the overall system against the ONRC and iRAP criteria, and identifying 5% of the system each year for modification to the updated standards. Those locations with the lowest overall safety ratings or the greatest mismatch between target and

[6] Florida DOT participated the initial pilot application of iRAP criteria in the United States, though the authors are unaware of how these criteria have been subsequently applied.

actual operating speeds are selected for modification. To avoid significant impacts to the network, these are divided roughly evenly between mobility corridors, where geometric improvements can be applied to safety accommodate higher operating speeds, and those that are intended to address the needs of lower-speed environments. This creates an ongoing process for reviewing the appropriateness of current speeds and speed limits, allowing the network to adapt itself to changing circumstances. The road segments selected for modification are then divided into three categories: engineer up, challenging conversations, and self-explaining roads.

Engineer Up

The speed-management plan identifies high-volume, economically-important roads that may not perform well on the KiwiRAP safety criteria, resulting in higher-speed travel that is unsafe. On these roads, engineering improvements are developed to bring the street to a safety standard that will permit safe travel at the road's intended operating speed.

Challenging Conversations

The second category is termed "challenging conversation." These are roads where the operating or posted speeds are in excess of the desirable operating speeds, but where environmental conditions, such as topography or local development, do not warrant increases in a roadway's design speed. In these cases, transportation agencies work with the public to develop a shared understanding of the street's specific safety problems, and develop consensus for solutions that will reduce speeds to safe levels.

Self-explaining Roads

There are also roads where the posted speed is in excess of the safe operating speed, but where road users already travel at desirable speeds. These are conditions often found in urban environments, where local development, high traffic volumes, and geometric conditions limit vehicle speeds. For these roadways, the posted speed limit can be justifiably reduced to reflect actual operating speeds. The advantage of this approach, according to the New Zealand Department of Transportation, is that it increases the credibility of the nation's speed-limit practices by ensuring that posted speed limits are consistently linked to actual operating speeds.

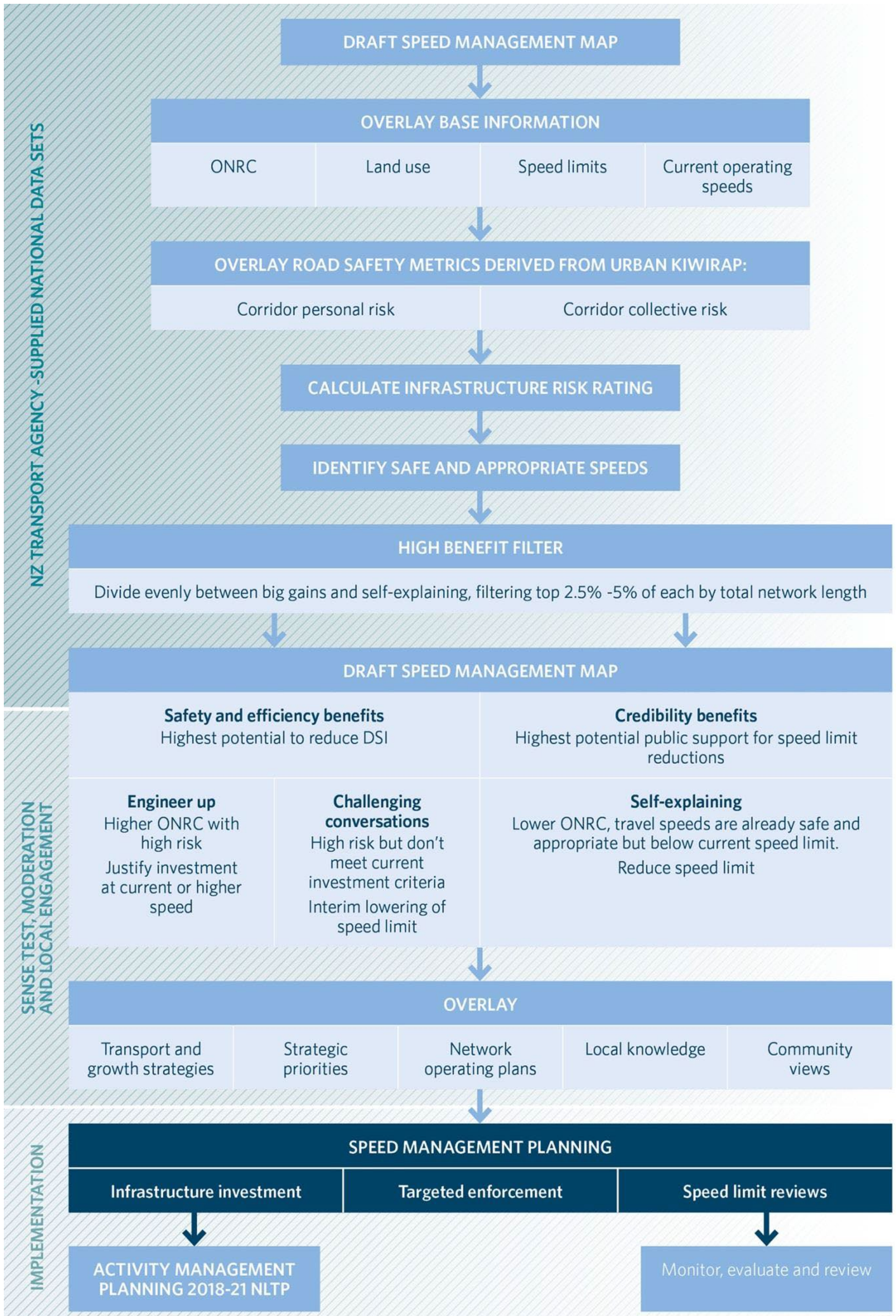

Figure 4-9: Implementation of New Zealand's ONRC Speed Management Program

4.4 Prevention: Reconsidering the Traffic Safety Responsibilities of Local Governments

The second strategy for addressing environmental risk factors occurring through a mismatch between the design of the transportation system and the built environment is preventative. Transportation agencies are not alone in responsibility for the creation of a safe system. Even the most meaningful efforts at ensuring a context-sensitive approach to transportation system design will ultimately fail if local developmental decisions change the system's developmental context without regard to concurrent adaptations to the transportation system. Local governments share responsibility for ensuring that current and future development can be safely accommodated by the transportation system that serves it. While a comprehensive review of state and local statutory mechanisms is beyond the scope of this study, this study concludes by identifying opportunities for addressing the safety impacts of local development on the transportation system.

Linking Safety to State Consistency and Concurrency Requirements

The 1985 Florida Growth Management Act requires *consistency* between the plans developed by state, regional, and local agencies, as well as that the impacts of future growth be addressed *concurrent* with new development. The purpose of the Growth Management Act was to prevent new growth from creating unfunded demands on public works. With respect to transportation, these requirements have related principally to congestion mitigation, rather than traffic safety. Yet, as demonstrated in the findings from this study, much of the safety problem that affects lower income areas, and indeed, much of the state transportation system, is the result of development proceeding without regard its ultimate safety impacts. It is thus worth revisiting consistency and concurrency in light of their relation to road safety outcomes.

Consistency

As a starting point for applying the provisions of Florida's Growth Management act to address traffic safety, safety needs to be treated as a discrete development outcome, rather than one incorporated into generalized goal statements such as the creation of a "safe and efficient transportation system." Safety outcomes often conflict with operational outcomes, and warrant independent consideration. This needs to entail discrete safety-related goal statements, as well as the inclusion of traffic-related deaths and injuries as an independent measure of system performance. Plan reviews undertaken to meet state consistency requirements may further prove useful as a means for preventing safety problems embedded into local comprehensive plans, particularly where future commercial or retail uses are being proposed along state facilities.

Concurrency

While consistency is principally a mechanism for policy review, concurrency is a regulatory tool, the purpose of which is to require new developments to cover the costs of their impacts to the transportation system. In practice, this has largely related to the assessment of impact fees to address level-of-service standards. This has proven problematic in congested urban areas, which operate below LOS standards, leading to the creation of concurrency exception areas. This limited definition of concurrency needs to be refined to account for traffic safety outcomes, particularly in urban areas that might otherwise be exempted from state concurrency requirements. The inclusion of safety as an explicit consideration in assessment of traffic impact fees for can be used as a means for both evaluating the safety impacts of new projects, as well as a mechanism that discouraging the development of projects known to have adverse safety outcomes.

Pursuing concurrency as a mechanism for addressing road safety requires the adoption of policies governing the assessment of impact fees. This can occur through the inclusion of safety analysis as part of traffic impact studies, much of which have already been defined through road safety audit practices. Zonal-level safety forecasts may also be developed using local safety data. The model specifications detailed in this study can be readily converted to safety forecasts by inputting changes to a zonal characteristics of proposed development as model variables. The model outputs provide estimates of changes in crash incidence that will occur as the result of a proposed development, providing an objective measure that can be used for the assessment of impact fees.

Access Management and Redevelopment Planning

FDOT's access management program has demonstrated the safety benefits of regulating access to the state arterial system. Yet the majority of lower income populations in Broward and Palm Beach Counties lie in older, developed areas, few of which have any meaningful access control. Yet new developments in these areas, often in the form of corporate gas stations and fast food chains, likewise have direct system access. The redevelopment of existing properties creates an opportunity for managing access through driveway consolidation and the relocation of system access away from highways and onto subordinate streets.

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APPENDIX A: UNADJUSTED RELATIVE RISK RATIOS

Table A-1: Unadjusted Pedestrian Risk Ratios

	All Crashes			KSI		
Pedestrian	Male	Female	Total	Male	Female	Total
14 and Under	5.23	2.59	3.80	3.18	2.59	2.19
15-19	3.64	2.90	3.28	3.57	2.90	4.06
20-24	1.28	1.65	1.41	3.04	1.65	4.64
25-34	0.84	1.38	1.00	0.86	1.38	1.00
35-44	1.56	1.74	1.65	2.01	1.74	2.37
45-54	2.03	2.11	2.04	2.15	2.11	1.85
55-64	3.59	1.26	2.05	2.91	1.26	1.63
65-69	1.22	2.89	1.67	0.72	2.89	1.15
70 and Older	3.01	2.27	2.59	3.34	2.27	2.56
Total	2.06	1.89	1.97	2.18	1.89	1.98

Table A-2: Unadjusted Bicyclist Risk Ratios

	All Crashes			KSI		
Bicyclist	Male	Female	Total	Male	Female	Total
14 and Under	1.34	1.17	1.30	1.38	1.17	1.28
15-19	1.43	0.75	1.21	1.53	0.75	1.43
20-24	3.68	2.08	3.05	11.19	2.08	5.13
25-34	1.80	1.32	1.59	1.71	1.32	1.55
35-44	1.42	1.74	1.53	1.36	1.74	1.42
45-54	1.99	0.94	1.67	1.73	0.94	1.49
55-64	1.62	2.57	1.62	1.26	2.57	1.31
65-69	1.44	0.76	1.23	1.37	0.76	0.97
70 and Older	0.51	2.51	0.56	0.45	2.51	0.47
Total	1.53	1.30	2.37	1.44	1.30	2.10

APPENDIX B: CHARACTERISTICS OF PEDESTRIANS INVOLED IN A CRASH IN LOWER INCOME BLOCK GROUPS

Table B-1: Characteristics of Pedestrians involved in a Crash, by Severity

Severity Level	County		Total	Pct.
	Broward	Palm Beach		
Unknown	1	0	1	0.0%
None	258	117	375	14.4%
Possible Injury	527	227	754	28.9%
Non-Incapacitating Injury	591	291	882	33.8%
Incapacitating Injury	289	137	426	16.3%
Fatal	109	57	166	6.4%
Non-Traffic	6	2	8	0.3%
Total	1,781	831	2,612	100%

Table B-2: Characteristics of Pedestrians involved in a Crash, by Time of Day

Time of Day	County		Total	Pct.
	Broward	Palm Beach		
Midnight to 2:59 am	80	41	121	4.6%
3 am to 5:59 am	60	30	90	3.4%
6 am to 8:59 am	243	93	336	12.9%
9 am to 11:59 am	192	88	280	10.7%
Noon to 2:59 pm	246	98	344	13.2%
3 pm to 5:59 pm	317	150	467	17.9%
6 pm to 8:59 pm	404	211	615	23.5%
9 pm to 11:59 pm	239	120	359	13.7%
Total	1,781	831	2,612	100.0%

Table B-3: Characteristics of Pedestrians involved in a Crash, by Age

Age Group	County		Total	Pct.
	Broward	Palm Beach		
14 and Under	40	79	119	4.6%
15-19	28	58	86	3.3%
20-24	30	55	85	3.3%
25-34	66	83	149	5.7%
35-44	35	70	105	4.0%
45-54	47	75	122	4.7%
55-64	55	84	139	5.3%
65-69	12	26	38	1.5%
70 and Older	57	69	126	4.8%
Not Coded	1,411	232	1,643	62.9%
Total	1,781	831	2,612	100.0%

Table B-4: Characteristics of Pedestrians involved in a 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	3	0	21	9	12	39	31	4	119	4.6%
15 - 19	2	0	22	8	10	15	15	14	86	3.3%
20 - 24	10	4	5	2	11	16	20	17	85	3.3%
25 - 34	14	6	21	11	15	21	36	25	149	5.7%
35 - 44	5	11	11	7	16	17	23	15	105	4.0%
45 - 54	5	5	16	19	12	23	29	13	122	4.7%
55 - 64	6	7	11	13	22	27	36	17	139	5.3%
65-69	0	1	6	8	6	7	8	2	38	1.5%
70 and Older	1	2	8	24	24	23	33	11	126	4.8%
Not Coded	79	54	217	178	220	280	380	235	1,643	62.9%
Total	125	90	338	279	348	468	611	353	2,612	100%

Table B-5: Characteristics of Pedestrians involved in a Crash, by Time, Age, 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 3 pm	3 pm to 6 pm	6 pm to 9 pm	9 pm to 11:59 pm		
Broward	14 and Under	1	0	8	3	7	13	8	0	40	2.2%
	15 - 19	0	0	7	2	2	6	5	6	28	1.6%
	20 - 24	6	4	1	1	3	5	5	5	30	1.7%
	25 - 34	4	3	7	6	11	7	18	10	66	3.7%
	35 - 44	2	4	8	3	4	5	3	6	35	2.0%
	45 - 54	2	3	7	7	4	9	13	2	47	2.6%
	55 - 64	3	2	6	6	9	9	13	7	55	3.1%
	65-69	0	0	2	0	4	3	3	0	12	0.7%
	70 and Older	0	2	4	11	14	7	12	7	57	3.2%
	Not Coded	62	42	193	153	188	253	324	196	1,411	79.2%
	Total	80	60	243	192	246	317	404	239	1,781	100%
Palm Beach	14 and Under	2	0	13	6	5	24	25	4	79	9.5%
	15 - 19	2	0	15	6	8	9	10	8	58	7.0%
	20 - 24	2	2	4	1	8	10	14	14	55	6.6%
	25 - 34	10	3	14	5	4	14	18	15	83	10.0%
	35 - 44	3	7	3	4	12	12	19	10	70	8.4%
	45 - 54	3	2	8	12	9	12	18	11	75	9.0%
	55 - 64	3	5	5	7	13	17	24	10	84	10.1%
	65-69	0	1	4	8	2	4	5	2	26	3.1%
	70 and Older	1	0	4	13	10	16	21	4	69	8.3%
	Not Coded	15	10	23	26	27	32	57	42	232	27.9%
	Total	41	30	93	88	98	150	211	120	831	100%

Table B-6: Characteristics of Pedestrians involved in a Crash, by Sex

Sex	County		Total	Pct.
	Broward	Palm Beach		
Not Coded	1,411	219	1,630	62.4%
Male	202	397	599	22.9%
Female	167	211	378	14.5%
Unknown	1	4	5	0.2%
Total	1,781	831	2,612	100%

Table B-7: Characteristics of Pedestrians involved in a 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	9	11	53	39	52	64	103	46	377	14.4%
Tuesday	13	7	67	44	35	60	75	37	338	12.9%
Wednesday	6	10	67	49	56	79	99	52	418	16.0%
Thursday	17	8	41	36	55	82	79	45	363	13.9%
Friday	11	10	66	43	61	93	99	57	440	16.8%
Saturday	29	27	25	44	44	38	89	74	370	14.2%
Sunday	36	17	17	25	41	51	71	48	306	11.7%
Total	121	90	336	280	344	467	615	359	2,612	100%

Table B-8: Characteristics of Pedestrians involved in a Crash, 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	4	3	13	10	11	15	22	15	93	15.5%
	Tuesday	3	3	15	8	10	10	13	13	75	12.5%
	Wednesday	2	3	17	9	14	11	26	12	94	15.7%
	Thursday	5	1	9	11	14	14	24	7	85	14.2%
	Friday	3	4	12	3	10	24	29	20	105	17.5%
	Saturday	4	8	8	8	7	10	20	17	82	13.7%
	Sunday	11	6	3	6	7	11	12	9	65	10.9%
	Total	32	28	77	55	73	95	146	93	599	100%
Female	Monday	0	2	4	4	5	12	17	2	46	12.2%
	Tuesday	1	0	10	10	4	12	14	3	54	14.3%
	Wednesday	1	1	11	6	8	21	15	5	68	18.0%
	Thursday	1	2	4	3	10	18	13	2	53	14.0%
	Friday	0	2	12	7	13	18	13	6	71	18.8%
	Saturday	5	3	2	10	9	6	14	5	54	14.3%
	Sunday	5	0	3	4	7	5	4	4	32	8.5%
	Total	13	10	46	44	56	92	90	27	378	100%

APPENDIX C: CHARACTERISTICS OF SEVERELY-INJURED PEDESTRIANS IN LOWER INCOME AREAS

Table C-1: Characteristics of Seriously-injured Pedestrians by Time of Day

Time of Day	Frequency	Pct.
Midnight to 2:59 am	67	5.1%
3 am to 5:59 am	40	3.1%
6 am to 8:59 am	144	11.0%
9 am to 11:59 am	132	10.1%
Noon to 2:59 pm	169	12.9%
3 pm to 5:59 pm	233	17.8%
6 pm to 8:59 pm	345	26.4%
9 pm to 11:59 pm	178	13.6%
Total	1,308	100%

Table C-2: Characteristics of Seriously-injured Pedestrians, by Age and County of Incidence

Age Group	County		Total	Pct.
	Broward	Palm Beach		
14 and Under	18	37	55	4.2%
15-19	13	33	46	3.5%
20-24	20	36	56	4.3%
25-34	34	40	74	5.7%
35-44	15	38	53	4.1%
45-54	18	35	53	4.1%
55-64	22	40	62	4.7%
65-69	5	11	16	1.2%
70 and Older	27	35	62	4.7%
Not Coded	708	123	831	63.5%
Total	880	428	1,308	100%

Table C-3: Characteristics of Seriously-injured Pedestrians, 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	1	0	5	4	7	18	18	2	55	4.2%
15 - 19	2	0	8	4	4	11	9	8	46	3.5%
20 - 24	4	5	1	1	8	12	12	13	56	4.3%
25 - 34	6	2	9	4	8	10	23	12	74	5.7%
35 - 44	2	3	8	4	6	9	14	7	53	4.1%
45 - 54	0	1	5	9	6	13	16	3	53	4.1%
55 - 64	4	2	5	6	14	10	16	5	62	4.7%
65-69	0	0	3	3	3	4	3	0	16	1.2%
70 and Older	0	1	6	11	9	13	18	4	62	4.7%
Not Coded	48	26	94	86	104	133	216	124	831	63.5%
Total	67	40	144	132	169	233	345	178	1,308	100%
Pct.	5.1%	3.1%	11.0%	10.1%	12.9%	17.8%	26.4%	13.6%	100%	

Table C-4: Characteristics of Seriously-injured Pedestrians, by Time and Age, Broward and Palm Beach Counties

County	Age Group	Time of Day: 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	Total	Pct.
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%

Table C-5: Characteristics of Seriously-injured Pedestrians, by Sex

Sex	County		Total	Pct.
	Broward	Palm Beach		
Not Coded	707	121	828	63.3%
Male	96	209	305	23.3%
Female	77	97	174	13.3%
Unknown	0	1	1	0.1%
Total	880	428	1,308	100%

Table C-6: 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	3	5	30	19	27	38	63	27	212	16.2%
Tuesday	5	1	21	19	12	25	46	22	151	11.5%
Wednesday	1	7	33	23	28	35	50	22	199	15.2%
Thursday	10	4	19	17	30	43	46	23	192	14.7%
Friday	7	2	22	22	29	47	56	25	210	16.1%
Saturday	20	12	10	18	17	21	43	37	178	13.6%
Sunday	21	9	9	14	26	24	41	22	166	12.7%
Total	67	40	144	132	169	233	345	178	1,308	100%

Table C-7: 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	1	1	10	7	7	9	14	11	60	19.7%
	Tuesday	1	1	2	3	5	7	8	8	35	11.5%
	Wednesday	0	2	8	5	6	7	12	3	43	14.1%
	Thursday	3	0	5	5	10	7	11	3	44	14.4%
	Friday	1	1	6	2	3	13	15	5	46	15.1%
	Saturday	2	4	1	2	3	6	10	8	36	11.8%
	Sunday	6	2	2	5	4	8	10	4	41	13.4%
	Total	14	11	34	29	38	57	80	42	305	100%
Female	Monday	0	0	0	1	5	8	12	2	28	16.1%
	Tuesday	0	0	1	2	0	4	7	1	15	8.6%
	Wednesday	0	1	7	4	6	9	7	3	37	21.3%
	Thursday	1	1	1	2	3	10	8	2	28	16.1%
	Friday	0	0	3	3	5	9	8	1	29	16.7%
	Saturday	3	1	2	2	4	2	6	3	23	13.2%
	Sunday	1	0	2	2	4	2	3	0	14	8.0%
	Total	5	3	16	16	27	44	51	12	174	100%

APPENDIX D: CHARACTERISTICS OF PEDESTRIANS KILLED IN LOWER INCOME BLOCK GROUPS

Table D-1: Pedestrians Killed in a Crash, by Time of Day

Time of Day	Frequency	Pct.
Midnight to 2:59 am	16	9.2%
3 am to 5:59 am	15	8.6%
6 am to 8:59 am	14	8.0%
9 am to 11:59 am	11	6.3%
Noon to 2:59 pm	11	6.3%
3 pm to 5:59 pm	11	6.3%
6 pm to 8:59 pm	41	23.6%
9 pm to 11:59 pm	55	31.6%
Total	174	100%

Table D-2: Characteristics of Pedestrians Killed in a Fatal Crash. by Age and County of Incidence

Age Group	County		Total	Pct.
	Broward	Palm Beach		
14 and Under	0	3	3	1.7%
15-19	2	1	3	1.7%
20-24	0	3	3	1.7%
25-34	4	5	9	5.2%
35-44	1	4	5	2.9%
45-54	6	9	15	8.6%
55-64	16	6	22	12.6%
65-69	1	2	3	1.7%
70 an Older	6	9	15	8.6%
Not Coded	79	17	96	55.2%
Total	115	59	174	100%

Table D-3: 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	0	0	0	1	1	3	1.7%
15 - 19	0	0	1	0	0	0	0	2	3	1.7%
20 - 24	1	0	0	0	0	1	0	1	3	1.7%
25 - 34	2	1	1	0	0	0	0	5	9	5.2%
35 - 44	2	0	0	0	0	0	2	1	5	2.9%
45 - 54	2	1	1	0	0	0	3	8	15	8.6%
55 - 64	1	3	2	3	2	2	4	5	22	12.6%
65-69	0	1	0	0	0	0	1	3	3	1.7%
70 and Older	1	0	0	1	2	2	6	1	15	8.6%
Not Coded	7	9	8	7	7	6	24	28	96	55.2%
Total	16	15	14	11	11	11	41	55	174	100%
Pct.	7.8%	9.0%	7.8%	6.0%	5.4%	6.6%	24.1%	33.1%	100%	

Table D-4: 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	0	0	0	0	0	0	0.0%
	15 - 19	0	0	1	0	0	0	0	1	2	1.8%
	20 - 24	0	0	0	0	0	0	0	0	0	0.0%
	25 - 34	2	0	1	0	0	0	0	1	4	3.5%
	35 - 44	1	0	0	0	0	0	0	0	1	0.9%
	45 - 54	1	0	1	0	0	0	2	2	6	5.3%
	55 - 64	1	1	1	2	2	1	4	4	15	13.2%
	65-69	0	0	0	0	0	0	1	0	1	0.9%
	70 and Older	0	0	0	0	0	0	3	3	6	5.3%
	Not Coded	7	6	7	6	7	5	20	21	79	69.3%
	Total	12	7	11	8	9	6	30	32	114	100%
Palm Beach	14 and Under	0	0	1	0	0	0	1	1	3	5.0%
	15 - 19	0	0	0	0	0	0	0	1	1	1.7%
	20 - 24	1	0	0	0	0	1	0	1	3	5.0%
	25 - 34	0	1	0	0	0	0	0	4	5	8.3%
	35 - 44	1	0	0	0	0	0	2	1	4	6.7%
	45 - 54	1	1	0	0	0	0	1	6	9	15.0%
	55 - 64	0	2	1	1	0	1	0	1	7	11.7%
	65-69	0	1	0	0	0	0	0	1	2	3.3%
	70 and Older	1	0	0	1	2	2	3	0	9	15.0%
	Not Coded	0	3	1	1	0	1	4	7	17	28.3%
	Total	4	8	3	3	2	5	11	23	60	100%

Table D-5: Characteristics of Pedestrians Killed in a Fatal Crash, by Sex

Sex	County		Total	Pct.
	Broward	Palm Beach		
Not Coded	82	16	98	56.3%
Male	22	29	51	29.3%
Female	10	14	24	13.8%
Unknown	1	0	1	0.6%
Total	115	59	174	100%

Table D-6: 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	1	0	0	1	2	0	7	2	13	7.5%
Tuesday	0	5	5	3	1	1	7	6	28	16.1%
Wednesday	2	1	3	3	0	1	7	8	25	14.4%
Thursday	3	0	1	3	3	2	4	5	21	12.1%
Friday	1	2	1	1	1	3	10	12	31	17.8%
Saturday	3	5	3	0	2	2	4	12	31	17.8%
Sunday	6	2	1	0	2	2	2	10	25	14.4%
Total	16	15	14	11	11	11	41	55	174	100%
Pct.	9.2%	8.6%	8.0%	6.3%	6.3%	6.3%	23.6%	31.6%	100%	

Table D-7: 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	1	0	0	0	0	0	3	0	4	7.8%
	Tuesday	0	2	1	0	0	0	1	2	6	11.8%
	Wednesday	1	0	0	0	0	0	2	3	6	11.8%
	Thursday	1	0	0	1	0	0	1	1	4	7.8%
	Friday	0	1	1	1	1	2	4	6	16	31.4%
	Saturday	1	0	3	0	0	1	0	4	9	17.6%
	Sunday	2	1	0	0	0	0	0	3	6	11.8%
	Total	6	4	5	1	1	3	11	19	51	100%
Female	Monday	0	0	0	1	0	0	0	0	1	4.2%
	Tuesday	0	0	1	1	0	0	1	1	4	16.7%
	Wednesday	1	0	1	0	0	1	1	2	6	25.0%
	Thursday	0	0	0	0	1	1	1	0	3	12.5%
	Friday	0	0	0	0	0	0	0	2	2	8.3%
	Saturday	0	1	0	0	0	0	1	0	2	8.3%
	Sunday	2	0	0	0	2	0	0	2	6	25.0%
	Total	3	1	2	2	3	2	4	7	24	100%

APPENDIX E: CHARACTERISTICS OF BICYCLISTS INVOLVED IN A CRASH IN LOWER INCOME BLOCK GROUPS

Table E-1: Bicyclist Crashes by Severity

Severity Level	County		Total	Pct.
	Broward	Palm Beach		
Unknown	2	4	6	0.3%
No Injury	206	73	279	13.1%
Possible Injury	505	280	785	36.9%
Non-Incapacitating Injury	511	308	819	38.5%
Incapacitating Injury	119	78	197	9.3%
Fatal	25	14	39	1.8%
Non-Traffic Fatal	1	1	2	0.1%
Total	1,369	758	2,127	100%

Table E-2: Characteristics of Bicyclists involved in a Crash, by Time of Day and County of Incidence

Time of Weekday	County		Total	Pct.
	Broward	Palm Beach		
Midnight to 2:59 am	21	9	30	1.4%
3 am to 5:59 am	22	10	32	1.5%
6 am to 8:59 am	199	96	295	13.9%
9 am to 11:59 am	189	117	306	14.4%
Noon to 2:59 pm	233	132	365	17.2%
3 pm to 5:59 pm	327	212	539	25.3%
6 pm to 8:59 pm	266	131	397	18.7%
9 pm to 11:59 pm	112	51	163	7.7%
Total	1,369	758	2,127	100%

Table E-3: Characteristics of Bicyclists involved in a Crash, by Age

Age Group	County		Total	Pct.
	Broward	Palm Beach		
14 and Under	24	54	78	3.7%
15-19	23	67	90	4.2%
20-24	30	67	97	4.6%
25-34	35	107	142	6.7%
35-44	31	71	102	4.8%
45-54	38	81	119	5.6%
55-64	36	84	120	5.6%
65-69	9	24	33	1.6%
70 and Older	11	19	30	1.4%
Not Coded	1,132	184	1,316	61.9%
Total	1,369	758	2,127	100%

Table E-4: Characteristics of Bicyclists involved in a 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	9	9	5	36	18	1	78	3.7%
15 - 19	1	0	10	11	15	28	21	4	90	4.2%
20 - 24	0	1	13	14	18	32	13	6	97	4.6%
25 - 34	3	5	12	16	23	31	34	18	142	6.7%
35 - 44	1	2	13	19	15	23	24	5	102	4.8%
45 - 54	2	6	22	19	15	24	26	5	119	5.6%
55 - 64	0	1	11	20	29	33	20	6	120	5.6%
65-69	0	0	6	7	5	10	3	2	33	1.6%
70 and Older	0	0	11	6	3	4	5	1	30	1.4%
Not Coded	23	17	188	185	237	318	233	115	1,316	61.9%
Total	30	32	295	306	365	539	397	163	2,127	100%

Table E-5: Characteristics of Bicyclists involved in a 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	2	2	0	10	9	1	24	1.8%
	15 - 19	0	0	1	3	5	8	5	1	23	1.7%
	20 - 24	0	1	5	3	2	12	4	3	30	2.2%
	25 - 34	1	1	6	4	4	5	11	3	35	2.6%
	35 - 44	1	0	5	6	3	8	7	1	31	2.3%
	45 - 54	0	3	6	6	5	7	8	3	38	2.8%
	55 - 64	0	0	3	6	11	10	5	1	36	2.6%
	65-69	0	0	3	3	1	2	0	0	9	0.7%
	70 and Older	0	0	4	1	1	2	2	1	11	0.8%
	Not Coded	19	17	164	155	201	263	215	98	1132	82.7%
	Total	21	22	199	189	233	327	266	112	1,369	100%
Palm Beach	14 and Under	0	0	7	7	5	26	9	0	54	7.1%
	15 - 19	1	0	9	8	10	20	16	3	67	8.8%
	20 - 24	0	0	8	11	16	20	9	3	67	8.8%
	25 - 34	2	4	6	12	19	26	23	15	107	14.1%
	35 - 44	0	2	8	13	12	15	17	4	71	9.4%
	45 - 54	2	3	16	13	10	17	18	2	81	10.7%
	55 - 64	0	1	8	14	18	23	15	5	84	11.1%
	65-69	0	0	3	4	4	8	3	2	24	3.2%
	70 and Older	0	0	7	5	2	2	3	0	19	2.5%
	Not Coded	4	0	24	30	36	55	18	17	184	24.3%
	Total	9	10	96	117	132	212	131	51	758	100%

Table E-6: Characteristics of Bicyclists involved in a Crash, by Sex

Sex	County		Total	Pct.
	Broward	Palm Beach		
Not Coded	1,124	167	1,291	60.7%
Male	196	469	665	31.3%
Female	48	119	167	7.9%
Unknown	1	3	4	0.2%
Total	1,369	758	2,127	100%

Table E-7: Characteristics of Bicyclists involved in a 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	4	4	33	39	57	93	58	14	302	14.2%
Tuesday	4	5	43	42	56	77	62	13	302	14.2%
Wednesday	0	5	59	43	49	86	62	29	333	15.7%
Thursday	1	4	64	48	59	78	47	23	324	15.2%
Friday	2	5	55	38	50	80	74	34	338	15.9%
Saturday	10	5	29	49	51	71	45	29	289	13.6%
Sunday	9	4	12	47	43	54	49	21	239	11.2%
Total	30	32	295	306	365	539	397	163	2,127	100%
Pct.	1.4%	1.5%	13.9%	14.4%	17.2%	25.3%	18.7%	7.7%	100%	

Table E-8: Characteristics of Bicyclists involved in a Crash, 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	1	2	9	12	12	30	16	2	84	12.6%
	Tuesday	0	3	13	13	15	21	22	3	90	13.5%
	Wednesday	0	1	17	13	15	32	19	7	104	15.6%
	Thursday	1	1	24	14	17	27	14	5	103	15.5%
	Friday	0	3	11	10	17	24	27	10	102	15.3%
	Saturday	3	2	11	18	17	24	17	8	100	15.0%
	Sunday	2	3	2	13	16	19	18	9	82	12.3%
	Total	7	15	87	93	109	177	133	44	665	100%
Female	Monday	0	0	1	2	4	10	8	1	26	15.6%
	Tuesday	1	0	6	7	3	6	5	0	28	16.8%
	Wednesday	0	0	4	2	7	6	8	0	27	16.2%
	Thursday	0	0	3	8	1	12	5	1	30	18.0%
	Friday	0	0	4	1	2	4	2	2	15	9.0%
	Saturday	0	0	3	5	2	6	1	1	18	10.8%
	Sunday	0	0	2	6	4	5	5	1	23	13.8%
	Total	1	0	23	31	23	49	34	6	167	100%

APPENDIX F: CHARACTERISTICS OF SERIOUSLY-INJURED BICYCLISTS IN LOWER INCOME AREAS

Table F-1: Characteristics of Seriously-injured Bicyclists, by Time of Day

Time of Day	County		Total	Pct.
	Broward	Palm Beach		
Midnight to 2:59 am	10	8	18	1.8%
3 am to 5:59 am	14	6	20	2.0%
6 am to 8:59 am	103	49	152	15.0%
9 am to 11:59 am	92	58	150	14.8%
Noon to 2:59 pm	90	54	144	14.2%
3 pm to 5:59 pm	134	109	243	23.9%
6 pm to 8:59 pm	139	70	209	20.6%
9 pm to 11:59 pm	48	32	80	7.9%
Total	630	386	1,016	100%

Table F-2: Characteristics of Seriously-injured Bicyclists, by Age

Age Group	County		Total	Pct.
	Broward	Palm Beach		
14 and Under	12	28	40	3.9%
15-19	14	32	46	4.5%
20-24	16	33	49	4.8%
25-34	14	54	68	6.7%
35-44	14	35	49	4.8%
45-54	20	41	61	6.0%
55-64	12	39	51	5.0%
65-69	5	11	16	1.6%
70 and Older	4	11	15	1.5%
Not Coded	519	102	621	61.1%
Total	630	386	1,016	100%

Table F-3: Characteristics of Seriously-injured Bicyclists, 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	4	4	2	20	10	0	40	3.9%
15 - 19	1	0	6	8	7	14	8	2	46	4.5%
20 - 24	0	1	8	9	5	14	8	4	49	4.8%
25 - 34	3	2	5	6	9	12	20	11	68	6.7%
35 - 44	0	2	5	8	10	10	12	2	49	4.8%
45 - 54	1	3	12	10	7	10	16	2	61	6.0%
55 - 64	0	1	7	6	9	15	11	2	51	5.0%
65-69	0	0	3	2	1	8	1	1	16	1.6%
70 and Older	0	0	5	4	1	1	4	0	15	1.5%
Not Coded	13	11	97	93	93	139	119	56	621	61.1%
Total	18	20	152	150	144	243	209	80	1,016	100%
Pct.	1.8%	2.0%	15.0%	14.8%	14.2%	23.9%	20.6%	7.9%	100%	

Table F-4: Characteristics of Seriously-injured Bicyclists, 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%

Table F-5: Characteristics of Seriously-injured Bicyclists, by Sex and County of Incidence

Sex	County		Total	Pct.
	Broward	Palm Beach		
Not Coded	518	97	615	60.5%
Male	92	231	323	31.8%
Female	20	56	76	7.5%
Unknown	0	2	2	0.2%
Total	630	386	1,016	100%

Table F-6: Characteristics of Seriously-injured Bicyclists, 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	1	2	13	23	17	42	30	3	131	12.9%
Tuesday	2	1	24	17	21	31	32	8	136	13.4%
Wednesday	0	3	31	20	19	42	35	18	168	16.5%
Thursday	1	4	32	24	28	34	21	7	151	14.9%
Friday	2	3	27	20	24	31	39	18	164	16.1%
Saturday	6	4	17	23	15	34	20	14	133	13.1%
Sunday	6	3	8	23	20	29	32	12	133	13.1%
Total	18	20	152	150	144	243	209	80	1,016	100%
Pct.	1.8%	2.0%	15.0%	14.8%	14.2%	23.9%	20.6%	7.9%	100%	

Table F-7: Characteristics of Seriously-injured Bicyclists, 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	0	1	3	8	3	15	9	1	40	12.4%
	Tuesday	0	0	10	3	6	11	10	3	43	13.3%
	Wednesday	0	1	9	4	6	13	14	5	52	16.1%
	Thursday	1	1	11	10	9	11	6	1	50	15.5%
	Friday	0	3	4	6	5	14	15	6	53	16.4%
	Saturday	2	1	7	8	3	14	8	4	47	14.6%
	Sunday	2	2	1	5	8	7	11	2	38	11.8%
	Total	5	9	45	44	40	85	73	22	323	100%
	Pct.	1.5%	2.8%	13.9%	13.6%	12.4%	26.3%	22.6%	6.8%	100%	
Female	Monday	0	0	1	0	0	5	6	0	12	15.8%
	Tuesday	1	0	1	2	2	2	1	0	9	11.8%
	Wednesday	0	0	2	2	4	2	4	0	14	18.4%
	Thursday	0	0	1	3	0	6	2	0	12	15.8%
	Friday	0	0	3	1	2	0	0	1	7	9.2%
	Saturday	0	0	1	3	2	3	0	1	10	13.2%
	Sunday	0	0	1	2	1	2	5	1	12	15.8%
	Total	1	0	10	13	11	20	18	3	76	100%
	Pct.	1.3%	0.0%	13.2%	17.1%	14.5%	26.3%	23.7%	3.9%	100%	

APPENDIX G: CHARACTERISTICS OF BICYCLISTS KILLED IN LOWER INCOME BLOCK GROUPS

Table G-1: Fatal Bicyclist Crashes by Time of Day

Time of Day	County		Total	Pct.
	Broward	Palm Beach		
Midnight to 2:59 am	3	0	3	7.3%
3 am to 5:59 am	2	1	3	7.3%
6 am to 8:59 am	3	1	4	9.8%
9 am to 11:59 am	2	2	4	9.8%
Noon to 2:59 pm	0	1	1	2.4%
3 pm to 5:59 pm	5	0	5	12.2%
6 pm to 8:59 pm	3	5	8	19.5%
9 pm to 11:59 pm	8	5	13	31.7%
Total	26	15	41	100%

Table G-2: Characteristics of Bicyclists Killed in a Fatal Crash, by Age

Age Group	County		Total	Pct.
	Broward	Palm Beach		
14 and Under	0	0	0	0.0%
15-19	0	0	0	0.0%
20-24	0	0	0	0.0%
25-34	2	2	4	9.8%
35-44	1	2	3	7.3%
45-54	3	3	6	14.6%
55-64	1	4	5	12.2%
65-69	0	2	2	4.9%
70 and Older	1	0	1	2.4%
Not Coded	18	2	20	48.8%
Total	26	15	41	100%

Table G-3: Characteristics of Bicyclists 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	0	0	0	1	1	4	9.8%
35 - 44	1	0	0	0	0	0	1	1	3	7.3%
45 - 54	0	1	1	0	0	0	1	3	6	14.6%
55 - 64	0	0	0	0	1	1	0	3	5	12.2%
65-69	0	0	0	1	0	0	1	0	2	4.9%
70 and Older	0	0	1	0	0	0	0	0	1	2.4%
Not Coded	2	1	1	3	0	4	4	5	20	48.8%
Total	3	3	4	4	1	5	8	13	41	100%
Pct.	7.3%	7.3%	9.8%	9.8%	2.4%	12.2%	19.5%	31.7%	100%	

Table G-4: Characteristics of Bicyclists 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%

Table G-5: Characteristics of Bicyclists Killed in a Fatal Crash, by Sex

Sex	County		Total	Pct.
	Broward	Palm Beach		
Not Coded	17	1	18	43.9%
Male	9	14	23	56.1%
Female	0	0	0	0.0%
Unknown	0	0	0	0.0%
Total	26	15	41	100%

Table G-6: Characteristics of Bicyclists 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	0	1	1	0	0	0	3	5	12.2%
Tuesday	0	2	0	1	0	3	1	0	7	17.1%
Wednesday	0	0	0	1	1	0	1	0	3	7.3%
Thursday	0	0	1	0	0	0	2	1	4	9.8%
Friday	0	0	1	0	0	0	1	4	6	14.6%
Saturday	3	0	1	0	0	0	2	1	7	17.1%
Sunday	0	1	0	1	0	2	1	4	9	22.0%
Total	3	3	4	4	1	5	8	13	41	100%
Pct.	7.3%	7.3%	9.8%	9.8%	2.4%	12.2%	19.5%	31.7%	100%	

Table G-7: Characteristics of Bicyclists Killed in a Fatal Crash, by Time of Day, Day of Week, and Sex [a.]

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	0	0	1	1	0	0	0	0	2	8.7%
	Tuesday	0	1	0	0	0	0	0	0	1	4.3%
	Wednesday	0	0	0	0	1	0	1	0	2	8.7%
	Thursday	0	0	1	0	0	0	0	1	2	8.7%
	Friday	0	0	0	0	0	0	1	3	4	17.4%
	Saturday	1	0	1	0	0	0	2	0	4	17.4%
	Sunday	0	1	0	1	0	1	1	4	8	34.8%
Total		1	2	3	2	1	1	5	8	23	100%
Pct.		4.3%	8.7%	13.0%	8.7%	4.3%	4.3%	21.7%	34.8%	100%	

[a.] *No Female Bicyclists were killed in either county during the study period*