Danger Afoot: Sidewalks, Environmental Justice, and Pedestrian Safety in Pinellas County, Florida

Craig W. Harmak
University of South Florida

Follow this and additional works at: http://scholarcommons.usf.edu/etd
Part of the American Studies Commons, and the Geography Commons

Scholar Commons Citation

This Thesis is brought to you for free and open access by the Graduate School at Scholar Commons. It has been accepted for inclusion in Graduate Theses and Dissertations by an authorized administrator of Scholar Commons. For more information, please contact scholarcommons@usf.edu.
Danger Afoot:
Sidewalks, Environmental Justice, and Pedestrian Safety
in Pinellas County, Florida

by

Craig W. Harmak

A thesis submitted in partial fulfillment of the requirements for the degree of
Master of Arts
Department of Geography
College of Arts and Sciences
University of South Florida

Major Professor: Jayajit Chakraborty, Ph.D.
Graham Tobin, Ph.D.
M. Martin Bosman, Ph.D.

Date of Approval:
April 6, 2007

Keywords: automobile accidents, urban planning, hazards, transportation, scale

© Copyright 2007, Craig W. Harmak
I would like to thank Dr. Jayajit Chakraborty for his patience, attention to detail, and expertise in all things thesis-related. Without his aid and persistence, this thesis would likely still be far from complete. As an advisor, I recommend him highly. I also thank my committee members, Dr. Graham Tobin, and Dr. M. Martin Bosman. Your advice and recommendations were invaluable. I very much appreciate the time and effort you have each put into making this thesis a better product. Sincere thanks as well go to Jim Burd and Shannon Whaley at the Fish and Wildlife Research Institute. Also thanks to Clay and Sarah. You each offered solid advice and counsel. Your efforts were very much worthwhile and always appreciated. Thanks also to my family and friends who never stopped asking, "Are you still working on that?" If nothing else, it always served as a useful bit of inspiration. Sincerely, thanks. Thanks especially to Mom, who has been there without exception, supportive, loving, and irreplaceable. It is a wonderful thing to know I always have someplace to go, when I need someplace to go. Finally, thanks to Lisa. You keep me going when I need to keep going, you worry when I struggle, and you care. You are also the best of editors. I Love you.
TABLE OF CONTENTS

List of Tables iii

List of Figures v

Abstract vii

Chapter 1 - Introduction and Research Questions 1

Chapter 2 - Literature Review 6

2.1 The Demographics of Pedestrians 7
2.2 Environmental Justice and the Pedestrian 8
2.3 Organization of the Built Environment 11
2.4 Pedestrian Perceptions 14
2.5 Politics and Pedestrians 17
2.6 Summary 19

Chapter 3 - Data Collection 21

3.1 Area Density 22
3.2 Income Levels within Pinellas County 25
3.3 Pedestrian-Related Motor Vehicle Accidents 27
3.4 Pinellas County Sidewalks 29
3.5 Pinellas County Roadways 31

Chapter 4 - Research Tasks & Methodology 33

4.1 Research Tasks for Question #1 33
4.2 Research Tasks for Question #2 36
4.3 Research Tasks for Question #3 42

Chapter 5 - Results: Characteristics of Pedestrian-Related Motor Veh Accidents 44

5.1 Temporal Characteristics 45
5.2 Structural Conditions 47
5.3 People and Pedestrian-Related Motor Vehicle Accidents 50
Chapter 6 - Results: Analysis of Sidewalk Density

6.1 100-Meter Radius

6.2 500-Meter Radius

6.3 1-Kilometer Radius

6.4 Sidewalk Density Index Statistical Analysis

Chapter 7 - Results: Socio-Demographic Factors

7.1 Results: Non-White

100-Meter Radius

500-Meter Radius

1-Kilometer Radius

Non-White Statistical Analysis

Summary

7.2 Results: Black

100-Meter Radius

500-Meter Radius

1-Kilometer Radius

Black Statistical Analysis

Summary

7.3 Results: Hispanic

100-Meter Radius

500-Meter Radius

1-Kilometer Radius

Hispanic Statistical Analysis

Summary

7.4 Results: Below Poverty

100-Meter Radius

500-Meter Radius

1-Kilometer Radius

Below Poverty Statistical Analysis

Summary

7.5 Socio-Demographic Factors: Summary

Chapter 8 - Conclusions and Discussion

Afterword

References

Appendices

Appendix A

Appendix B

Appendix C

Appendix D
List of Tables

Table 5.3a Pedestrian Description for Pinellas County PRMVAs 50
Table 5.3b Causes for Pinellas County PRMVAs 51
Table 5.3c PRMVAs and Pedestrian Injury 52
Table 5.3d PRMVAs and Pedestrian Fatality 52
Table 6.1a Mean SDI for All 100-Meter Cells 57
Table 6.1b Mean SDI for Aggregated 100-Meter Cells 58
Table 6.2a Mean SDI for All 500-Meter Cells 61
Table 6.2b Mean SDI for Aggregated 500-Meter Cells 62
Table 6.3a Mean SDI for All 1-Kilometer Cells 66
Table 6.3b Mean SDI for Aggregated 1-Kilometer Cells 67
Table 6.4a Logistic Regression for SDI 69
Table 6.4b Ordinary Least Squares Regression for SDI 71
Table 7.1a Mean Non-White for All 100-Meter Cells 76
Table 7.1b Mean Non-White for Aggregated 100-Meter Cells 77
Table 7.1c Mean Non-White for All 500-Meter Cells 80
Table 7.1d Mean Non-White for Aggregated 500-Meter Cells 81
Table 7.1e Mean Non-White for All 1-Kilometer Cells 84
Table 7.1f Mean Non-White for Aggregated 1-Kilometer Cells 85
Table 7.1g Logistic Regression for Non-White 88
Table 7.1h Ordinary Least Squares Regression for Non-White 89
Table 7.2a Mean Black for All 100-Meter Cells 93
Table 7.2b Mean Black for Aggregated 100-Meter Cells 93
Table 7.2c Mean Black for All 500-Meter Cells 95
Table 7.2d Mean Black for Aggregated 500-Meter Cells 96
Table 7.2e  Mean Black for All 1-Kilometer Cells  
Table 7.2f  Mean Black for Aggregated 1-Kilometer Cells  
Table 7.2g  Logistic Regression for Black  
Table 7.2h  Ordinary Least Squares Regression for Black  
Table 7.3a  Mean Hispanic for All 100-Meter Cells  
Table 7.3b  Mean Hispanic for Aggregated 100-Meter Cells  
Table 7.3c  Mean Hispanic for All 500-Meter Cells  
Table 7.3d  Mean Hispanic for Aggregated 500-Meter Cells  
Table 7.3e  Mean Hispanic for All 1-Kilometer Cells  
Table 7.3f  Mean Hispanic for Aggregated 1-Kilometer Cells  
Table 7.3g  Logistic Regression for Hispanic  
Table 7.3h  Ordinary Least Squares Regression for Hispanic  
Table 7.4a  Mean Below Poverty for All 100-Meter Cells  
Table 7.4b  Mean Below Poverty for Aggregated 100-Meter Cells  
Table 7.4c  Mean Below Poverty for All 500-Meter Cells  
Table 7.4d  Mean Below Poverty for Aggregated 500-Meter Cells  
Table 7.4e  Mean Below Poverty for All 1-Kilometer Cells  
Table 7.4f  Mean Below Poverty for Aggregated 1-Kilometer Cells  
Table 7.4g  Logistic Regression for Below Poverty  
Table 7.4h  Ordinary Least Squares Regression for Below Poverty
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1a</td>
<td>Florida Population Density by County</td>
<td>23</td>
</tr>
<tr>
<td>3.1b</td>
<td>Pinellas County Population Density by Census Block</td>
<td>24</td>
</tr>
<tr>
<td>3.2</td>
<td>Pinellas County Per Capita Income</td>
<td>26</td>
</tr>
<tr>
<td>3.3</td>
<td>Pedestrian-Related Motor Vehicle Accident Locations</td>
<td>28</td>
</tr>
<tr>
<td>3.4</td>
<td>Pinellas County Sidewalks</td>
<td>30</td>
</tr>
<tr>
<td>3.5</td>
<td>Pinellas County Roadways</td>
<td>32</td>
</tr>
<tr>
<td>5.1a</td>
<td>PRMVAs Aggregated by Month</td>
<td>45</td>
</tr>
<tr>
<td>5.1b</td>
<td>PRMVAs Aggregated by Time of Day</td>
<td>46</td>
</tr>
<tr>
<td>5.1c</td>
<td>PRMVAs by Light Conditions</td>
<td>47</td>
</tr>
<tr>
<td>5.2a</td>
<td>PRMVAs by Moisture Condition</td>
<td>48</td>
</tr>
<tr>
<td>5.2b</td>
<td>PRMVAs by Traffic Control Device</td>
<td>48</td>
</tr>
<tr>
<td>5.2c</td>
<td>Pinellas County Site Location Factors</td>
<td>49</td>
</tr>
<tr>
<td>6.1a</td>
<td>SDI at 100-Meter Scale</td>
<td>56</td>
</tr>
<tr>
<td>6.1b</td>
<td>SDI 100-Meter PRMVA Frequency</td>
<td>57</td>
</tr>
<tr>
<td>6.1c</td>
<td>SDI 100-Meter PRMVA Frequency Aggregated</td>
<td>58</td>
</tr>
<tr>
<td>6.2a</td>
<td>SDI at 500-Meter Scale</td>
<td>60</td>
</tr>
<tr>
<td>6.2b</td>
<td>SDI 500-Meter PRMVA Frequency</td>
<td>62</td>
</tr>
<tr>
<td>6.2c</td>
<td>SDI 500-Meter PRMVA Frequency Aggregated</td>
<td>63</td>
</tr>
<tr>
<td>6.3a</td>
<td>SDI at 1-Kilometer Scale</td>
<td>65</td>
</tr>
<tr>
<td>6.3b</td>
<td>SDI 1-Kilometer PRMVA Frequency</td>
<td>67</td>
</tr>
<tr>
<td>6.3c</td>
<td>SDI 1-Kilometer PRMVA Frequency Aggregated</td>
<td>68</td>
</tr>
<tr>
<td>7.1a</td>
<td>Percent Non-White at 100-Meter Scale</td>
<td>75</td>
</tr>
<tr>
<td>7.1b</td>
<td>Percent Non-White at 500-Meter Scale</td>
<td>79</td>
</tr>
<tr>
<td>Figure 7.1c</td>
<td>Percent Non-White 500-Meter PRMVA Frequency</td>
<td>80</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>Figure 7.1d</td>
<td>Percent Non-White 500-Meter PRMVA Frequency Aggr</td>
<td>81</td>
</tr>
<tr>
<td>Figure 7.1e</td>
<td>Percent Non-White at 1-Kilometer Scale</td>
<td>83</td>
</tr>
<tr>
<td>Figure 7.1f</td>
<td>Percent Non-White 1-Kilometer PRMVA Frequency</td>
<td>85</td>
</tr>
<tr>
<td>Figure 7.1g</td>
<td>Percent Non-White 1-Kilometer PRMVA Frequency Aggr</td>
<td>86</td>
</tr>
<tr>
<td>Figure 7.2a</td>
<td>Percent Black at 100-Meter Scale</td>
<td>92</td>
</tr>
<tr>
<td>Figure 7.2b</td>
<td>Percent Black at 500-Meter Scale</td>
<td>94</td>
</tr>
<tr>
<td>Figure 7.2c</td>
<td>Percent Black 500-Meter PRMVA Frequency</td>
<td>96</td>
</tr>
<tr>
<td>Figure 7.2d</td>
<td>Percent Black 500-Meter PRMVA Frequency Aggregated</td>
<td>97</td>
</tr>
<tr>
<td>Figure 7.2e</td>
<td>Percent Black at 1-Kilometer Scale</td>
<td>98</td>
</tr>
<tr>
<td>Figure 7.2f</td>
<td>Percent Black 1-Kilometer PRMVA Frequency</td>
<td>100</td>
</tr>
<tr>
<td>Figure 7.2g</td>
<td>Percent Black 1-Kilometer PRMVA Frequency Aggregated</td>
<td>101</td>
</tr>
<tr>
<td>Figure 7.3a</td>
<td>Percent Hispanic at 100-Meter Scale</td>
<td>107</td>
</tr>
<tr>
<td>Figure 7.3b</td>
<td>Percent Hispanic at 500-Meter Scale</td>
<td>110</td>
</tr>
<tr>
<td>Figure 7.3c</td>
<td>Percent Hispanic 500-Meter PRMVA Frequency</td>
<td>112</td>
</tr>
<tr>
<td>Figure 7.3d</td>
<td>Percent Hispanic 500-Meter PRMVA Frequency Aggregated</td>
<td>113</td>
</tr>
<tr>
<td>Figure 7.3e</td>
<td>Percent Hispanic at 1-Kilometer Scale</td>
<td>114</td>
</tr>
<tr>
<td>Figure 7.3f</td>
<td>Percent Hispanic 1-Kilometer PRMVA Frequency</td>
<td>116</td>
</tr>
<tr>
<td>Figure 7.3g</td>
<td>Percent Hispanic 1-Kilometer PRMVA Frequency Aggr</td>
<td>117</td>
</tr>
<tr>
<td>Figure 7.4a</td>
<td>Percent Below Poverty at 100-Meter Scale</td>
<td>122</td>
</tr>
<tr>
<td>Figure 7.4b</td>
<td>Percent Below Poverty at 500-Meter Scale</td>
<td>124</td>
</tr>
<tr>
<td>Figure 7.4c</td>
<td>Percent Below Poverty 500-Meter PRMVA Frequency</td>
<td>125</td>
</tr>
<tr>
<td>Figure 7.4d</td>
<td>Percent Below Poverty 500-Meter PRMVA Frequency Aggr</td>
<td>126</td>
</tr>
<tr>
<td>Figure 7.4e</td>
<td>Percent Below Poverty at 1-Kilometer Scale</td>
<td>127</td>
</tr>
<tr>
<td>Figure 7.4f</td>
<td>Percent Below Poverty 1-Kilometer PRMVA Frequency</td>
<td>129</td>
</tr>
<tr>
<td>Figure 7.4g</td>
<td>Percent Below Poverty 1-Kilometer PRMVA Frequency Aggr</td>
<td>130</td>
</tr>
</tbody>
</table>
ABSTRACT

Though often taken for granted, few everyday activities involve so much genuine danger as the hazards associated with motor vehicles. Urban areas are built, modified, and/or deconstructed with motoring in mind. Also true is that few are at as much risk, as are those pedestrians who dare to cross paths with motor vehicles. Unfortunately, all too often, pedestrians are casualties of encounters with the ubiquitous automobile. The Tampa-St. Petersburg-Clearwater, Florida metropolitan statistical area (MSA) has recently been deemed, by one study, to be the nation’s second most dangerous MSA for pedestrians. Using information on pedestrian/motor vehicle accident sites, sidewalk location and density, and U.S. Census demographic data, this project focuses on Pinellas County --the most densely populated county in the state of Florida. Issues that were investigated in this case study include: (a) the spatial distribution of pedestrian accident risk within the county, (b) the relationship between the presence of sidewalks and Pedestrian Related Motor Vehicle Accidents (PRMVAs), and (c) the environmental
justice implications of these PRMVs. This thesis seeks to identify spatial and socio-economic trends associated with pedestrian accidents and thus provide an improved understanding of the nature of the danger experienced by pedestrians in the heavily motorized world of west-central Florida.
CHAPTER 1

INTRODUCTION
AND RESEARCH QUESTIONS

When looking at the city, it is readily apparent that urban spatial structure is intrinsically tied to the networks that link the component parts. In early 21st century America, transportation networks and automobile roadways, in particular, are the most dominant features influencing the expanding shape and size of urban environments. Between 1980 and 2003, total roadway miles in the U.S. have increased by more than 100,000 miles to 3,974,107 miles (US-DOT, 2005). This increase has largely occurred in urban areas which experienced a nearly 50 percent growth in roadway mileage. In fact, rural roadways have actually decreased nearly 200,000 miles as rural areas have been engulfed by expanding urban zones (US-DOT, 2005). This expansion of roadways has been fueled, in part, by a nearly 50 percent increase in the number of motor vehicles plying the nation’s roadways between 1980 and 2003 (US-DOT, 2005). Motor vehicles are clearly a significant part of the fabric of American life and as such, receive substantial attention by policymakers and industry. With all this attention and funding given to motorists, often overlooked are the means for those who must, or merely choose to, travel in a non-motorized fashion. Sidewalks offer, and perhaps even encourage, an alternative mode of transport. While automobile traffic arteries are constructed and expanded, the
more environmentally-friendly options are often forgotten. At best, the option of improving pedestrian travel routes is given scant consideration, but simply not deemed worthy, leaving the transit choices limited.

Pedestrians are particularly at risk when moving about in urban environments. When compared to travel by automobile, foot travel is as much as 50 times as dangerous (Aultman-Hall, Kaltenecker, 1999). Despite this extreme difference in safety, frequently little is done to improve this situation. A recent study (Ernst, 2004), indicates Florida has the four most dangerous metropolitan areas in the nation (the Orlando MSA ranks first, Tampa-Saint Petersburg-Clearwater is second). This study used a weighted formula based on pedestrian miles traveled to account for differing regions and their varied volumes of pedestrian traffic. Even in light of these facts, the streets remain a frequently under-funded and all too often downright dangerous place for those who walk and bicycle.

A useful indicator of recent trends in walking and biking may be seen in U.S. Census data on journey-to-work trends. In 1990, there were almost 300,000 people commuting to work in Pinellas County. Of these, just 4.4 percent chose to bike or walk. In 2000, the County had well over 400,000 commuters but the percentage of bikers and pedestrian commuters declined to a mere 2.8 percent. So severe was this downturn, that despite a robust 40.7 percent increase in the number of commuters, the absolute number of walking and bicycling commuters actually decreased from 13,149 in 1990 to 11,854 in 2000 (U.S. Census, 2000). While several factors could have contributed to this precipitous drop, the dire lack of viable pedestrian arteries is likely to be an important contributing factor.
Significant too, are the dangers faced by those without the means to travel by automobile. City dwellers can often be seen traveling afoot or on bicycles, going to work, getting consumables from the market, or simply visiting friends and family. The more affluent may do this because they choose to, or perhaps seek to enjoy the fresh air, and get some exercise, or possibly even due to a concern for the environmental degradation that is otherwise perpetrated by their sport utility vehicle. The less prosperous city dweller may do this because they have no choice. They cannot afford to do otherwise. They have no car. For this low-income urbanite, the pathways for walking and biking are not a luxury of recreation or convenience. The foot and bicycle-oriented routes are an absolute necessity to function in their everyday life. For these folks, walking and biking will be done whether there are sidewalks and bike lanes present or not. For them, the only question is the level of danger each trip will entail. This predicament may well be an issue of environmental injustice. In 1994, President Clinton issued Executive Order 12898 defining a federal environmental justice policy. This Order mandated that all Federal agencies consider and act to alleviate any disproportionate adverse health and environmental effects that may be incurred by minorities and those of lower income. In 1997, the United States Department of Transportation furthered this with their own policy notice stating that environmental justice concerns should be incorporated in all transportation plans, programs, and policies.

Issues of concern for environmental justice have historically and primarily focused on the disproportionate distribution of dis-amenities such as polluting facilities or locally unwanted land uses (LULUs). Inequities in the provision of
amenities, such as sidewalks and related passageways for pedestrians, may also represent a violation of environmental justice principles. Therefore, it is important to examine if racial/ethnic minorities and low-income individuals may be adversely affected by the structure of the urban pedestrian environment.

In summary, there is an ongoing need for research into the spatial and practical constructs that inhibit pedestrian public safety. In particular, the importance that available sidewalks may have upon the walking class has been under-investigated. The thesis project addresses these issues by exploring which locations within the transportation network present disproportionate hazards for pedestrians. Potential associations between sidewalk availability and pedestrian related motor vehicle accidents (PRMVAs) are examined. Finally, the environmental justice implications of pedestrian accidents and their safety are investigated by analyzing the spatial relationship between PRMVA incidence and the proportion of racial/ethnic minorities and low-income individuals.

This research project examines several key issues and problems associated with pedestrian and bicyclist safety in an urban environment dominated by the presence of motor vehicles. The following research questions were investigated, based on a case study conducted in Pinellas County, Florida:

1. What is the spatial distribution of pedestrian-related motor vehicle accidents (PRMVAs) within the study area? Which parts of the transportation network in Pinellas County are more likely to experience an incidence of PRMVAs? Under what conditions are PRMVAs most likely to occur?
2. Is there a spatial association between sidewalk/roadway ratio and the incidence of PRMVAs? Are PRMVAs more or less likely to occur in areas where more sidewalks are present relative to roadways?

3. What are the environmental justice implications of PRMVA incidences in the county? Are PRMVAs more likely to occur in areas containing a disproportionately large number of racial/ethnic minorities and/or low-income individuals?

A combination of several statistical and spatial analytic methods were used in conjunction with geographic information systems (GIS) software to explore these research questions.

This study focused on pedestrian related motor vehicle accidents. For the purposes of this project, the accidents referenced encompass motor vehicle accidents involving exclusively pedestrians on foot. While consideration was given to include bicyclists as well, it was determined that the safety concerns of those riding bicycles are substantially different enough to be best served by another study focusing exclusively upon bicycle safety. The motor vehicles mentioned include all forms of motorized vehicles including cars, trucks, and motorcycles.
CHAPTER 2

LITERATURE REVIEW

The material that follows divides the existing literature related to the subject into several different, though inevitably related issues. “The Demographics of Pedestrians” is a brief overview of some studies that highlight specific groups of people that may be collectively in greater danger than others. “Environmental Justice and the Pedestrian” looks at the issue of environmental injustice and literature that has addressed this issue of distributive equity. “Organization of the Built Environment” focuses on the structural elements that play such an integral role in the safety and welfare of pedestrians. “Pedestrian Perceptions” highlights why improved pedestrian facilities are necessary, with special emphasis on how pedestrians may be imperiling themselves and what may be done to improve their safety. The final portion, “Politics and Pedestrians,” touches on the practical matters of politics. This section reviews some elements of how, why, (and why not) municipalities choose to direct their often pedestrian, pedestrian-oriented efforts.
2.1 - The Demographics of Pedestrians

Often the best way to better understand the nature of a problem is by studying the characteristics of the people involved. This section delves into several studies that chose to focus on particular classifications of pedestrians.

A 1998 study reviewed pedestrian accidents in Florida (Baltes, 1998). The paper sought to categorize accidents using a number of factors including demographics. Five years of crash data were utilized. The results indicated that elderly pedestrians were the most likely to be involved in an accident and also suffered the most severe injuries.

A recent study of Arizona pedestrians considered the race/ethnicity of those who were fatally injured (Campos-Outcalt, Bay, Dellapenna, Cota, 2002). This article, while featuring an ethnic group not appearing in significant numbers in most of Florida (Native Americans), does present the unfortunate, and apparently unevenly distributed incidence of pedestrian fatality amongst minority groups. Using the national Fatality Analysis Reporting System (FARS) coupled with death certificate information, the authors compiled data covering the period of 1990-1996. Their results showed a significantly greater rate of Native American pedestrian fatalities when compared to the population as a whole. Interestingly, alcohol played a disproportionate role in many of these fatalities, the rationale given that because no alcohol can be sold on reservations, a long walk is often necessary to get alcohol. This study represents one of the few that sought to incorporate a racial/ethnic consideration into the dangers for pedestrians.

Another category of imperiled pedestrians is perhaps surprising to some extent. In a Virginia study, it was discovered that older males, walking in rural areas, and
who have been drinking are in greater danger than the typical pedestrian (Hebert Martinez, Porter, 2004). The authors reviewed crash trends from 1990-1999. While the aforementioned males were most likely to die in an accident, urban areas were the most dangerous, and those aged 5-19 were most likely to be involved in an accident.

Children are in increased danger as pedestrians. The demographic agents at issue were investigated in a recent article featuring four California communities (LaScala, Gruenewald, Johnson, 2004). The notion that school areas feature large numbers of pedestrian children is pursued. Reviewing demographic data, it is discovered that in the communities studied, pedestrian children injuries were greatest in areas with high youth populations, more unemployment, fewer high-income households, and more traffic flow. Most of this is not surprising, but the analysis does provide confirmation for what otherwise would be mere assumptions.

2.2 - Environmental Justice and the Pedestrian

The environmental justice movement in the U.S. and related research has primarily focused on environmental pollution and the siting of undesirable land uses. Presidential Executive Order 12898 mandated that “each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations” (Clinton, 1994). This edict serves to expand the potential reach of environmental justice and the ability to correct injustices. The U.S. Department of Transportation further accentuated the potential reach of environmental justice. “The
objective of this Order is the development of a process that integrates the existing statutory and regulatory requirements in a manner that helps ensure that the interests and well being of minority populations and low-income populations are considered and addressed during transportation decision making” (US Department of Transportation Order on Environmental Justice, 1997).

From the practical founding of the environmental justice movement through the preponderance of the most current literature, exposure to air, water, and ground pollution has been covered most thoroughly (see reviews by Cutter, 1995; Bowen, 2002). There has also been some attention given to the disproportionate effects levied upon the built environment of minorities and the economically disadvantaged (Greenberg, 1993; Liu, 2001).

In one survey of existing literature, studies of environmental justice are subdivided into three categories with particular focus on transportation issues: process-based, benefit-based, and cost-based claims (Schweitzer, Valenzuela, 2004). Process-based issues deal with the decision-making process and the lack of influence low-income and minorities hold. Benefit-based issues include concerns such as access to economic opportunity (or lack thereof) and the equitable enforcement of environmental regulations. Cost-based issues refer to the siting of locally unwanted land uses (LULUs) and the inequitable distribution of environmental externalities, including more accidents and greater pollution. While each of these subdivisions reflects an intriguing aspect of environmental justice, none specifically addresses the safety of pedestrians in these situations. The focus tends to be not on the dangers that automobiles pose for pedestrians, but rather the secondary and tertiary effects of motor vehicles. These include
such effects as the resultant air pollutants and the structural damage neighborhoods incur concurrent with inconsiderate placement of divisive major roadways.

An expansion of environmental justice focus is exhibited in a study using the technology of geographic information systems (GIS) to look at the impacts of vehicle-generated pollutants and the often neglected noise effects (Chakraborty, Schweitzer, Forkenbrock, 1999). This paper highlights the advantages of using newer technologically based tools to better quantify, present, and understand the effects of transportation networks upon minorities and the poor.

Another report delves into the political structures that direct the planning of urban transportation environments in occasionally inequitable fashion (Sanchez, Wolf, 2005). Metropolitan Planning Organizations (MPOs) are the “conduits” whereby funds are routed. These MPOs are, as most any essentially political entity, subject to bias, misrepresentation, and outright corruption. The efforts toward a level of effective transportation equity likely require appropriate representation within MPOs. This concern for the structures of politics reflects a philosophical, rather than more directly practical consideration of environmental justice.

Yet another environmental justice perspective is that of differing levels of physical fitness (Greenberg, Renne, 2005). This study offers the reasoning that African Americans residing in self-defined “fair or poor quality” neighborhoods were less apt to walk or bike and consequently were less healthy. The notion of “walkability” is one necessarily fraught with a vagueness inherent in the form. There is also a mention that even if a neighborhood were more “walkable,” would that necessarily lead to more walking and ultimately a more physically fit populace? This focus, while differing from
the planned direction of this thesis, does seemingly indicate minorities perceive a greater incidence of substandard pedestrian infrastructure in their neighborhoods.

2.3 - Organization of the Built Environment

The structural elements of neighborhoods are certainly important when considering pedestrian safety. Rural and small urban areas are examined in a recent article (Ossenbruggen, Pendharkar, Ivan, 2001). The authors had an expectation that areas where greater number of pedestrians was traveling would likely result in an increased level of hazard. They compared residential zones, shopping areas, and village zones. The village zone represents an area with businesses that rely heavily on pedestrian traffic for patronage. Reviewing police reports, they discovered the area with the greatest number of pedestrians was also the safest area. The village area experiences slowest average speeds and has the significant factor of readily available sidewalks. The significance of the infrastructure and the resultant increased safety should not be underestimated.

There is, as with any public expenditure, a concern for the costs of adding to the infrastructure of a neighborhood. In a Norwegian study, a look at cost-benefit analysis is made (Elvik, 2000). This article chooses to focus on what policy makers consider and, as this study indicates, fail to consider. The conclusions of this study show that with a failure to account for the valuable benefits occurring with improvements, such as pedestrian traffic signals and separate bike and pedestrian pathways, there is an incomplete cost-benefit analysis at work. Also being overlooked are the more subtle and
less quantifiable health, pollution, and general welfare effects that occur with increased pedestrian and bicycling activity.

A Canadian study (Aultman-Hall, Hall, 1998) sought to improve understanding of where bicyclists were in most peril of accidents. The authors looked at three possible danger classification classes: on-road, off-road pathways, and sidewalks. There were also three separate categories of results for accidents: collision, fall (a non-contact result, often incurred while avoiding a collision), and injury. They attached questionnaires to parked bicycles at apparent work and school locations, choosing only to focus on those that used their bikes for commuting purposes. The response rate was greater than 50 percent, with an impressive total of over 1600 surveys returned. A significant finding was that only 15 percent of self-reported accidents had been reported to the police. Notable also was the fact that bicyclists who had experienced fatality, as well as those who perhaps were involved in an incident that prevents them from cycling anymore, were each clearly not receiving these surveys. The survey also included questions of bicycling frequency and length, important because the numbers were crunched to determine the distance traveled per “event.” The results showed that there were statistically significant differences between the rates of injury and rates for falls, while the rate for collisions was not statistically significantly different. The statistically safest way to travel is on the road, followed by bike paths, with the least safe being the sidewalk. An important consideration also is that while sidewalk travel had the greatest chance of danger in the Ottawa area, it was also completely bereft of any reported “significant injuries.” Overall, the rate of bicycle accidents was determined to be “between 10 and 41 times” as great as automobile travel.
A similar study, done by one of the same authors as the previously mentioned article, looked at the larger metropolis of Toronto (Aultman-Hall, Kaltenecker, 1999). This study’s results were largely the same but to a somewhat more severe extent. As it turns out, the dangers were even greater in Toronto for bicyclists. In this case, however, sidewalk accidents indicated the greatest likelihood of major injuries as well. In Toronto the bicycle danger was an even larger 26-68 times that of automobile related accidents.

Not to be overlooked is the factor of the automobile, and how drivers behave and the resultant effects. In a paper about the effect of automobile speed and other variables (Garder, 2004), pedestrian related accidents in Maine were analyzed. Predicted and actual crash numbers were compared. Predicted numbers were determined by considering pedestrian and vehicular volumes on randomly chosen roadways. Swedish and English prediction models were then used to compute an expected number. It is explained that there are no U.S. models to perform this task. Actual crash information was gleaned from police reports. These European models delivered results that fell short of actual accidents. This may be due to the significantly different nature of European and American roadways, automobiles, and perhaps even the attitudes of the drivers. The study did yield confirmation that high speeds lead to more pedestrian related accidents. Another apparently related factor was that wider roads also were less safe than predicted. Also confirmed was the idea that marked crosswalks are safer than those not marked, though the author is quick to point out, crosswalks are often placed at the safest possible location to begin with.
2.4 - Pedestrian Perceptions

Pedestrians are often at issue with motorists. Motorists, by the same token, are often at odds with pedestrians. A recent article reviewed these attitudes and suggested some ideas for remedy (Redmon, 2003). According to the author, pedestrians showed a lack of understanding for their rights of way, were disturbed by frequent lack of sidewalks, and did not understand the value of their own visibility. Motorists were bothered by too-slow pedestrians, also did not understand their right of way, and notably, often drove because they felt safer driving than walking. This piece offers a good summary of the misunderstandings that often plague automobile-pedestrian encounters and what can be done to improve these situations.

An issue can sometimes be the conditions under which pedestrians and bicyclists view their own visibility. According to a 2004 study (Tyrrell, Wood, Carberry, 2004), pedestrians’ misunderstanding of their own visibility may be a factor in the danger that they find themselves in after dark. In this work, the authors had a collection of people walk in place on the shoulder of a road after dark. When these people felt they were visible to an oncoming driver, they pressed a button. The self-reported visibility indicated that the pedestrians typically believed they were visible long before the driver actually saw them. In this experiment, pedestrians on average believed they were visible at 443.0 feet. The drivers on average actually saw them at just 251.0 feet - an astonishingly significant difference. These findings accentuate the idea that in many cases, pedestrians do not realize the extent of their danger. Perception differs markedly from reality.
In a summary of visibility aids, a recent paper (Kwan, Mapstone, 2004) reviewed findings that shed some light on what may be viable to aid in visibility, and thus safety, for pedestrians. The findings generally yielded predictable results. Bright colors are more visible. A flashing or strobe light increased chances of being seen sooner. Red and yellow reflective colors were more visible. In most cases, motion helped to improve visibility as well. As of the time of this review, the authors were not aware on any study that focused on pedestrian/bicyclist-motor vehicle accidents that compared a before and after effect of visibility aids. The results reported in this paper, in conjunction with the aforementioned paper above (Tyrrell, et al), clearly make a case for educating pedestrians and bicyclists of their potential danger as well as creating and/or maintaining an infrastructure that is conducive to their safety.

In some cases, there are dangers where they are not expected. By a similar token, there can be cases where, although dangers are perceived, there is little actual occurrence of accidents. In a recent paper (Schneider, Ryznar, Khattak, 2004), this issue was investigated. These authors reviewed accidents occurring around the University of North Carolina at Chapel Hill, a college town with a substantial mix of pedestrian, bicycle, and automobile traffic. The focus of this study was to develop an idea on a proactive solution to prevent further incidence of pedestrian related accidents. They looked from two angles. On one side, they reviewed police reports to find out about actual accident details. On the other, they administered surveys to determine what people thought of as existing dangerous conditions. Using geographic information systems, they plotted the actual accident sites around campus. They then plotted the perceived danger spots on campus as based on survey respondents. Using chi-squared analysis, the two
sets of points were compared. The results indicated a statistically significant difference between actual and perceived danger. A nearest neighbor cluster analysis revealed similarly significant results. An important consideration is that while this study revealed that accidents tended not to happen as often in areas that were perceived to dangerous, this should not imply that the perception of danger was incorrect. Quite the contrary, when people are in areas they think may be more dangerous, they tend to behave with an increased level of caution. This greater caution would conceivably seem to lead to an actual lessening of accident occurrences. This study appears to back up this notion. An unfortunate potential irony is the relative increase in occurrence of accidents at less likely places may well lead to a greater concern for those areas. This is at the expense of areas that, due to more cautious behavior, experience fewer accidents. The result is dangerous places become safer with behavioral modifications, while apparently safe areas experience lax concern for safety although the area may in fact be intrinsically far more dangerous.

The fear of crime committed upon a pedestrian can be oppressive. When on foot, there is no safety barrier around to supply a feeling of security. A U.K. article looks at how the fear of crime can be impacted by the addition of improved street lighting (Painter, 1996). This type of study supplies firm credence to the expected idea that lighting improves safety and though in this case the danger considered is crime rather than automobiles, the positive impact of improved infrastructure is still reinforced.

In a study of California, New York, and North Carolina pedestrian and bicyclist accidents, injury and spatial factors of accidents were reviewed (Stutts, Hunter, 1999). In this case, data were collected via surveys from several hospitals in these locations.
Perhaps the most important result of this paper was a reiteration that police-reported pedestrian and bicyclist accidents are far less than the actual incidence of these types of accidents. The danger is far greater than any accident statistics indicate.

Race and perception of safety is the subject of another paper (Reed, Parikh, 2004). This study revealed the particularly salient point that although minorities tend to have a strong view that they are behaving safely as pedestrians, they represent a disproportionate number of PRMVAs. The implication may be that because minorities are more likely to live in more densely packed urban environments, they are more likely to be both more aware of their dangers and be more subject to the hazards of being a pedestrian in the city. It too is conceivable that the infrastructure that may support the urban minority pedestrian (UMP) is insufficient thus resulting in greater UMP danger.

2.5 - Politics and Pedestrians

No matter the good intentions of those performing studies, policy changes are largely done via politics. A study was performed recently reviewing responsible parties who determine specific pedestrian policy within Utah municipal governments (Librett, Yore, Schmid, 2003). Using surveys mailed to localities, the authors sought to find if ordinances existed that promoted “physical activity” (including, but not limited to such things as sidewalks, bike lanes, and greenways). Dividing cities into high, medium, and slow growth, planning ordinances were found to be most common in fast growth areas. In fact, the faster the projected growth, the greater the chance that these sort of ordinances existed. This further emphasizes the point that planning is never more important than in areas experiencing substantial change. Like the area of focus for this
study, Pinellas County is an area undergoing tremendous growth. It is unclear if Pinellas will show the necessary attention to such planning issues.

Sometimes government needs to be steered in a more productive direction to avoid further deterioration of the environment. In a study covering the U.K., transport policy is considered with a look toward sustainable planning (Owens, 1995). Three planning notions are brought forth. “Predict and Provide” aims to create the infrastructure that is expected to be needed. This is the policy most likely in place currently (as of the paper’s publication). “The Price is Right” has users paying for the costs as they go. Here, the nature of costs and their worth can make this a subtle proposition. “The Planning Panacea” is the third concept. This is oriented more with an idea of manipulating use toward the operation of less polluting means of transport. Each of these philosophies has valid attributes and in reality can contribute to practical policy making. The issue becomes one of the appropriate proportions each idea would best contribute.

Seattle has a reputation as a civically progressive city. An article explaining Seattle’s “Comprehensive Plan” goes far, in theory, at how city planning can work for the benefit of pedestrians (Antiput, Gray, Woods, 1996). Seattle’s plan entailed (as much as was politically possible), a re-creation of an early 20th century-style streetcar environment. This scene was one where “urban villages” were organized in a pedestrian-friendly fashion. Also part of their “Pedestrian Programme” was a decided effort to incorporate safety and design elements with pedestrians in mind. This demonstrates that under the right circumstances, a pedestrian-oriented municipality is possible.
2.6 - Literature Review Summary:

Pedestrians and bicyclists may not even be entirely aware of the dangers present in an urban environment dominated by motor vehicles. While every pedestrian and bicyclist has likely had some form of “near-miss” involving automobiles, the dangers are often gravely underestimated. Neighborhoods of differing affluence often have a differing infrastructure. Of particular importance for the bicyclist and pedestrian is the presence or absence of safety-oriented features such as sidewalks, bicycle-specific lanes, well-marked roadways, and ample lighting, among other things. There may be a difference between those neighborhoods that have these attributes and those that do not. This difference may well contribute to an increased hazard for the low-income and non-white, of whom frequently are less likely to have alternative forms of transportation beyond traveling on foot or via bicycle.

The safety concerns for pedestrians are well documented in the literature. Many are focused on the adverse health effects of injured pedestrians (Stutts, Hunter, 1999) or physical fitness concerns (Greenberg, Renne, 2005). Governmental authorities, such as the U.S. Department of Transportation and the National Highway Transportation Safety Administration, often simply quantify the numbers. Some do look at the structural elements such as dangerous intersections (Leden, 2002) or the potential for structural improvements to lessen pedestrian dangers (Clarke, Hummer, Dutt, 1996). What is lacking, however, is a more detailed investigation into how the ‘urban hardware,’ specifically sidewalks, may affect pedestrian safety. Much more research is needed to address specifically how the presence of sidewalks may affect the number, type, and severity of pedestrian related motor vehicle accidents. This study aims to fill some of
that void by addressing how the oft-neglected urban amenity--the sidewalk, may impact the safety of pedestrians.

Pre-existing environmental justice research has addressed a great many concerns associated with dangerous pollutants and a wide range of chemical and other environmental hazards. What remains to be investigated is whether the structural elements of the built environment show patterns of environmental injustice. The significant question remains: are the neighborhoods of racial/ethnic minorities and the less affluent subject to structural surroundings that may put the pedestrian in some measure of disproportionate danger?
CHAPTER 3

DATA COLLECTION

Pinellas County is located on west-central Florida’s tourist-friendly “Suncoast.” This county, part of the Tampa-Saint Petersburg-Clearwater MSA, has been well-documented as an exceptionally dangerous place to be a pedestrian (Ernst, 2004). Pinellas has Saint Petersburg occupying the southern portion, and Clearwater, to the north, as the two largest cities. Pinellas County is a smaller peninsula on the Florida peninsula, bordered by the Gulf of Mexico to the west and Tampa Bay to the east. Due to this confined condition, and what is generally seen as an attractive climate, it is the state’s most densely populated county (U.S. Census, 2000). The population density of Pinellas County (3,292 per square mile) is twice that of nearby Hillsborough County. It is also nearly three times that of Miami-Dade County and more than twice that of south Florida’s Broward County. Pinellas is more than eleven times as densely populated than the state as a whole.

Significant too is the robust eight percent rate of population growth between 1990 and 2000 (U.S. Census, 2000). This largely urbanized and geographically restricted area continues to grow at an overwhelming pace. This growing population of exceptional density, when coupled with the reality of an exceptionally high incidence of Pedestrian Related Motor Vehicle Accidents (PRMVAs), makes Pinellas County a
particularly suitable area for this study. Also important is the availability of relevant data. Pinellas County government has the necessary accident data as well as substantial socio-demographic information in various forms.

The County also has approximately 4,347 miles (6,995 km) of roadways (U.S. Census, 2000) in place to accommodate a resident populace of 921,482 (U.S. Census, 2000), in addition to countless more who visit the area as tourists. With these types of numbers, it may be expected that there will tend to be a considerable collection of motor vehicle versus pedestrian accidents. This study addresses these issues by reviewing accident site data in conjunction with infrastructure data (specifically sidewalk locations). These data were spatially analyzed in conjunction with socioeconomic data (specifically assessing the geography of those below poverty) and ethnic/racial data (specifically concerning Blacks, Hispanics, and a more generalized category including all ‘Non-Whites’). These data were gathered at the census block group levels of aggregation, obtained from the 2000 U.S. Census of Population and Housing. The intention was to search for possible environmental injustice patterns reflected in an inferior infrastructure in these neighborhoods, and the possible resultant increased danger for the less affluent.

3.1 - Area Density

According to the U.S. Census, a 2004 estimate puts the total population of Florida at 17,397,161 (U.S. Census, 2005) with the population density at 3,292 people per square mile. The following density map (Figure 3.1a), shows population density based on 2004 estimates. The darker shades serve to strongly indicate Florida’s
concentrated urban environments which, not coincidentally, are also among the most hazardous nationwide for pedestrians.

Pinellas County is the most densely populated county in Florida. Figure 3.1b depicts the spatial distribution of population within Pinellas County, on the basis of census block level data. The map indicates that although the county as a whole is indeed densely settled, there are certainly portions more crowded than others with Saint Petersburg's central areas and Clearwater further north being more densely populated.
Figure 3.1b: Pinellas County Population Density by Census Block, 2000
3.2 - Income Levels within Pinellas County

Not unlike most any region, the distribution of wealth within the county is varied and clustered. Figure 3.2 displays the per capita income as of the 2000 U.S. Census and portrays a useful idea of the distribution of affluence in Pinellas County. The barrier islands on the Gulf coast of the peninsula, as well as the Snell Isle and Shore Acres neighborhoods on Saint Petersburg's Tampa Bay shoreline are areas of higher incomes. Midtown Saint Petersburg and smaller regions in northern Clearwater are less affluent.
Figure 3.2: Pinellas County Per Capita Income, 2000
3.3 - Pedestrian Related Motor Vehicle Accident Locations

Pedestrian related motor vehicle accident site data were obtained from the Pinellas County Information Systems Office. It was selected from a much larger dataset that included all types of automobile accidents. These data covers all 691 reported traffic incidents involving pedestrians and motor vehicles from January 1, 2002 through December 31, 2003. Among the included information are injuries and fatalities, the apparent cause of the accident, whether or not drugs and/or alcohol was a factor, the time of day when the accident occurred, and the particular location of the accident (driveway, sidewalk, road, etc.) The spatial distribution of these accidents in Pinellas County is depicted in Figure 3.3. An unfortunate limitation of the data may lie in the likelihood that a great many accidents may be unreported, particularly if no injury is involved (Stutts, Williamson, Whitley, Sheldon, 1990). An assumption here will be that the distribution of these unreported accidents does not differ spatially from those accidents that are reported.
Figure 3.3: Pinellas County PRMVA Locations, 2002-2003
3.4 - Pinellas County Sidewalks

This dataset was also obtained from Pinellas County Information Systems. The data represented indicates improved sidewalks in existence at the time of the survey. This information is typically updated at irregular intervals as new information is gathered. The update utilized for this study was dated July 13, 2005. Previous revisions that might more accurately match the period of PRMVAs in this study were not available. It is assumed, however, that any additions or deletions of sidewalk extents are likely relatively small and as a practical matter, inconsequential. A review of this sidewalk dataset was completed within ArcGIS software utilizing an aerial photograph backdrop from the 2004 United States Geological Survey. The sidewalk dataset was found to have a number of omissions and a scattering of duplications. These errors were judiciously corrected utilizing the ArcEditor extension within an ArcGIS environment. It is important to note that sidewalk improvements and maintenance may not be done at predictable intervals. As a result, existing sidewalks may be in markedly differing states of condition. Some may be mapped but may be in such a state of disrepair as to make a simple activity, such as pushing a baby stroller, nearly impossible and effectively useless. Without a thorough and (at this point) unfeasible round of ground-truthing, these concerns will unfortunately be ignored. The corrected dataset, shown in Figure 3.4, does seem to indicate a spatial pattern largely paralleling major automobile arteries. Also, significantly, there is apparently less sidewalk coverage than there is automobile arterial coverage.
Figure 3.4: Pinellas County Sidewalk Extents, 2005
3.5 - Pinellas County Roadways

These data were obtained from ESRI’s StreetMap USA. This set covers all roadways including, Interstates, U.S., state, and county highways, as well as local streets. As a matter of course, this dataset was reviewed in conjunction with 2004 U. S. Geological Survey aerial photography within an ArcGIS environment. Here it was discovered that although the dataset is largely complete and accurate, it did have several irregularities, inconsistencies and omissions. These issues were rectified using the ArcEditor extension associated with ArcGIS software. While every effort was made to correct flaws within this dataset, it should be understood that minor imperfections could still exist. The map (Figure 3.5) below represents the corrected roadway layer and clearly indicates the varying, though generally high density of roadways throughout much of Pinellas County.
Figure 3.5: Pinellas County Roadways, 2005
CHAPTER 4

RESEARCH TASKS
AND METHODOLOGY

Introduction

The tasks necessary to investigate the potential relationships identified in the primary research questions required the use of various statistical techniques, as well as the utilization of geographic information systems (GIS) software. Each task and its associated steps are outlined in detail below:

4.1 - Research Tasks for Question 1:

What is the spatial distribution of pedestrian-related motor vehicle accidents (PRMVAs) within the study area? Which parts of the transportation network in Pinellas County are more likely to experience an incidence of PRMVAs? Under what conditions are PRMVAs most likely to occur?

Accident Characteristics

The purpose of this task was to better grasp the characteristics of PRMVAs in Pinellas County. The Pinellas County Information Systems Office assembled tabular information covering the 691 reported accidents at issue during the
period of this study. Variables included the date, time, and location of the incident, the road and weather conditions, the age and state of inebriation (or not) of involved parties, and any citations issued, among many other things. The results were statistically analyzed to determine which conditions, circumstances, and accident characteristics may be significantly associated with the incidence of PRMVAs. Tabular summaries of the basic elements as gathered and described in the associated police reports were assembled and are presented in Chapter 5.

Seasonal variation was the first factor examined. Florida, and in particular Pinellas County experiences an annual regular influx of temporary residents. Many are relatively unfamiliar with the area. Some are tourists, coming to explore the many area attractions. Many are elderly and perhaps slow to respond to an unexpected pedestrian crossing their path. Seasonal flux in PRMVAs was seen as a great likelihood.

The time of day when accidents happen was also of interest. Periods when automobile traffic is highest, such as during morning and late afternoon rush hours, is also a period when corresponding pedestrian traffic may also be higher. During these times of day, hazards were greatest.

A factor more related to the physical environment rather than the yeoman, workaday, clock-centric world, was that of the light conditions when the PRMVA took place. Dawn, daylight, dusk, and dark (with and without artificial light) are each characteristics gathered for each accident.

Information was also included on whether there was some structural issue with the roadway, or whether the road was wet, dry, or simply "slippery." There were also additional potential factors included in this database such as whether there might be
environmental influences at work. These may have included visually obstructive trees and shrubs, "inclement weather," as well as signage that may have limited the view of those involved in these accidents. There was even "glare" listed as a possible contributing factor.

Roadway components that may have played a part in these PRMVAs are listed as well. The presence or absence of traffic signals, stop signs, crossing guards are mentioned as are if these incidents transpired in a school zone or some sort of no passing zone or other "special speed zone." There was information about what component of the roadway experienced this accident. Intersections, driveways, entry and exit ramps, bridges, parking lots and several other possibilities were included.

An important component is that of any injuries or fatalities that befell the involved parties. This study did not seek to specifically focus on the casualties of PRMVAs but nonetheless, the happenstance of such misfortune can be telling and serve as a reminder of the very real severity of this hazard.

Citations and the presence of any alcohol or drugs of the involved players was yet another valuable element of information gathered in this database. While again, not the focus of this project, this knowledge helped to better understand why these accidents materialize.
4.2 - Research Tasks for Question 2:

Is there a spatial association between sidewalk/roadway ratio and the incidence of PRMVAs? Are PRMVAs more or less likely to occur in areas where more sidewalks are present relative to roadways?

Spatial Subdivision of the Study Area

To best ascertain the spatial incidence of PRMVAs, the County was subdivided into a large number of equally-sized polygons (zones) of uniform shape. Census enumeration units (e.g., census tracts, block groups) were not appropriate for this purpose because they lack the spatial consistency required for this study. Boundaries of census units also tend to be coincident with traffic thoroughfares, which tend to be where significant numbers of PRMVAs occur. Large numbers of PRMVAs that occurred on study area borders may compromise an intent of this study.

To address these problems, this study utilized polygons of uniform size and shape whose boundaries do not coincide with roadways. A hexagonal grid, when aligned properly, helps minimize the occurrence of significant numbers of data sites falling on borders. Compared to square or rectangular grid cells, the hexagonal grid has been deemed particularly statistically effective at representing a subdivided space (Olea, 1984, Cox, Cox, Ensor, 1997). The hexagonal shape also replicates a circular zone, but without any voids or overlap of grid cells. This circular cell shape better serves to explain areas, rather than mere points of potential pedestrian danger.

Choosing a particular size for the hexagon grid is particularly important. Too large a grid and the risk of overlooking specific dangerous areas may become an
issue. In these instances, dangerous areas may become muted by falling within the same hexagonal cell as areas of relative pedestrian safety. An opposing potential concern may be choosing a cell size that is too small. In these cases, dangerous areas may be too restricted, creating an assumption of nearby safe pedestrian zones when in fact something so simple (and unfortunately possible) as digitizing variation and errors may place an accident site in an adjacent cell, rather than reflecting the actual location of an accident.

Attention must be given to the realities of the digital spatial placement of the pedestrian accident sites. Specific site locations were determined by Pinellas County Information Systems Office personnel based on information gleaned from official police reports. As a practical matter, reports of this nature might often have somewhat dubious location information (i.e. "near the Burger King on 44th Ave"), making specific accident site geocoding similarly dubious.

For this study, hexagonal cell sizes were created at three radii: 100 meters, 500 meters, and 1000 meters. These numbers represent the radius from the centroid to the corner of each hexagonal cell. The choice of these radii was based somewhat on an intuitive notion of the appropriate size an urban pedestrian "zone" might conceivably be and is certainly open for further discussion and consideration.

To create the desired hexagonal grid, it was necessary to utilize an older edition of Geographic Information Systems (GIS) software as there was no ArcGIS capability found to create such a grid. ESRI's ArcView 3.3 was used in conjunction with a "Build Hexagons" extension compatible exclusively with this version of GIS software. The hexagon grids were constructed at each of the 100 meter, 500 meter, and 1000 meter radius scales and then saved as ArcGIS 9.1-compatible shapefiles.
Within ArcGIS, the aforementioned hex grid shapefiles were clipped to match a 1:40,000 Pinellas County vector shoreline obtained from the Florida Fish and Wildlife Conservation Commission (FWC). The resulting areas reflect a reasonably accurate shoreline with lakes, rivers, and other significant water bodies removed. It is very important that these water features were removed as the accurate land area of each cell provided a valuable basis for subsequent computations.

**Sidewalks**

The sidewalk data layer was next added to an ArcGIS session in conjunction with the 100, 500, and 1000 meter hexagonal grid layers. With the GIS map projection set to Albers Equal Area, sidewalk lengths were then calculated. It was here necessary to subdivide the sidewalks such that the appropriate lengths of sidewalk were spatially assigned to the appropriate grid cells. The ArcGIS intersect tool served this purpose. Finally, the lengths of sidewalk located in each grid cell, at each scale, were calculated using the analytical capabilities of GIS software.

**Roadways**

Roadway data layers were then added. Only those roadways that may reasonably be expected to have sidewalks paralleling them were of interest for this study. Consequently, interstate highway roadways were removed from this dataset, as these types of arteries are specifically designed for motor vehicle traffic at the exclusion of pedestrians. Roadway lengths were assigned and mileage was then calculated using an identical set of processes as in 4.2b.
The Sidewalk Density Index

The previous two steps resulted in lengths being summed for sidewalks and roadways within each 100, 500, and 1000 meter radius hexagonal grid cells in Pinellas County. The Sidewalk Density Index is the result of a simple formula where the length of sidewalk miles is compared to the total roadway miles inside each grid cell. The index was computed for each hexagonal zone using the following formula:

$$\text{Sidewalk Density Index (SDI)} = \frac{S}{R}$$

where $S = \text{sidewalk miles within that zone and}$

$R = \text{roadway miles within the zone}$.

The result yields a value generally between 0 and 1, with 0 representing a zone that contains absolutely no sidewalks and 1 representing a complete match of sidewalks with roadways. Contended here is that in ideal circumstances, every road will have a corresponding sidewalk paralleling it. This resulting Sidewalk Density Index serves to give better indications of what specific areas have a relative abundance or paucity of sidewalks. There are rare instances where the SDI value can exceed 1. These results are most likely to occur when examining park-type settings and were found to be exceedingly rare.

Pedestrian-Related Motor Vehicle Accident Sites

The geocoded locations of PRMVAs were added next to an ArcGIS session along with the 100, 500, and 100 meter radius hexagon layers. Utilizing the
point-in-polygon functionality of the Hawth's Tools GIS extension within an ArcGIS setting, the number of PRMVAs was counted for each hexagonal grid cell. This tallied number represents the basis for which pedestrian danger was determined for each cell. The values are the PRMVA frequency values and are simply the number of PRMVAs per hexagonal cell. These accident sites were then separated into two classes: those cells with PRMVAs and those without.

**Bivariate Regression Analysis Procedure**

The strength and significance of the statistical association between the PRMVA frequency (the dependent variable) and each explanatory variable (the SDI, percent Non-White, Black, Hispanic, and Below Poverty) was analyzed at each of the three scales of interest (100-meter, 500-meter, and 1-kilometer radius) on all hexagonal grid cells using SPSS statistical software. A simple application of ordinary least squares (OLS) regression was not considered to be appropriate because: (1) the distribution of the dependent variable (PRMVAs) was non-normal; and (2) a large proportion of hexagonal grid cells at each scale showed no PRMVA occurrence (values of the dependent variable equal zero). In order to obtain the best fit for the data, a two-equation approach was utilized (Duan, Manning, Morris, Newhouse, 1983; Daniels, Friedman, 1999). This two-step approach partitions the dependent variable into two observed random variables. In the first step, logistic regression is used to analyze the dichotomous event of PRMVA occurrence or non-occurrence (dependent variable coded as either 1 or 0) for each grid cell. In the second step, OLS regression is used to model the frequency (number) of
PRMVAs for only those grid cells where accidents occurred. The general form of the model is as follows:

**STEP 1: Logistic Regression:**

\[
\log_e \left[ \frac{P(y = 1)}{P(y = 0)} \right] = \beta_0 + \beta_1 x
\]

where: \( y = 0 \) when accident frequency = 0
and \( y = 1 \) when accident frequency >0

**STEP 2: Ordinary Least Squares Regression**

\[ E(y) = \beta_0 + \beta_1 x \]

where: \( y \geq 1 \)

This implies: \( E(\text{accidents}) = P(\text{accidents}>0) \times E(\text{accidents}|\text{accidents}>0). \)
4.3 - Research Tasks for Question 3:

What are the environmental justice implications of PRMVA incidences in the county? Are PRMVs more likely to occur in areas containing a disproportionately large number of racial/ethnic minorities and/or low-income individuals?

Data of Racial/Ethnic Minority and Poverty Status

This was obtained via the application of U.S. Census block group level socio-demographic and racial/ethnic data, as available. Variables typically considered in previous environmental justice studies have included the percentage non-white, percentage African-American, percentage Hispanic, and percentage below poverty within a given community. Here too, these demographic groups were considered. A process of areal interpolation (Gregory, 2002; Brindley, Wise, Maheswarean, Haining, 2005) was applied to transfer population data from census enumeration units to the aforementioned hexagonal grid cells created in section 4.2, above. It is here where the significance of an accurate measure of land area becomes clear. The demographic elements within census units were applied proportionately to the appropriate hexagonal cell. For example, if a hexagonal cell was spatially composed of three different census units, representing areas of say, 50 percent, 35 percent, and 15 percent, then the cell's demographic values were apportioned and calculated in matching proportions. This procedure makes the significant, though practical, assumption that there is a uniform distribution of people within the relevant census unit.
It should be noted here that this study focuses on the socio-demographic attributes of neighborhoods at varying scales. The intent of this study is not to address the specific socio-demographic standing of the individuals involved in PRMVAs.

The statistical association between PRMVA incidences and the proportion of individuals in each socio-demographic category was analyzed at each scale using the two-step regression approach described previously. Binary logistic regression was first used to analyze the effect of the Non-White/Black/Hispanic/Below Poverty percentage on the probability of a grid cell experiencing an accident. Next, Ordinary Least Squares (OLS) Regression was used to examine the linear relationship between PRMVA frequency and Non-White percentages at each scale, on cells with at least one accident.
CHAPTER 5

RESULTS:
CHARACTERISTICS OF PEDESTRIAN-RELATED
MOTOR VEHICLE ACCIDENTS

Introduction

This chapter provides a summary of the basic factors and elements associated with pedestrian-related motor vehicle accident (PRMVA) occurrences in Pinellas County, based upon data assembled by the Pinellas County Information Systems Office. The information was compiled from police reports covering the two years of this study (2002-2003) and clearly is of inconsistent detail and quality. As a result of the nature of this diverse assortment of reports, this summary is not concise but rather a useful collection of potentially meaningful facts and figures.

PRMVA characteristics can be quite varied. Seasonal fluctuations, temporal variations, weather, structural, and several human element-type factors can play a part in the occurrence of a PRMVA. The chapter will first look at temporal factors to better understand effects beyond those of a spatial nature. Next, structural elements will be reviewed to better grasp the character of the place where the PRMVA happened. Finally, the individuals involved in the accidents will be considered, including factors
such as their sobriety and how the involved party's actions may have played a role, as well as whether any injuries occurred.

5.1 - Temporal Characteristics

Florida's population varies over the year thanks largely to a seasonal influx of temporary residents as well as a considerable volume of tourists. Florida also experiences weather conditions that, while refreshing and soothing to some, can also make the extended summer months unreasonably warm for those who may otherwise commute afoot. As Figure 5.1a shows, the period when seasonal residents appear, is also the time where the number of PRMVAs are higher. The complementary period is a trough during the broiling summer months when the often overwhelming heat and vicious daily thunderstorms surely keep many would-be pedestrians indoors, thus conceivably reducing summertime pedestrian numbers and consequently, diminishing their chances of being involved in a PRMVA.

Figure 5.1a: Pinellas County PRMVA occurrence (2002-2003) aggregated by month
During the two year period this study covers (2002-2003), reported PRMVs have occurred at all hours. The following chart gives some indication of how pedestrian danger varied throughout the day (Figure 5.1b). Notably, the number of PRMVs peaked during the morning and late afternoon rush hour periods. Not surprisingly, the wee hours of the morning were the least likely to experience an accident.

**Figure 5.1b**: Pinellas County PRMVA occurrence (2002-2003) aggregated by time-of-day

It should be noted that the hourly breakdown may reflect how the work and school days function rather than any particular visibility issues that may be salient for a particular period of the day. A better way of considering the effects of visibility may be to review whether accidents happened in some disproportion during daylight, dark, or the periods somewhere in between.
As shown in Figure 5.1c, 40 percent of Pinellas County PRMVAs happen during periods of marginal or no natural light. Certainly pedestrians can be difficult to see under the best of circumstances, but remain in substantial danger even when the sun goes down.

**Figure 5.1c:** Pinellas County PRMVA occurrence by light conditions

5.2 - Structural Conditions

The wet and dry road conditions can also be a factor for pedestrians and their encounters with motor vehicles although as we can see below, (Figure 5.2a), the vast majority of PRMVAs occur when conditions are dry rather than wet or "slippery." In all likelihood, forbidding conditions can be expected to keep those afoot, indoors.
Figure 5.2a: Pinellas County PRMVA occurrence by moisture condition

Traffic control conditions are summarized in Figure 5.2b. Here we see that areas with no traffic controls are the places with the greatest chance of tallying a

Figure 5.2b: Pinellas County PRMVA occurrence by traffic control device
PRMVA. What is less than clear is why this occurs. Without concise pedestrian travel information, the answer to this question is difficult to deduce.

One of the goals of this project is to address the issue of the structural elements potentially contributing to pedestrian safety, specifically sidewalks. The aggregated police reports do help provide some information about the location of PRMVAs with respect to structural roadway element at the accident site. Figure 5.2c displays the site location factors and reveals that although almost half of PRMVAs happen away from intersections, railroad crossings and bridges, almost 40 percent are around intersections. Clearly the intersection is a dangerous place to be a pedestrian.

**Figure 5.2c: Pinellas County Site Location Factors**
5.3 – The People and Pedestrian-Related Motor Vehicle Accidents

An interesting, even fascinating, view of pedestrian-related accidents can be gleaned by perusing the police reports' "Pedestrian Description" category (Table 5.3a).

**Table 5.3a: Pedestrian Description for Pinellas County PRMVAs, 2002-2003**

<table>
<thead>
<tr>
<th>PEDESTRIAN DESCRIPTION</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midblock-Other</td>
<td>79</td>
</tr>
<tr>
<td>Intersection-Other</td>
<td>69</td>
</tr>
<tr>
<td>Vehicle/Turn Merge</td>
<td>54</td>
</tr>
<tr>
<td>Midblock Dash</td>
<td>34</td>
</tr>
<tr>
<td>Intersection Dash</td>
<td>30</td>
</tr>
<tr>
<td>Walking Along Rd/With Traffic</td>
<td>30</td>
</tr>
<tr>
<td>Intersection-Driver Violation</td>
<td>27</td>
</tr>
<tr>
<td>Ped Not In Roadway</td>
<td>24</td>
</tr>
<tr>
<td>Ped Walks into Vehicle-Midblock</td>
<td>14</td>
</tr>
<tr>
<td>Other-Weird</td>
<td>12</td>
</tr>
<tr>
<td>Play Vehicle Related</td>
<td>12</td>
</tr>
<tr>
<td>Backing Vehicle</td>
<td>11</td>
</tr>
<tr>
<td>Dart Out - Second Half</td>
<td>10</td>
</tr>
<tr>
<td>Disabled Vehicle Related</td>
<td>9</td>
</tr>
<tr>
<td>Walking Along Rd/Against Traffic</td>
<td>9</td>
</tr>
<tr>
<td>Working On Roadway</td>
<td>8</td>
</tr>
<tr>
<td>Ped Walks Into Vehicle-At Intersection</td>
<td>7</td>
</tr>
<tr>
<td>Dart Out - First Half</td>
<td>6</td>
</tr>
<tr>
<td>Expressway Crossing</td>
<td>5</td>
</tr>
<tr>
<td>Ped Waiting To Cross At/Near Curb</td>
<td>5</td>
</tr>
<tr>
<td>Playing In Roadway</td>
<td>5</td>
</tr>
<tr>
<td>Exiting/Entering Parked Vehicle</td>
<td>4</td>
</tr>
<tr>
<td>Trapped</td>
<td>4</td>
</tr>
<tr>
<td>Inadequate Information</td>
<td>3</td>
</tr>
<tr>
<td>Mult Threat Not At Intersection</td>
<td>3</td>
</tr>
<tr>
<td>Vendor/Ice Cream Truck</td>
<td>3</td>
</tr>
<tr>
<td>Cannot Specify</td>
<td>2</td>
</tr>
<tr>
<td>Dart Out - Cannot Specify</td>
<td>2</td>
</tr>
<tr>
<td>Driverless Vehicle</td>
<td>2</td>
</tr>
<tr>
<td>Emergency/Police Vehicle Related</td>
<td>2</td>
</tr>
<tr>
<td>Hot Pursuit</td>
<td>2</td>
</tr>
<tr>
<td>School Bus-Related</td>
<td>2</td>
</tr>
<tr>
<td>Commercial Bus-Related</td>
<td>1</td>
</tr>
<tr>
<td>Mult Threat-At Intersection</td>
<td>1</td>
</tr>
<tr>
<td>Walking To/From Disabled Vehicle</td>
<td>1</td>
</tr>
</tbody>
</table>
The table gathers sometimes interesting information about the circumstances of these PRMVAs. This represents a sort of catch-all for what may have been the unofficial cause of the accident in question. The most common responses ("Midblock-Other," and Intersection-Other") have all the specificity of someone filling out a police report with great haste and little attention to any real consideration. Intriguing though, and included without further explanation, are such esoteric descriptions as "Trapped," and "Other-Weird."

The official causes listed on accident reports can also prove useful in helping to understand the nature of the respective accidents. Table 5.3b shows the

**Table 5.3b: Causes for Pinellas County PRMVAs, 2002-2003**

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failed to Yield Right-of-Way</td>
<td>363</td>
</tr>
<tr>
<td>Careless Driving</td>
<td>183</td>
</tr>
<tr>
<td>No Improper Driving/Action</td>
<td>73</td>
</tr>
<tr>
<td>All Other</td>
<td>59</td>
</tr>
<tr>
<td>Alcohol-Under Influence</td>
<td>28</td>
</tr>
<tr>
<td>Obstructing Traffic</td>
<td>24</td>
</tr>
<tr>
<td>Disregarded Other Traffic Control</td>
<td>23</td>
</tr>
<tr>
<td>Alcohol and Drug-Under Influence</td>
<td>19</td>
</tr>
<tr>
<td>Disregarded Traffic Signal</td>
<td>12</td>
</tr>
<tr>
<td>Improper Backing</td>
<td>11</td>
</tr>
<tr>
<td>Driver Distraction</td>
<td>6</td>
</tr>
<tr>
<td>Exceeded Stated Speed Limit</td>
<td>6</td>
</tr>
<tr>
<td>Exceeded Safe Speed Limit</td>
<td>6</td>
</tr>
<tr>
<td>Driving Wrong Side/Way</td>
<td>3</td>
</tr>
<tr>
<td>Followed Too Closely</td>
<td>3</td>
</tr>
<tr>
<td>Fleeing Police</td>
<td>3</td>
</tr>
<tr>
<td>Failed to Maintain Equip./Vehicle</td>
<td>3</td>
</tr>
<tr>
<td>Drove Left of Center</td>
<td>3</td>
</tr>
<tr>
<td>Improper Turn</td>
<td>2</td>
</tr>
<tr>
<td>Improper Passing</td>
<td>2</td>
</tr>
<tr>
<td>Disregarded Stop Sign</td>
<td>2</td>
</tr>
<tr>
<td>Vehicle Modified</td>
<td>1</td>
</tr>
<tr>
<td>Improper Load</td>
<td>1</td>
</tr>
<tr>
<td>Improper Lane Change</td>
<td>1</td>
</tr>
</tbody>
</table>
breakdown of causes as determined by the authorities associated with the studied accidents. In many cases, multiple causes were listed for a single PRMVA. "Failure to Yield Right-of-Way" and "Careless Driving" were the most common offenses. There were only 73 incidences of "No Improper Driving/Action" among the 691 reported PRMVAs during 2002-2003. In the vast majority of cases, the motorists' actions were considered in some measure causal for PRMVAs in Pinellas County.

Decidedly important, but not the particular focus of this study, is the physical harm incurred upon the pedestrian in these PRMVAs. As shown in Table 5.3c, nearly 80 percent of accidents resulted in some number of injuries. A significant nine percent of PRMVAs led to fatalities (Table 5.3d). Most pedestrians involved in reported PRMVAs walk away with some measure of injury or worse.

Table 5.3c: PRMVAs and Pedestrian Injury, 2002-2003

<table>
<thead>
<tr>
<th>INJURED</th>
<th>#</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>132</td>
<td>19.1%</td>
</tr>
<tr>
<td>1</td>
<td>523</td>
<td>75.7%</td>
</tr>
<tr>
<td>2</td>
<td>29</td>
<td>4.2%</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>0.7%</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0.1%</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

Table 5.3d: PRMVAs and Pedestrian Fatality, 2002-2003.

<table>
<thead>
<tr>
<th>DEATHS</th>
<th>#</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>629</td>
<td>91.0%</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>9.0%</td>
</tr>
</tbody>
</table>
PRMVA Characteristics Results in Summary

Pedestrian-related motor vehicle accidents in Pinellas County occur at all times of day and night, throughout every season, under significantly varying conditions, and can be extremely dangerous. PRMVAAs are more likely to occur during the rush hour periods of the day and less frequently during the summer months. The vast majority of accidents occur when conditions are dry. Most occur away from intersections (although a considerable amount transpire near intersections). The largest number take place where there is no traffic control mechanism. Some sort of motorist malfeasance, inaction, or neglect is generally considered the cause of these accidents. Pedestrian health also fairs poorly when a PRMVA is involved. Simply put, the pedestrian is in dire danger at all times in most places in the heavily motorized urban environment.
CHAPTER 6

RESULTS:
ANALYSIS OF SIDEWALK DENSITY

This chapter focuses on the relationship between the occurrence of Pedestrian-Related Motor Vehicle Accidents (PRMVAs) and a measure of Sidewalk Density. This relationship was examined by analyzing the spatial association between these two variables at each of three resolutions in sequence, 100-meter, 500-meter, and 1-kilometer radius hexagonal grid cells. In the first portion of this chapter, a review of the constituent data at each scale is presented. The data were first tabulated at each PRMVA level and then aggregated into appropriate categories to better identify any trends. In the second section, the data were further analyzed using statistical inferential tests to investigate the significance of the observed relationships between pedestrian accident occurrence and sidewalk density.

An effective way to measure how sidewalks and roadways relate in a given area is the Sidewalk Density Index (SDI), explained previously in Chapter 5. The SDI is calculated as the sum of the lengths of sidewalks divided by the sum of the lengths of roadways, in a given area (in these cases, hexagonal cells at each of the three studied scales).
6.1 – Sidewalk Density Index: 100-Meter Radius

Sidewalk density may be expected to match urban settlement patterns. Such is largely the case in Pinellas County. Figure 6.1a depicts the density of sidewalks within the study area. This version is based on hexagonal cells subdividing the county on a fine 100-meter radius. Darker areas on the map represent a greater density of sidewalks relative to the roadways in the respective 100-meter radius cells. Evident are clustered areas of sidewalks where the population is also predictably more dense. The map displays SDI patterns that would seem to indicate that sidewalk density parallels that of roadway density. There are also a few aberrant cells where the SDI exceeds 1, indicating a greater sum of lengths of sidewalks in a cell than that of roadways. Further visual investigation using aerial photography has shown these are typically areas of public spaces such as parkland and areas near schools.
Figure 6.1a: Pinellas County Sidewalk Density Index, 100-Meter Radius Cells

Pinellas County
SDI
100-meter radius

- 0.0000
- 0.0001 - 0.5456
- 0.5457 - 0.9585
- 0.9586 - 422,996.1

Kilometers
The tables to follow indicate how the number of accident occurrences per cell relates to the SDI. In these tables, the SDI values listed represent the mean SDI for all cells at the corresponding accident occurrence level.

Table 6.1a describes the relationship between the SDI values and accident frequency for the 100-meter radius cells. At this scale, there is a notable upward trend in the SDI as the number of accidents per cell increases (0 to 4), implying a positive association between accident frequency and the SDI. With the exception of one cell which experienced five accidents, the SDI values in all categories exceed that of the Pinellas County mean SDI (0.4566) as shown in Figure 6.1b.

Table 6.1a: 100-Meter Radius Cells. Mean Sidewalk Density Index (SDI) at each PRMVA level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>0.4094</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>0.6451</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>0.7499</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>0.7133</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1.0400</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>0.2635</td>
</tr>
</tbody>
</table>

Figure 6.1b: 100-Meter Radius Cells – SDI and PRMVA/Cell at each PRMVA level. The red horizontal line represents the mean SDI, countywide.
Table 6.1b and Figure 6.1c show an aggregated summary of the same data to aid in the identification of a more consistent trend. With this type of classification, outliers are grouped into more manageable categories and the resulting trend is decidedly more reliable. Here we can see that without exception, as the accidents per cell increases, so too does the mean Sidewalk Density Index. It should also be noted that at such a fine scale, fully 98 percent of the 31,106 100-meter radius cells experience no accident occurrence at all. Still, the results are intriguing but it is important to look at other scales to better grasp what these numbers may suggest. The exceptionally fine radius of these cells may serve to imply a descriptive accuracy beyond the realistic digitization quality of the represented roadways and pedestrian arteries.

Table 6.1b: 100-Meter Radius Cells. Mean Sidewalk Density Index (SDI) at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>0.409394</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>0.645066</td>
</tr>
<tr>
<td>2+</td>
<td>76</td>
<td>0.740577</td>
</tr>
</tbody>
</table>

Figure 6.1c: 100-Meter Radius Cells – SDI and PRMVA/Cell at aggregated PRMVA levels. The red horizontal line represents the mean SDI, countywide.
6.2 - Sidewalk Density Index: 500-Meter Radius

Figure 6.2a shows the same basic SDI dataset as Figure 6.1a, except the data were interpolated/extrapolated using 500-meter radius cells. At this coarser scale, each full hexagon (unreduced by substantial water bodies) covers almost 650,000 square meters in area. This is substantially larger than the area of a mere 26,000 square meters occupied by a 100-meter radius hexagon but considerably smaller than the nearly 2.6 million square meter area covered by the 1-kilometer radius hexagons. With an increase in radii, the areas of hexagons, as with a more traditional square grid, increase exponentially.
Figure 6.2a: Pinellas County Sidewalk Density Index, 500-Meter Radius Cells
At the 500-meter radius, it was reasonable to expect a substantial decrease in the number of cells with no PRMVAs, and indeed this was the case. Of the 1,458 cells of a 500-meter radius, just 75 percent have a zero value or no accidents (Table 6.2a). While still a large number, it is a notable reduction from the 98 percent cells without accidents observed at the 100-meter scale. When looking at all the mean SDI values, there is some corresponding upward inclination, but the outliers mask much of the real variation. Notably, however, the mean SDI at each PRMVA level with at least two accidents exceeds the countywide SDI average of 0.4566 by significant margins.

Table 6.2a: 500-Meter Radius Cells. Mean Sidewalk Density Index (SDI) at each PRMVA level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>0.3292</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>0.4287</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>0.5316</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>0.5314</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>0.6072</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>0.5866</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>0.6984</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>0.5771</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>0.5265</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>0.7291</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>0.9000</td>
</tr>
</tbody>
</table>

The bar graph (Figure 6.2b) reveals this upward trend in the association between PRMVAs and sidewalk density though the trough at the higher accident levels may serve to obscure this pattern slightly.
Figure 6.2b: 500-Meter Radius Cells – SDI and PRMVA/Cell at each PRMVA level. The red horizontal line represents the mean SDI, countywide.

An aggregated version of this same 500-meter data, (Table 6.2b), reveals a pattern that is far more consistent and clearly indicates a positive correspondence between accident prevalence and sidewalk presence. Here, the SDI values yield a mean higher than the countywide average (0.4566) by a substantial margin at the PRMVA classifications with at least two accidents.

Table 6.2b: 500-Meter Radius Cells. Mean Sidewalk Density Index (SDI) at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>0.3292</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>0.4287</td>
</tr>
<tr>
<td>2-4</td>
<td>129</td>
<td>0.5421</td>
</tr>
<tr>
<td>5+</td>
<td>25</td>
<td>0.6274</td>
</tr>
</tbody>
</table>

When a bar chart (Figure 6.2c) is produced, the clarity of the positive association between and PRMVA/cell is more apparent when then PRMVA values are aggregated.
Figure 6.2c: 500-Meter Radius Cells – SDI and PRMVA/Cell – Aggregated -The red horizontal line represents the mean SDI, countywide.
6.3 - Sidewalk Density Index: 1-Kilometer Radius

The final scale that this study covers is based on hexagonal grid cells at the 1000-meter radius (Figure 6.3a). A concern at this scale is that the substantially large cell size may mask the effects of particular areas, and at a fully one kilometer radius, these cells are fairly expansive. As noted earlier, hexagonal cells of this size have an area that is four times (2,600,000 versus 650,000 square meters) as expansive as that of the 500-meter cells. When compared to the 100-meter radius cells, the difference is monumental. The 1-kilometer cells have 100 times the area when contrasted with that of 100-meter cells. Notably however, the coarser 1-kilometer scale results in only 55 percent of the cells without a single PRMVA.
Figure 6.3a: Pinellas County Sidewalk Density Index, 1 Kilometer Radius Cells
When looking at the mean SDI values for each accident level at the 1000-meter radius, (Table 6.3a), a linear trend between SDI and PRMVA frequency is less obvious.

Table 6.3a: 1 Kilometer Radius Cells. Mean Sidewalk Density Index (SDI) at each accident level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>0.2761</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>0.4504</td>
</tr>
<tr>
<td>2</td>
<td>37</td>
<td>0.4466</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>0.4105</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>0.4625</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>0.5053</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>0.4467</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>0.3491</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>0.5350</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>0.3330</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>0.6906</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>0.6183</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>0.1708</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>0.7826</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>0.8414</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>0.5535</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>0.2808</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>0.8917</td>
</tr>
</tbody>
</table>

When these 1-kilometer radius values are summarized graphically, evidence of positive association is present though the trend is marred by some aberrant elements (Figure 6.3b).
**Figure 6.3b**: 1 Kilometer Radius Cells – SDI and PRMVA/Cell at each PRMVA level. The red horizontal line represents the mean SDI, countywide.

The aggregation of values is only slightly useful at this 1000-meter scale.

Table 6.3b and Figure 6.3c demonstrate that hidden amongst the outliers, aberrations, and oddities, there is only a modestly identifiable consonant trend between the increasing volume of accidents in a cell and an increasing SDI value.

**Table 6.3b**: 1-Kilometer radius cells. Mean Sidewalk Density Index (SDI) at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>0.2761</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>0.4504</td>
</tr>
<tr>
<td>2-4</td>
<td>87</td>
<td>0.4402</td>
</tr>
<tr>
<td>5-9</td>
<td>27</td>
<td>0.4626</td>
</tr>
<tr>
<td>10+</td>
<td>15</td>
<td>0.6491</td>
</tr>
</tbody>
</table>
The results of the preliminary analysis of these three scales serve to remind that the choice of proper geographic resolution is imperative to producing appropriate and viable results. The same three scales and methodology were used to analyze the socio-demographic factors and investigate potential environmental justice implications for the pedestrian in Chapter 7.
6.4 - Sidewalk Density Index: Statistical Analysis

The previous portion of this analysis examined sidewalk density only on the basis of descriptive measures and summary statistics. To best examine the strength and significance of the statistical association between the SDI and PRMVA frequency, two separate tests of statistical inference were performed using SPSS statistical software. As described in Chapter 4, a two-step approach was utilized because a large proportion of grid cells experienced zero accidents. Binary logistic regression was first used to analyze the effect of sidewalk density on the probability of any grid cell experiencing an accident. Next, Ordinary Least Squares (OLS) Regression was used to examine the linear effect of the SDI on the number of pedestrian accidents at each scale, for cells that experienced one or more accidents.

STEP 1: Logistic Regression

The dependent variable for the logistic regression analysis (accident occurrence) was treated as a dichotomous event with each cell coded as either 1 or 0 to represent the presence or absence of a PRMVA, respectively. Table 6.4a shows the results of this analysis.

Table 6.4a: Logistic Regression of SDI on PRMVA Occurrence.

<table>
<thead>
<tr>
<th>SDI</th>
<th>N</th>
<th>B</th>
<th>sig</th>
<th>exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100M</td>
<td>31,106</td>
<td>0.006</td>
<td>0.156</td>
<td>1.006</td>
</tr>
<tr>
<td>500M</td>
<td>1,458</td>
<td>1.549</td>
<td>0.000</td>
<td>4.705</td>
</tr>
<tr>
<td>1KM</td>
<td>428</td>
<td>2.485</td>
<td>0.000</td>
<td>12.001</td>
</tr>
</tbody>
</table>
For each logistic model, the natural logarithm of the odds that a grid cell experiences an accident is assumed to be a linear function of the independent variable (sidewalk density) and the maximum likelihood method is used to estimate the model. The table describes the total number of cells at the described scale (N), the value of the logistic regression coefficients (B) for the independent variable, and the observed level of significance (p-values) for each model. To further aid in interpreting the regression results, the table also provides the odds ratio or the exponent of the regression coefficient produced by each logistic model \([\exp(B)]\). This ratio may be interpreted as a multiplier of the odds of an accident occurring in a grid cell. When the value exceeds 1, the odds of experiencing a PRMVA increase that many times for each unit change of the SDI in the model.

As the table indicates, at the 100-meter scale, the association between accident occurrence and sidewalk density is not statistically significant (p>0.10). At the 500-meter and 1-kilometer scales, however, the effects are statistically significant (p<0.01) and positive. Thus, at the 500-meter radius scale, a one-unit increase in SDI boosts the odds of a PRMVA occurrence by a factor of 4.7. At the 1-kilometer scale the odds of a PRMVA occurrence increase by a staggering 12 times for each one-unit increase in the SDI.

STEP 2: Ordinary Least Squares Regression

The second step in this two-equation analysis focuses on only those cells that experienced at least one PRMVA and uses OLS Regression to analyze the relationship between the number of accidents (the dependent variable) and SDI (the independent variable). Table 6.4b summarizes the results of these regression models for
each scale of study and provides the sample size, the least squares coefficients for the independent variables, and the related levels of significance.

**Table 6.4b: Least Squares Regression for Sidewalk Density Index on PRMVA frequency for those Cells with at Least One Accident.**

<table>
<thead>
<tr>
<th>SDI</th>
<th>N</th>
<th>B</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>100M</td>
<td>595</td>
<td>0.090</td>
<td>0.091</td>
</tr>
<tr>
<td>500M</td>
<td>354</td>
<td>1.552</td>
<td>0.000</td>
</tr>
<tr>
<td>1KM</td>
<td>191</td>
<td>3.914</td>
<td>0.002</td>
</tr>
</tbody>
</table>

When grid cells are considered at the 100-meter radius, the relationship between PRMVA frequency and the SDI is statistically significant and positive only at the .10 level of significance (p<.10). At the 500-meter and 1-kilometer radius scales, the regression coefficients produced are each larger and statistically significant (p<.01). A one-unit increase in the SDI leads to an increase of about 1.5 accidents at the 500-meter scale and almost four accidents at the 1-kilometer scale.
Sidewalk Density Index Results in Summary

As scales increase in size, the appearance of trends and tendencies also increases. When looking at the SDI data through the aid of aggregation, there appears to be some positive association between SDI and PRMVA occurrence, particularly at the 1-kilometer, and even more so, the 500-meter radius scales. The density of sidewalks is consistently greater in areas that experience PRMVAs compared to areas without reported accidents. The two-step regression analyses confirm that associations between accident occurrence and sidewalk density are both positive and, in two coarser scales, statistically significant, even at the .01 level of significance. The probability of PRMVA occurrence and number of such occurrences both increase significantly as sidewalk density increases, at the 500-meter and 1-kilometer scales. As the scale increases so too do the coefficients, implying a stronger effect of sidewalk density upon PRMVA occurrence at coarser scales.
CHAPTER 7

RESULTS:
ANALYSIS OF RACE/ETHNICITY AND POVERTY STATUS

This chapter examines the environmental justice implications of pedestrian-related motor vehicle accidents (PRMVAs) by analyzing several socio-demographic categories and their relationship to PRMVAs. The following variables are those typically utilized in environmental justice research including: Non-White, Black, Hispanic, and Below Poverty. It is acknowledged that these categories may represent groups of sometimes significant overlap. The goal here is not to examine interrelationships between these groups in terms of accident occurrence, but rather to isolate and analyze each of these factors with respect to the geographic distribution of PRMVAs within the study area. The following sections display layouts with the spatial distribution of the aforementioned socio-demographic groups. For each individual group, a map was produced with the relevant data interpolated as necessary. The sections that follow are similarly structured to that of the SDI results section (Chapter 6). It should be reiterated that the issue being studied is NOT the race/ethnicity or poverty status of the specific pedestrians who are involved in these PRMVAs, but rather the socio-demographic characteristics of the neighborhood in which the PRMVA occurs, as defined
by hexagonal grid cells at various scales. The analyses presented in this chapter are based on data gathered at the census block group level.

7.1 – Results: Percent Non-White

This section seeks to uncover the spatial relationship between PRMVA occurrence and the proportion of Non-White individuals in Pinellas County. Specifically, the objective was to determine if PRMVAs are more likely to occur in those areas with a disproportionately high number of Non-White residents. The association was examined at the 100-meter, 500-meter, and 1-kilometer radius scales similar to the methods utilized with the SDI in Chapter 6.

Figures 7.1a, 7.1b, and 7.1d each display the distribution of Non-White population as a percentage of the total population, at three hexagonal grid scales. At the 100-meter radius scale, the distribution largely follows that of the census block groups on which this hexagonal display is based. At the 500-meter scale, smaller areas of unique character begin to be blended with neighboring cells of perhaps differing character. At the 1-kilometer scale, a significant degree of agglomeration has served to mask all but the most essential characteristics. In Pinellas County, as of the 2000 U.S. Census, 14.1 percent of the population listed themselves as Non-White.
Figure 7.1a: Pinellas County Percentage Non-White, 100-Meter Radius Cells
Non-White: 100-Meter Radius

When PRMVA occurrence is examined at three different scales, some interesting differences begin to emerge. As shown in Table 7.1a, at the 100-meter scale, 98 percent of the 31,106 hexagonal cells experienced zero PRMVAs during the period studied. Among grid cells with one or more PRMVAAs, there are few discernable patterns or trends. Notably, four out of five frequency levels experiencing accidents indicate a mean Non-White percentage of population greater than the corresponding Pinellas County average of 14.1 percent.

Table 7.1a: 100-Meter Radius Cells. Mean percentage of Non-White population at each accident level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>NON-WHITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>11.0%</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>20.3%</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>16.8%</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>22.8%</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>9.8%</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>31.6%</td>
</tr>
</tbody>
</table>

When accident values are viewed in aggregate at the 100-meter scale, no consistent positive trends are observed in the relationship. It is abundantly clear that grid cells with at least one accident are likely to have a disproportionately Non-White percentage of population (Table 7.1b).
Table 7.1b: 100-Meter Radius Cells. Mean percentage of Non-White Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>NON-WHITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>11.0%</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>20.3%</td>
</tr>
<tr>
<td>2+</td>
<td>76</td>
<td>18.0%</td>
</tr>
</tbody>
</table>
Non-White: 500-Meter Radius

The countywide Non-White percentage distribution with the 500-meter radius scale grid cells differs from the 100-meter view (Figure 7.1b). At this scale, the spatial delineation no longer matches that of the constituent census enumeration units. Wider visible spatial trends are gained at a likely loss of finer neighborhood details. At the 500-meter radius scale, a positive association between PRMVAs and Non-White percentage becomes evident.
Figure 7.1b: Pinellas County Percentage Non-White, 500-Meter Radius Cells
When looking at each accident level individually, the relationship between the percent Non-White and PRMVA occurrence is not clearly apparent (Table 7.1c). The bar graph (Figure 7.1c) also fails to show any significant trends.

**Table 7.1c:** 500-Meter Radius Cells. Mean percentage of Non-White Population at each accident level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>NON-WHITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>8.5%</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>15.1%</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>16.7%</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>18.6%</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>35.4%</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>26.3%</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>22.0%</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>8.0%</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>27.0%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>15.9%</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>11.0%</td>
</tr>
</tbody>
</table>

**Figure 7.1c:** 500-Meter Radius Cells. Mean percentage of Non-White Population at each accident level. The red horizontal line represents the countywide mean.
When the data are aggregated, a positive association between the two variables emerges (Table 7.1d). As the aggregated table exhibits, grouping at specific levels can be a useful aid in helping to reveal trends. When this information is placed in graphical form, the trend and direction are distinctly evident (Figure 7.1c). The effects of changing scales appear significant. When aggregated, areas with PRMVA occurrence (AX/CELL ≥1) each exceed the county average for percent Non-White (14.1 percent), while grid cells without PRMVAS indicate a substantially lower mean.

Table 7.1d: 500-Meter Radius Cells. Mean percentage of Non-White Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>NON-WHITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>8.5%</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>15.1%</td>
</tr>
<tr>
<td>2-4</td>
<td>129</td>
<td>19.8%</td>
</tr>
<tr>
<td>5+</td>
<td>25</td>
<td>23.2%</td>
</tr>
</tbody>
</table>

Figure 7.1d: 500-Meter Radius Cells. Mean percentage of Non-White Population at aggregated accident levels. The red horizontal line represents the countywide mean
Non-White: 1-Kilometer Radius

The coarsest scale considered is the 1-kilometer radius grid cell. An important justification for using multiple data resolutions is to find the scale which allows trends to become evident without the undo loss of the specific and pertinent character of a neighborhood. Perhaps at a 1-kilometer radius, the considerable area in question begins to approach this limit. As noted earlier, hexagonal cells of this size have an area that is four times (2,600,000 versus 650,000 square meters) that of the 500-meter cells. Even more notable is that the 1-kilometer cells have 100 times the area when contrasted with that of 100-meter grid cells. Figure 7.1d shows that at the 1-kilometer grid scale, vast areas of a relatively high percentage Non-White cover much of Saint Petersburg as well as Clearwater.
Figure 7.1e: Pinellas County Percentage Non-White, 1-Kilometer Radius Cells
Table 7.1e shows that at 1-kilometer, the scale may be too coarse to indicate any reliable association. Trends are also not clearly visible in the bar graph (Figure 7.1e).

**Table 7.1e: 1-Kilometer Radius Cells.** Mean percentage of Non-White Population at each accident level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>NON-WHITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>5.9%</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>11.0%</td>
</tr>
<tr>
<td>2</td>
<td>37</td>
<td>9.3%</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>10.8%</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>16.7%</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>20.7%</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>16.3%</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>15.3%</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>52.6%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>13.5%</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>6.9%</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>30.6%</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>23.0%</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>81.3%</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>46.0%</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>13.5%</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>11.3%</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>24.6%</td>
</tr>
</tbody>
</table>
**Figure 7.1f**: 1-Kilometer Radius Cells. Mean percentage of Non-White at each accident level. The red horizontal line represents the countywide mean

![Figure 7.1f](image)

Significantly, however, when these same numbers are aggregated, there indeed emerges a persistent and positive association between PRMVAs and the mean Non-White percentage. The effects of aggregation are visibly distinct when contrasting Figures 7.1f and 7.1g.

**Table 7.1f**: 1-Kilometer Radius Cells. Mean percentage of Non-White Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>NONWHITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>5.9%</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>11.0%</td>
</tr>
<tr>
<td>2-4</td>
<td>87</td>
<td>11.8%</td>
</tr>
<tr>
<td>5-9</td>
<td>27</td>
<td>23.9%</td>
</tr>
<tr>
<td>10+</td>
<td>15</td>
<td>26.0%</td>
</tr>
</tbody>
</table>

The chosen values for aggregation were carefully selected and consistently applied. Importantly, appropriate discretion needs to be taken in selecting proper values for aggregation.
Figure 7.1g: 1-Kilometer Radius Cells. Mean percentage of Non-White Population at aggregated accident levels. The red horizontal line represents the countywide mean.
Non-White: Statistical Analysis

Up to this point, descriptive measures and summary statistics have been used to examine the relationship between the Non-white percentage and PRMVA occurrences at three different scales. As was explained in Chapter 4, a two-step regression approach was necessary due to the exceptionally large number of grid cells with a zero accident occurrence. Binary logistic regression was used first to analyze the effect of the Non-White proportion on the probability of any grid cell experiencing an accident. Next, Ordinary Least Squares (OLS) Regression was used to examine the linear relationship between PRMVA frequency and Non-White percentages at each scale, on cells that had at least one accident.

STEP 1: Logistic Regression

The dependent variable (PRMVA occurrence) was treated as a dichotomous event, and coded as either 1 or 0 to represent presence or absence of PRMVAs, respectively. As described previously for the SDI, the natural logarithm of the odds that a grid cell experiences an accident is assumed to be a linear function of the independent variable (in this case, Non-White percentage) for each logistic model and the maximum likelihood method is used to estimate the model. Table 7.1g displays the results of the logistic regression models at each scale involving the percentage Non-White variable.
Table 7.1g: Logistic Regression for Percent Non-White on PRMVA Occurrence.

<table>
<thead>
<tr>
<th>NON-WHITE</th>
<th>N</th>
<th>B</th>
<th>sig</th>
<th>exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100M</td>
<td>31,106</td>
<td>0.018</td>
<td>0.000</td>
<td>1.018</td>
</tr>
<tr>
<td>500M</td>
<td>1,458</td>
<td>0.030</td>
<td>0.000</td>
<td>1.031</td>
</tr>
<tr>
<td>1KM</td>
<td>428</td>
<td>0.074</td>
<td>0.000</td>
<td>1.077</td>
</tr>
</tbody>
</table>

The table describes the total number of cells at the described scale (N), the value of the logistic regression coefficient (B), and the observed level of significance (p-values). To aid in interpreting the regression results, the exponent of the regression coefficient or odds ratio produced by each logistic model [exp(B)] is also provided. The odds ratio may be interpreted as a multiplier of the odds of an accident occurring in a grid cell. When the value exceeds 1, the odds of experiencing a PRMVA increase that many times for each one percentage change in the Non-White proportion.

Table 7.1g indicates that the relationship between PRMVA occurrence and percent Non-White is positive and statistically significant (p<.001) at all scales. Also worthy of note is the positive and increasing trend evident as the scales expand. At the 100-meter scale, a one percent increase in the Non-White percentage increases the odds of a PRMVA by almost two percent. The odds increase by over three percent at the 500-meter scale and by almost eight percent at the 1-kilometer scale.

STEP 2: Ordinary Least Squares Regression

This step includes only those cells that had at least one (≥1) reported PRMVA and uses OLS regression to examine the association between PRMVA frequency (the dependent variable) and Non-White percentage (the independent variable).
Table 7.1h summarizes the results including the sample size, least squares coefficient for the independent variable, and the related levels of significance.

**Table 7.1h: Least Squares Regression for Percent Non-White on PRMVA Frequency for Cells with at Least One Accident.**

<table>
<thead>
<tr>
<th>NON-WHITE</th>
<th>N</th>
<th>B</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>100M</td>
<td>595</td>
<td>0.000</td>
<td>0.745</td>
</tr>
<tr>
<td>500M</td>
<td>354</td>
<td>0.009</td>
<td>0.017</td>
</tr>
<tr>
<td>1KM</td>
<td>191</td>
<td>0.056</td>
<td>0.000</td>
</tr>
</tbody>
</table>

At the 100-meter radius scale, the results fail to achieve statistical significance (p>.10). The 500-meter and 1-kilometer scales do however, yield significant results (p<.05), as well as positive relationships. The least square coefficients suggest that a ten percent increase in the Non-White percentage in a grid cell would result in an increase of only 0.1 PRMVAs at the 500-meter scale, and about 0.6 accidents at the 1-kilometer scale.
Non-White Results Summary

When basic descriptive measures are utilized, there is strong evidence of an association between the Non-White percentage and accident frequency. When viewing the summary statistics in tabular format, there appears some reliable association between PRMVAs and the percentage Non-White. This relationship between the variables is particularly notable at finer scales. When analyzed through a two-step regression approach, the relationship between PRMVA occurrence and percentage Non-White is confirmed to be consistently positive and increasing with the size of grid cells. The probability of PRMVA occurrence and the number of such occurrences both increase significantly as the Non-White proportion increases, at the 500-meter and 1-kilometer scales. Clearly, there appears to be a positive and statistically significant connection between the distribution of PRMVAs and percentage Non-White in Pinellas County.
7.2 – Results: Percent Black

This section closely matches the format used in the previous section that focused on the Non-White population distribution. The objective in this section was to determine if PRMVA occurrences and frequency are more likely in areas with a disproportionately large number of Black residents. PRMVA distribution was spatially analyzed in conjunction with the percentage of the Black population in Pinellas County at each of three scales (100-meter, 500-meter, and 1-kilometer radius cells). These same data were then statistically analyzed using a two-step regression process utilizing logistic regression and ordinary least squares regression, as described in Chapter 4, and applied in the SDI and Non-White sections.

The Non-White classification examined in the previous section includes all categories of non-white population of which Black (or African-American) represents the largest minority. This group represented 9.0 percent of the overall Pinellas County population as of 2000 (US Census, 2000). Figures 7.2a, 7.2b, and 7.2e each display the county distribution of Black population as a percentage of the total population. Not surprisingly, this distribution closely matches that of the Non-White demographic. Also, as with that group, neighborhoods increasingly lose their robustness as the scales become coarser.
Figure 7.2a: Pinellas County Percentage Black, 100-Meter Radius Cells

Pinellas County
Pct BLACK
100-meter radius
- 0.00% - 0.68%
- 0.69% - 1.27%
- 1.26% - 3.57%
- 3.58% - 99.63%
Black: 100-Meter Radius

At the 100-meter radius grid, there is certainly some apparent propensity for PRMVAs to occur disproportionately in cells with higher Black proportions. Grid cells without any PRMVAs average 6.4 percent Black compared to the countywide proportion of 9.0 percent. This is a notable difference although a review at each accident level (Table 7.2a) delivers results that indicate at best, an erratic trend. In aggregate (Table 7.2b), it becomes increasingly clear that grid cells with higher Black concentrations are to some extent more likely to experience a PRMVA. This scale leaves much to be desired for those seeking useful linear trends, however.

Table 7.2a: 100-meter Radius Cells. Mean percentage of Black Population at each accident level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BLACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>6.4%</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>14.2%</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>10.7%</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>17.0%</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1.4%</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>19.2%</td>
</tr>
</tbody>
</table>

Table 7.2b: 100-meter Radius Cells. Mean percentage of Black Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BLACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>6.4%</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>14.2%</td>
</tr>
<tr>
<td>2+</td>
<td>76</td>
<td>11.9%</td>
</tr>
</tbody>
</table>
Figure 7.2b: Pinellas County Percentage Black, 500-Meter Radius Cells
**Black: 500-Meter Radius**

Interestingly, at this scale, those cells without PRMVAs have a mean Black population of just 4.4 percent. This is smaller than half the overall Black distribution (9.0 percent) throughout the county. At the 500-meter scale, the percent Black category again displays some irregularity and a lack of consistent relationship when considered at each PRMVA level (Table 7.2c).

**Table 7.2c: 500-Meter Radius Cells. Mean percentage of Black Population at each accident level.**

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BLACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>4.4%</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>9.8%</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>10.6%</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>11.7%</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>30.1%</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>21.2%</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>17.9%</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1.6%</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>15.1%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>9.8%</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>7.3%</td>
</tr>
</tbody>
</table>

A bar graph (Figure 7.2c) makes the apparent lack of consistent association at this scale all the more evident. Intriguingly, the pattern seems to peak at the middle accident levels with lower proportions of the Black population at the lowest and higher accident rates.
When aggregated, there materializes a heretofore unseen positive association between the considered factors (Table 7.2d). Areas with no PRMVs indicate a mean percentage of the Black population that is approximately half that of the county average. Those grid cells with one PRMVA indicate a mean that is close to the average for the county, while those cells with five or more accidents have a percentage Black rate of nearly twice the Pinellas County mean.

### Table 7.2d: 500-Meter Radius Cells. Mean percentage of Black Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BLACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>4.4%</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>9.8%</td>
</tr>
<tr>
<td>2-4</td>
<td>129</td>
<td>13.6%</td>
</tr>
<tr>
<td>5+</td>
<td>25</td>
<td>17.2%</td>
</tr>
</tbody>
</table>

The contrast between the non-aggregated and the aggregated graphs is notable. When sorted on each PRMVA level, the bar graph shows little indication of a
coherent association between PRMVA occurrence and percentage Black (Figure 7.2c).

In fact, a cursory glance at the column graph could lead one to believe the association could be negative, in part due to a generous spike for cells with four accidents. The bar graph of the aggregated data helps to elucidate this positive relationship (Figure 7.2d). It is useful to note that at each aggregated accident level, the number of cells with accidents decreases at a relatively consistent rate.

**Figure 7.2d:** 500-Meter Radius Cells. Mean percentage of Black Population at aggregated accident levels. The red horizontal line represents the countywide mean.
Figure 7.2e: Pinellas County Percentage Black, 1-Kilometer Radius Cells
Black: 1-Kilometer Radius

The apparent inconsistency of direction observed at the 500-meter radius for the Black category is also obvious at the 1-kilometer radius scale (Table 7.2e). At this scale, grid cells that experienced zero PRMVAs over the two year study period were, on average, just 2.6 percent Black (county proportion: 9.0 percent Black). For cells with

Table 7.2e: 1-Kilometer Radius Cells. Mean percentage of Black Population at each accident level

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BLACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>2.6%</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>6.6%</td>
</tr>
<tr>
<td>2</td>
<td>37</td>
<td>5.0%</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>6.0%</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>9.6%</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>15.0%</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>11.9%</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>3.0%</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>47.9%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>4.2%</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>1.5%</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>24.0%</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>12.6%</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>77.6%</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>36.7%</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>5.2%</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>3.0%</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>18.5%</td>
</tr>
</tbody>
</table>

PRMVAs, the Black proportion ranged from a mere 1.5 percent to a tremendous 77.6 percent. The key factor is that the actual number of PRMVAs in these extreme areas is quite small. Figure 7.2f shows the irregular association graphically.
Figure 7.2f: 1-Kilometer Radius Cells. Mean percentage of Black Population at each accident level. The red horizontal line represents the countywide mean.

Aggregation of these values helps to reduce the effect of outliers that may otherwise mislead (Table 7.2f). At this aggregation, as was the case at the 500-meter scale, there is a tremendous jump in Black proportion in areas with five or more PRMVA occurrences per grid cell.

Table 7.2f: 1-Kilometer Radius Cells. Mean percentage of Black Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BLACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>2.6%</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>6.6%</td>
</tr>
<tr>
<td>2-4</td>
<td>87</td>
<td>6.6%</td>
</tr>
<tr>
<td>5-9</td>
<td>27</td>
<td>18.1%</td>
</tr>
<tr>
<td>10+</td>
<td>15</td>
<td>19.3%</td>
</tr>
</tbody>
</table>

Graphically, the effect and utility of aggregation is clear when Figures 7.2f and 7.2g are compared. With all levels graphed individually, there is only the vaguest of patterns. When aggregated, there appears some evidence of a positive association between Black proportions and PRMVA occurrences.
Figure 7.2g: 1-Kilometer Radius Cells. Mean percentage of Black Population at aggregated accident levels. The red horizontal line represents the countywide mean.
Black: Statistical Analysis

Summary statistics and descriptive measures have revealed valuable information on the association between the percentage of the Black population and PRMVA occurrences. As with the SDI and the percent Non-White classifications described previously, two tests of statistical inference were conducted using SPSS statistical software. As described in Chapter 4, a two-step approach based on logistic regression and OLS regression was utilized because a large proportion of grid cells experienced no accidents.

STEP 1: Logistic Regression

Binary logistic regression was performed by first coding each grid cell as a 1 or 0, representing the presence or absence of a PRMVA respectively. Table 7.2g displays the results of the logistic regression model at each scale based on using the percent Black in each cell as the independent variable. The table contains the number of grid cells at each scale (N), the logistic regression coefficient (B), for the independent variable, and the observed level of significance (p-value). The odds ratio or the exponent of the regression coefficient produced by each logistic model to aid in interpreting the regression results \[\exp(B)\] is also provided.

Table 7.2g: Logistic Regression for Percent Black on PRMVA Occurrence.

<table>
<thead>
<tr>
<th>BLACK</th>
<th>N</th>
<th>B</th>
<th>sig</th>
<th>\exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100M</td>
<td>31,106</td>
<td>0.016</td>
<td>0.000</td>
<td>1.016</td>
</tr>
<tr>
<td>500M</td>
<td>1,458</td>
<td>0.026</td>
<td>0.000</td>
<td>1.026</td>
</tr>
<tr>
<td>1KM</td>
<td>428</td>
<td>0.054</td>
<td>0.000</td>
<td>1.056</td>
</tr>
</tbody>
</table>
As was the case with the percentage Non-white category (of which Black is the largest component), a statistically significant association with the odds of accident occurrence is observed at each scale (p<.001). As observed in the regression results for the Non-White percentage, the relationship is positive and increases in strength as the scale increases. At the 100-meter scale, a one percent increase in the Black proportion increases the odds of a PRMVA occurrence by 1.6 percent. With each percent increase in the Black proportion, the odds of a PRMVA increase by 2.6 percent at the 500-meter scale and 5.6 percent at the 1-kilometer scale.

STEP 2: Ordinary Least Squares Regression

The second step in this two-equation analysis includes only those cells that experienced at least one PRMVA and uses OLS Regression to analyze the relationship between the number of accidents (the dependent variable) and percentage Black (the independent variable). Table 7.2h contains the product of the Ordinary Least Squares regression at each geographic scale. The relationship between the two variables is not statistically significant only at the 100-meter radius scale (p>.10). At the larger 500-meter and 1-kilometer scales, there is a positive relationship coupled with statistical significance (p<.05). The OLS coefficients indicate that a ten percent increase in the

<table>
<thead>
<tr>
<th>BLACK</th>
<th>N</th>
<th>B</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>100M</td>
<td>595</td>
<td>0.00</td>
<td>0.662</td>
</tr>
<tr>
<td>500M</td>
<td>354</td>
<td>0.008</td>
<td>0.035</td>
</tr>
<tr>
<td>1KM</td>
<td>191</td>
<td>0.049</td>
<td>0.001</td>
</tr>
</tbody>
</table>
proportion Black would yield an increase of just 0.1 PRMVAs at the 500-meter scale and an increase of half an accident at the 1-kilometer scale. It is notable that the coefficient is six-times higher at the 1-kilometer scale than at the 500-meter scale indicating some increasing effect as the scale increases.
**Black: Results Summary**

The percent Black variable offers an intriguing set of results that are quite similar to those obtained for the Non-White category. When examining the data on the basis of summary statistics in tabular format and bar charts, there is apparent evidence of a significant spatial association between PRMVAs and the distribution of Black population as a percentage of total population. Areas with the highest PRMVA occurrence levels have remarkably high proportions of Black distribution. In aggregation, these numbers become particularly robust. When the data are analyzed through a two-step regression approach, the statistical significance of the positive associations are reinforced at almost all geographic scales. Consistently, at the 500-meter and 1-km scale, the probability of PRMVA occurrence and the number of such occurrences both increase significantly as the Black proportion increases.
7.3 – Results: Percent Hispanic

This section of the study addresses whether PRMVA occurrences and frequency are higher in areas with a disproportionate number of Hispanic residents. These relationships were spatially evaluated using the same methodology described in previous sections with the SDI, Non-White, and Black variables.

When compared to the distribution of the Black population, Hispanics are more widely dispersed and not concentrated in specific areas. Figures 7.3a, 7.3b, and 7.3e each exhibit the distribution of Hispanics as a percentage of the total population at varying scales. With just 4.6 percent of the county's population, Hispanics represent about half the overall proportion of the Black community (U.S. Census, 2000).
Figure 7.3a: Pinellas County percentage Hispanic, 100-Meter Radius Cells
Hispanics at 100-Meter Radius

The 100-meter radius grid cells do not reveal clearly identifiable patterns for this ethnic group. As Table 7.3a suggests, there is little obvious direction and only a slightly greater propensity for those cells with accidents to have a disproportionate number of Hispanic residents. While Pinellas County overall is 4.6 percent Hispanic, the mean percent Hispanic ranges from a low of 4.0 percent to a high of just 6.7 percent for cells with zero to four PRMVAs. These numbers, while marginally higher than the average countywide Hispanic percentage, display only a slightly positive relationship between PRMVA occurrence and percent Hispanic.

Table 7.3a: 100-Meter Radius Cells. Mean percentage of Hispanic Population at each accident level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>HISPANIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>4.0%</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>5.7%</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>6.7%</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>4.3%</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>6.5%</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>13.7%</td>
</tr>
</tbody>
</table>

Even when aggregated, the direction is, at best, a modest indicator of relationship between these two factors (Table 7.3b). Here we see that although the direction is consistent, it is not immediately obvious. It is again an important reminder that entirely 98 percent of 100-meter radius cells had no PRMVA occurrence over the two year period of study.
Table 7.3b: 100-Meter Radius Cells. Mean percentage of Hispanic Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>HISPANIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>4.0%</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>5.7%</td>
</tr>
<tr>
<td>2+</td>
<td>76</td>
<td>6.4%</td>
</tr>
</tbody>
</table>
Figure 7.3b: Pinellas County Percentage Hispanic, 500-Meter Radius Cells
Hispanics at 500-Meter Radius

Even at the previously useful 500-meter radius scale, the association between the percentage Hispanic and PRMVA occurrence appears modest. Except for an aberration at the 8 accident/cell level, no clear trends exist (Table 7.3c). When reviewing the entire breakdown of PRMVA s it does at first appear to exhibit some measure of trend, but at the higher PRMVA occurrence levels, the pattern seems to waver.

Table 7.3c: 500-Meter Radius Cells. Mean percentage of Hispanic Population at each accident level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>HISPANIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>3.6%</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>4.6%</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>5.2%</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>5.6%</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>6.9%</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>5.7%</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>3.3%</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>6.2%</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>14.7%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>4.0%</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>9.5%</td>
</tr>
</tbody>
</table>

Graphically, the interesting upward trend at the 0 to 5 PRMVA levels is quite evident, though the pattern is decidedly more obscure at higher accident levels (Figure 7.3c).
Figure 7.3c: 500-Meter Radius Cells. Mean percentage of Hispanic Population at each accident level. The red horizontal line represents the countywide mean.

The trends appear unimpressive when aggregated, although there is a consistently positive and increasing pattern (Table 7.3d). Figure 7.3d is a particularly vivid demonstration of this positive trend. Although the range in values is relatively slight, the direction is clear. At PRMVA accident levels of zero, the percentage Hispanic is below the corresponding county proportion of 4.6 percent. For cells with one accident, the county proportion is matched. At accident levels greater than one PRMVA, the proportion of Hispanics exceeds the Pinellas County proportion to an increasing degree.

Table 7.3d: 500-Meter Radius Cells. Mean percentage of Hispanic Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>HISPANIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>3.6%</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>4.6%</td>
</tr>
<tr>
<td>2-4</td>
<td>129</td>
<td>5.5%</td>
</tr>
<tr>
<td>5+</td>
<td>25</td>
<td>6.6%</td>
</tr>
</tbody>
</table>
Figure 7.3d: 500-Meter Radius Cells. Mean percentage of Hispanic Population at aggregated accident levels. The red horizontal line represents the countywide mean.
Figure 7.3e: Pinellas County Percentage Hispanic, 1-Kilometer Radius Cells
Hispanics at 1-Kilometer Radius

At the coarsest of scales, there is still only the slightest of adverse PRMVA consequences for Hispanics. Table 7.3e indicates a generally indistinct relationship between PRMVA occurrences and the proportion of Hispanic individuals in Pinellas County. It is worthy of note that areas without PRMVA occurrences are one-third less Hispanic than the county proportion.

Table 7.3e: 1-Kilometer Radius Cells. Mean percentage of Hispanic Population at each accident level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>HISPANIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>3.0%</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>3.7%</td>
</tr>
<tr>
<td>2</td>
<td>37</td>
<td>3.9%</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>4.7%</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>5.7%</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>5.2%</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>3.8%</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>6.1%</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>4.0%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>4.1%</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>4.9%</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>6.6%</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>16.0%</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>2.9%</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>5.9%</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>5.7%</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>9.1%</td>
</tr>
</tbody>
</table>

When viewed graphically, there are clearly visible spikes in PRMVA occurrence at the 12, 16 and 23 accident levels but the other data classes fail to offer support for a readily identifiable association between PRMVA occurrence and the percentage Hispanic classification (Figure 7.3f).
Figure 7.3f: 1-Kilometer Radius Cells. Mean percentage of Hispanic Population at each accident level. The red horizontal line represents the countywide mean.

In aggregation, some direction emerges, but apparent indicators are subtle and only moderate (Table 7.3f). The column graph below (Figure 7.3g) exhibits some measure of positive relationship although only the 10+ class exceeds the countywide proportion by any appreciable degree.

Table 7.3f: 1-Kilometer Radius Cells. Mean percentage of Hispanic Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>HISPANIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>3.0%</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>3.7%</td>
</tr>
<tr>
<td>2-4</td>
<td>87</td>
<td>4.6%</td>
</tr>
<tr>
<td>5-9</td>
<td>27</td>
<td>4.4%</td>
</tr>
<tr>
<td>10+</td>
<td>15</td>
<td>7.9%</td>
</tr>
</tbody>
</table>
Figure 7.3g: 1-Kilometer Radius Cells. Mean percentage of Hispanic Population at aggregated accident levels. The red horizontal line represents the countywide mean.
Hispanic: Statistical Analysis

To this point the percentage Hispanic classification has only been examined based on descriptive measures and summary statistics. As described previously, a two-step approach was utilized again to examine the strength and significance of the statistical association between the Hispanic category and PRMVA incidence.

STEP 1: Logistic Regression

The Hispanic percentage in each grid cell was used as an independent variable to analyze the dichotomous dependent variable (PRMVA occurrence). Table 7.3g summarizes the results provided by the logistic regression models at each scale.

<table>
<thead>
<tr>
<th>HISPANIC</th>
<th>N</th>
<th>B</th>
<th>sig</th>
<th>exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100M</td>
<td>31,106</td>
<td>0.086</td>
<td>0.000</td>
<td>1.090</td>
</tr>
<tr>
<td>500M</td>
<td>1,458</td>
<td>0.137</td>
<td>0.000</td>
<td>1.146</td>
</tr>
<tr>
<td>1KM</td>
<td>428</td>
<td>0.472</td>
<td>0.000</td>
<td>1.604</td>
</tr>
</tbody>
</table>

At each scale, a statistically significant (p<.001) and positive relationship is observed between the dependent and independent variables. The odds ratio values also increase persistently as the scale of consideration broadens. At the 100-meter radius, a one percent increase in percentage Hispanic yields a nine percent increase in the odds of a PRMVA occurrence. The odds increase to 14.6 percent at 500-meters, and burgeon to 60 percent when the 1-kilometer scale is considered.
STEP 2: Ordinary Least Squares Regression

The second step in this two-equation approach considers only those cells that experience at least one PRMVA and uses OLS Regression to analyze the relationship between the number of accidents (the dependent variable) and the percentage Hispanic (the independent variable). Table 7.3h summarizes the results table for the OLS regressions.

Table 7.3h: Least Squares Regression for Percent Hispanic on PRMVA Frequency for Cells with at Least One Accident.

<table>
<thead>
<tr>
<th>HISPANIC</th>
<th>N</th>
<th>B</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>100M</td>
<td>595</td>
<td>0.003</td>
<td>0.409</td>
</tr>
<tr>
<td>500M</td>
<td>354</td>
<td>0.059</td>
<td>0.000</td>
</tr>
<tr>
<td>1KM</td>
<td>191</td>
<td>0.569</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Matching, to some degree, the results of the Black category, there is a lack of statistical significance at the 100-meter scale (p>.10) but strong evidence of a statistically significant association (p<.001) at the 500-meter and 1-kilometer scales. Additionally, positive relationships between percent Hispanic and PRMVA frequency exist. At the 500-meter scale, the least squares coefficient suggest that a ten percent increase in percent Hispanic would result in a 0.6 increase in PRMVA and at the 1-kilometer scale, a ten percent Hispanic increase leads to a relatively substantial gain of almost six accidents.
Hispanic: Results Summary

Summary statistics and simple descriptive measures are less reliable for this variable compared to the SDI, percent Non-White, and percent Black. At each scale, the Hispanic category shows only limited evidence of a strong association with PRMVAs. While descriptive analysis reveals a pattern that supports a positive and increasing association with PRMVAs at each scale, aberrations are common. However, the two-step regression analysis reveals stronger associations between the Hispanic percentage and accident incidence. Statistical significance exists at all scales and the positive relationships increase rather dramatically with increasing scales. When examining exclusively those cells with PRMVAs at the 1-kilometer scale, the results are exceptionally strong and associations reliably positive. More than any other variable considered in this study, regression analysis serves to uncover meaningful associations between the disproportionate distribution of Hispanic residents and both occurrence and frequency of PRMVAs.
7.4 – Results: Percent Below Poverty

Unlike the three previous sections, which dealt with racial or ethnic groups of Pinellas County, this section is concerned with the economic status of the population. Poverty-riddled areas in Pinellas County are frequently spatially coincident with that of Black areas. As can readily be seen in the following figures (Figures 7.4a, 7.4b, 7.4e), Saint Petersburg's Midtown neighborhood and a region just south of Safety Harbor represent two areas both disproportionately destitute and, in significant numbers, Black. While certain racial and ethnic groups have a greater statistical propensity to find themselves below poverty, any number of demographic groups can also be Below Poverty. Countywide, 10.0 percent of Pinellas County residents fell below Federal poverty standards in 2000 (U.S. Census, 2000). While not a small proportion, this is far smaller than Florida's statewide average of 14.1 percent and marginally lower than the national rate of 12.4 percent.

Patterned much like the previous sections, the percent Below Poverty segment was spatially examined at each of three scales (100-meter, 500-meter, and 1-kilometer radius). First, descriptive and summary statistics were utilized. Second, a two-step regression model was conducted to better elucidate the relationship between those Below Poverty and the incidence of PRMVAs in Pinellas County.
Figure 7.4a: Pinellas County Percentage Below Poverty, 100-Meter Radius Cells
Below Poverty: 100-Meter Radius

As with the previously examined variables, there is some indication that this segment is disproportionately affected by PRMVA occurrences (Table 7.4a). Whereas countywide the poverty rate stands at 10.0 percent, cells without any PRMVA incidence over the two-year period show an average Below Poverty rate of 8.2 percent. At each of the other frequency levels, the county average was exceeded to varying degrees. An upward trend in greater accident frequency in more poverty stricken areas is possible but an aggregated version of this table serves to make this clearer (Table 7.4b). In aggregate, areas experiencing PRMVs, on average readily exceed the Pinellas County poverty rate.

Table 7.4a: 100-Meter Radius Cells. Mean percentage of Below Poverty Population at each accident level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BEL POVERTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>8.2%</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>13.5%</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>13.9%</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>16.3%</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>10.3%</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>23.4%</td>
</tr>
</tbody>
</table>

Table 7.4b: 100-Meter Radius Cells. Mean percentage of Below Poverty Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BEL POVERTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>8.2%</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>13.5%</td>
</tr>
<tr>
<td>2+</td>
<td>76</td>
<td>14.4%</td>
</tr>
</tbody>
</table>
Figure 7.4b: Pinellas County Percentage Below Poverty, 500-Meter Radius Cells
**Below Poverty: 500-Meter Radius**

500-meter radius grid cells reveal an even larger discord between those areas with and without accidents (Table 7.4c, Figure 7.4c). In areas without accidents, the poverty rate stands at only 7.2 percent. In grid cells with at least one accident, all but two frequency levels exceeded the county mean of 10.0 percent.

**Table 7.4c:** 500-Meter Radius Cells. Mean percentage of Below Poverty Population at each accident level.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BEL POVERTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>7.2%</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>10.4%</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>12.2%</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>14.0%</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>18.5%</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>18.0%</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>17.8%</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>9.5%</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>15.0%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>23.3%</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>9.1%</td>
</tr>
</tbody>
</table>

**Figure 7.4c:** 500-Meter Radius Cells. Mean percentage of Below Poverty Population at each accident level. The red horizontal line represents the countywide mean.
Without aggregation, there is some hint of a trend hidden amongst the irregularities at this scale. When placed in aggregate, a more visible pattern becomes obvious (Table 7.4d). Notably, in grid cells with at least two PRMVAs, the poverty rate in substantially exceeded.

**Table 7.4d:** 500-Meter Radius Cells. Mean percentage of Below Poverty Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BEL POVERTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>7.2%</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>10.4%</td>
</tr>
<tr>
<td>2-4</td>
<td>129</td>
<td>13.5%</td>
</tr>
<tr>
<td>5+</td>
<td>25</td>
<td>17.2%</td>
</tr>
</tbody>
</table>

A comparison of Figures 7.4b and 7.4c illustrate the value of aggregation in these cases. Whereas the lower accident levels show a somewhat consistent trend, the higher accident levels are less obvious, until the values are aggregated.

**Figure 7.4d:** 500-Meter Radius Cells. Mean percentage of Below Poverty Population at aggregated accident levels. The red horizontal line represents the countywide mean.
Figure 7.4e: Pinellas County Below Poverty distribution, 1-Kilometer Radius Cells

Pinellas County
Pct BEL POVERTY
1 KM radius
- 0.00% - 4.43%
- 4.44% - 6.48%
- 6.49% - 8.93%
- 8.94% - 37.54%
Below Poverty: 1-Kilometer Radius

At the 1-kilometer radius, grid cells with no PRMVAs experience a Below Poverty rate of a mere 5.5 percent, and are substantially smaller than the Pinellas County rate of 10.0 percent. Prior to aggregation, there is some indication of a positive association between PRMVAs and the proportion of those Below Poverty, (Table 7.4e), particularly when the data are seen in graphical form (Figure 7.4f).

Table 7.4e: 1-Kilometer Radius Cells. Mean percentage of Below Poverty Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BEL POVERTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>5.5%</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>7.8%</td>
</tr>
<tr>
<td>2</td>
<td>37</td>
<td>8.4%</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>10.1%</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>11.6%</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>13.7%</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>11.3%</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>9.3%</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>19.0%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>18.2%</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>9.6%</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>21.1%</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>17.7%</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>32.5%</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>18.5%</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>16.6%</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>14.7%</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>22.6%</td>
</tr>
</tbody>
</table>
Figure 7.4f: 1-Kilometer Radius Cells. Mean percentage of Below Poverty Population at each accident level. The red horizontal line represents the countywide mean.

Once the table is aggregated into reasonable PRMVA groupings, there is a clearly visible progression and the positive association between the factors appears impressively strong (Table 7.4f). At this 1-kilometer level, there is quite a clear direction and some measure of consistency with the positive relationship between the percent Below Poverty and PRMVs.

Table 7.4f: 1-Kilometer Radius Cells. Mean percentage of Below Poverty Population at aggregated accident levels.

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>BEL POVERTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>5.5%</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>7.8%</td>
</tr>
<tr>
<td>2-4</td>
<td>87</td>
<td>9.8%</td>
</tr>
<tr>
<td>5-9</td>
<td>27</td>
<td>13.7%</td>
</tr>
<tr>
<td>10+</td>
<td>15</td>
<td>18.4%</td>
</tr>
</tbody>
</table>

Graphically, the positive and linear relationship is particularly evident and appears strong (Figure 7.4g). In aggregate, the relationship is remarkably consistent, as is
the reliable decrease in the number of PRMVA cells as accident volume increases. The association between Below Poverty areas and PRMVA incidence is plainly discernable.

**Figure 7.4g:** 1-Kilometer Radius Cells. Mean percentage of Below Poverty Population at aggregated accident levels. The red horizontal line represents the countywide mean.
*Below Poverty: Statistical Analysis*

The last portion of this analysis follows the format used previously for the other variables (the SDI, percent Non-White, percent Black, and percent Hispanic). The strength and significance of the statistical association between the Below Poverty percentage and PRMVA incidence was examined using both logistic regression and ordinary least squares regression methods.

**STEP 1: Logistic Regression**

The percentage Below Poverty in each grid cell was used as an independent variable to analyze the dichotomous dependent variable (PRMVA occurrence). Table 7.4g summarizes the results provided by the logistic regression models at each scale.

<table>
<thead>
<tr>
<th>BELOW POVERTY</th>
<th>N</th>
<th>B</th>
<th>sig</th>
<th>exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100M</td>
<td>31,106</td>
<td>0.074</td>
<td>0.000</td>
<td>1.076</td>
</tr>
<tr>
<td>500M</td>
<td>1,458</td>
<td>0.239</td>
<td>0.000</td>
<td>1.269</td>
</tr>
<tr>
<td>1KM</td>
<td>428</td>
<td>0.292</td>
<td>0.000</td>
<td>1.339</td>
</tr>
</tbody>
</table>

As the table indicates, the association between percent Below Poverty and PRMVA occurrence is positive and statistically significant at all scales (p<.001). Interestingly, the Below Poverty category produces an odds ratio that is higher (and thus of greater effect) than all the racial/ethnic categories at each respective level, except Hispanics (whose ratio is higher at the 100-meter and 1-kilometer levels). At the 100-meter radius scale, a one percent increase in the Below Poverty population results in a 7.6
percent increase in the odds of a PRMVA occurrence. The odds of accident occurrence increase to 26.9 percent at the 500-meter scale and 34 percent at 1-kilometer radius scale.

STEP 2: Ordinary Least Squares Regression

The second step in this two-equation approach considers only those cells that experienced at least one PRMVA and uses OLS Regression to analyze the relationship between the number of accidents (the dependent variable) and percent Below Poverty (the independent variable). Table 7.4h summarizes the results from the OLS regressions.

**Table 7.4h: Least Squares Regression for Percent Below Poverty on PRMVA Frequency for Cells with at Least One Accident.**

<table>
<thead>
<tr>
<th>BELOW POVERTY</th>
<th>N</th>
<th>B</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>100M</td>
<td>595</td>
<td>0.003</td>
<td>0.187</td>
</tr>
<tr>
<td>500M</td>
<td>354</td>
<td>0.088</td>
<td>0.000</td>
</tr>
<tr>
<td>1KM</td>
<td>191</td>
<td>0.295</td>
<td>0.000</td>
</tr>
</tbody>
</table>

At the 100-meter radius scale, there is insufficient evidence of statistical significance (p>.10). At the 500-meter and 1-kilometer scales, models indicate both statistical significance (p<.001) and a positive relationship between the variables. The least squares coefficients indicate that a ten percent increase in the percent Below Poverty would yield an increase of almost one accident at the 500-meter scale and nearly three accidents at the 1-kilometer scale.
Below Poverty: Results Summary

The Below Poverty category appears to have one of the strongest spatial relationships with pedestrian-related motor vehicle accidents among the variables considered in this study. Areas with PRMVAs are clearly more likely to contain a higher percentage of Below Poverty residents than the countywide proportion. At each scale and for all grid cells with at least one accident, this appears consistent. These patterns are confirmed by the two-step regression analysis which provides strong evidence of a statistically significant and positive relationship between the proportion Below Poverty and accident occurrence or frequency. Areas with PRMVA incidence in the county are disproportionately populated by residents who are Below Poverty.
7.5 – Socio-Demographic Factors: Summary

Based on the information uncovered in this chapter, pedestrian-related motor vehicle accidents in Pinellas County appear to be disproportionately distributed with respect to the proportion of individuals in the four categories (Non-White, Black, Hispanic, and Below Poverty), considered in the study.

Summary statistics revealed a substantially high proportion of each variable in grid cells which experienced at least one accident. At the 100-meter radius scale, patterns in most cases were not readily apparent. When values were aggregated, tendencies toward higher numbers of the four categories became only slightly more apparent. When the scale shifted to the 500-meter radius, both trends and increasingly positive correspondence emerged. When values were aggregated, each one of the four socio-demographic categories displayed a consistent and increasing positive trend. Both the percentage Black and Below Poverty categories exhibited notably high disproportionate values in cells with PRMVA occurrences. At the 1-kilometer scale, although a positive relationship remained, much of the impressive upward trends and linearity faded as apparently discrete regions began to blend with dissimilar adjacent areas. When aggregated, the socio-demographic factors generally displayed a modest association with PRMVs, except for the Below Poverty classification, which retained a particularly strong relationship at this scale.

A two-step regression analysis further confirmed the significance of the relationships between each variable and PRMVA incidence. At the 100-meter radius scale, binary logistic regression revealed statistically significant, and unrelentingly positive coefficients for each explanatory variable. When OLS regression was performed
at this 100-meter scale on those cells with at least one accident, there was limited
evidence of a statistically significant relationship between accident frequency and the
proportion of the variable examined.

The logistic regression results at the 500-meter radius scale yielded
positive coefficients that considerably exceeded the corresponding values at the 100-
meter level. At this radius, each of the Non-White, Black, Hispanic and Below Poverty
percentages produced statistically significant, positive relationships with PRMVAs. The
percent Below Poverty category in particular, displayed the strongest effect on PRMVA
occurrence. The least squares regressions of cells with PRMVAs delivered statistically
significant results that were again indicative of a positive relationship between the
frequency of accidents and each variable considered.

Intriguing results came from the 1-kilometer radius logistic regression
analysis. Here, the Hispanic odds ratio was particularly high, exceeding even that of the
percent Below Poverty category. Least squares regression imparted reaffirming positive
PRMVA relationships, particularly with Hispanics, whose coefficient was nearly twice as
high as that of the Below Poverty group.

For each of the studied variables, at each of the scales considered,
wherever there were statistically significant results, positive relationships between
pedestrian-related motor vehicle accidents and these variables were obtained. The
variables considered here represent those classifications typically utilized in
environmental justice studies and without exception, the evidence is clear. There appears
to be significant evidence of environmental injustice in the spatial distribution of
pedestrian-related motor vehicle accidents in Pinellas County.
CHAPTER 8

CONCLUSIONS AND DISCUSSION

Locational hazards were the crux of the investigation presented in this thesis. It is contended here that the dangers incurred by pedestrians afoot (and for that matter, on bicycles) can be represented by a spatial pattern that may allow for a better understanding of the relevant dangers. It is imperative to the understanding of this study that accident sites are more than just a point where an accident has occurred. Particular accident sites are indicative of proven dangerous areas for pedestrians. The identification of specific trends and patterns in the spatial distribution of pedestrian-related motor vehicle accidents sites can help direct attention toward factors that make certain places more hazardous than others for pedestrians and more specifically, the disadvantaged groups in society. An improved understanding of the geography of pedestrian danger may lead not only to a safer environment for those who may not be of the motorized set, but also, in a wider sense, would help with the planning of more functional, efficient, and inviting urban environments.

The dangers that befall pedestrians in Pinellas County, Florida, may well be little different from hazards experienced elsewhere. In this county, pedestrian-related
motor vehicle accidents (PRMVAs) occur more frequently when conditions are dry, in daylight hours, during the less warmer months, and around the rush hour periods of the day. PRMVAs are as likely to happen near an intersection as other location on the transportation network. Motorists are usually at fault due to their "failure to yield" or "careless driving." Pedestrians are frequently injured, and all too often killed in these encounters. This would seem to come as no surprise as the expected components of motorist-involved pedestrian accidents.

This study also revealed that, in Pinellas County, the presence of sidewalks relates positively to the chance of a person afoot being involved in a PRMVA. It appears that the greater the volume of sidewalks, the more likely there will be a PRMVA occurrence. The results of statistical analysis suggest that sidewalk density and pedestrian danger are associated. This relationship should not be construed however, in any way, as being causual. This study did not set out to address causality. The goal of this project was to identify spatial associations between PRMVAs and the considered factors. Sidewalks are unlikely to create danger on their own. Instead, they are more likely to be located in areas with pre-existing dangerous elements. If anything, sidewalks may be best described as a “pull factor” for pedestrians. The presence of a sidewalk could lure the pedestrian into choosing a particular route, even if this choice results in a longer and less convenient journey. The appearance of a sidewalk makes an intrinsically dangerous trip at least a little more comfortable. The practical question that arises from this is to identify a remedy for this pedestrian danger.
The study also provided evidence of locational inequities in the distribution of pedestrian accidents, with respect to the racial/ethnic and economic status of the residential population. In Pinellas County, it is apparent that PRMVA incidences occur more frequently in predominantly Non-White neighborhoods, in general, and Black and Hispanic communities, in particular. Additionally, those Below Poverty are decidedly more predisposed to live in an area with a disproportionate level of danger for pedestrians. Admittedly, each of the four categories examined in this study partially overlaps with at least one other category. The utilization of overlapping socio-demographic categories was not accidental. The purpose was to view potential factors in various ways to better ascertain the nature and magnitude of possible inequities. It was revealed that although all Non-Whites experience some measure of spatial inequity as pedestrians, the Black population was the most susceptible. It was also discovered that areas characterized by individuals in poverty, regardless of race or ethnicity, were also likely to experience higher probabilities and frequencies of accident occurrence. The environmental injustice implications of PRMVA incidence are intriguing and considerable, and certainly warrant further study.

The environmental justice (EJ) movement was a response to a set of disturbing, and in retrospect, readily apparent inequities in the siting of the most visible and destructive elements of America’s heavy industry. Smokestacks, toxic waste dumps, and chemical storage facilities are each easily recognized as hazards with adverse human health effects. The research literature initiated by the environmental justice movement has empirically demonstrated that spatially, these hazardous facilities were
disproportionately located in minority and low-income neighborhoods. This thesis has revealed patterns of disparity in the occurrence of pedestrian-related motor vehicle accidents.

Initially, this study sought to investigate the simple issue of the built environment and how it may impact pedestrian safety. The most direct pedestrian-related element of the built environment is the sidewalk. They are installed for no other purpose than to increase pedestrian safety. With further examination of this issue, it has become apparent that the methodology developed for analyzing sidewalk density in this thesis could be used to address more than just the hardware within the city. There was an opportunity to expand the scope and relevance of this project by further investigating the relationship between pedestrian safety and neighborhood demographics. Environmental justice studies have traditionally examined the location of dis-amenities. Rather than limiting the investigation to the noxious facilities that are present, this thesis expands the notion of environmental injustice by examining pedestrian safety in the same fashion that environmental justice research has considered industrial hazards and pollutants. Safe pedestrian travel is no less a worthwhile and deserving amenity than clean air and unpolluted drinking water. Minorities and the economically disadvantaged are entitled to this amenity no less than the majority and the more affluent. By choosing to investigate a pervasive hazard in this way, it is hoped the definition of environmental justice can be extended to include consideration for amenities beyond industrial pollutants and produce a better understanding of the disparities in today's society.
The study makes a methodological contribution by using a hexagonal approach for the spatial definition of analytical units. Prior studies have used pre-defined census units, zip code areas, overlapping circular buffers, and municipal boundaries to spatially subdivide areas of study. Unlike past approaches, this project has utilized discrete and non-overlapping hexagonal cells, at three distinct geographic scales. This allows for greater flexibility and effectively avoids edge-effect problems where events occur on boundaries of areal units. Often, predefined boundaries coincide with roadways which would otherwise place a great many PRMVAs on these borders. An arbitrary, consistently applied hexagon grid addresses the problem and thus provides more reliable analytical results.

Another consideration that was treated with great discretion was that of scale. When studying spatial attributes, it is important to consider that the results of statistical analysis are sensitive to the choice of geographic scale. This is the Modifiable Areal Unit Problem (MAUP) which suggests that the strength and significance of relationships increase as the scales becomes coarser (Sui, 1999). Instead of choosing a single spatial scale, this project deals with potential MAUP concerns by analyzing each relationship at three distinct scales. Issues of spatial extrapolation and interpolation take a considerable liberty with the notion that areal characteristics are consistently distributed throughout the zones of consideration. By working with three scales, this concern was addressed in a way that inconsistencies would more likely be revealed with any unreasonable interpolations or extrapolations.
Much consideration has been made over the possibility that the analysis may have yielded differing results at other scales. The choice of scales that differ from those chosen could conceivably have great effect on the results. This was a major decision, but at each end there were troubling issues. If the radius was further widened, ever-increasing scales may have rewarded this study with increasingly strong statistical inferences, but the nature of a neighborhood (the essential focus of this project) would be lost. Smaller areas were deemed over-precise and all too likely to exceed the precision of the source data. Some consideration was made for what size of an area would reasonably represent an urban neighborhood. Somewhat arbitrarily, though with much deliberation, 100-meter, 500-meter, and 1-kilometer radii were chosen. Ultimately, it was decided practical considerations must exceed statistically pleasing results.

If there was a wider reaching, practical goal for this project, it was to create an increased appreciation for sidewalks and pedestrian travel. It was hoped that information gleaned from this work would promote the need for more and better routes for those who do not use motorized means of transport. This study began with a preconception that that lack of sidewalks creates a public safety concern for pedestrians. It was presumed that areas with an absence of sidewalks would experience a greater number of pedestrian-related motor vehicle accidents. Surprisingly, this is clearly not so. In fact, the opposite appears to be more the case. Where there are more sidewalks, there are also more accidents. In retrospect, the reason behind this seems evident. If sidewalks exist, more people are likely to choose to walk that particular route. Sidewalks act as a "pull" factor for pedestrians. Generally, sidewalks are laid out with some apparent regard
for the most commonly needed routes of pedestrian travel. They are where they are, because they are needed there. This is not to assume that they are always where they are needed, but rather are generally placed appropriately. The end result of all this is that pedestrians are most likely to be hit where pedestrians are most likely to be, that is to say, on a sidewalk, or perhaps an associated zone such as a crosswalk. Still, although pedestrians are involved in more PRMVAs in areas with the greatest volume of sidewalks, it should not at all be assumed that increasing the number of sidewalks will lead to more PRMVAs. Perhaps, an increase in sidewalks would allow for safer alternative routes where pedestrians could better avoid the aforementioned motorized hazards that lurk on the roadways. Then, reasonably, more sidewalks can mean more safety for those afoot.

Why does there appear to be an increasing proportion of minorities and economically disadvantaged individuals in areas with a greater occurrence of PRMVAs? Perhaps it is because minorities, who are so often less affluent, are more likely to walk when they need to get somewhere. Maybe they have no access to motorized means of transport. Maybe the absence of convenient and reliable public transportation leaves these groups with no other choice. Perhaps it is the sheer numbers of walking minorities and poor that result in a greater incidence of PRMVAs. This purpose of the study was to identify spatial patterns and relationships, but not the processes that explain the patterns. Further research seeking to identify the causes of these trends is encouraged.
Perhaps the most significant limitation of this study is the absence of data. Specifically, there is a lack of information due to all of the unreported PRMVAs that surely happen each day. Certainly when one of the involved parties is injured, the accident is likely to involve the authorities, and thus reported, thereby becoming one of the component statistics for this project. There are undoubtedly a great many accidents that involve a pedestrian who is perhaps just grazed or bumped by an automobile, and are fortunate enough to just "walk it off." Perhaps the automobile driver might seek to avoid having an accident on their driving record, and thus keep their car insurance rates down. And maybe the pedestrian victim would rather not wait around for the proper authorities to show up, and subject themselves to mounds of paperwork and volumes of irretrievably lost time. The result is that the accident doesn't get reported. These incidents are not included in this study. Only accident reports filed with the proper authorities are considered here.

Another important factor that this study did not (and could not) focus upon was the total volume of pedestrians along any given route. For this, there simply is no concise dataset yet produced that would cover the number of pedestrians that travel each route in this urban environment. As a practical matter, it would seem unreasonable to expect any such pedestrian survey to be completely thorough, covering all routes, all times of day, throughout the entire year. Certainly it would be expected that more heavily trafficked (both afoot and motorized) routes would likely experience more PRMVAs. But to what extent are these occurrences happening at disproportionate rates? At this point, the data necessary to build such a knowledge base is not available.
Initially, this study was intended to investigate the dangers faced by both pedestrians and bicyclists. Each, it seemed, faced a similar danger in the ubiquitous automobile. Alas, as it turns out, despite the author's personal (and very situational) misgivings of the practice, bicyclists and pedestrians do indeed have differing safety zones. To wit, studies show that bicyclists are in increased danger when biking on the sidewalk whereas a pedestrian is generally said to be more out of harm's way when walking on that same sidewalk (Wachtel, Lewiston, 1994, Senturia, et al, 1997). The bicyclist is considered to be safer on the roadways so much so that many municipalities have legally mandated roadway travel in lieu of bicycles utilizing sidewalks. To dispute the value of the existing statistics may be foolhardy but an intuitive thought is that when biking on the sidewalk, a bicyclist encounters potential intersect points with automobiles at driveways, intersections, crosswalks, and perhaps a few other places. When biking on a roadway, every single length of travel represents a potential, and legally accessible, intersect point where the automobile and the bicycle can readily cross paths. Intuitively, one might think the simple act of reducing the number of potentially hazardous intersect points would be the easiest way to reduce PRMVAs. But with the legal encouragement of roadway travel for bicyclists, this study could not presume to treat pedestrians and bicyclists alike. The intended arteries for each are different. Additional worthwhile
opportunities for future research rest with further exploring the differing nature of the hazards encountered by the pedestrian and the bicyclist.
REFERENCES


APPENDICES
### APPENDIX A

100-METER RADIUS SUMMARY TABLES

**Table A-1:** Summary of the Studied Factors - 100-Meter Radius Scale – Each Accident Level

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>WHITE</th>
<th>NON-WHITE</th>
<th>BLACK</th>
<th>HISPANIC</th>
<th>BEL POVERTY</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>89.0%</td>
<td>11.0%</td>
<td>6.4%</td>
<td>4.0%</td>
<td>8.2%</td>
<td>0.4094</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>79.7%</td>
<td>20.3%</td>
<td>14.2%</td>
<td>5.7%</td>
<td>13.5%</td>
<td>0.6451</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>83.2%</td>
<td>16.8%</td>
<td>10.7%</td>
<td>6.7%</td>
<td>13.9%</td>
<td>0.7499</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>77.2%</td>
<td>22.8%</td>
<td>17.0%</td>
<td>4.3%</td>
<td>16.3%</td>
<td>0.7133</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>90.2%</td>
<td>9.8%</td>
<td>1.4%</td>
<td>6.5%</td>
<td>10.3%</td>
<td>1.0400</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>68.4%</td>
<td>31.6%</td>
<td>19.2%</td>
<td>13.7%</td>
<td>23.4%</td>
<td>0.2635</td>
</tr>
</tbody>
</table>

**Table A-2:** Summary of the Studied Factors - 100-Meter Radius Scale – Aggregated Accident Levels

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>WHITE</th>
<th>NON-WHITE</th>
<th>BLACK</th>
<th>HISPANIC</th>
<th>BEL POVERTY</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>89.0%</td>
<td>11.0%</td>
<td>6.4%</td>
<td>4.0%</td>
<td>8.2%</td>
<td>0.4094</td>
</tr>
<tr>
<td>1</td>
<td>519</td>
<td>79.7%</td>
<td>20.3%</td>
<td>14.2%</td>
<td>5.7%</td>
<td>13.5%</td>
<td>0.6451</td>
</tr>
<tr>
<td>2+</td>
<td>76</td>
<td>82.0%</td>
<td>18.0%</td>
<td>11.9%</td>
<td>6.4%</td>
<td>14.4%</td>
<td>0.7406</td>
</tr>
</tbody>
</table>

**Table A-3:** Summary of the Studied Factors - 100-Meter Radius Scale – Comparing Cells With and Without PRMVAs

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>WHITE</th>
<th>NON-WHITE</th>
<th>BLACK</th>
<th>HISPANIC</th>
<th>BEL POVERTY</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30511</td>
<td>89.0%</td>
<td>11.0%</td>
<td>6.4%</td>
<td>4.0%</td>
<td>8.2%</td>
<td>0.4094</td>
</tr>
<tr>
<td>1+</td>
<td>595</td>
<td>80.0%</td>
<td>20.0%</td>
<td>13.9%</td>
<td>5.7%</td>
<td>13.6%</td>
<td>0.6573</td>
</tr>
</tbody>
</table>
### APPENDIX B

**500-METER RADIUS SUMMARY TABLES**

**Table B-1:** Summary of the Studied Factors - 500-Meter Radius Scale – Each Accident Level

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>WHITE (%)</th>
<th>NON-WHITE (%)</th>
<th>BLACK (%)</th>
<th>HISPANIC (%)</th>
<th>BEL POVERTY (%)</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>91.5%</td>
<td>8.5%</td>
<td>4.4%</td>
<td>3.6%</td>
<td>7.2%</td>
<td>0.3292</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>84.9%</td>
<td>15.1%</td>
<td>9.8%</td>
<td>4.6%</td>
<td>10.4%</td>
<td>0.4287</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>83.3%</td>
<td>16.7%</td>
<td>10.6%</td>
<td>5.2%</td>
<td>12.2%</td>
<td>0.5316</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>81.4%</td>
<td>18.6%</td>
<td>11.7%</td>
<td>5.6%</td>
<td>14.0%</td>
<td>0.5314</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>64.6%</td>
<td>35.4%</td>
<td>30.1%</td>
<td>6.9%</td>
<td>18.5%</td>
<td>0.6072</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>73.7%</td>
<td>26.3%</td>
<td>21.2%</td>
<td>5.7%</td>
<td>18.0%</td>
<td>0.5866</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>78.0%</td>
<td>22.0%</td>
<td>17.9%</td>
<td>3.3%</td>
<td>17.8%</td>
<td>0.6984</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>92.0%</td>
<td>8.0%</td>
<td>1.6%</td>
<td>6.2%</td>
<td>9.5%</td>
<td>0.5771</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>73.0%</td>
<td>27.0%</td>
<td>15.1%</td>
<td>14.7%</td>
<td>15.0%</td>
<td>0.5265</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>84.1%</td>
<td>15.9%</td>
<td>9.8%</td>
<td>4.0%</td>
<td>23.3%</td>
<td>0.7291</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>89.0%</td>
<td>11.0%</td>
<td>7.3%</td>
<td>9.5%</td>
<td>9.1%</td>
<td>0.9000</td>
</tr>
</tbody>
</table>

**Table B-2:** Summary of the Studied Factors - 500-Meter Radius Scale – Aggregated Accident Levels

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>WHITE (%)</th>
<th>NON-WHITE (%)</th>
<th>BLACK (%)</th>
<th>HISPANIC (%)</th>
<th>BEL POVERTY (%)</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>91.5%</td>
<td>8.5%</td>
<td>4.4%</td>
<td>3.6%</td>
<td>7.2%</td>
<td>0.3292</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>84.9%</td>
<td>15.1%</td>
<td>9.8%</td>
<td>4.6%</td>
<td>10.4%</td>
<td>0.4287</td>
</tr>
<tr>
<td>2-4</td>
<td>129</td>
<td>80.2%</td>
<td>19.8%</td>
<td>13.6%</td>
<td>5.5%</td>
<td>13.5%</td>
<td>0.5421</td>
</tr>
<tr>
<td>5+</td>
<td>25</td>
<td>76.8%</td>
<td>23.2%</td>
<td>17.2%</td>
<td>6.6%</td>
<td>17.2%</td>
<td>0.6274</td>
</tr>
</tbody>
</table>
Table B-3: Summary of the Studied Factors - 500-Meter Radius Scale – Comparing Cells With and Without PRMVAs

<table>
<thead>
<tr>
<th>AX/CELL</th>
<th># CELLS</th>
<th>WHITE</th>
<th>NON-WHITE</th>
<th>BLACK</th>
<th>HISPANIC</th>
<th>BEL POVERTY</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1104</td>
<td>91.5%</td>
<td>8.5%</td>
<td>4.4%</td>
<td>3.6%</td>
<td>7.2%</td>
<td>0.3292</td>
</tr>
<tr>
<td>1+</td>
<td>354</td>
<td>82.6%</td>
<td>17.4%</td>
<td>11.7%</td>
<td>5.1%</td>
<td>12.0%</td>
<td>0.2553</td>
</tr>
</tbody>
</table>
Table C-1: Summary of the Studied Factors - 1-Kilometer Radius Scale – Each Accident Level

<table>
<thead>
<tr>
<th>AXICELL</th>
<th># CELLS</th>
<th>WHITE</th>
<th>NON-WHITE</th>
<th>BLACK</th>
<th>HISPANIC</th>
<th>BEL POVERTY</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>94.1%</td>
<td>5.9%</td>
<td>2.6%</td>
<td>3.0%</td>
<td>5.5%</td>
<td>0.2761</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>89.0%</td>
<td>11.0%</td>
<td>6.6%</td>
<td>3.7%</td>
<td>7.8%</td>
<td>0.4504</td>
</tr>
<tr>
<td>2</td>
<td>37</td>
<td>90.7%</td>
<td>9.3%</td>
<td>5.0%</td>
<td>3.9%</td>
<td>8.4%</td>
<td>0.4466</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>89.2%</td>
<td>10.8%</td>
<td>6.0%</td>
<td>4.7%</td>
<td>10.1%</td>
<td>0.4105</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>83.3%</td>
<td>16.7%</td>
<td>9.6%</td>
<td>5.7%</td>
<td>11.6%</td>
<td>0.4625</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>79.3%</td>
<td>20.7%</td>
<td>15.0%</td>
<td>5.2%</td>
<td>13.7%</td>
<td>0.5053</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>83.7%</td>
<td>16.3%</td>
<td>11.9%</td>
<td>3.8%</td>
<td>11.3%</td>
<td>0.4467</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>84.7%</td>
<td>15.3%</td>
<td>3.0%</td>
<td>6.1%</td>
<td>9.3%</td>
<td>0.3491</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>47.4%</td>
<td>52.6%</td>
<td>47.9%</td>
<td>4.0%</td>
<td>19.0%</td>
<td>0.5350</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>86.5%</td>
<td>13.5%</td>
<td>4.2%</td>
<td>4.1%</td>
<td>18.2%</td>
<td>0.3330</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>93.1%</td>
<td>6.9%</td>
<td>1.5%</td>
<td>4.9%</td>
<td>9.6%</td>
<td>0.6906</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>69.4%</td>
<td>30.6%</td>
<td>24.0%</td>
<td>6.6%</td>
<td>21.1%</td>
<td>0.6183</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>77.0%</td>
<td>23.0%</td>
<td>12.6%</td>
<td>16.0%</td>
<td>17.7%</td>
<td>0.1708</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>18.7%</td>
<td>81.3%</td>
<td>77.6%</td>
<td>2.9%</td>
<td>32.5%</td>
<td>0.7826</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>54.1%</td>
<td>46.0%</td>
<td>36.7%</td>
<td>5.9%</td>
<td>18.5%</td>
<td>0.8414</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>86.5%</td>
<td>13.5%</td>
<td>5.2%</td>
<td>12.5%</td>
<td>16.6%</td>
<td>0.5535</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>88.8%</td>
<td>11.3%</td>
<td>3.0%</td>
<td>5.7%</td>
<td>14.7%</td>
<td>0.2808</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>75.4%</td>
<td>24.6%</td>
<td>18.5%</td>
<td>9.1%</td>
<td>22.6%</td>
<td>0.8917</td>
</tr>
</tbody>
</table>
Table C-2: Summary of the Studied Factors - 1-Kilometer Radius Scale – Aggregated Accident Levels

<table>
<thead>
<tr>
<th>AX/CCELL</th>
<th># CELLS</th>
<th>WHITE</th>
<th>NONWHITE</th>
<th>BLACK</th>
<th>HISPANIC</th>
<th>BEL POVERTY</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>94.1%</td>
<td>5.9%</td>
<td>2.6%</td>
<td>3.0%</td>
<td>5.5%</td>
<td>0.2761</td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>89.0%</td>
<td>11.0%</td>
<td>6.6%</td>
<td>3.7%</td>
<td>7.8%</td>
<td>0.4504</td>
</tr>
<tr>
<td>2-4</td>
<td>87</td>
<td>88.2%</td>
<td>11.8%</td>
<td>6.6%</td>
<td>4.6%</td>
<td>9.8%</td>
<td>0.4402</td>
</tr>
<tr>
<td>5-9</td>
<td>27</td>
<td>76.1%</td>
<td>23.9%</td>
<td>18.1%</td>
<td>4.4%</td>
<td>13.7%</td>
<td>0.4626</td>
</tr>
<tr>
<td>10+</td>
<td>15</td>
<td>74.0%</td>
<td>26.0%</td>
<td>19.3%</td>
<td>7.9%</td>
<td>18.4%</td>
<td>0.6491</td>
</tr>
</tbody>
</table>

Table C-3: Summary of the Studied Factors - 1-Kilometer Radius Scale – Comparing Cells With and Without PRMVs

<table>
<thead>
<tr>
<th>AX/CCELL</th>
<th># CELLS</th>
<th>WHITE</th>
<th>NONWHITE</th>
<th>BLACK</th>
<th>HISPANIC</th>
<th>BEL POVERTY</th>
<th>SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>237</td>
<td>94.1%</td>
<td>5.9%</td>
<td>2.6%</td>
<td>3.0%</td>
<td>5.5%</td>
<td>0.2761</td>
</tr>
<tr>
<td>1+</td>
<td>191</td>
<td>85.7%</td>
<td>14.3%</td>
<td>9.2%</td>
<td>4.5%</td>
<td>10.4%</td>
<td>0.4631</td>
</tr>
</tbody>
</table>
APPENDIX D

REGRESSION SUMMARY TABLES

Table D-1: Binary Logistic Regression – 100-Meter Radius – All Factors

<table>
<thead>
<tr>
<th>100-M</th>
<th>N</th>
<th>B</th>
<th>sig</th>
<th>exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-White</td>
<td>31,106</td>
<td>0.018</td>
<td>0.000</td>
<td>1.018</td>
</tr>
<tr>
<td>Black</td>
<td>31,106</td>
<td>0.016</td>
<td>0.000</td>
<td>1.016</td>
</tr>
<tr>
<td>Hispanic</td>
<td>31,106</td>
<td>0.086</td>
<td>0.000</td>
<td>1.090</td>
</tr>
<tr>
<td>Below Poverty</td>
<td>31,106</td>
<td>0.074</td>
<td>0.000</td>
<td>1.076</td>
</tr>
</tbody>
</table>

Table D-2: Ordinary Least Squares Regression – 100-Meter Radius – All Factors

<table>
<thead>
<tr>
<th>100-M</th>
<th>N</th>
<th>B</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-White</td>
<td>595</td>
<td>0.000</td>
<td>0.745</td>
</tr>
<tr>
<td>Black</td>
<td>595</td>
<td>0.000</td>
<td>0.662</td>
</tr>
<tr>
<td>Hispanic</td>
<td>595</td>
<td>0.003</td>
<td>0.409</td>
</tr>
<tr>
<td>Below Poverty</td>
<td>595</td>
<td>0.003</td>
<td>0.187</td>
</tr>
<tr>
<td>SDI</td>
<td>595</td>
<td>0.090</td>
<td>0.091</td>
</tr>
</tbody>
</table>

Table D-3: Binary Logistic Regression – 500-Meter Radius – All Factors

<table>
<thead>
<tr>
<th>500-M</th>
<th>N</th>
<th>B</th>
<th>sig</th>
<th>exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-White</td>
<td>1,458</td>
<td>0.030</td>
<td>0.000</td>
<td>1.031</td>
</tr>
<tr>
<td>Black</td>
<td>1,458</td>
<td>0.026</td>
<td>0.000</td>
<td>1.026</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1,458</td>
<td>0.137</td>
<td>0.000</td>
<td>1.146</td>
</tr>
<tr>
<td>Below Poverty</td>
<td>1,458</td>
<td>0.239</td>
<td>0.000</td>
<td>1.269</td>
</tr>
<tr>
<td>SDI</td>
<td>1,458</td>
<td>1.549</td>
<td>0.000</td>
<td>4.705</td>
</tr>
</tbody>
</table>
APPENDIX D
(CONTINUED)

Table D-4: Ordinary Least Squares Regression – 500-Meter Radius – All Factors

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>B</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-White</td>
<td>354</td>
<td>0.009</td>
<td>0.017</td>
</tr>
<tr>
<td>Black</td>
<td>354</td>
<td>0.008</td>
<td>0.035</td>
</tr>
<tr>
<td>Hispanic</td>
<td>354</td>
<td>0.059</td>
<td>0.000</td>
</tr>
<tr>
<td>Below Poverty</td>
<td>354</td>
<td>0.088</td>
<td>0.000</td>
</tr>
<tr>
<td>SDI</td>
<td>354</td>
<td>1.552</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table D-5: Binary Logistic Regression – 1-Kilometer Radius – All Factors

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>B</th>
<th>sig</th>
<th>exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-White</td>
<td>428</td>
<td>0.074</td>
<td>0.000</td>
<td>1.077</td>
</tr>
<tr>
<td>Black</td>
<td>428</td>
<td>0.054</td>
<td>0.000</td>
<td>1.056</td>
</tr>
<tr>
<td>Hispanic</td>
<td>428</td>
<td>0.472</td>
<td>0.000</td>
<td>1.604</td>
</tr>
<tr>
<td>Below Poverty</td>
<td>428</td>
<td>0.292</td>
<td>0.000</td>
<td>1.339</td>
</tr>
<tr>
<td>SDI</td>
<td>428</td>
<td>2.485</td>
<td>0.000</td>
<td>12.001</td>
</tr>
</tbody>
</table>

Table D-6: Ordinary Least Squares Regression – 1-Kilometer Radius – All Factors

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>B</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-White</td>
<td>191</td>
<td>0.056</td>
<td>0.000</td>
</tr>
<tr>
<td>Black</td>
<td>191</td>
<td>0.049</td>
<td>0.001</td>
</tr>
<tr>
<td>Hispanic</td>
<td>191</td>
<td>0.569</td>
<td>0.000</td>
</tr>
<tr>
<td>Below Poverty</td>
<td>191</td>
<td>0.295</td>
<td>0.000</td>
</tr>
<tr>
<td>SDI</td>
<td>191</td>
<td>3.914</td>
<td>0.002</td>
</tr>
</tbody>
</table>