

## EXAMINING SOCIAL VULNERABILITY AND THE ASSOCIATION WITH PEDESTRIAN CRASHES

2016-2020 Pedestrian Crashes



**SUMMARY:** This issue brief examines the association between the Centers for Disease Control and Prevention (CDC)'s Social Vulnerability Index (SVI) and crashes that result in pedestrian serious injuries or fatalities in Georgia by region. The relationship between the nationally standardized SVI and the rate of pedestrian serious injury and fatal crashes was determined using three different analytical methods: 1) bivariate mapping, 2) difference in mean tests among SVI quintiles, and 3) regression analyses. All methods show a statistically significant positive correlation between the vulnerability of the census tract population and the rates of pedestrian serious and fatal injury crashes. This relationship was present for overall vulnerability as well as socioeconomic status, household composition and disability, minority status and language, and housing type and transportation vulnerability themes. The rates of serious injury and fatal pedestrian crashes increase as the census tract vulnerability increases across the Atlanta region, other urban counties, and rural counties. CDC's SVI data and other related sociodemographic variables can be leveraged to impartially assess roadway and public health concerns related to pedestrian safety. The findings from this analysis may encourage stakeholders to apply SVI assessments when implementing and identifying pedestrian safety efforts (i.e., engineering improvements, programmatic interventions, campaigning and education efforts, and other countermeasures to improve pedestrian safety).

### Introduction

Over the past decade (2011-2020), the rise of pedestrian serious injuries and fatalities on the roadway has been a growing concern in the United States and the state of Georgia. In Georgia, overall traffic-related fatalities increased by 36 percent, traffic fatalities that did not involve pedestrians increased by 26 percent, and pedestrian-related traffic fatalities more than doubled between 2011 and 2020. Pedestrian fatal and serious injury rates differ among specific sociodemographic groups. In 2020, Non-Hispanic Black/African Americans were 1.8 times more likely to be fatally injured in a motor vehicle traffic crash compared to their Non-Hispanic White counterpart. Vulnerable road users such as persons aged 65 years and over also experienced a higher rate of pedestrian fatalities compared to other age groups.

Recently, federal and state agencies have taken a more holistic approach to addressing traffic safety issues by implementing the Safe System approach. This approach focuses on developing transportation systems that accommodate human mistakes and increase the survivability of serious crashes by assessing road user behavior, roadway designs, and post-crash care. Additionally, traffic safety practitioners, roadway engineers, and public health professionals have taken steps to incorporate sociodemographic data into the Safe System approach. USDOT promotes the use of sociodemographic data to make systematic and impartial decisions that improve the safety of communities that are underserved or vulnerable.

The Centers for Disease Control and Prevention (CDC) created the Social Vulnerability Index (SVI), which assesses and prioritizes geographic areas that may be vulnerable in their ability to respond and prepare for public health emergencies and disasters. Though the SVI was not primarily developed for traffic safety analysis, it is a valuable data source that can identify vulnerable populations at the census tract level. The goal of this investigation is to:

1. Describe the spatial relationship between SVI and pedestrian serious injury and fatal crashes across the Georgia regions (Atlanta Region, other urban counties, and rural counties);
2. Compare the differences in the pedestrian serious injury and fatal crash rates by SVI quintiles across the Georgia regions; and
3. Examine the association between the SVI and pedestrian serious injury and fatal crashes across the Georgia regions.

## Methods

### Geo-Mapping Pedestrian Crashes

The location of pedestrian serious injury and fatal crashes were obtained from the Fatality Analysis Reporting System (FARS) and the Georgia Department of Transportation's Numetric crash data platform. Serious injury pedestrian crashes are crashes with no pedestrian fatalities, but at least one pedestrian was reported by law enforcement to have a serious injury.<sup>1</sup> A pedestrian fatal crash is a traffic crash resulting in the death of at least one pedestrian within 30 days.

Between 2016 and 2020, there were 1,245 fatal pedestrian crashes and 1,892 serious injury pedestrian crashes that occurred in Georgia. The geographic coordinates of these crashes were mapped using ArcMap v.10.8.2. The counts of pedestrian serious injury and fatal crashes were then aggregated at the census tract level using the 2018 CDC SVI census tract shapefiles (CDC,

2018). The crash rate was determined by taking the average number of crashes within the five-year period (2016-2020), divided by the 2014-2018 estimated population number (ACS, 2018).

### CDC's Social Vulnerability Index

The CDC SVI identifies socially vulnerable populations by combining 15 sociodemographic data elements from the 2014-2018 American Community Survey estimates. The SVI value (ranging from zero to one) is a percentile rank that equates to the percentage of census tracts that are at or below the SVI value—the greater the SVI, the more tracts that are below the value, and the greater the vulnerability. CDC grouped related SVI variables into four themes: Socioeconomic Status, Household Composition & Disability, Minority Status & Language, and Housing Type & Transportation.

**Figure 1. 2018 CDC Social Vulnerability Themes and Related Sociodemographic Variables**

Overall Vulnerability	Socioeconomic Status	Below Poverty
		Unemployed
		Income
		No High School Diploma
	Household Composition & Disability	Aged 65 or Older
		Aged 17 or Younger
		Civilian with a Disability
		Single-Parent Households
	Minority Status & Language	Minority
		Speaks English "Less than Well"
	Housing Type & Transportation	Multi-Unit Structures
		Mobile Homes
		Crowding
		No Vehicle
		Group Quarters

Adopted from the 2018 CDC SVI Documentation

<sup>1</sup> Suspected serious injury is used when any injury, other than fatal injury, prevents the injured person from walking, driving, or normally continuing the activities the person was capable of before the injury occurred. A suspected serious injury may result in one or more of the following: • Severe laceration resulting in exposure of underlying tissues/muscle/organs or resulting in significant loss of blood • Broken or

distorted extremity (arm or leg) • Crush injuries • Suspected skull, chest or abdominal injury other than bruises or minor lacerations • Significant burns (second and third-degree burns over ten percent or more of the body) • Unconsciousness when taken from the crash scene • Paralysis.

For this study, the SVI measures (overall vulnerability and by each theme) were analyzed as a continuous variable to examine the spatial relations and associations between SVI and pedestrian crash outcomes. The SVI scores were also grouped into quintiles to compare the differences in crash outcomes by quintile grouping.

### Analysis

The analysis included 1,966 census tracts in Georgia that were predominately a residential population and excluded tract segments that were predominately college campuses, military institutions, or similar non-residential demographic. The census tracts used in the analysis were grouped into the following categories that describe the Georgia rural and urban regions: the Atlanta Region<sup>2</sup>, other urban counties, and rural<sup>3</sup> counties. Descriptive data were reported by each Georgia region; however, the census tract data (more granular) was used to examine clustering, differences, and correlations. Three methods are used to assess the relationship between SVI and the rate of pedestrian serious injury and fatal crashes.

1. A bivariate map was created to display the relationship between SVI scores and the rate of pedestrian serious injury and fatal crashes at the census tract level using ArcMap v.10.8.2.
2. A Kruskal-Wallis test was conducted to examine differences in pedestrian serious injury and fatal crash rates across the overall SVI quintiles and SVI theme quintiles. This relationship was tested in the Atlanta Region, other urban counties, and rural counties.
3. Regression analyses were performed to determine the association of SVI to pedestrian serious injury and fatal crash rates. A negative binomial distribution is assumed due to the over dispersed nature of crash data.

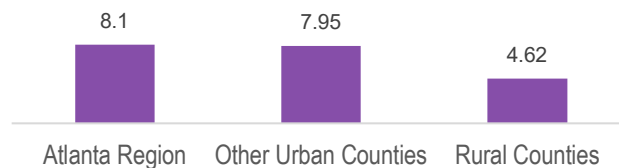
<sup>2</sup> The Atlanta Region includes the ten counties that are defined by the Atlanta Regional Commission (ARC): Cherokee, Clayton, Cobb, DeKalb, Douglas, Fayette, Fulton, Gwinnett, Henry, and Rockdale counties.

## Results

### Descriptive Statistics

Between 2016 and 2020, 3,134 motor vehicle traffic crashes in Georgia resulted in at least one pedestrian serious injury or fatality. Within this 5-year period, nearly half of these incidences occurred in Atlanta Region (49 percent), followed by the other urban counties (34 percent) and rural counties (16 percent). The mean serious injury and fatal pedestrian crash rate per 100,000 population-year is 8.10 in the Atlanta Region, 7.95 in other urban counties, and 4.62 in rural counties (see Figure 2).

**Figure 2. Mean Serious Injury and Fatal Pedestrian Crash Rate (per 100,000 census tract population-year) by Georgia Region**



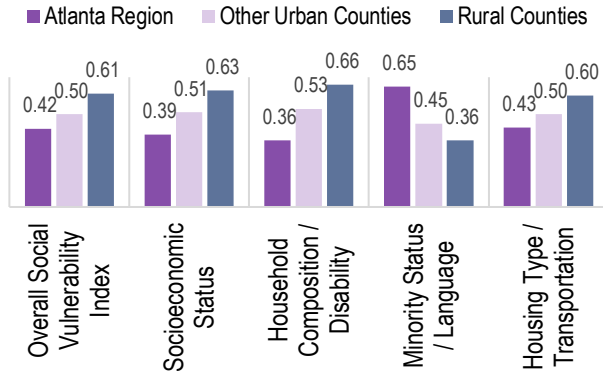
Source: 2016-2018 Numetric; 2014-2018 American Community Survey Estimated Population by Census Tract

The ten counties in the Atlanta Region are less vulnerable (overall SVI score of 0.42) compared to other urban counties (SVI of 0.50) and rural counties (0.61). As shown in Figure 3, this general pattern applies to all the other SVI themes, except for Minority Status & Language (Theme 3). Rural counties are least vulnerable for the minority status and language theme (score of 0.36) compared to the Atlanta Region (0.65) and other urban counties (0.45).

These findings summarize social vulnerability and rates of pedestrian serious and fatal injury crashes by the Georgia regions; however, the trends are different when looking at more granular data at the census tract level as described in the other analytical methods.

<sup>3</sup>Rural counties are counties that have a residential population less than 50,000 persons. This is different than roadway classifications where urban road systems can be located in urban clusters (or metropolitan areas) of at least 2,500 persons within the rural counties.

**Figure 3. Mean Social Vulnerability Index (SVI) and SVI Themes by Georgia Region**



Source: 2018 CDC SVI

Table A1 in the appendix compares descriptive statistics for pedestrian crash rates, pedestrian serious injury and fatal rates, overall SVI scores, and SVI theme scores across the three Georgia regions.

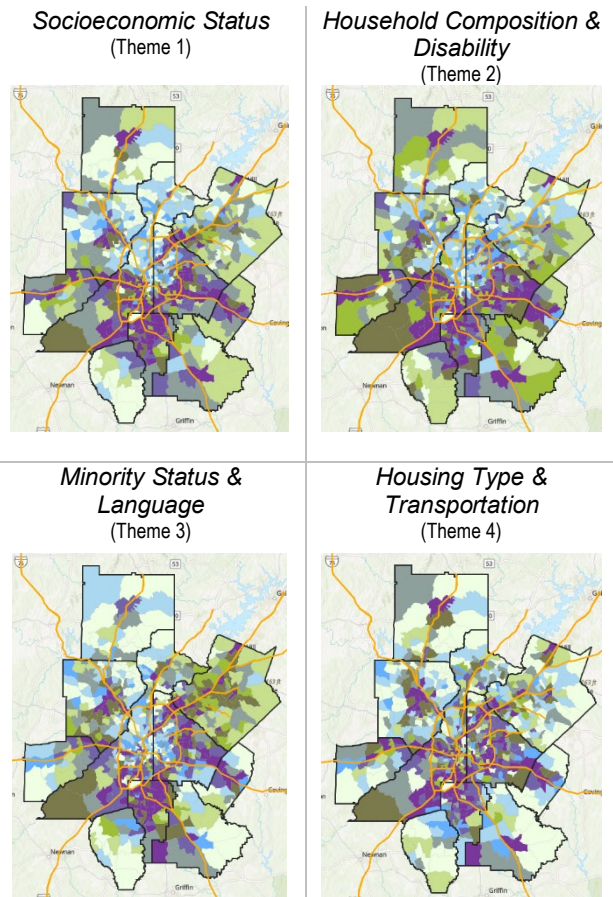
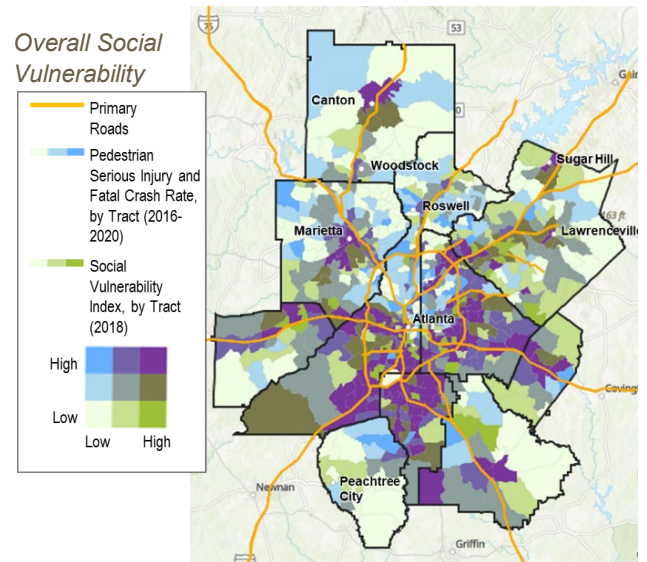
### Bivariate Mapping

Moran's I analysis showed significant spatial clustering of the rate of serious and fatal injury pedestrian crashes within the Atlanta Region (Moran's I = 0.225). The rate of serious and fatal pedestrian crashes in other urban counties, which are scattered throughout Georgia, showed dispersion and randomness (Moran's I = -0.147). The rate of serious and fatal pedestrian crashes was nearly random throughout Georgia's rural counties (Moran's I = 0.027).

Figure 4 displays a bivariate map of the rate of serious injury and fatal pedestrian crashes and the SVI (overall and theme) by census tract for the Atlanta Region. The census tracts with the most vulnerability and higher rates of pedestrian serious and fatal injury crashes are primarily concentrated in the southern regions of Fulton County near the I-285 and I-85 intersection. This pattern in south Fulton County applies to the overall SVI and each SVI theme.

Figure A1 in the appendix shows a statewide bivariate map of serious injury and fatal pedestrian crash rates and overall SVI.

**Figure 4. Bivariate Map of Serious Injury and Fatal Pedestrian Crash Rates (per 100,000 census tract population) and Social Vulnerability Index in the Atlanta Region, by Overall SVI and SVI Themes**



The Atlanta Region includes the ten counties that are defined by the Atlanta Regional Commission (ARC): Cherokee, Clayton, Cobb, DeKalb, Douglas, Fayette, Fulton, Gwinnett, Henry, and Rockdale counties.

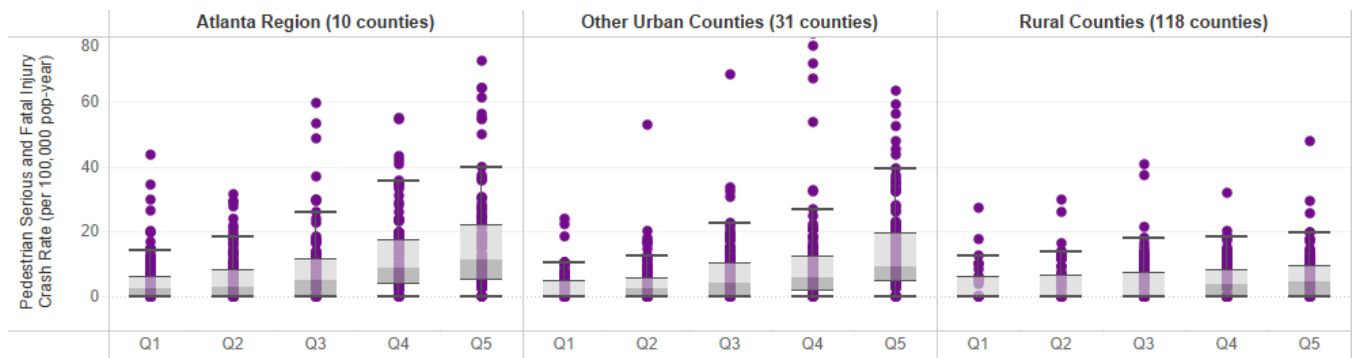


**Comparison Analysis**

Figure 5 displays the distribution of pedestrian serious and fatal injury crash rates among overall SVI quintiles for the Georgia regions. Across each region, there were significant differences in the rates of pedestrian serious and fatal injury crashes by the quintiles for *overall* SVI (shown in Figure 5). The rates of pedestrian serious and fatal crashes are higher in more vulnerable census tracts.

The Kruskal Wallis results (Table A2) show a significant difference in rates and vulnerability quintiles across all but one SVI theme. There is no significant difference between pedestrian serious and fatal injury crash rates across the socioeconomic status vulnerability quintiles in rural counties.

**Figure 5. Distribution of Census Tract Pedestrian Serious and Fatal Injury Crash Rate (per 100,000 population-year) by Overall SVI Quintile and Georgia Region**



**Regression Analysis**

Table 1 displays show the correlation between the SVI scores (overall and theme) and the rates of pedestrian serious and fatal injury crashes. All SVI themes have a positive and significant relationship between SVI and the pedestrian crash rate in Atlanta Regions, other urban counties, and rural counties.

Table A3 in the appendix shows a correlation between each SVI sociodemographic variable and pedestrian crash rates. In the Atlanta Region, all but four sociodemographic variables have a significant positive relationship with pedestrian serious and fatal injury crash rates. The four variables that do not have a significant correlation were Aged 65 or Older, Aged 17 or Younger, Speaks English "Less than Well," and Mobile Homes.

**Table 1. Summary Results of the Correlation between Social Vulnerability Index and Rate of Pedestrian Serious and Fatal Injury Crashes by Georgia Region**

Social Vulnerability Index Theme	Atlanta Region (10 counties)			Other Urban Counties (31 counties)			Rural Counties (118 counties)		
	Coefficient	95% CI	p-value	Coefficient	95% CI	p-value	Coefficient	95% CI	p-value
Social Vulnerability Index	1.94	(1.51, 2.37)	<0.001	2.03	(1.56, 2.49)	<0.001	0.82	(0.74, 0.90)	<0.001
Socioeconomic Status	1.85	(1.42, 2.28)	<0.001	2.10	(1.63, 2.57)	<0.001	0.40	(0.31, 0.48)	<0.001
Household Composition & Disability	0.88	(0.38, 1.38)	<0.001	0.86	(0.37, 1.36)	<0.001	0.75	(0.67, 0.83)	<0.001
Minority Status & Language	1.42	(0.94, 1.91)	<0.001	0.90	(0.36, 1.43)	<.01	0.62	(0.55, 0.69)	<0.001
Housing Type & Transportation	2.06	(1.61, 2.50)	<0.001	1.93	(1.46, 2.40)	<0.001	0.61	(0.54, 0.68)	<0.001

## Conclusion and Recommendations

This study illustrates a positive and significant correlation between the CDC's social vulnerability index (SVI) and the rates of pedestrian serious and fatal injury crashes. This relationship was present in the Atlanta Regions, other urban counties, and rural counties. The relationship in rural counties is not significant under some statistical tests. As the vulnerability of the census tract population increases, the rates of pedestrian serious and fatal crashes also increase. Furthermore, this relationship was present with the four SVI themes that include 1) socioeconomic status, 2) household composition and disability, 3) minority status and language, and 4) housing type and transportation. There are also significant differences in the rates experienced in the least vulnerable (first and second quintiles) and most vulnerable (fourth and fifth quintiles) census tracts.

The correlation identified implies that SVI can be used to gauge pedestrian safety systemically and proactively. It is encouraged to utilize SVI assessment to address pedestrian safety concerns from viewpoints that include public health, engineering, planning, and more. CDC's SVI data is now included in the Georgia Department of Transportation's Numetric crash data platform. Therefore, this information is readily available for practitioners to use in Georgia.

### Additional Information:

See the 2020 Non-Motorist (Pedestrians and Bicyclists) Georgia Traffic Safety Facts for more information on non-motorist traffic crashes, serious injuries, and fatalities.

### References:

Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program.  
CDC/ATSDR Social Vulnerability Index 2018 Database Georgia.

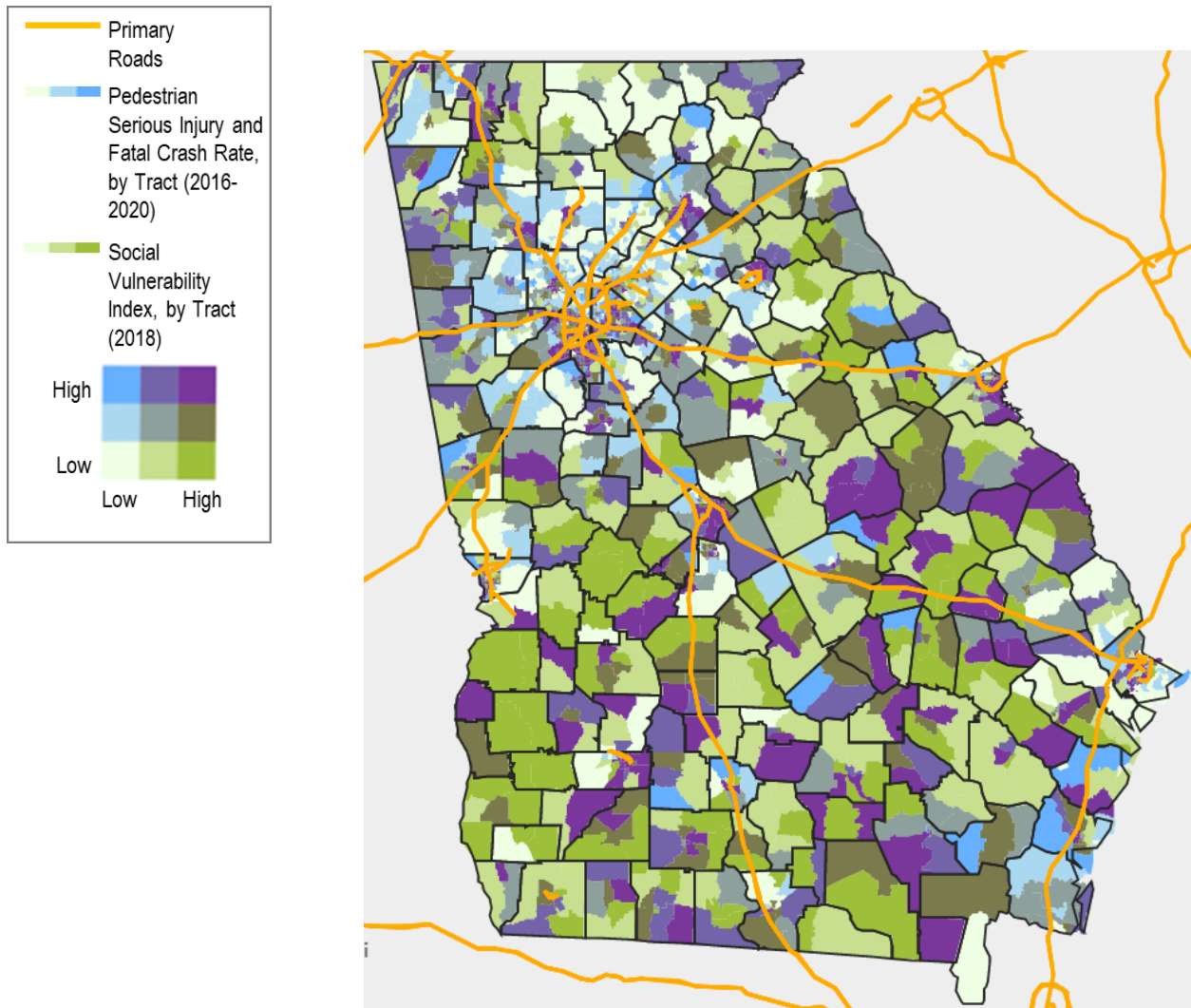
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**Table A1. Descriptive Statistics of Study Variables by Georgia Region**

Study Variables	Statistic Measure	Atlanta Region (10 counties)	Other Urban Counties (31 counties)	Rural Counties (118 counties)
<b>Pedestrian Crash Rate</b> per 100,000 Population-Year	Mean ± Std. Deviation	50.54 ± 71.93	35.89 ± 65.32	17.17 ± 17.60
	Median (Range)	27.07 (0 - 890.21)	18.41 (0 - 1,160.37)	13.10 (0 - 132.37)
	Number of Tracts	735	705	516
<b>Serious and Fatal Injury Pedestrian Crash Rate</b> per 100,000 Population-Year	Mean ± Std. Deviation	8.10 ± 11.73	7.95 ± 14.43	4.62 ± 6.33
	Median (Range)	4.32 (0 - 130.14)	4.19 (0 - 159.54)	2.53 (0 - 47.71)
	Number of Tracts	735	705	516
<b>Overall Social Vulnerability Index</b>	Mean ± Std. Deviation	0.42 ± 0.30	0.5 ± 0.29	0.61 ± 0.23
	Median (Range)	0.38 (0 - 1)	0.48 (0 - 1)	0.62 (0.01 - 1)
	Number of Tracts	733	704	515
<b>Socioeconomic Status</b> (Theme 1)	Mean ± Std. Deviation	0.39 ± 0.29	0.51 ± 0.29	0.63 ± 0.22
	Median (Range)	0.32 (0 - 1)	0.49 (0 - 1)	0.66 (0.03 - 0.99)
	Number of Tracts	733	704	515
<b>Household Composition &amp; Disability</b> (Theme 2)	Mean ± Std. Deviation	0.36 ± 0.26	0.53 ± 0.29	0.66 ± 0.23
	Median (Range)	0.31 (0 - 1)	0.52 (0 - 1)	0.69 (0 - 1)
	Number of Tracts	734	705	515
<b>Minority Status &amp; Language</b> (Theme 3)	Mean ± Std. Deviation	0.65 ± 0.27	0.45 ± 0.26	0.36 ± 0.25
	Median (Range)	0.72 (0 - 1)	0.43 (0 - 1)	0.33 (0 - 0.96)
	Number of Tracts	735	705	516
<b>Housing Type &amp; Transportation</b> (Theme 4)	Mean ± Std. Deviation	0.43 ± 0.29	0.5 ± 0.29	0.6 ± 0.26
	Median (Range)	0.41 (0 - 1)	0.49 (0 - 1)	0.64 (0.04 - 0.99)
	Number of Tracts	733	705	515

**Figure A1. Statewide Bivariate Map of Serious Injury and Fatal Pedestrian Crash Rates (per 100,000 census tract population) and Overall Social Vulnerability Index**





**Table A2. Kruskal Wallis Test Results of Difference in Serious Injury and Fatal Pedestrian Crash Rates among Social Vulnerability Index Quintiles (Overall and Theme) by Georgia Region**

Theme / Quintile		Atlanta Region (10 counties)					Other Urban (31 counties)					Rural (118 counties)				
		n	Mean Rank	df	$\chi^2$	p	n	Mean Rank	df	$\chi^2$	p	n	Mean Rank	df	$\chi^2$	p
<b>Social Vulnerability Index</b> Overall	Q1 [least vulnerable]	229	272.24	4	121.48	<.001	131	252.92	4	124.31	<.001	30	217.77	4	15.29	0.004
	Q2	152	331.84				163	276.58				75	229.83			
	Q3	118	372.11				136	353.76				136	239.82			
	Q4	125	460.94				120	402.76				145	270.23			
	Q5 [most vulnerable]	108	499.71				154	477.29				129	289.15			
<b>Socioeconomic Status</b> (Theme 1)	Q1	253	276.5	4	122.11	<.001	116	246.80	4	119.27	<.001	<u>21</u>	<u>232.71</u>	<u>4</u>	<u>6.06</u>	<u>0.195</u>
	Q2	165	330.19				162	280.56				<u>63</u>	<u>240.19</u>			
	Q3	104	415.28				156	361.4				<u>130</u>	<u>271.42</u>			
	Q4	115	460.35				110	373.95				<u>165</u>	<u>244.67</u>			
	Q5	95	502.22				160	478.56				<u>136</u>	<u>273.50</u>			
<b>Household Composition &amp; Disability</b> (Theme 2)	Q1	249	348.43	4	45.2	<.001	117	307.80	4	51.49	<.001	24	214.50	4	18.61	0.001
	Q2	187	308.25				138	313.58				66	223.26			
	Q3	139	381.12				150	310.04				101	256.18			
	Q4	94	443.95				142	374.84				155	242.84			
	Q5	64	467.23				158	442.06				169	292.74			
<b>Minority Status &amp; Language</b> (Theme 3)	Q1	61	271.89	4	54.15	<.001	158	294.02	4	42.55	<.001	172	238.51	4	18.29	0.001
	Q2	92	275.62				159	326.64				140	266.42			
	Q3	137	342.56				166	356.89				88	229.11			
	Q4	164	379.94				140	383.4				87	305.80			
	Q5	281	424.55				82	457.96				28	277.89			
<b>Housing Type &amp; Transportation</b> (Theme 4)	Q1	195	248.65	4	114.47	<.001	146	264.11	4	85.31	<.001	46	216.60	4	15.01	0.005
	Q2	157	348.21				143	287.67				90	228.87			
	Q3	142	389.02				146	368.43				103	254.87			
	Q4	139	446.75				125	401.38				126	260.45			
	Q5	97	477.52				144	447.92				150	288.27			

**Table A3. Correlation between Social Vulnerability Index Related Sociodemographic Variables and Rate of Pedestrian Serious and Fatal Injury Crashes by Georgia Region**

Social Vulnerability Themes and Related Sociodemographic Variables		Atlanta Region (10 counties)			Other Urban Counties (31 counties)			Rural Counties (118 counties)		
		Coefficient	95% CI	p-value	Coefficient	95% CI	p-value	Coefficient	95% CI	p-value
Socioeconomic Status	Below Poverty	2.03	(1.60, 2.46)	<.001	2.17	(1.73, 2.63)	<.001	0.60	(0.52, 0.69)	<.001
	Unemployed	1.30	(0.86, 1.76)	<.001	1.40	(0.94, 1.86)	<.001	<i>0.03</i>	<i>(-0.04, 0.10)</i>	<i>0.42</i>
	Income	1.53	(1.10, 1.96)	<.001	1.54	(1.05, 2.04)	<.001	0.60	(0.52, 0.69)	<.001
	No High School Diploma	1.44	(0.97, 1.91)	<.001	1.34	(0.85, 1.84)	<.001	0.20	(0.12, 0.29)	<.001
Household Composition & Disability	Aged 65 or Older	<u>-0.56</u>	<u>(-1.05, -0.08)</u>	<u>0.02</u>	<u>-0.09</u>	<u>(-0.64, 0.46)</u>	<u>0.74</u>	<u>-0.52</u>	<u>(-0.60, -0.44)</u>	<u>&lt;.001</u>
	Aged 17 or Younger	<u>-0.13</u>	<u>(-0.58, 0.33)</u>	<u>0.57</u>	<u>-0.28</u>	<u>(-0.78, 0.22)</u>	<u>0.27</u>	0.47	(0.41, 0.55)	<.001
	Civilian with a Disability	1.06	(0.53, 1.61)	<.001	1.31	(0.79, 1.85)	<.001	0.61	(0.52, 0.71)	<.001
	Single-Parent Households	1.04	(0.61, 1.48)	<.001	0.90	(0.42, 1.38)	<.001	0.65	(0.59, 0.73)	<.001
Minority Status & Language	Minority	1.99	(1.53, 2.46)	<.001	1.71	(1.23, 2.20)	<.001	0.85	(0.78, 0.93)	<.001
	Speaks English "Less than Well"	<i>0.12</i>	<i>(-0.33, 0.57)</i>	<i>0.59</i>	<i>-0.26</i>	<i>(-0.73, 0.21)</i>	<i>0.27</i>	0.18	(0.13, 0.25)	<.001
Housing Type & Transportation	Multi-Unit Structures	1.26	(0.90, 1.63)	<.001	0.89	(0.46, 1.34)	<.001	0.76	(0.69, 0.84)	<.001
	Mobile Homes	<u>-0.28</u>	<u>(-0.86, 0.29)</u>	<u>0.33</u>	<u>-0.53</u>	<u>(-1.05, -0.01)</u>	<u>0.05</u>	<u>-0.07</u>	<u>(-0.19, 0.05)</u>	<u>0.24</u>
	Crowding	0.89	(0.49, 1.30)	<.001	0.76	(0.31, 1.22)	<.001	<i>0.03</i>	<i>(-0.03, 0.10)</i>	<i>0.28</i>
	No Vehicle	1.92	(1.52, 2.34)	<.001	2.02	(1.58, 2.47)	<.001	1.20	(1.12, 1.28)	<.001
	Group Quarters	0.66	(0.27, 1.05)	<.001	0.86	(0.50, 1.24)	<.001	0.10	(0.06, 0.15)	<.001

Note: Underlined text indicates a negative coefficient (i.e., a negative relationship between the variable and serious and injury crash rate, the italicized text indicates an insignificant correlation. Not all variables had a significant and/or positive relationship to serious and injury crash rate due to various other contributing crash factors on the roadway.