Scholar Commons
USF University of South Florida

University of South Florida
Scholar Commons

Graduate Theses and Dissertations

Graduate School

1-1-2015

Risk-Taking Characteristics as Explanatory Variables in Variations of Fatality Rates in the Southeastern United States

Jodi Anne Godfrey
University of South Florida, jodis@mail.usf.edu

Follow this and additional works at: http://scholarcommons.usf.edu/etd

Part of the Civil Engineering Commons, and the Transportation Engineering Commons

Scholar Commons Citation

Godfrey, Jodi Anne, "Risk-Taking Characteristics as Explanatory Variables in Variations of Fatality Rates in the Southeastern United States" (2015). *Graduate Theses and Dissertations.*
http://scholarcommons.usf.edu/etd/5483

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.

المنارة للاستشارات

www.manaraa.com

Risk-Taking Characteristics as Explanatory Variables in Variations of Fatality Rates in the Southeastern United States

by

Jodi A. Godfrey

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Civil Engineering
with a concentration in Transportation Engineering
Department of Civil and Environmental Engineering
College of Engineering
University of South Florida

Co-Major Professor: Steven Polzin, Ph.D.
Co-Major Professor: Abdul Pinjari, Ph.D.
Xuehao Chu, Ph.D.

Date of Approval:
March 20, 2015

Keywords: socio-demographic characteristics, linear regression analysis, bivariate correlation analysis, fatalities, risk-taking behavior

Copyright © 2015, Jodi A. Godfrey

المنارة للاستشارات

www.manaraa.com

DEDICATION

This thesis is dedicated to my husband who has been my rock, support, and guidance in all major decision making throughout my adult life, in addition to building the confidence needed to succeed in all aspects of my academic career and beyond. To my son, who motivates me to do the best I can at every endeavor, and also to my late father, who passed away due to a motorcycle accident when I was a teenager which influenced my passion to make the roads a safer network for all users.

المنارة للاستشارات
www.manaraa.com

ACKNOWLEDGMENTS

I would like to acknowledge my astounding advisors and committee. My professor, supervisor, and co-advisor Steve Polzin, Ph.D. for all the guidance, effort, and interest he provided me with through the entire thesis process. In addition I would like to acknowledge my professor and co-advisor Abdul Pinjari, Ph.D. for his guidance, and suggestions throughout the thesis process. Acknowledgment is also due to Xuehao Chu, Ph.D. for his guidance and support throughout the entire process. Finally I would like to acknowledge the Center for Urban Transportation Research (CUTR) for all the support, resources, and knowledge the center provided me with as a graduate research assistant throughout my graduate studies, without which I would not have had the opportunity I was provided with.

المنارة للاستشارات
www.manaraa.com

TABLE OF CONTENTS

المنارة للاستشارات
www.manaraa.com

المنارة للاستشارات
www.manaraa.com

LIST OF TABLES

المنارة للاستشارات

www.manaraa.com

LIST OF FIGURES

المنارة للاستشارات

www.manaraa.com

ABSTRACT

Traffic fatalities accounted for 1.24 million lives lost in 2013 worldwide, and almost 33 thousand of those fatalities were in the U.S. in 2013. The southeastern region of the nation stands out for continuously having higher fatality rates per mile driven than the national average. If one can establish compelling relationships between various factors and fatality rates, then policies and investments can be targeted to increase the safety on the network by focusing on policies that mitigate those factors. In this research effort risk-taking characteristics are explored. These factors have not been as comprehensively reviewed as conventional factors such as vehicle and facility conditions associated with safety. The hypothesis assumes if a person exhibits risk-taking behavior, that risk-taking behavior is not limited to only one aspect of risk, but is likely to occur in multiple facets of the person's life. Some of the risk-taking characteristics explored include credit score, safety belt use, smoking and tobacco use, drug use, mental health, educational attainment, obesity, and overall general health characteristics. All risk-taking characteristics with the exception of mental health were found to have statistically significant correlations with fatality rates alone. However, when a regression model was formed to estimate fatality rates by risk-taking characteristics, only four risk-taking characteristics – credit score, educational attainment, overall poor health, and seat belt use were found to be statistically significant at an integrated level with other

المنارة للاستشارات

www.manaraa.com

demographic characteristics such as unemployment levels and population born is state of residency. By identifying at-risk population segments, education, counseling, enforcement, or other strategies may be deployed to help improve travel safety.

المنارة للاستشارات

www.manaraa.com

CHAPTER 1:

INTRODUCTION

1.1 Background

Traffic fatalities account for an astonishing 1.24 million deaths per year worldwide (*Global Status Report on Road Safety,* 2013). In the United States nearly 33 thousand lives were lost in motor vehicle crashes ("Traffic Safety Facts," 2014). These alarming statistics are coupled with the economic costs of motor vehicle crashes, which in 2010 were an estimated $277 billion in the United States (Economic and Societal Impact of Motor Vehicle Crashes, 2014). These statistics leave no wonder as to why safety is of the utmost importance in all transportation sectors. Safety is a complicated issue with many interrelated factors which affect the safety of a roadway network. With the complete understanding that there are several factors not explored in this thesis, the focus is mostly on risk-taking behavior as a construct to fatality rates. Many studies have been performed to distinguish the factors associated with the variation in safety measures throughout the United States and the world. The southeastern region of the U.S. stands out for having some of the highest rates of injury and fatality crashes per capita, which has led to several studies that try to explain the unsafe anomalies associated with the southeastern region. The majority of previous studies have focused on physical design of infrastructure, weather, government policies, and socio-demographic

المنارة للاستشارات
www.manaraa.com

factors such as gender, age, race and ethnicity; such as: "Stop Sign Violations: The role of race and ethnicity on fatal crashes," by Romano, Voas and Tippetts, which describes the role of race/ethnicity in fatal crashes, "Analyzing Road Safety in the United States," by Oster and Strong, which reviews the road safety performance in theU.S., "Injury Severity of Multivehicle Crash in Rainy Weather," by Jung, Qin, and Noyce, which studied effects of rainy weather on injury severity of crashes, and "A call to Safety," by Heller, which addresses issues about distracted driving policies in the U.S. All of the issues from previous studies are important and have significant impacts on the safety of the roadway network. However, this thesis is different in that the focus is on risk-taking behaviors, cultural factors, and health factors associated with the socio-demographic characteristics as possible explanatory factors in the variation of fatality rates in the southeastern region of the U.S.

There are several definitions of risk-taking behavior available. Risk taking behavior is defined as, "any consciously, or non-consciously controlled behavior with a perceived uncertainty about its outcome, and/or about its possible benefits or costs for the physical, economic, or psycho-social well-being of oneself or others (Trimpop, 1994)." Another definition of risk-taking behavior is "the tendency to engage in behaviors that have the potential to be harmful or dangerous, yet at the same time provide the opportunity for some kind of outcome that can be perceived as positive (Tull, 2014)." Yet another alternative definition of risk-taking behavior is the actions of a person when facing the possibility of physical, social, or financial harm due to a hazard, uncertainty in outcomes, or to seek feelings of excitement (Rohrmann, 2002). The risk-taking driving behaviors that are being referred to in this thesis are the unhealthy risk-taking driving behaviors, some of which are

المنارة للاستشارات
www.manaraa.com

avoidable choices, and some of which are often unavoidable such as driving to work in adverse weather, or driving home in the dark. The idea that an individual is more likely to engage in risky driving behaviors if they are willing to engage in other unhealthy risk-taking behavior in their life decisions comes from the idea that each type of risk is associated with the individual's perception of their self-worth, self-esteem, and confidence (McLeod, S.A., 2012). Examples of other risky behavior in life decisions are the choice to smoke, drink alcohol, use illicit drugs, drop out of school, recklessly take out lines of credit that are nearly impossible to repay given the individuals financial situation, etc.

Some of the risk-taking, cultural, and health factors that were initially explored in this research include credit scores, seat belt use, education levels, poverty and homelessness levels, alcohol consumption, drug and tobacco use, obesity, overall general health, and depression and other mental health issues causing diminished cognitive capabilities. Road use factors which were considered include share of tourists and visitors, vehicle occupancy levels, lighting condition of fatal crashes, average age of vehicles, and land use patterns. Through the exploration of the data available at both aggregate and disaggregate levels, many of the above mentioned factors were found to have correlations with fatality rates at the state and regional levels, suggesting that understanding these different characteristics of the population by geographical region can help to determine, explain, and potentially provide insight regarding how to improve the safety of the roadway network for personal vehicle travel.

The idea in correlating risk-taking behavior with fatality rates comes from the assumption that individuals who have a higher likelihood of performing risky

المنارة للاستشارات
www.manaraa.com

behavior in some aspects of their life are also more likely to display risk-taking behaviors while driving or as pedestrians. Risk-taking behavior while driving is referring to aggressive driving characteristics such as: speeding, reactionary lane changing without proper notification or attention, tailgating, hard braking, etc. The National Highway Traffic Safety Administration (NHTSA) defines the occurrence of aggressive driving as "an individual commits a combination of moving traffic offenses so as to endanger other persons or property (NHTSA.gov)." Other risk taking behavior while driving could include distracted driving, drowsy driving, impaired driving, lack of use of safety equipment while driving such as safety belt use, helmet use for motorcycle drivers, or improper or lack of car seat use for children and infants (*Research & Evaluation*, 2014). In addition, risk-taking might include activities such as driving in inclement weather and in poor road conditions, driving a vehicle in need of maintenance, or allowing oneself to be distracted while driving, etc. Similarly, behaviors of pedestrians, bicyclists, and motorcyclists can include risk-taking elements.

1.2 Introductory Note

Vehicular crash rates and fatality rates are consistently higher in the southeastern U.S. than the national average as shown in the Fatality Analysis Reporting System. In addition, pedestrian fatality rates are also consistently higher in the southeastern U.S. than the national average (Dangerous by Design, 2014). With safety as a top priority in all sectors of transportation, it is imperative that the safety of the roadway network in the southeastern region of the U.S. is improved. To improve the safety of the roadway network, the factors associated with the lack

المنارة للاستشارات
www.manaraa.com

of safety in the region must be identified and addressed. Transportation safety is an extremely complicated subject matter with an enormous number of interrelated factors which influence safety as a whole. If transportation network safety were an easy issue to address, or if safety was a straightforward problem with a singular best answer, then solutions would be readily available. With the understanding of the complicated nature of the problem of safety, this thesis focuses on just one aspect, risk-taking characteristics. In order to identify the possible explanatory factors involved with the lack of safety on the southeastern U.S. roadway network, risk-taking characteristics are being explored, which were previously not evaluated as conventional factors associated with safety.

1.3 Southeastern Transportation Center

The Southeastern Transportation Center (STC) is a consortium focused on comprehensive transportation safety and is comprised of nine universities in the southeastern U.S. The University of Tennessee is the lead institution which is home to the director and co-director. The other universities include: the University of Central Florida, University of Alabama, University of Alabama Birmingham, University of Kentucky, North Carolina A&T State University, University of North Carolina – Chapel Hill, and Clemson University. It is important to note that the regions referred to are in accordance with U.S. Department of Transportation's (DOT) definitions of regions, not the U.S. Census Bureau's definition of regions. The DOT defines region four of the U.S. as Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee. In 2010, each of the states in the southeastern region had higher fatality rates than the national average

www.manaraa.com

both in terms of per capita and per vehicle miles of travel, and half of the southeastern states ranked in the top ten of overall fatalities per capita, however as of 2012, the number of southeastern states ranked in the top ten dropped to only three, but there is still plenty of room for improvement (Southeastern Transportation Center, 2015).

This thesis is part of a study being carried out by the University of South Florida in collaboration with the University of Tennessee and the University of Alabama, each of whom have various tasks exploring the relationship between risk-taking factors and travel safety. This thesis is representative of just one part of the efforts being carried out by the University of South Florida.

1.4 Objective

The objective of this thesis is to explain the variation of fatality rates in the southeastern region of the U.S. using different risk-taking characteristics as explanatory variables in addition to several socio-demographic characteristics known to effect driving behavior. The hypothesis being tested is that if the average population in a specific geographical area behaves in a risky manner as a whole in economic and health impacting characteristics that the same population may also behave in a risky manner while operating a motor vehicle or using the roadway network in other manners such as walking or biking. In other words, if an individual is willing to take a given type of risk, they are inherently more likely to take multiple risks, not just a singular risk. The hypothesis, restated is that if a person exhibits risk-taking behavior, that risk-taking behavior is likely not limited to only one aspect of risk, but is likely to occur in multiple facets of the person’s life.

المنارة للاستشارات
www.manaraa.com

1.5 Outline

This thesis gives an overall literature review comparing the variation of fatality rates in the United States (U.S.) and the rest of the world for completeness, then focuses on the variation of fatality rates in the southeastern region of the U.S. compared to the rest of the nation. Following the fatality rate review, the different risk-taking characteristics explored are reviewed. The methodology data collection and analysis follows the literature review. In the fourth chapter of the thesis, the data collection and analysis is reviewed, and the proposed regression model to estimate fatality rates by geography and risk-taking characteristics is introduced. The final chapter, chapter five, contains the conclusions and the suggestions for future research regarding the topic of risk-taking variables as explanatory factors in estimating fatality rates by geography.

للاستشارات المنارة
www.manaraa.com

CHAPTER 2:

LITERATURE REVIEW

The following literature review covers fatality rates, the variation of fatality rates by geography, and the risk-taking behaviors that are proposed as explanatory factors which affect the variation in fatality rates.

2.1 United States Compared to World's Fatality Rates

Worldwide in 2010, 1.24 million people were killed in road traffic injuries, which are estimated to be the eighth leading cause of death globally (*Global Status Report on Road Safety,* 2013). The World Health Organization (WHO) reported that road traffic fatality rates vary from 24.1 per 100,000 population in the African Region, to 10.3 per 100,000 population in the European Region. The U.S. experienced an 11.4 per 100,000 population traffic fatality rate in 2010. The statistics show that the middle-income countries have the highest road traffic fatality rates at an average of 20.1 per 100,000 population, followed by low-income countries at an average rate of 18.3 traffic fatalities per 100,000 population, and high-income countries have among the lowest traffic fatality rates at an average of 8.7 per 100,000 population. This variation in fatality rates by income status is related to the share of vulnerable road users in a country. Vulnerable road users include pedestrians, bicyclists, motorcyclists, and other users of two- or three-

المنارة للاستشارات
www.manaraa.com

wheeled vehicles. Low- and middle-income countries have a higher proportion of vulnerable roadway users, due to the lower costs and higher availabilities of these modes. The U.S. is categorized as a high-income country, however many of the laws which help to reduce traffic fatality rates are at subnational levels, leaving plenty of room for improvement in traffic safety. A national urban speed limit suggested by the WHO is less than or equal to 50 kilometers per hour, which converts to about 30 miles per hour, however is only implemented in 47% of the world's population. The U.S. is one of the only countries with motorcycle helmet laws and seat-belt laws at subnational levels when compared to the rest of the world.

Perhaps most alarming is the share of countries with child restraint laws in place coupled with good law enforcement of these laws. Child restraint law enforcement is yet another area where the U.S. is categorized at a subnational level (*Global Status Report on Road Safety,* 2013). While the U.S. is not among the highest traffic fatality rates in the world, there is plenty of room for improvement in the safety of the roadway network in the U.S. With each of the above mentioned safety measures, speed limit, helmet laws, seat belt laws, child restraint laws, etc. high levels of enforcement and high perception of enforcement is key to ensuring new and existing policies are as effective as possible.

Differences in infrastructure conditions among countries also have great influences on the safety variations of the networks. Road design, engineering, construction, and maintenance are all influences to the safety of the roadway users for all modes. According to the WHO, 77 percent of countries already carry out some type of road safety audit on new road infrastructure, however existing

المنارة للاستشارات
www.manaraa.com

infrastructure also needs to be inspected with focuses on high risk, high incident areas. In addition to infrastructure, typical vehicle age also plays a significant role in the safety of a road network (*Global Status Report on Road Safety,* 2013). Technology is improving tremendously with each passing year, and along with the improved technology, the safety features in vehicles increase as well. With increasing safety features such as multiple airbags, antilock brakes, and crushable designs which allow the impact to be absorbed by the vehicle rather than the occupant, the injury severity of motor vehicle crashes should reduce. This increase in technology is often seen first in high-income countries where the population can afford the luxuries of newer vehicles.

Emergency healthcare capacities are also a variable that plays a significant role in the survivability of a person involved in a sever motor vehicle crash. According to the WHO, as of 2013 only 59 countries have ambulatory services that can rapidly transport the majority of patients to a hospital in the event of a crash. In addition to the ambulatory services that are unavailable in many countries around the world, the proportion of doctors and nurses that are trained to provide emergency medical services range from less than 40 percent in the African and South-East Asia regions to under 90 percent in the Eastern Mediterranean region. In the region of the Americas, about half of nurses and over 70 percent of doctors have this type of training (*Global Status Report on Road Safety,* 2013).

2.2 National Average Compared to Southeastern U.S.

Section 2.2 of this thesis focuses on the variation of characteristics between the southeastern region of the nation and the rest of the nation, including fatality

المنارة للاستشارات

www.manaraa.com

rates and other characteristics that may affect fatality rates. The higher fatality rates that occur in the southeastern region of the U.S. are a great motivation for this study, and a phenomenon that should be researched thoroughly to improve the safety of the southeastern U.S. population. The following table displays the fatality rates in each state in the southeastern region, and the national average fatality rate, in addition to the lowest and highest state in the nation.

Table 1 Fatality Rates in Southeastern Region

South Carolina	1.70
Mississippi	1.58
Kentucky	1.55
Tennessee	1.40
Alabama	1.35
Florida	1.26
North Carolina	1.23
Georgia	1.12
Total U.S.	1.11
D.C. (Lowest)	0.62
Montana (Highest)	1.74

Data Source: FARS and Census Bureau

2.2.1 Fatality Rates

U.S. roadways have experienced a reduction in fatalities of nearly 25 percent between 2004 and 2013, however this still equated to almost 33 thousand motor vehicle traffic crash deaths in 2013 (*Traffic Safety Facts*, 2014). The national fatality rate in the U.S. is measured by exposure, thus is measured in fatalities per 100 million vehicle miles traveled (VMT) for most uses. In 2013, the U.S. fatality rate was 1.10 per 100 million VMT, which constituted a 3.5 percent decrease in just one year, and also ties for the lowest fatality rate on record for the nation (*Traffic Safety Facts*, 2014). Just as recently as 2008, motor vehicle traffic crashes were

المنارة للاستشارات
www.manaraa.com

the number one cause of death for every age from 13 through 30 (Subramanian, 2012). The CDC reports fatality rates per population in the top 50 Metropolitan Statistical Areas (MSA), and found that while overall, 74% of MSAs had traffic fatality rates below the national average, the traffic fatality rates in the southern states were generally higher. Furthermore, the highest vehicular fatality rates are concentrated in the southeastern region of the U.S. (Motor Vehicle Crash Deaths in Metropolitan Areas – United States, 2012). Pedestrian fatalities are another area of concern, where the southeastern U.S. ranks higher than the national average in fatalities. In 2012, pedestrians represented nearly 15 percent of all traffic fatalities in the U.S. (Dangerous by Design, 2014). The share of traffic deaths involving pedestrians in the U.S. has been an increasing trend from 2004 through 2013 (Dangerous by Design, 2014). Even more alarming is the overrepresentation of the southeastern region of the U.S. when the top 50 metropolitan areas are ranked by Pedestrian Danger Index (PDI) shown in Table 2. The PDI gives and approximation of the likelihood of a person on foot being struck and killed by a vehicle based on the best available measure of how many people are likely to be walking and the number of pedestrian fatalities in the past five years of data. The states in the southeastern U.S. account for eight of the top ten worst metropolitan areas, and each of the top six are in the southeastern states. Florida is currently the worst among the PDI rankings, home to the top four most dangerous metropolitan areas for pedestrians (Dangerous by Design, 2014). These alarming pedestrian fatality rates, and overall traffic crash fatality rates in the southeastern region of the U.S. leads to the obvious question of why. Is it the demographics of the southeastern U.S., the physical design, the governmental policies or lack thereof, the

المنارة للاستشارات
www.manaraa.com

environmental variations of the southeastern U.S. from the rest of the nation, or maybe it is all of the above mentioned reasons and more that the southeastern U.S. has such alarming fatality rates.

Table 2 Pedestrian Danger Index Ranks in Southeastern Region

Rank	**Metro Area**	**PDI**
1	Orlando-Kissimmee, FL	244.28
2	Tampa-St. Petersburg Clearwater, FL	190.13
3	Jacksonville, FL	182.71
4	Miami-Fort Lauderdale-Pompano Beach, FL	145.33
5	Memphis, TN-MS-AR	131.26
6	Birmingham-Hoover, AL	125.60
8	Atlanta-Sandy Springs-Marietta, GA	119.35
10	Charlotte-Gastonia-Concord, NC-SC	111.74
15	Nashville-Davidson Murfreesboro-Franklin, TN	100.79
16	Raleigh-Cary, NC	100.35

Data Source: Dangerous by Design, 2014

2.2.2 Demographics

Unfortunately, the higher than average fatality rates are not the only characteristics that are present in the southeastern U.S. When the intergenerational upward mobility of children was calculated based on the mobility of their parents it was found that the southeastern region of the U.S. stands out very distinctly from the rest of the country as being much less upwardly mobile than other regions of the nation (Chetty, et. al., 2014). According to Chetty, et al. intergenerational mobility is the degree to which a child's social and economic opportunities are dependent upon their parents' social and economic status. The U.S. Census Bureau also shows southeastern poverty levels to be among the highest in the nation, with

المنارة للاستشارات
www.manaraa.com

poverty shares of population ranging from more than 17 percent in Florida to nearly 24 percent in Mississippi (Small Area Income and Poverty Estimates, 2013). The national share of population below the poverty line is less than 16 percent. This thesis sets out to determine the varying socio-economic and socio-demographic characteristics in the region that may help to explain why the fatality rates are consistently above the national averages. The main argument defined is that poverty is greatly correlated to propensity for risk taking behavior, and risk-taking behavior is linked to driving characteristics that make the roadway network in the southeastern U.S. inherently more dangerous.

The approximate 2013 population of the U.S. was 316 million people, of which 23.3% were under 18 years of age, and 14.1% were over the age of 65, leaving 62.6% of the population in the typical working adult age range (Census, 2013). As of 2013, 50.8% of the U.S. population was female. Racially the majority of the U.S. was White, accounting for a 77.7% share of the population, followed by 13.2% Black or African American, 5.3% Asian, 1.2% American Indian, 0.2% Native Hawaiian or other Pacific Islander, and 2.4% are two or more races. When the average was taken over the past 5 years of data, from 2009 to 2013, 86.0% of the U.S. population over age 25 was a high school graduate or higher, and 28.8% of that same age group had a Bachelor's degree or higher. From 2009 to 2013, the average share of the population below poverty level was 15.4% (Census, 2013).

The approximate 2013 population of the southeastern U.S. was 63 million people, of which 22.6% were under 18 years of age, and 15.4% were over the age of 65, leaving 62.0% of the population in the typical working adult age range as shown in Figure 1 (Census, 2013). As of 2013, 51.2% of the southeastern U.S.

المنارة للاستشارات
www.manaraa.com

population was female. Racially the majority of the southeastern U.S. population was White, accounting for a 71.5% share of the population, followed by 21.6% Black or African American, 2.2% Asian, 0.4% American Indian, less than one tenth of one percent are Native Hawaiian or other Pacific Islander, and 2.1% were two or more races as shown in Figure 2. Total shares of race do not add to 100 percent due to errors associated with rounding. When the average was taken over the past 5 years of data, from 2009 to 2013, 84.8% of the southeastern U.S. population over age 25 was a high school graduate or higher, and 25.5% of that same age group had a Bachelor's degree or higher as shown in Figure 3. From 2009 to 2013, the average share of the southeastern population below poverty level was 17.7% (Census, 2013). In general, the southeastern U.S. has less working age adults, more young people, more elderly, and a larger share of Black or African American population than the rest of the nation. The southeastern states are also disproportionately less educated, and have a larger share of the population below poverty than the national average. Each of these demographic characteristics has an impact on the general safety of the roadway network in the southeastern U.S.

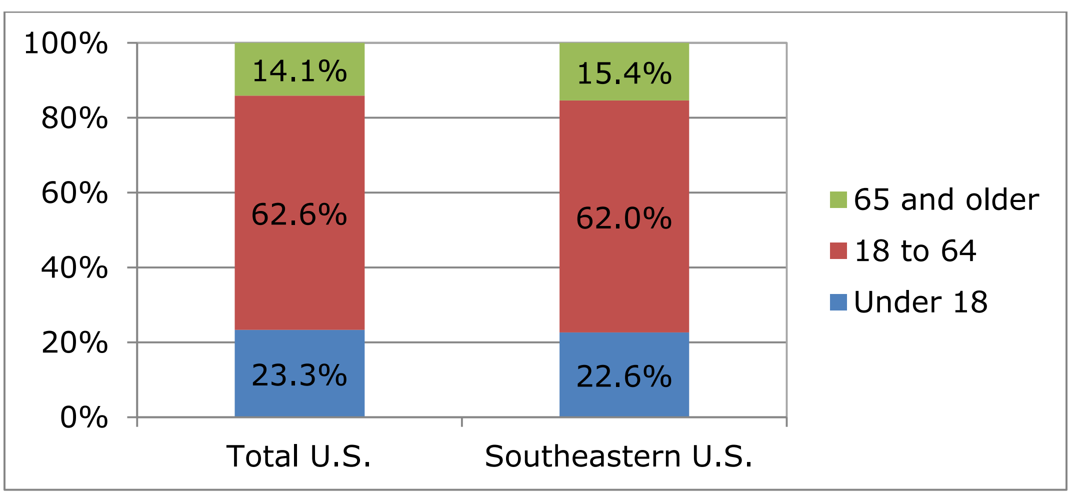

Figure 1 Age Group Comparisons. Data Source: U.S. Census Bureau

المنارة للاستشارات
www.manaraa.com

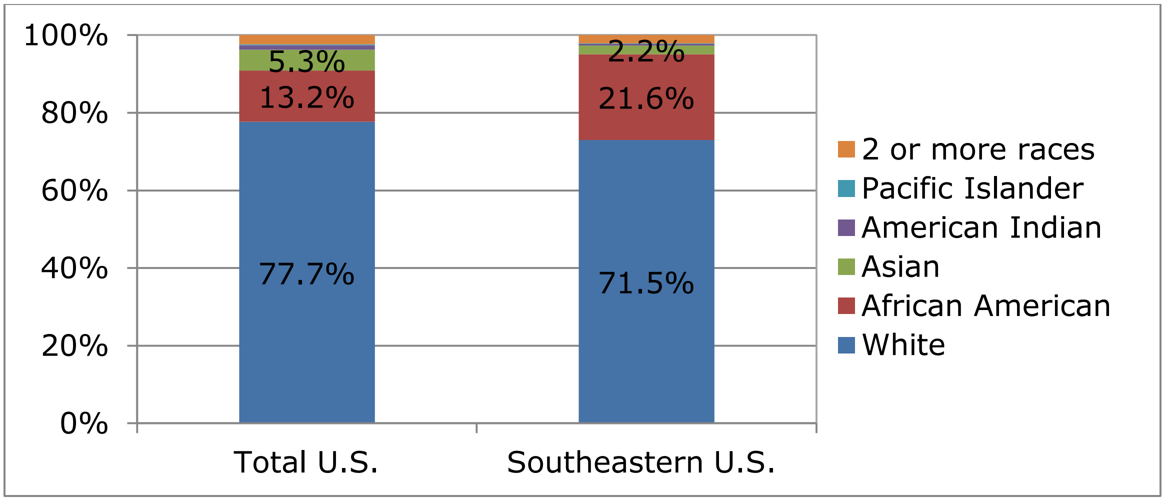

Figure 2 Race Comparisons. Data Source: U.S. Census Bureau

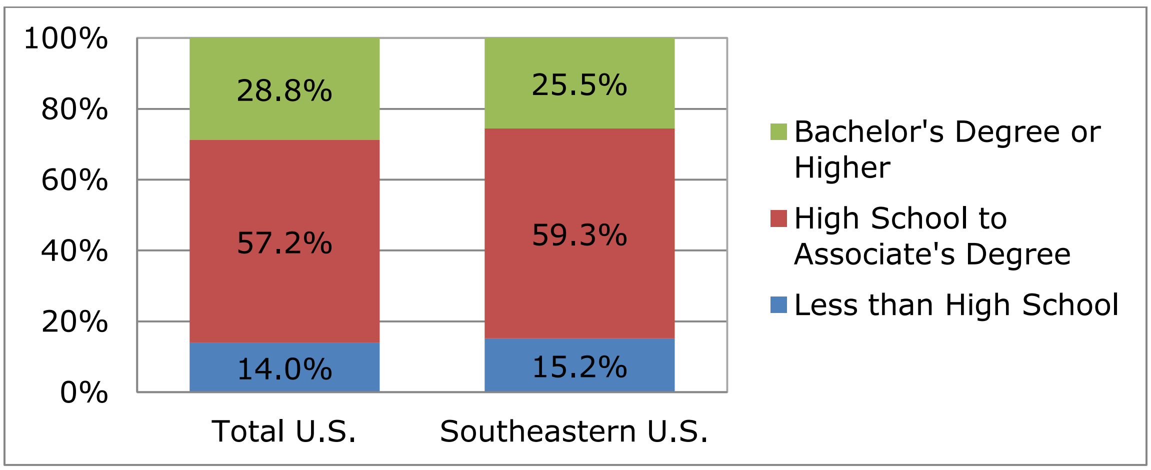

Figure 3 Education Comparisons. Data Source: U.S. Census Bureau

According to Polzin, demographics, more specifically race and ethnicity, have been found to have strong distinctions in mode choice, and some mode choices are distinctly safer than others. Hispanics are twice as likely to carpool as White Non-Hispanics, and almost three times as likely to use transit to commute. Transit commute share is the greatest among the Black population. Hispanics have the highest commute share of bicycle travel, and Asians have the highest share of walk as a commute mode choice (Polzin, et al., 2013). While this thesis focuses primarily

www.manaraa.com

on fatality rates of the overall roadway network, it is important to understand the connection between share of alternative mode users and the safety of a roadway network. Vulnerable road users such as pedestrians and bicyclists experience the highest risk when traveling on the roadway network. Non-motorists have the inherent exposure risk, without the shell of a vehicle surrounding them. In addition, they are traveling at slower speeds than vehicular modes, and thus cannot react as quickly to avoid dangerous situations as one with a motor vehicle could. On the contrary, transit use is inherently a safer mode choice than personal vehicle travel. Transit travel injury or fatality rate is about one-tenth the personal vehicle travel rate, and transit oriented communities have about one-fifth of the per capita fatality rates as automobile oriented communities (Litman, 2014). The safety increase with transit is not only associated with the larger size of the vehicle which can absorb more of the shock of an impact should an incident occur, but also with the improvements of physical design of the infrastructure which often corresponds with transit-oriented development (TOD).

2.2.3 Physical Design

TODs increase the safety for communities as a whole, most notably by giving pedestrians and transit users "defensible spaces" and providing settings with fewer hazards for non-motorists (TCRP Report 102, 2004). The change in physical design of a network that implements TODs includes traffic-calming characteristics such as speed humps, streetscapes with wide grassy medians and reduced width lanes to further reduce the speed of vehicles. In addition other mixed-use land-use patterns that are incorporated increase the overall safety of the network for all users.

المنارة للاستشارات
www.manaraa.com

Communities in the southern Sunbelt that were established and grew dominantly in the post-war period were designed to accommodate automobile travel and sprawling low density neighborhoods (Dangerous by Design, 2014). These designs are not only more dangerous for vulnerable road users, but are also inherently more dangerous for all modes of travel because of the tendencies to have higher speed limits, wider lanes, and accommodate larger capacities. The arterial focused designs are concentrated on the purpose of serving quick automobile travel. Although the arterials are commonly populated with shopping centers, office parks, and residential access, people or communities are too often the secondary concerns, or non-concerns in the design process of the arterials (Dangerous by Design, 2014).

The physical design however, is not only considering the safety of the vulnerable road users, but also the effect of physical design on the fatalities of vehicular road users. "Since 1979, the proportion of traffic fatalities involving the collision with a fixed object on the roadside has fluctuated between nineteen and twenty-three percent (Delgado, 2011)." In the southeastern region, it was calculated by Wang (2006) that roadside hazards accounted for at least one death in forty percent of all crashes in which a vehicle occupant was fatally injured. With a ten percent higher share in the southeastern region, it is obvious that roadside hazards play a role in the increase in fatality rates in the southeastern region.

2.2.4 Governmental Policies

The federal, state, and local laws and policies put in place have significant impacts on the transportation system, with growing awareness on the emphasis on

المنارة للاستشارات
www.manaraa.com

quality of life and health, in addition to the efficient movement of people and goods (CDC, 2010). The CDC has made several recommendations to increase the safety of the transportation network. One recommendation includes providing the individual states with incentives to implement and strengthen laws associated with: seat-belt use, booster-seat use, helmet use for motorcyclists and bicyclists, impaired and distracted driving, reducing speed limits, comprehensive graduated driver licensing, improved roadway design, increased education on safe driving, bicycling, and walking, and community designs that promote reduced speeds in neighborhoods. The CDC also recommends increasing support for new technologies to improve the safety of motor vehicles and enable vehicles to withstand crashes with lower risk of injury to the occupants and non-occupants, and also new technologies to prevent alcohol impaired driving (CDC, 2010).

2.2.4.1 Seat Belt Policies

Wearing a seat belt reduces the likelihood of occupant death by roughly sixty percent, when involved in a motor vehicle accident (Levitt and Porter, 1999). When states pass laws to require the use of front-seat occupants to wear seat belts, the average seat belt usage rates increase about seventeen percent (Cohen and Einav, 2001). Table 3 displays the southeastern states and their primary seatbelt policies in addition to some national comparisons. Some states currently have secondary seat belt laws, which require the driver to be pulled over for an unrelated offense, and do not allow law enforcement to stop a vehicle for the sole purpose of not wearing a seat belt. In other states, seat belt laws are primary offenses, meaning law enforcement can stop a vehicle for the sole purpose of not wearing a seat belt. It was estimated that if all states which had secondary seatbelt enforcement laws in

المنارة للاستشارات
www.manaraa.com

2001 changed their laws to primary, the national seat belt usage rate would have increased from 68% to 77% and in turn would have saved approximately 500 lives per year (Cohen and Einav, 2001). When comparing seat belt usage between states with primary seat belt laws and states with secondary or without seatbelt laws, in 2013 the share of seat belt usage varied by 11% (Traffic Safety Facts, 2014). The trends from 1995 to 2013 show a reduction of Daytime percent unrestrained personal vehicle occupant fatalities associated with an increase in overall safety belt usage (Traffic Safety Facts, 2014). Booster seat laws have similar safety influences as seat belt laws. Booster seat laws were associated with a 17% reduction in the per capita rate of children who sustained fatal or incapacitating injuries from motor vehicle accidents (Eichelberger, A.H., Chouinard, A.O., Jermakain, J.S., 2012).

Table 3 Primary Seat Belt Policies

Alabama	Front Seat only
Florida	Front seat and minors in rear seats
Georgia	Front seat and minors in rear seats
Kentucky	All
Mississippi	Front Seat only
North Carolina	Front (secondary for rear seat)
South Carolina	All
Tennessee	Front Seat only
Nationally	33 states have primary front seat laws (17 primary all seats)

Data Source: GHSA

2.2.4.2 Helmet Policies

Motorcycle helmet laws vary among the states, with some states having universal helmet laws, some states having partial helmet laws, and a few states having no helmet laws at all as of February 2015. A universal helmet law is

www.manaraa.com

inclusive of all motorcycle riders regardless of age, experience, or insurance coverage. Many states also extend the helmet laws to cover riders of low-powered cycles which are not classified as motorcycles, such as mopeds and scooters, while some states specify the extension to low-powered cycles with specific minimum engine displacement, braking, and/or top speed specifications. A partial helmet law is generally age dependent, with some states having additional dependent criteria as well. As of February 2015, There are currently three states in the U.S. which have no helmet laws at all; Illinois, Iowa, and New Hampshire. Currently 19 states and the District of Columbia have universal helmet laws, and 28 states have partial helmet laws. The majority of the states in the southeastern region of the U.S. have universal helmet laws with the exception of Florida and South Carolina. The partial helmet laws in Florida are inclusive of all riders under the age of 21 without exception, and riders over the age of 21 who do not carry a minimum of $10,000 in medical insurance. From 1967 to 2000 all motorcycle riders in Florida were required to wear helmets; however the law was changed to a partial law in July of 2000. In South Carolina, all riders under the age of 21 are required to wear a helmet, but once the rider reaches the age of 21, there are no applicable helmet laws. From 1967 to 1980 there was a universal helmet law in effect in South Carolina, at which time the law was reduced to a partial law covering only riders under the age of 21 (Motorcycles, 2015) . Motorcycles require important consideration when trying to reduce overall traffic fatality rates because motorcyclists account for a disproportionate share of traffic fatalities. In 2011 motorcyclists accounted for 14 percent of all traffic fatalities while only accounting for less than one percent of all vehicle miles of travel (Traffic Safety Facts, 2013). Helmet laws are closely

المنارة للاستشارات
www.manaraa.com

correlated with helmet use and with motorcycle fatalities. In states where a universal helmet law was repealed, the average helmet use decreased 41% and the total number of motorcycle fatalities increased 38% (Use of Motorcycle Helmets: Universal Helmet Laws, 2014). On the contrary, states that changed from partial or no helmet laws to universal helmet laws experienced an increase in helmet use of 56% and a decrease in motorcycle fatalities of 37% (Use of Motorcycle Helmets: Universal Helmet Laws, 2014).

2.2.4.3 Distracted Driving Policies

While the term distracted driving is defined by the National Highway Traffic Safety Administration (NHTSA) as inattention that occurs when a driver diverts their attention away from the task of driving to focus on another activity (Driver Distraction Program, 2010), distracted driving laws generally only pertain to the use of electronic devices (Distracted Driving Laws, 2015). Alarmingly, no state in the U.S. bans all cell phone use while driving, and only twenty states prohibit cell phone use for school bus drivers, and thirty-eight states ban cell phone use for novice drivers. The definition of novice driver varies by state and is usually determined by the level of licensure and/or by the driver's age. Currently forty-four states have texting while driving bans in place, and in the southeastern region, that is inclusive of all states except Mississippi, which only prohibits texting while driving for school bus drivers and drivers with learners' permits. Distracted driving accounts for approximately ten percent of all fatal crashes in the U.S. and nearly one in every five (17%) injury crashes (Traffic Safety Facts, 2013). It has been demonstrated that high visibility of law enforcement is an effective way of reducing cellphone/text message use while driving in certain situations. This measure is reliant on increased

المنارة للاستشارات
www.manaraa.com

law enforcement presence in addition to increased media coverage about the increased enforcement, which in turn increases the perceived risk of being caught violating the law. This measure is of course, only effective where laws are in place to deter drivers from distractions. While this measure has only been implemented in a few states, Hartford, Connecticut saw a hand-held cell phone use decrease of 57% (Countermeasures That Work, 2013).

2.2.4.4 Drunk Driving Policies

Driving while drunk or intoxicated is a crime in all states in the U.S.; however the definition of the legal limit of blood alcohol concentration (BAC) varies greatly across states. In all U.S. states the minimum BAC to receive a penalty for driving under the influence (DUI) is 0.08. Other states have additional penalties for excessive BAC limits which vary from 0.10 in Rhode Island to 0.20 in Florida and Tennessee (GHSA, 2015). Many countermeasures to deter drivers from driving under the influence have been proven to be effective such as; revocation or suspension of license for refusal to submit to a BAC test, publicized sobriety checkpoints, saturation patrol of areas prone to DUI's during specific times when DUI's are at the highest, generally associated with the closing of the local alcoholic establishments (Countermeasures That Work, 2013). Mothers against Drunk Driving (MADD) was established in 1980 when a mother lost her daughter in an accident caused by a drunk driver, and the goal of MADD was to make the drunk driving laws stricter (Ronis, 2014).The effectiveness of strengthening DUI laws was reflected in the reduction of fatalities associated with drunk drivers. Between 1982 and 2005 the share of drivers in fatal crashes with BAC of 0.08 or higher decreased

المنارة للاستشارات
www.manaraa.com

from 35 percent to just 20 percent (Statistical Analysis of Alcohol-Related Driving Trends, 2008).

2.2.4.5 Speed Policies

Speed is greatly associated with the severity of a collision, especially when a pedestrian is involved. Figure 4 shows how the percentage of pedestrian fatalities increases with speed increments of just 10 miles per hour (mph). "Studies suggest that a fatal pedestrian accident is 6 times less likely to happen if the vehicle speed is 23 mph as opposed to 28 mph" (Photo Enforcement Program – Historical Perspective, 2006). Photo enforcement programs installed to enforce speed limits in school zones have shown to be effective in reducing the number and severity of speeding drivers, thus making the network safer for all users (Photo Enforcement Program – Historical Perspective, 2006). The southeastern region, highest and lowest top speeds are shown in Table 4.

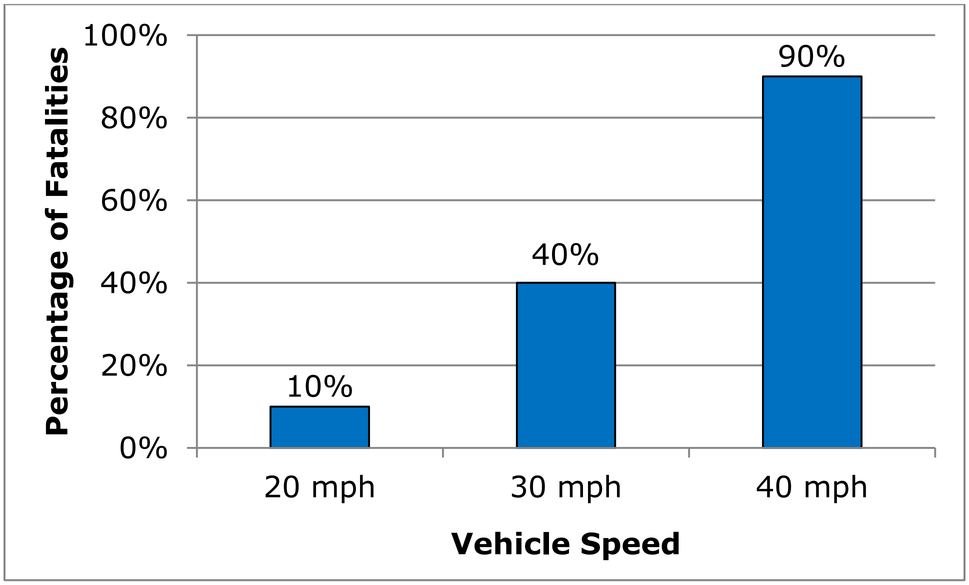

Figure 4 Pedestrian Fatality Share by Vehicle Speed. Amended from: Photo Enforcement Program – Historical Perspective, 2006. City of Renton, WA.

www.manaraa.com

Table 4 Top Speeds

Top Speed by State	
All SE States	70
Lowest (Alaska)	55
Highest (Texas)	85

Data Source: motorists.org

2.2.5 Environmental Variations

There are several factors to be considered when trying to distinguish the reasoning behind the higher than average fatality rates in the southeastern region, and one factor which cannot be over looked is the environmental differences. The southeastern region of the U.S. has much milder winters than the rest of the nation. If we compare the average high temperatures in the historically coldest months of the year, December through February, in Tampa, Florida the average high temperature is in the 70's, in Montgomery, Alabama the average high temperature is in the 60's, and in Memphis, Tennessee the average high temperature is in the 50's. However when those average high temperatures are compared to some states in the northern parts of the U.S. a much colder trend is apparent. The average high temperature in those same months in St. Paul, Minnesota is in the 20's, which is similar to Bismarck, North Dakota. And the states in the Northeastern region of the state average highs are in the 30's and low 40's (U.S. Climate Data, 2015). In addition to the milder temperatures of the winter, the higher temperatures in the summer are often reasoning to wait until the sun goes down to participate in outdoor activities in the warmer months. For instance, one may choose to go before sunrise or wait until sunset to go for a jog outside because those are the times when the temperatures are milder during the summer months.

www.manaraa.com

This overrepresentation of pedestrians and bicyclists in the dark may be an explanatory factor in the increased number of pedestrian fatalities in the southeastern region.

In general, one state in the southeastern region stands out from the rest in visitor attractiveness, Florida, also known as the "Sunshine State". Orlando is the leader of all cities in the U.S. at attracting visitors, with over 48 million attracted in 2009 (Forbes, 2010). With the warm weather, tons of amusement parks, over thirteen hundred miles of coastline accompanied by breathtaking beaches and the largest cruise market in the world, Florida is major attractor of visitors, both domestically and internationally (Census, 2010). In 2013 Florida received nearly 94 million visitors (VisitFlorida, 2015). With this amount of tourists visiting the state each year, there is a disproportionate share of unfamiliar drivers on the roadway network in the Sunshine State. It has been found that the volume of tourists or visitors who are unfamiliar drivers are proportionate to the number of traffic fatalities in the region, meaning as the number of unfamiliar drivers increases on the roadway network, so too does the number of traffic fatalities (Somasundaraswaran, 2010). The combination of outdoor inviting weather, and increased share of unfamiliar drivers on the roadway play a significant role in the increased number of pedestrian and bicycle fatalities in the state of Florida (Dangerous by Design, 2014). This same reasoning could also be extended to motorcycle fatality rates in the state, with weather conditions which make it inviting to ride a motorcycle year round, and a greater proportion of unfamiliar drivers on the network, it is a recipe for increased fatalities (Reyes, 2013).

المنارة للاستشارات
www.manaraa.com

2.3 Risk-Taking Characteristics

Risk-taking characteristics are descriptive of behavior which can be perceived as risk-taking behavior. For this thesis, the adopted definition of risk-taking behavior is defined as "the tendency to engage in behaviors that have the potential to be harmful or dangerous, yet at the same time provide the opportunity for some kind of outcome that can be perceived as positive(Tull, 2014)." Risk-taking characteristics may not only be tied to an individual's specific driving behavior, but also to the propensity to procrastinate on general upkeep of the vehicle, such as changing tires, brake pads, and oil on a routine basis. As the upkeep of a vehicle is neglected, the chances of vehicle failure of some kind increase, and the risk of incident also increases. In this thesis the types of risk-taking characteristics will be limited to the following; credit score, smoking and tobacco use, alcohol use, drug use, mental health, obesity, general health, and educational attainment. A credit score is a risk-taking characteristic because it gives an idea of the financial responsibility of the credit holder, and thus a lower credit score is often tied to an individual who takes more financial risks than an individual with a higher credit score. Tobacco use, alcohol, and drug use are all associated with adverse health characteristics and each present different levels of risk users are exposing themselves to. Mental health, obesity, and overall general health may not be as straight forward as the previous risk taking characteristics; however they are associated with general risk. For example, someone who suffers from some form of mental instability may be more likely to engage in risky behavior, which they may not be able to control, and while the mental disability is not a risk they chose, it is still a contributing factor to their life (Guiang, 2014). Finally education levels are

المنارة للاستشارات
www.manaraa.com

generally correlated with income levels, specifically of the family. It has been shown that youth from low income families are less likely to graduate from high school, get a degree, and are more likely to engage in risky behaviors (Kent, 2009).

2.3.1 Credit Score

Beginning with perhaps the most controversial of all risk taking or cultural behavior traits, credit score is already used in 47 states within the U.S. as a factor to predict the consumer's likelihood and amount of insurance losses, with the exception of Massachusetts, Hawaii, and California. To clarify credit-based scoring is not the sole factor in determining the amount of an individual's automobile premium, it is just one of several factors used in the calculation of risk, which varies by insurance company, explaining why the same person may pay a much different premium for the same automobile depending on which insurance agency their automobile insurance is issued through. According to the National Association of Insurance Commissioners (NAIC) credit-based scores were introduced in the 1990's and 95% of auto insurers that are able to use credit-based insurance scores do so, citing that research shows a correlation between credit scores and insurance losses. A credit-based insurance score is not exactly the same as a general credit score, as it only uses specific aspects of an individual's credit score to rate them, such as; payment history, outstanding debt, credit history length, pursuit of new credit, and credit mix (NAIC, 2012). The Insurance Information Institute (III) states, "Studies have shown a 99 percent correlation between insurance scores and loss ratio," meaning individuals with low credit-based insurance scores, account for a higher share of the claim dollars paid. In July of 2007 the Federal Trade

المنارة للاستشارات
www.manaraa.com

Commission (FTC) released a report to Congress on the impacts of credit based scores on consumer automobile insurance, which determined that score based predictors were much more accurate than using race and ethnicity. The report also states while there is no definitive reasoning as to why the low credit scores, on average, lead to higher amounts and rates of claims, the report did give some reasoning as to why strong credit history likely leads to reduced claims. The FTC report states:

> "A strong credit history, however, might indicate that a consumer has taken care in managing his or her financial affairs by avoiding loans that might be difficult to repay, avoiding high balances on credit cards, making sure that bills are not misplaced and are paid on time, etc. A consumer who is prudent in financial matters may also be cautious in other matters related to insurance, such as being more likely to put time, effort, and money into things like car and home maintenance, cautious driving habits, etc. An overall inclination to be prudent may lead a consumer both to have a strong credit history and file fewer insurance claims."

It should be noted that this credit-based insurance scoring reasoning is based on an average, and is not completely explanatory for each individual circumstance; however it is the best way currently available to predict losses, or more precisely, loss ratios. It should also be noted through this same FTC study, that 59 percent of consumers are predicted to have lower premiums when credit-based scoring is used instead of previous methods of calculating premiums without using credit as a factor.

المنارة للاستشارات
www.manaraa.com

2.3.2 Smoking and Tobacco Use

Other risk-taking behavior includes one's choice to use tobacco, alcohol, or illicit drugs. These decisions can be greatly tied to cultural effects, as the probability of an individual to choose to partake in these specific behaviors is often much greater when the individual was exposed to these behaviors throughout their childhood. The Center for Disease Control and Prevention (CDC) reports that the probability of use of alcohol and other drugs is correlated to the probability of tobacco use. In addition, 99 percent of tobacco users report trying tobacco before their 26th birthday, indicating that it is extremely rare for an adult who never tried tobacco to pick up the habit after their 25th birthday. This is also indicates that teens and young adults are generally more impressionable, have less understanding or care of the consequences related to their behavioral choices, and thus more likely to take risks in general. Many teens who are aware of the consequences associated with smoking, drug use, or alcohol use think that the consequences do not apply to them, which can also be mirrored in their choice to behave in a risky manner while driving, because again, they think that they are the exception; that crashes happen to everyone else, but not to them. Social groups such as peers and family members have a great influence on the probability of youth to use tobacco, because they tend to see it as acceptable or normal. Other influences demonstrated to affect tobacco use include low socioeconomic status, low education levels, low self-esteem, and exposure to tobacco advertising. Smoking and other use of tobacco is categorized as risk-taking behavior because it is known to have adverse effects on health ranging from bad breath and foul-smelling clothes to diseases such as cancer and even death. The CDC reports that smoking harms nearly every

المنارة للاستشارات
www.manaraa.com

organ of the body and is tied to nearly one in every five deaths in the U.S. Individuals who are willing to take the risks associated with the use of tobacco are also likely to take risks in other aspects of their life, including the way they drive. It is arguable that if an individual is willing to smoke, they have less regard for the human life, and thus are more likely to drive erratically, aggressively, while distracted, or in other circumstances that would otherwise be considered risky.

2.3.3 Drug Use

Drug use, while highly correlated with tobacco use. The U.S. Federal Department of Health and Human Services has an agency called SAMHSA, which stands for Substance Abuse and Mental Health Services Administration, whose mission is to "reduce the impact of substance abuse and mental illness on America's communities." Drug use is known to have adverse health effects on the user, and thus when an individual chooses to use any drug, they are in turn willing to put their body at risk. This general idea has inspired several studies, many of which compare adolescent substance use with risky sexual behavior. It has been found that substance using adolescent females had higher rates of sexually transmitted diseases, and more pregnancies than non-abusing adolescent females (Tapert, et. Al., 2001). To focus back to the risk of interest of this thesis, driving and fatal crash risk, it has been found that the "use of drugs while driving tends to have a larger effect on the risk of fatal and serious injury accidents than on the risk of less serious accidents" (Rune, 2013). One aspect of risk-taking is sensation seeking, or trying to attain a feeling of euphoria or excitement. Sensation seeking as a construct predicts alcohol use, smoking, sexual behavior, substance use, and

المنارة للاستشارات
www.manaraa.com

driving under the influence (Ames, et al., 2002). Several studies have associated sensation seeking with not only substance use/abuse, specifically marijuana, such as Satinder and Black (1984), but also associated sensation seeking with erratic and aggressive driving such as Jonah (1997). With current ever-changing laws associated with marijuana use at the present time, it is important to note that "the more prevalent and socially acceptable a drug is in a particular population, the less likely it is to find a relationship between the use of that drug and sensation-seeking orientation (Satinder and Black, 1984)." This is particularly important when referring to marijuana use in the U.S., because as of 2015, twenty-three states and the District of Columbia have legalized some type of marijuana use, whether medical or recreational (governing.com, 2015).

2.3.4 Mental Health

Adults with symptoms of depression, just one type of mental disability, were significantly more likely to engage in certain risk behaviors than persons without depression (Mental Health in the United States, 2005). A study by Prochaska et al. studied 693 people with serious mental illness for the number of risk-taking behaviors they participated in. The average number of risk-taking behaviors the sample of serious mentally ill participated in was 5.2 with 100 percent using tobacco, 68 percent eating high fat diets, 46 percent using marijuana, and 26 percent binge drinking. The seriously mentally ill population is more vulnerable and thus more impressionable into making risky behavior choices such as smoking (Prochaska, et al., 2014) Chwastiak et al. conducted a report on veterans with serious mental illness and found there is an increased risk for mentally ill patients

المنارة للاستشارات
www.manaraa.com

to have multiple health risk behaviors. The NHTSA held a symposium in 1999 where the Executive Director of the Institute for Mental Health Initiatives, Mr. Michael Benjamin, addressed the topic of aggressive driving. Mr. Benjamin mentioned that aggressive driving is a characteristic of high-risk-behavior individuals often with uncontrolled anger and violence, requesting that aggressive driving improvement strategies be incorporated into driving education and anger management classes (NHTSA, 1999).

2.3.5 Obesity

Obesity is defined as having an excessive amount of body fat, measured as a body mass index (BMI) of 30.0 or higher, calculation is shown in Equation 1 (Mayo Clinic, 2014).

$$BMI = \frac{Weight\ (Kg)}{(Height\ (m))^2} \geq 30 \qquad \text{Equation 1}$$

According to the researchers at the Mayo Clinic, obesity is usually a result of a combination of genetics, lifestyle, inactivity and unhealthy dieting, although even when ramped within a family, diet and exercise can mitigate and control onset of obesity. Obesity is often a result of choices made by an individual, whether conscious or subconscious, and is related to several other quality-of-life altering characteristics such as depression, shame, social isolation, lower work achievement, etc. (Mayo Clinic, 2014). The mentioned mental characteristics are known to affect ones increased propensity to engage in risky behavior, thus obesity can also be associated with an individual's increased propensity to behave in a risky manner.

المنارة للاستشارات
www.manaraa.com

In 2003, Arbabi S, et al. wrote "The Cushion Effect" in which they stated that, "In motor vehicle accidents, obese individuals are less likely than normal-weight individuals to suffer abdominal and pelvic injuries." However a nonlinear relationship was discovered in the study, and overweight people tended to have lower fatality risk than normal weight and obese patients, with an implication that the cushion effect is optimal when the patient has not yet reached the level of obesity, where other factors affect the health of the individual (Arbabi, 2003). Since that publication another study (Cramer C. et al.) indicates, "More protective soft tissue leads to changing absorption and distribution of energy, thereby serving as protection for abdominal organs." This could be a possible indication that obesity, while leading to more risk-taking behavior may not have as large effect as initially considered in overall average vehicular fatality rates by geography.

2.3.6 General Health

General overall health, as assessed in the Behavioral Risk Factor Surveillance System (BRFSS) is self-determined, however is surveyed along with several other behavioral health questions, thus is assumed to be relatively related to chronic diseases, healthy behaviors, and access to preventative health-care services. The top five causes of death in the U.S. according to the CDC are heart disease, cancer, lower respiratory diseases, accidents, and stroke; at least four of which are effected by risk-taking health decisions made by an individual. Accidents', meaning any unintentional injury, is the only one that is not necessarily effected by health related risk-taking behavior (CDC, 2015). The most common known causes of heart disease, cancer, respiratory diseases and stroke are unhealthy diet, lack of

المنارة للاستشارات
www.manaraa.com

exercise, being overweight, and smoking (Mayo Clinic, 2015), all of which are due to risk-taking choices made by an individual, with some added risk from air pollution, allergens, and occupational agents (WHO, nd).

2.3.7 Educational Attainment

Obtaining an education is not a risk taking behavior, but rather the lack of educational attainment is a risk taking behavior. Referring back to the established definition of risk taking presented earlier in the introduction of this thesis, an action that can be dangerous or harmful with the perception of some type of positive outcome; dropping out of school may be viewed as a positive outcome by a young individual who experiences less responsibility and more free time, however their future success can be harmed by the action of dropping out of school. "People with more education are likely to live longer, to experience better health outcomes, and to practice health-promoting behaviors such as exercising regularly, refraining from smoking, and obtaining timely healthcare check-ups and screenings (Education Matters for Health, 2009)." Educational attainment and poverty are interrelated, with the Federal Educational Testing Service (ETS) reporting that adults who grew up in poverty are likely to achieve a lower level of educational attainment, have lower earnings when they enter the work force, pay less in taxes, and "exhibit negative behaviors and health outcomes that add a burden to the nation's economy" (ETS, 2013). In other words, the less education a person completes the more likely that person is to act in a risky manner, including breaking laws and endangering their health. Education has also been linked to sense of control, indicating that as an individual's education levels increase they gain a greater

المنارة للاستشارات
www.manaraa.com

perception of how their actions influence their circumstances (Education Matters for Health, 2009). Thus, the individual will be less likely to act in a risky manner, given a better understanding of the possible outcomes associated with the risky behavior. As education levels increase, the healthy behavior levels such as healthy diet, exercise, and lack of smoking, increase, and life expectancy increases (Maralani, 2014).

المنارة للاستشارات
www.manaraa.com

CHAPTER 3:

DATA COLLECTION AND METHODOLOGY

The following sections of chapter three review the data collected from each source, along with the methodologies used in the collection of each set of data. The large range of data sources resulted in varying methodologies. The final sections of chapter three describe the methodology used in the data analysis performed.

3.1 Fatality Rates

Fatality rates can be defined as fatalities per one hundred million vehicle miles of travel (VMT), to account for exposure. Fatality rates can also be defined as fatalities per population, to give an overall risk per person. In a previously mentioned report, Dangerous by Design, mode specific fatality rates are calculated by approximate exposure. For example, pedestrian volumes are not adequately reported, so often an estimation of propensity to walk as a mode choice is estimated along with historical pedestrian fatalities to calculate a pedestrian fatality rate. To account for regression to mean, the fatality rates used in this thesis are always an average of three years of data. According to De Pauw, et al. regression to mean is referring to the phenomena that high crash frequency periods are often followed by low crash frequency periods which occurs due to the randomness associated with vehicular crashes. Regression to mean uses multiple years of data

www.manaraa.com

to account for fluctuations which over time generally represent a mean value. Without using multiple years of data to account for regression to mean, the data may be under-representative or over-representative of the actual fatality rates (DePauw, et al., 2014.) The following sections describe the data which was collected and the methodology of each source of data that was used in the determination of fatality rates.

3.1.1 Fatality Analysis Reporting System

The Fatality Analysis Reporting System (FARS) was the data source used to gather and examine all of the fatality rates, and all of the specific characteristics of the fatalities. The FARS (2013) reports fatality information and characteristics in eighteen data files, three of which were used to evaluate the given data, the crash level file, the vehicle level file and the person level file. The levels of data are shown in Table 5.

Table 5 Levels of Data in FARS

Name	**Variables Includes**
Crash	crash level
Vehicle	vehicle level
Person	individual specific
Parkwork	parked and working vehicles
cevent	sequence of all qualifying events, e.g. crossed center line
vevent	sequence of events for each vehicle
vsoe	sequence of events for each in-transport vehicle
distract	driver distractions
factor	vehicle circumstances
drimpair	physical impairment of driver od motor vehicle
nmimpair	physical impairment of non-motorist, e.g. pedestrian
maneuver	actions taken by driver to avoid something or someone
nmprior	what non-motorists are doing prior to crash

المنارة للاستشارات
www.manaraa.com

Table 5 Continued

safetyeq	safety equipment used by non-motorists
violatn	violations charged to drivers
vision	circumstances which may have obscured the driver's vision
damage	all areas of vehicle damaged in the collision

Data Source: Fatality Analysis Reporting System, 2013

There are several characteristics which are present in several levels of reported data files used such as; the state the crash occurred in, the date, time, and location of the crash, and the roadway function where the crash occurred, as shown in Table 6.

Table 6 Data Level Inclusivity

Data Level	**Entries**	**Includes**
Crash	1 per crash	number of: vehicles involved, occupants, fatalities and weather, lighting conditions, manner of collision, first harmful event, related factors, work zone details, school bus, rail crossing, time of EMS arrival, if driver was drunk
Vehicle	1 per vehicle	VIN number, weight class, body type of vehicle, number of occupants, travel speed, initial contact point, roll over, fire, fatalities, registration state, license state of driver, type of license, driver height and weight, previous convictions
Person	1 per person	injury level, age, sex, race, person type, injury severity, seating position, restraint/helmet use or misuse, airbag deployment, ejection and ejection path, alcohol and drug tests, time of death, other related factors

Data Source: Fatality Analysis Reporting System 2013

The FARS is produced through the National Highway Traffic Safety Administration (NHTSA), and is a census compilation of fatal motor vehicle crashes from all 50 states, the District of Columbia, and Puerto Rico since 1975. In order for

المنارة للاستشارات
www.manaraa.com

an incident to be reported as a FARS case, it must have occurred on a roadway that is customarily open to the public, and must have resulted in at least one related fatality within 30 days of the crash. Non-fatal crashes are not reported in the database, nor are crashes that occur on private property or crashes where the injured individual passes away more than 30 days after the collision. FARS data is gathered by representatives in each state from police reports, death certificates and coroner reports, vehicle registration and driver licensing files, hospital records, EMS reports, vital statistics, and other state records; however no personal identifying information is recorded to comply with the Privacy Act and allow all data files to be made available to the public. The number of entries per state is dependent on the aforementioned requirements to qualify as a fatal crash.

Fatality rates were calculated using the number of fatalities over a three year period, to account for regression to mean in fatality levels, divided by the number of vehicle miles of travel (VMT) for the same three years, obtained from the FHWA Highway Statistics Series by state as shown in Equation 2.

$$Fatatlity\ Rate = \frac{\sum_{2010}^{2012} Fatalities}{\sum_{2010}^{2012} VMT/100\ million} \qquad \text{Equation 2}$$

The southeastern region calculations used the sum of the fatalities in the eight southeastern states divided by the sum of the VMT for the corresponding states, again using the three year totals to account for regression to mean variations, as shown in Equation 3.

$$\frac{\sum_{i=1}^{i=8} \sum_{2010}^{2012} Fatalities}{\sum_{i=1}^{i=8} \sum_{2010}^{2012} VMT/100\ million} \qquad \text{Equation 3}$$

where i=1:8 is representative of each southeastern state.

المنارة للاستشارات
www.manaraa.com

In addition to fatalities, several other characteristics such as age and gender of driver involved in fatal crash, lighting condition of fatal crash, and vehicle occupancy of fatal crashes which are reported in the above mentioned files were used to determine if correlations existed, and the levels of the correlations between fatality rates by geography. This was done using a file that was created by combining the same years, 2010 through 2012, that were used to calculate the fatality rates for consistency. These files were then manipulated using Excel and SPSS to find similarities, differences and correlations by state, national, and southeastern regional levels.

3.1.2 Census Bureau Population Data

The U.S. Census Bureau conducts annual American Community Surveys (ACS) data collection in all 50 states, the District of Columbia, and Puerto Rico. The ACS uses a series of monthly samples to produce annual estimates at the state level. The ACS is inclusive of not only the housing unit population but also, as of 2006, the group quarter population as well. In 2010, approximately 2.9 million housing unit addresses were selected; in 2011 the sample size was increased to 3.54 million addresses per year. The sampling of the data is collected in two phases, and the first phase consists of two stages. The first stage of the first phase consists of dividing each county into five sub-frames, which are each a representative sample of addresses in the county. The addresses are sorted and assigned to one of the five sub-frames, to ensure that no household is sampled more than once in a five-year period. The second stage of the first phase assigns the selected addresses into a month within the year of the data collection. The

المنارة للاستشارات
www.manaraa.com

sampling rate varies by the size of the blocks in the sampling entity, with the blocks in the smallest sampling entities at a rate of 15 percent, blocks in small sampling entities at a rate of 10percent and blocks in medium sampling entities at a rate of 7 percent. Blocks in large sampling entities with predicted levels of completed interviews greater than 60 percent can have a sampling rate as small as 0.5 percent. The second phase of sample selection gathers non-mailable (mail is directed to a post office box, or address is incomplete) and non-responding addresses with computer assisted telephone interviews and computer assisted personal interviews. In 2012, a total of 2.2 million of the estimated 132.5 million housing units completed the interview, yielding a sample population of approximately 1.7 percent which covers about 93 percent of the population (Census, 2014).

Once the sample is determined and the data is collected, "weights are used to bring the characteristics of the sample more into agreement with those of the full population by compensating for differences in sampling rates across areas"(Census, 2014). The ACS uses ratio estimation to make more precise estimations of population by age, sex, race, etc. Adjustments are made to account for incomplete interviews and vacant housing units. Multiyear estimation methodology involves reweighing data over a three or five year period by pooling the data and using a derivation of multiyear controls (Census, 2014).

The U.S. Census bureau was used for all population estimates and calculations. This includes share of population calculations for specific age groups, race, sex, and for weighing percentages of rates in the southeastern region. When the population data was used from the U.S. Census Bureau a three-year estimate

www.manaraa.com

from 2012 was used, to properly account for the corresponding data and fatality rates which also used three years of data for all calculations.

3.1.3 Federal Highway Administration

The U.S. Department of Transportation has a department called the Federal Highway Administration (FHWA) which publishes data and statistics at the national and state level. One publication in particular which was used extensively for the collection of data for analysis, is the annual Highway Statistics Series which contains statistical information on bridges, highway infrastructure and travel, travelers, vehicles, motor fuel, revenue and expenditures, conditions and safety, and performance indicators (Highway Statistics Series, 2013). The majority of the data reported in the Highway Statistics Series is submitted by individual states and is analyzed for consistency against previous year's data and against national data, and is then prepared and processed through the Office of Highway Policy Information within the FHWA.

The highway travel statistics reported in the Highway Statistics Series collects annual average daily traffic (AADT) and centerline mileage in accordance with the Highway Performance Monitoring System Field Manual (HPMS) (Highway Statistics Series, 2013). In accordance with HPMS, AADT of all sections of interstate, National Highway System and principal arterials are collected on a 100 percent basis; however for minor arterials and collectors, sample AADT's are collected and expanded in accordance with HPMS. The per capita VMT in the Highway Statistics Series is based on information from three sources, the Nationwide Personal Transportation Survey, the Truck Inventory and Use Survey,

المنارة للاستشارات
www.manaraa.com

and the National Transportation Statistics report. Data from the Truck Weight Study are collected in each state via weigh-in-motion systems.

In this thesis, the FHWA's publications of the Highway Statistics Series were used to calculate the total VMT by state, and were summed to calculate southeastern region and national totals. The VMT data was subsequently used as a denominator in the calculations of the fatality rates by state, southeastern region, and at a national level (Highway Statistics Series, 2013).

3.2 Descriptive Data

Descriptive data collection was an imperative process in the analysis performed to construct this thesis. The fatality rates that were calculated using the above mentioned methodology were set as the dependent variable and the descriptive characteristics that were collected and calculated were used as independent variables to model the variation in fatality rates by geography. The characteristics and the methodologies for each data source are below.

3.2.1 Federal Highway Administration

In addition to the VMT statistics used to calculate the dependent variable, fatality rates, FHWA was also used to collect state level descriptive statistics such as licensed drivers by age group, registered vehicles, and some ratios of these statistics were calculated such as registered vehicles per licensed driver, which were considered for use as descriptive independent variables in the fatality rate linear regression model, presented later in this thesis, but were found to not be correlated at an integrated level.

المنارة للاستشارات
www.manaraa.com

The licensed drivers' statistics reported in the Highway Statistics Series collects data from individual state departments of motor vehicles who issue drivers licenses. There are some specifics about this data which should be noted. The ratio of licensed drivers to total population should never be 1 due to the population who choose not to become licensed or have mental or physical disabilities that limit their ability to obtain a driver's license. However the ratio may be higher than expected due to some extenuating circumstances. There is a chance that some drivers may be doubly counted if, for instance, they move from one state to another and get licensed in their new state of residence; they will be double counted until their original state license expires or until they relinquish that license. Other factors that may not be represented in the statistics are drivers who drive without obtaining a license, drivers who fraudulently obtain multiple licenses, and deceased individuals whose licenses will usually be counted until expiration (Highway Statistics Series, 2013).

Vehicle registrations are another variable which are reported to the FHWA by individual states, and states practices vary widely throughout the U.S. All states use a vehicle registration renewal system which distributes the renewal workload throughout all months of the year, with the exception of some vehicles in some states which are renewed on a calendar year basis. For example, trucks in certain weight classes may be registered by calendar year, while most personal vehicles are generally registered annually in the birth month of the vehicle owner. To attempt uniformity between states to the extent possible, information is reported as nearly as possible on a calendar-year basis, with extra efforts put forth to exclude title transfers and re-registrations which may occur in the pre-registration grace

المنارة للاستشارات
www.manaraa.com

period. It is possible that vehicles registered more than once in the same state, are reported as multiple vehicles, although contrary to reporting protocol (Highway Statistics Series, 2013).

3.2.2 Census Bureau Descriptive Demographic Data

In addition to the above mentioned population data collected from the American Community Survey (ACS) through the U.S. Census Bureau, several other descriptive characteristics statistics were also collected from the ACS (Census, 2014). Educational attainment, specifically the share of population over the age of 25 years who graduated from high school or obtained a high school equivalent general education diploma, and the share of the same age group that obtained a Bachelor’s degree or higher by state, southeastern region, and at the national level were obtained. The split of sex of the population by geography was also explored as a possible explanatory variable in the fatality rate variations. The share of elderly population, those 65 years of age or older, was also determined by geography using ACS data to try to distinguish which states had higher than national rates of aging population. The share of residents born in their state of residency was gathered via ACS data to give an idea of the share of population who were at least at one time an unfamiliar driver on the roadway network, and also who might contribute to the share of out of state visitors who would also be unfamiliar drivers on the roadway network. Finally, the share of population below poverty level was explored as a possible explanatory independent variable, given the poverty stricken population is more likely to use vulnerable means of travel given the lower costs associated with those means, such as walking or riding a bicycle.

المنارة للاستشارات
www.manaraa.com

Each of these above mentioned descriptive characteristics obtained using the ACS data have allocation rates which are a measure of nonresponse. These allocation rates vary by state and by variable, and range from about five percent to about fifteen percent. The ACS methodology states that when the nonresponse rate for a specific characteristic is high, bias can be introduced if the non-responses differ substantially from given responses. Allocation rates are calculated by dividing the number of nonresponses allocated for a specific characteristic in a specific state divided by the total number of responses for that characteristic in that state times one hundred to give a share, as shown in Equation 4.

$$Allocation\ Rates = \frac{non-responses}{total\ responses} \times 100 \qquad \text{Equation 4}$$

3.2.3 Fair Isaac Company (FICO)

While the literature review from a previous section in this thesis states that insurance companies use only certain characteristics of an individual's credit score to determine their credit based insurance score, the concept behind the correlation of a credit score and likelihood to behave in a risky manner in other aspects in life should be cohesive using a general credit score as well. The FICO credit score is comprised of varying importance of five factors; payment history (35%), amounts owed (30%), length of credit history (15%), new credit (10%) and types of credit used (10%) as shown in Figure 5 (MyFICO, 2015). The Equal Credit Opportunity Act (ECOA) was enacted in 1974 and makes it unlawful for a creditor to use race, color, religion, origin, sex, or marital status or age as a basis to determine an individual's credit score.

المنارة للاستشارات
www.manaraa.com

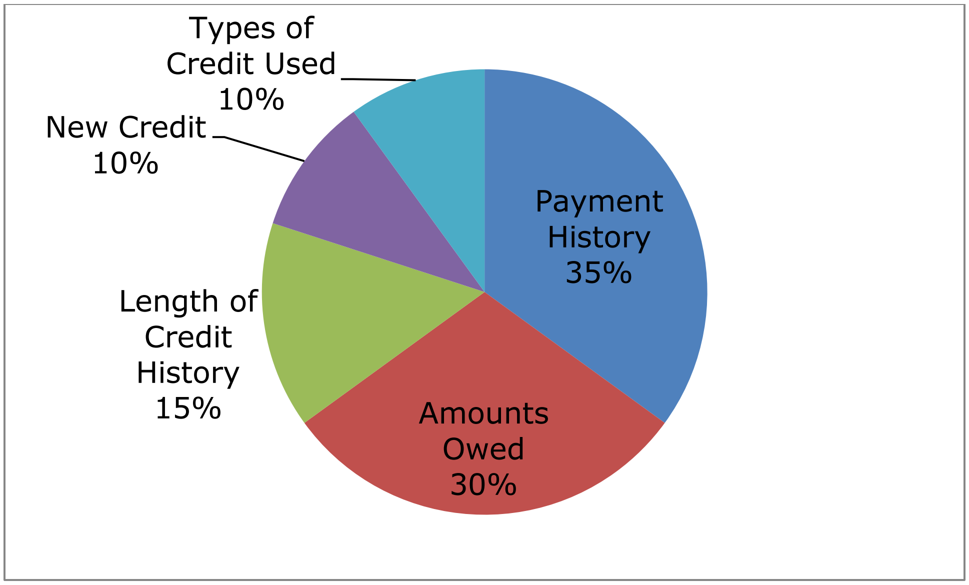

Figure 5 Credit Score Factors. Data Source: MyFICO.com

The credit trends, average credit score by state, were collected through Credit Karma, which is an internet source that provides credit scores to their members, in addition to providing the average credit score trends by state, age and domain. This is done by taking their members and performing crosstab analyses with credit scores and the perspective characteristics. The result yields that the state with the lowest average credit score is Mississippi with a score of 612, and the state with the highest average credit score is Hawaii with a score of 659 (Credit Karma, 2013).

3.2.4 Federal Department of Health and Human Services

The Federal Department of Health and Human Services has a department called the Substance Abuse and Mental Health Services Administration (SAMHSA) which conducts an annual National Survey on Drug Use and Health (NSDUH) to population age 12 years and older. The NSDUH generates estimates on a national

www.manaraa.com

state and sub-state level to describe patterns of prevalence of alcohol, drug and tobacco use and mental health disorders in the U.S. The 2012 survey data used in the analysis of this thesis was a compilation of data collected from 136,147 respondents in all 50 states and the District of Columbia, with an overall response rates ranging from 45.8 percent to 75.2 percent with a median response rate of 61.5 percent (SAMHSA, 2013).

The survey state small area estimation obtained using the survey-weighted hierarchical Bayes estimation methodology models aggregate data at the state and national level. The Bayesian confidence interval for the NSDUH is a 95 percent confidence interval, which is asymmetric meaning that the size difference between the lower limit and the estimate is not equal to the size difference between the upper limit and the estimate. The asymmetry is appropriate when dealing with small percentages, such as those in the NSDUH, and help to adjust for overestimating or underestimating the actual precision levels of the data. It should also be noted that if two states have overlapping confidence intervals that does not indicate equivalency of the state estimates. It is also noteworthy that correlated substance use cannot be properly extracted at a small area level, but can be done at a national level. For example, subtracting cigarette use from tobacco use at a state level could give negative results, which would be misleading and should be avoided, however making that same substitution at the national level is valid and would indicate proper non-cigarette tobacco use (SAMHSA, 2013).

For this thesis, the NSDUH was used to collect and compare state and national data by age group for marijuana use in the past year, illicit drug, alcohol, binge alcohol, tobacco product, and cigarette use in the past month, in addition to

المنارة للاستشارات
www.manaraa.com

serious mental illness, any mental illness, thought of suicide, and depressive episodes in the past year. All of the shares were tabulated and the correlations to fatality rates by state were determined.

3.2.5 Center for Disease Control and Prevention (CDC)

The CDC is also under the umbrella of the Federal Department of Health and Human Services. The CDC produces a uniform questionnaire called the Behavioral Risk Factor Surveillance System (BRFSS) which was first conducted in the early 1980's, and became a nationwide surveillance system in 1993. The BRFSS conducted more than 500,000 interviews nationally in 2011, making it the largest phone survey in the world. The data used in this thesis was from data collected in 2011 and 2012, which used more a sophisticated methodology than the previous years. The new methodology uses iterative proportional fitting, with weights applied through several strata including age, gender, race/ethnicity, educational attainment, marital status, property ownership, and telephone ownership (CDC, 2013). In addition, cellular telephone interview standards have been accepted as of 2011; and due to the multiple methodology changes which occurred in 2011, any pre-2011 data should not be directly compared to 2011 and subsequent data.

> "Response rates for BRFSS are calculated using standards set by the American Association of Public Opinion Research Response Rate Formula #4. The response rate is the number of respondents who completed the survey as a proportion of all eligible and likely-eligible persons. The mean survey response rate for all states, territories and Washington, DC, in 2013 was 46.4 and ranged from 29.0 to 60.3. Response rates for states included in this

المنارة للاستشارات
www.manaraa.com

analysis had a median of 9.1% and ranged from 4.9% to 21.2%. For detailed information see the BRFSS Summary Data Quality Report (CDC, 2013)."

The response rate Formula 4 defined in the American Association of Public Opinion Research includes partial interviews as respondents and also allocates cases where the eligibility is unknown. The formula used the summation of complete and partial interviews as the numerator, divided by a denominator which is the summation of complete and partial interviews plus the summation of the refused non-contact, and other interviews plus the estimated proportion of cases of unknown eligibility that are eligible multiplied by the sum of unknown if household is occupied and unknown other interviews as shown in Equation 5 (AAPOR, 2011).

$$RR = \frac{(I+P)}{(I+P)+(R+NC+O)+e(UH+UO)} \qquad \text{Equation 5}$$

where RR = response rate

I = complete interview

P = partial interview

R = refusal and break-off

NC = non-contact

O = other

UH = unknown if household is occupied

UO = unknown other.

From this survey, the data collected for comparison to fatality rates by geography included Alcohol use in the past 30 days, body mass index (BMI), specifically BMI classifications such as underweight, normal weight, overweight, and obese, and self-described overall general health classification, specifically self-described excellent and poor health conditions.

المنارة للاستشارات
www.manaraa.com

3.3 Methodology of Data Analysis

To initially determine the likelihood of correlation between the different risk-taking and other socio-demographic and socio-economic characteristics and fatality rates by geography, a very broad based collection of data from multiple sources occurred over approximately a nine month time period. The data was collected from all of the above mentioned sources. In addition, some additional sources were initially explored but not included in this thesis because they were found to have insignificant correlations early in the data collection stages. For the exploratory data collection the first correlations were calculated using Pearson Correlation Coefficients comparing the array of data of average fatality rates by state over the three year period to each of the above mentioned independent variables, and if the correlation coefficient was of a magnitude smaller than 0.30, positive or negative, it was disregarded and considered to be of little significance to the research. Following the collection of data, and the calculations of correlation coefficients, several characteristics were obtained and used to complete bivariate correlation analyses and a regression model was eventually formed to estimate the fatality rates by specific correlated characteristics. The intention is to understand the strength of the relationship between the respective variables and fatality rates.

3.3.1 Bivariate Pearson Correlation Analyses

Correlation coefficients are indicators of how closely plotted data fits a straight line. The closer the correlation coefficient is to a magnitude of one, the better the fit of the data to a straight line. Whether the correlation coefficient is positive or negative indicates the sign of correlation. For instance, if a correlation

المنارة للاستشارات
www.manaraa.com

coefficient is calculated to be -0.9 there is a strong negative correlation between the variables indicating as one variable increases, the opposite variable decreases proportionately. On the other hand, if the correlation coefficient is calculated to be 0.9, then the relationship between the two variables is indicated to be a strong positive correlation, meaning as one characteristic increases, the other characteristic also increases proportionately. Using a 95 percent two-tailed confidence interval a correlation coefficient is said to be of moderate statistical significance if the magnitude of the Pearson Correlation Coefficient is larger than 0.3, positive or negative (Explorable.com). Alternatively, any Pearson Correlation Coefficient that is less than 0.3 in magnitude is statistically insignificant at the 95 percent confidence interval. The confidence interval indicates the probability of an estimate being representative of the individual sample 95 percent of the time. The Pearson Correlation Coefficient is calculated as shown in Equation 6.

$$r = \frac{\sum(X-\bar{X})(Y-\bar{Y})}{\sqrt{\sum(X-\bar{X})^2}\sqrt{\sum(Y-\bar{Y})^2}} \qquad \text{Equation 6}$$

where r = Pearson Correlation Coefficient

X = fatality rate

Y = each independent variable individually

$\bar{X}$ = the average fatality rate

$\bar{Y}$ = the average of each independent variable.

A Bivariate Pearson Correlation analysis was calculated in SPSS with each of the above mentioned characteristics entered by state. This correlation analysis was used to determine the characteristics which had significant correlations not only to the fatality rates by state, but also between each characteristic. For instance, it is

المنارة للاستشارات

www.manaraa.com

known from the literature review previously performed that education levels and poverty levels are greatly negatively correlated, with higher education levels indicating a much lower probability of living in poverty. Given the strength of the correlation between the two characteristics, only one should be used in the linear regression model to estimate fatality rates by risk-taking characteristics, with the choice of which variable to use depending on the interactions with other variables used in the model. This type of comprehensive analysis was performed throughout all previously listed characteristics to determine which characteristics best estimates fatality rates by geography at a state level.

It is noteworthy that the correlation between two variables does not indicate causation. For example, while credit score is correlated with the safety of an automobile, the crash is not caused because an individual has a poor credit score. Thus correlation and causation have two different meanings and should not be used interchangeably. On the other hand, this does not mean that fatality rates cannot be affected by the implementation of specific goals to improve specific characteristics. For instance, risk-taking behavior reduces with an increase in education levels, therefore it is arguable that if more of the population becomes more educated and is counseled on the consequences of risk-taking behavior, the risk-taking behavior may decrease, thus decreasing the probability of a fatal crash occurring. More reasoning behind this will be presented in the data analysis and conclusion portions of this thesis.

المنارة للاستشارات
www.manaraa.com

3.3.2 Regression Model

A linear regression model is used to describe the relationship between a dependent variable and one or more independent variables. Linear regression models use the same concept introduced in algebra as an equation of a line, as shown in Equation 7. Linear regression was used with the assumption that all variables were linearly correlated with the fatality rates at a state level. Nonlinear correlations were initially calculated but resulted in extremely similar correlation coefficients there for a linear regression was used.

$$Y = a + b_1X_1 + b_2X_2 \ldots b_zX_z \qquad \text{Equation 7}$$

where Y = the dependent variable, in this case fatality rate

a = a constant

each X_i = i^{th} independent variable

each b_i = coefficient for independent variable X_i.

The regression models calculated for this thesis were estimated using a 95 percent confidence interval to determine statistical significance. The Pearson Correlation Coefficients mentioned in the previous section 3.3.1, were used to determine which variables should be considered for input into the linear regression model. Once the original regression model was estimated the magnitude of the t statistic score was compared to a critical t statistic score of 1.28 which is associated with a one-tailed confidence interval of 90 percent. This 90 percent confidence interval indicates that the probability of each parameter in the regression model is statistically significant 90 percent of the time. The coefficient of each of the variables in the linear regression model represents the change in fatality rates per each increment in the given variable, given all else remains constant.

المنارة للاستشارات
www.manaraa.com

When using a linear regression model to describe a dependent variable, a null hypothesis is inherently being tested. The null hypothesis is a statement that all else remaining the same, that specific independent variable does not influence the value of the dependent variable. If the magnitude of the t statistic score is greater than or equal to the critical t statistic score associated with the given confidence interval, then the null hypothesis can be rejected. A null hypothesis is never accepted, but rather can fail to be rejected. If there is a failure to reject the null hypothesis at a given confidence interval, that variable is inherently insignificant in influencing the dependent variable. The specific calculated linear regression model used to estimate the fatality rates by geography will be given in the following chapter.

المنارة للاستشارات
www.manaraa.com

CHAPTER 4:

DATA ANALYSIS

The variables that were collected and analyzed were mentioned in the previous chapter on data collection and methodology. This chapter will focus on the specific data analyses that were performed, and the significance or insignificance that each variable was found to have. It is important to note that while some variables have significant Pearson Correlation Coefficients in the initial stages of comparison, when all significant variables were considered for the regression model, many were found to be statistically insignificant at an overall level. Therefore, while twenty-five characteristics were calculated and compared to fatality rates, only six variables were used to construct the linear regression model, three of which can be considered to be classified as risk-taking behaviors, and three which are descriptive or demographic characteristics not necessarily associated with risk-taking behaviors. These non-risk-taking behaviors were still important to include in the regression model to include as many variables as possible, which increases the accuracy of the estimate model and reduces unobserved component captured in the error term.

المنارة للاستشارات
www.manaraa.com

4.1 Fatality Variation across Geography

Although the NHTSA reports fatality rates, not only per VMT, but also per population, they do not report fatality rates for the southeastern region specifically. The rates are also yearly rates, and for the purposes of accounting for the regression to mean, the fatality rates for three years were calculated. A simple average of fatality rates would not be precisely representative of the three year average fatality rate, thus the number of fatalities was recorded from the NHTSA FARS files, and the VMT was recorded from the FHWA Highway Statistics Series for each state over each year of analysis from 2010 to 2012. For the calculation of the southeastern region fatality rate the sums of fatalities over three years in each of the eight southeastern states were summed. The same procedure was done to the VMT rates for each of the eight states, and the summation of the fatalities was divided by the summation of the VMTs. The eight states in the southeastern region include Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee. These averaged fatality rates were used as the dependent variable in all analyses regarding this thesis. The fatality rates by state, national average and southeastern region calculated from the FARS database are all listed in Table 7. It should be noted that every state in the southeastern region of the U.S. has a higher fatality rate than the national average fatality rate, and southeastern states represent three of the top six states in the highest fatality rates. These are unfortunate statistics, and leave a massive amount of room for improvement on the safety of the roadway network in the southeastern U.S.

www.manaraa.com

Table 7 Fatality Rates by State

State	Fatality Rate	State	Fatality Rate	State	Fatality Rate
District of Columbia	0.62	Oregon	0.98	Texas	1.34
Massachusetts	0.65	Indiana	0.99	Arizona	1.34
Minnesota	0.69	Wisconsin	1.00	Kansas	1.35
Washington	0.79	Nebraska	1.01	Alabama	1.35
New Jersey	0.80	Maine	1.07	New Mexico	1.39
Rhode Island	0.82	Nevada	1.08	Tennessee	1.40
Connecticut	0.83	Total U.S.	1.11	South Dakota	1.42
New Hampshire	0.84	Georgia	1.12	Oklahoma	1.45
California	0.87	Hawaii	1.13	Wyoming	1.48
Maryland	0.88	Delaware	1.16	Louisiana	1.53
Illinois	0.89	Idaho	1.17	North Dakota	1.54
Utah	0.90	Missouri	1.17	Kentucky	1.55
New York	0.91	Iowa	1.18	Mississippi	1.58
Virginia	0.93	North Carolina	1.23	Arkansas	1.67
Vermont	0.94	Florida	1.26	South Carolina	1.70
Ohio	0.96	SE region	1.31	West Virginia	1.73
Michigan	0.97	Pennsylvania	1.31	Montana	1.74
Colorado	0.98	Alaska	1.32		

Note: Yellow indicates the states in the southeastern region, orange indicates the southeastern average, and green indicates the national average.
Data sources: Fatality Analysis Reporting System, 2010-2012 for data on fatalities; FHWA's annual Highway Statistics for VMT.

4.2 Risk-Taking Variations across Geography

Unfortunately for the southeastern region of the U.S. fatality rates are not the only characteristics that are chart toppers. The following three risk-taking characteristics are all characteristics which every state in the southeastern region ranks worse than the national average, and each of the characteristics are presented in their respective tables in ascending order; therefore for a characteristic such as credit score, each of the southeastern states have values lower than the national average, whereas for poor overall health, each of the southeastern states have shares higher than the national average. The states in the

المنارة للاستشارات
www.manaraa.com

southeastern U.S. also have some of the worst credit scores in the nation, taking all three top spots for lowest credit scores in the nation starting from the lowest, Mississippi with an average FICO credit score of 612, South Carolina is next to lowest with an average score of 621, and Alabama comes in third with an average of 623. In addition, all eight southeastern states rank within the lowest nineteen states for credit scores, the highest of which is Florida at 637, which is still below the national average of 640, as shown in Table 8. This is an indication that each of the southeastern states has average FICO credit scores below the national average credit score (FICO, 2013).

Another factor where the southeastern states rank worse than the nation is overall poor health as indicated by the BRFSS. All eight states in the southeastern region have higher rates of poor health than the national average of 4.4 percent as shown in Table 9. The southeastern average share of adult population with poor health is 6.1 percent. Bachelor's degree or higher educational attainment is yet another characteristic where every state in the southeastern region ranks worse than the national average share. For the adult population 25 years of age or older, the national share of population that has obtained at least a Bachelor's degree is 28.8 percent. For that same age group in the southeastern states, the average share is 25.5 percent, and the state with the highest share in the southeastern region is Georgia, with 28.0 percent of the population with a Bachelor's degree or higher as shown in Table 10.

المنارة للاستشارات

www.manaraa.com

Table 8 Credit Scores by State

State	Credit Score	State	Credit Score	State	Credit Score
Mississippi	612	Michigan	636	South Dakota	646
South Carolina	621	Florida	637	Vermont	646
Alabama	623	Nevada	637	Oregon	647
Arkansas	624	Maryland	638	Rhode Island	647
Louisiana	624	Idaho	639	District of Columbia	648
Kentucky	627	Wisconsin	639	North Dakota	648
Texas	627	Wyoming	639	Alaska	650
West Virginia	628	Total U.S.	640	New Hampshire	650
Oklahoma	629	Arizona	640	California	651
Tennessee	629	Illinois	640	Connecticut	651
Georgia	630	Kansas	640	Washington	651
SE region	630	Pennsylvania	640	New Jersey	653
Indiana	631	Iowa	641	New York	654
Missouri	632	Virginia	643	Minnesota	655
New Mexico	632	Montana	645	Maine	658
North Carolina	632	Utah	645	Massachusetts	658
Ohio	634	Colorado	646	Hawaii	659
Delaware	635	Nebraska	646		

Note: Yellow indicates the states in the southeastern region, orange indicates the southeastern average, and green indicates the national average.
Data Source: CreditKarma.com, 2012

Table 9 Overall Poor Health by State

State	Poor Health	State	Poor Health	State	Poor Health
Minnesota	2.9	New Jersey	4.0	Texas	5.0
District of Columbia	3.0	North Dakota	4.0	Oregon	5.2
South Dakota	3.0	Virginia	4.0	Florida	5.3
Colorado	3.1	Wisconsin	4.1	Missouri	5.4
Utah	3.1	Washington	4.2	New Mexico	5.4
Connecticut	3.2	Wyoming	4.2	North Carolina	5.4
Maryland	3.2	Ohio	4.3	Indiana	5.5
Hawaii	3.3	Arizona	4.4	South Carolina	5.9
Idaho	3.4	Delaware	4.4	SE region	6.1
Iowa	3.4	Nevada	4.4	Oklahoma	6.3
Massachusetts	3.4	Total U.S.	4.4	Louisiana	6.5

المنارة للاستشارات
www.manaraa.com

Table 9 Continued

New Hampshire	3.4	Alaska	4.5	Alabama	7.3
Vermont	3.4	California	4.6	Kentucky	8.0
Nebraska	3.5	Georgia	4.6	Arkansas	8.2
Kansas	3.8	Montana	4.7	Mississippi	8.3
Rhode Island	3.8	Pennsylvania	4.7	Tennessee	8.5
Illinois	4.0	Michigan	4.8	West Virginia	8.8
Maine	4.0	New York	4.8		

Note: Yellow indicates the states in the southeastern region, orange indicates the southeastern average, and green indicates the national average.
Data Source: BRFSS, 2011-2012

Table 10 Bachelor's Degree or Higher by State

State	Higher Degree	State	Higher Degree	State	Higher Degree
West Virginia	18.3	Missouri	26.2	Kansas	30.3
Arkansas	20.1	South Dakota	26.2	Utah	30.3
Mississippi	20.1	Florida	26.4	California	30.7
Kentucky	21.5	Texas	26.7	Rhode Island	31.3
Louisiana	21.8	Wisconsin	26.8	Illinois	31.4
Nevada	22.4	Arizona	26.9	Washington	31.9
Alabama	22.6	North Dakota	27.2	Minnesota	32.6
Indiana	23.2	North Carolina	27.3	New York	33.2
Oklahoma	23.5	Alaska	27.5	New Hampshire	33.7
Tennessee	23.8	Pennsylvania	27.5	Vermont	34.8
Wyoming	24.7	Maine	27.9	Virginia	35.2
Idaho	25.1	Georgia	28.0	New Jersey	35.8
South Carolina	25.1	Nebraska	28.5	Connecticut	36.5
Ohio	25.2	Montana	28.7	Maryland	36.8
SE region	25.5	Total U.S.	28.8	Colorado	37.0
Iowa	25.7	Delaware	28.9	Massachusetts	39.4
New Mexico	25.8	Oregon	29.7	District of Columbia	52.4
Michigan	25.9	Hawaii	30.1		

Note: Yellow indicates the states in the southeastern region, orange indicates the southeastern average, and green indicates the national average.
Data Source: U.S. Census Bureau, 2010-2012

When it comes to the number of states in the southeast that have a larger share of adult smokers than the national average, the region is not quite as bad as

المنارة للاستشارات
www.manaraa.com

the fatality rate rankings and the credit score rankings. However, only one southeastern state, Florida (16.8 percent), has a smaller share of adult smokers than the national average (18.2 percent). In the southeastern states the average share of adult population that smokes is 20.0 percent as shown in Table 11 (BRFSS, 2012). Trends of alcohol use in the past 30 days are a bit more promising. The average share of the adult population in the southeastern states that reported drinking alcohol in the past month was 46.6 percent, which is lower than the national average of 54.5 percent. As a matter of fact, only one southeastern state, Florida (54.7 percent), had a higher share of alcohol drinkers than the national average as shown in Table 12 (BRFSS, 2012).

Table 11 Adult Tobacco Users by State

State	Tobacco Users	State	Tobacco Users	State	Tobacco Users
Utah	10.3	Illinois	18.0	Wyoming	20.6
California	12.5	Minnesota	18.0	Pennsylvania	21.0
Hawaii	13.3	Total U.S.	18.2	North Dakota	21.2
Connecticut	15.5	Nebraska	18.5	Michigan	21.4
New Jersey	15.7	Wisconsin	18.7	Alabama	21.5
Texas	15.9	District of Columbia	18.8	Indiana	21.9
Washington	16.1	Georgia	18.8	South Carolina	22.0
New Hampshire	16.2	Montana	19.0	Missouri	22.1
Arizona	16.3	Virginia	19.0	Alaska	22.6
Maryland	16.4	New Mexico	19.1	Ohio	23.4
Massachusetts	16.6	Nevada	19.4	Louisiana	23.5
New York	16.6	Iowa	19.5	Oklahoma	23.7
Vermont	16.6	Delaware	19.6	Tennessee	24.3
Florida	16.8	South Dakota	19.6	Mississippi	24.8
Idaho	17.2	Kansas	20.0	Arkansas	25.9
Oregon	17.3	Maine	20.2	Kentucky	26.5
Rhode Island	17.4	SE region	20.2	West Virginia	27.3
Colorado	17.7	North Carolina	20.3		

Note: Yellow indicates the states in the southeastern region, orange indicates the southeastern average, and green indicates the national average.
Data Source: BRFSS, 2012

المنارة للاستشارات
www.manaraa.com

Table 12 Adult Alcohol Drinkers by State

State	Alcohol Users	State	Alcohol Users	State	Alcohol Users
Utah	30.7	Idaho	49.6	Nebraska	57.5
West Virginia	34.0	Arizona	51.5	South Dakota	57.8
Tennessee	37.5	Kansas	51.5	Maine	58.6
Kentucky	38.2	Virginia	52.0	New Jersey	58.6
Mississippi	38.4	Wyoming	53.0	Washington	58.7
Arkansas	39.8	Ohio	53.3	Montana	58.8
Alabama	40.3	Nevada	54.1	North Dakota	61.0
Oklahoma	42.0	Pennsylvania	54.4	Oregon	61.0
North Carolina	44.3	Maryland	54.5	Colorado	61.9
SE region	46.6	Total U.S.	54.5	Connecticut	62.6
Georgia	47.1	Florida	54.7	Rhode Island	62.6
New Mexico	48.3	Alaska	55.4	Vermont	62.9
Indiana	48.5	New York	55.4	Massachusetts	63.6
Missouri	48.5	California	55.5	Minnesota	63.6
South Carolina	48.5	Michigan	56.6	New Hampshire	63.7
Louisiana	49.0	Delaware	57.1	District of Columbia	64.3
Hawaii	49.3	Illinois	57.2	Wisconsin	64.6
Texas	49.3	Iowa	57.2		

Note: Yellow indicates the states in the southeastern region, orange indicates the southeastern average, and green indicates the national average.
Data Source: BRFSS, 2012

Serious mental illness is another characteristic that was explored as being associated with increased risk-taking behaviors, thus possibly associated with traffic fatality rates. For adults 26 years of age and older, the average share of the population that had a serious mental illness was higher in the southeastern region than the national average share, however three of the southeastern states had lower shares of mental illness in that age group, Alabama, Florida, and Georgia, as shown in Table 13.

المنارة للاستشارات
www.manaraa.com

Table 13 Adults (26+) with Serious Mental Illness by State

State	Mental Illness	State	Mental Illness	State	Mental Illness
Maryland	3.16	Delaware	4.10	Montana	4.58
New Jersey	3.16	Total U.S.	4.14	Ohio	4.62
Illinois	3.24	Minnesota	4.16	Missouri	4.66
Connecticut	3.28	Texas	4.16	Tennessee	4.66
Hawaii	3.32	Wisconsin	4.16	Idaho	4.69
South Dakota	3.51	Nebraska	4.18	Oregon	4.81
New York	3.71	Wyoming	4.19	North Carolina	4.84
Alabama	3.79	Massachusetts	4.21	Mississippi	4.86
New Hampshire	3.79	Arizona	4.26	Washington	4.90
Colorado	3.83	Alaska	4.27	Maine	4.96
California	3.87	New Mexico	4.30	Rhode Island	4.99
Virginia	3.90	SE region	4.32	Kentucky	5.03
District of Columbia	3.95	Louisiana	4.33	Oklahoma	5.14
Florida	3.98	Iowa	4.37	West Virginia	5.27
Pennsylvania	4.01	Kansas	4.40	Utah	5.36
Georgia	4.02	South Carolina	4.41	Vermont	5.36
Nevada	4.05	Indiana	4.44	Arkansas	5.41
North Dakota	4.05	Michigan	4.58		

Note: Yellow indicates the states in the southeastern region, orange indicates the southeastern average, and green indicates the national average.
Data Source: NSDUH, 2012

4.3 Correlations with Fatality Rates

Pearson Correlation Coefficients were calculated for each explored characteristic by state to get an idea of how much the characteristic related not only to fatality rates, but also to other characteristics. This is an important step in the analysis because a regression model should not include two highly correlated variables as independent variables. Including two highly correlated variables in a regression model will skew the results of the model and make the output of the model less reliable. While all correlations that were above 0.3 are considered statistically significant at a 95 percent confidence interval, not all statistically

www.manaraa.com

significant characteristics remained significant when multiple characteristics were entered into the regression model. Therefore, some of the variables that are shown below to have individual statistical significance to the fatality rates by state are not included in the final regression model used to estimate the fatality rates. All correlations between fatality rates and characteristics are presented in Table A1 located in the appendix.

4.3.1 Credit Score

The average credit score for each state and the nation as a whole was collected and the weighted average for the southeastern region was calculated using a population based weighted average over the eight southeastern states (CreditKarma, 2015). The Pearson Correlation Coefficient was calculated between the average credit scores and the average fatality rates. As noted previously, the closer the magnitude of the coefficient is to one, the stronger the correlation between the two arrays of values. The Pearson Correlation Coefficient between credit scores and fatality rates was calculated to be -0.643 which is statistically significant at the 95 percent confidence interval. This is indicative of a strong negative correlation. This means that with 95 percent confidence, average credit scores are related to fatality rates at the state level. Credit score is one characteristic that may help to explain the increased levels of fatality rates in the southeastern region when compared to the rest of the U.S. because the credit scores are significantly lower in the southeastern states also.

المنارة للاستشارات
www.manaraa.com

4.3.2 Smoking

The average share of the adult population that has used any tobacco product in the past thirty days (of the survey) was calculated using the BRFSS data and the NSDUH data, although the results were nearly identical between the two data sources, the BRFSS data was used because the methodology of the survey contained a larger sample size. The Pearson Correlation Coefficient was calculated comparing tobacco use among adults to fatality rates by state, and was found to be 0.641, indicating that there is a moderate statistically significant correlation at a 95 percent confidence interval. This correlation can be interpreted as meaning states with a higher share of adult smoking population also have higher fatality rates. This is a correlation and not causation, meaning that while smoking does not cause motor vehicle crashes, smoking is considered a risk-taking behavior. As hypothesized, as the share of the adult population that uses tobacco increases, the share of adults who are likely to behave in a risky manner also increases, thus the number of fatal crashes increases.

4.3.3 Alcohol Consumption

The average share of the adult population that has consumed an alcoholic beverage in the past month was calculated using the BRFSS data collected over a two year period. This is self-reported alcohol use, so the share may be under representative of the actual share of the adult population that has had a drink, because some individuals that are classified as adults but are not of legal drinking age may be less apt to tell the truth in a voluntary survey. In addition, several counties in the southeastern region of the nation are dry counties which prohibit the

www.manaraa.com

sale, distribution, and consumption of alcohol, which may also lead to inaccuracies when referring to self-reporting in a survey. Any self-reported survey data should be used with caution with an understanding that error biases may potentially be higher than other forms of data collection. A southeastern region weighted average was calculated to compare with the given national average, and it was found that the southeastern states have a smaller share (46.6 percent) of adult population that consumed alcohol in the past month (of the survey) than the national average (54.5 percent) (BRFSS, 2012). The Pearson Correlation Coefficient that was calculated comparing the alcohol consumption by state to fatality rates by state was -0.577, indicating that there is a moderate negative statistically significant correlation between the two variables at a 95 percent confidence interval. It is of importance to note that simply consuming an alcoholic beverage in the past month is not in itself a risk-taking behavior, but rather the act of driving while intoxicated would be considered a risk-taking behavior. Therefore the correlation coefficients found in this section of the thesis may not be of much significance when referring to fatality rate variations by risk-taking behavior characteristics. The same limitations are present in the other types of drinking used in this thesis, as all the data relating to alcohol consumption was retrieved from the same source. Binge drinking and heavy drinking are again from self-reported survey collected data, and is found to be less of an actual indicator of risk-taking behavior than originally hypothesized. Binge drinking is defined by the BRFSS as more than five drinks at one time for a male and more than four drinks at one time for a female. Another variable that was compared to fatality rates is average share of the adult population that admitted to binge drinking in the last 30 days. Binge drinking share also had a statistically

المنارة للاستشارات
www.manaraa.com

significant Pearson Correlation Coefficient at a value of -0.366, with a confidence interval of 95 percent. While this is a statistically significant correlation, the correlation is defined as moderate, not strong, and is less correlated than any alcohol consumption is to fatality rates. The share of binge drinkers in the adult population is less in the southeastern region than the national level (BRFSS, 2012). This negative correlation is not what was expected, as the original hypothesis was that as alcohol use, a potentially risky behavior, increases, fatality rates would also increase. Yet as previously mentioned, the act of consuming an alcoholic beverage is not necessarily a risky behavior in itself, but the risk associated with drinking alcohol is introduced if driving occurs subsequent to the alcohol consumption. Given the above mentioned limitations of the data in addition to the aggregate level that the data was collected, the negative correlations are of little significance to this thesis. Of possible greater significance, is the sales volume of alcohol, and the correlations between alcohol sales and fatality rates. Gruenewald and Ponicki (1995) report finding a positive correlation between alcohol sales and nighttime fatal crashes using data from 38 states over a 12 year time period (Gruenewald,P.J., Ponicki, W.R., 1995). McMillan and Lapham (2006) found a 42 percent increase in alcohol related crash fatalities on Sunday correlated to Sunday packaged alcohol sales ban being lifted in New Mexico (McMillan,G.P., Lapham,S., 2006).

4.3.4 Drug Use

Using the NSDUH given through the SAMHSA, drug use is categorized into three categories in addition to five age groups, some of which are overlapping. The

المنارة للاستشارات
www.manaraa.com

categorization of drug use is defined as illicit drug use in the past month, marijuana use in the past month, and illicit drugs other than marijuana in the past month. At the national level it is theoretically sound to add the marijuana use and illicit drug use other than marijuana to get total drug use, however because of the methodology mentioned in section three of this thesis; it is not sound to do that same iteration at the state level. The age groups that are included in the survey are shown in Table 14.

Table 14 Age Groups of NSDUH

Age Group (years)	Represents
12 +	All respondents
12 - 17	Minor respondents
18 - 25	Young adult respondents
18 +	Adult respondents
26 +	Older adult respondents

Data source: NSDUH, 2012

For the all illicit drug use category, the Pearson Correlation Coefficient was calculates to be inversely correlated (-0.53) in the 18 to 25 year old age range when compared with total fatality rates. However, when the correlation to fatality rates of only the 18 to 25 year old age group was calculated, all illicit drug use was found to have a strong statistically significant correlation of 0.95 (NSDUH, 2012). This is an indication that it is not sound to correlate independent characteristics of a specific age group to a dependent characteristics that is inclusive of all age groups, meaning the share of young adult illicit drug users is not directly correlated with the overall fatality rate, but is strongly correlated to the fatality rate of young adults. This presents a clearer representation of what one would expect, given drug use is

المنارة للاستشارات
www.manaraa.com

an inherently risky behavior that also causes an individual to behave in a risky manner. The same trends are present in marijuana only use, and in illicit drugs other than marijuana, however are not found to be of statistical significance at any reasonable confidence interval (NSDUH, 2012). It should be noted that as mentioned in the previous methodology, the sample size for the NSDUH is not nearly the size of other similar population surveys, thus the results should be used with caution.

4.3.5 Physical Health

The BRFSS reports shares of adults in body mass index (BMI) ranges from underweight to obese, in addition to overall general health from poor to excellent. For the purposes of this thesis, three physical health characteristics were chosen to compare with fatality rates by state; obese BMI (30.0 or higher), excellent overall health, and poor overall health. The national share of the adult population that is classified as having an obese BMI is 29.4 percent, which is less than one percent lower than the southeastern region average share of adult population with an obese BMI (30 percent). Florida is the only state in the southeastern region that has a lower share of obese adult population than the national average. The Pearson Correlation Coefficient was calculated comparing the share of adult population that is obese with the fatality rates by state was found to be 0.616, which is statistically significant at a 95 percent confidence interval. It is worth noting again that correlation coefficients do not indicate causation, but correlation, and it is imperative that the two are not confused. When the correlation between general health and obesity is calculated it was found that obesity has a statistically

المنارة للاستشارات
www.manaraa.com

significant strong direct correlation with poor health (0.714) and a statistically significant strong inverse correlation with excellent health (-0.821). This is an indication that as the share of adults that are obese increase, the share of adults that are overall generally unhealthy increases, and the share of generally excellent healthy population decreases. This is also an indication that both overall health and obesity should not be included in a regression model to estimate fatality rates, as they are more correlated with each other than they are correlated with fatality rates.

In the case of overall health, Pearson Correlation Coefficients were calculated between excellent overall health and fatality rates, between poor overall health and fatality rates, and between excellent overall health and poor overall health. All correlations were found to have moderate statistical significant correlations at a 95 percent confidence interval. Excellent overall health and fatality rates have a moderate inverse correlation of -0.615. The healthier the population, the more likely they are to survive a collision that an otherwise unhealthy person may not have survived. Just as intuitive, the correlation between overall poor health and fatality rates is a direct correlation of 0.666. If an unhealthy person is involved in a traffic collision, their chances of survival is less than that of a healthy person. For completeness, the overall poor health and overall excellent health were also compared, and were found to have a strong inverse statistically significant correlation of -0.771, indicating that they should not both be used in a regression model to estimate the fatality rates by state.

المنارة للاستشارات
www.manaraa.com

4.3.6 Mental Health

Mental health was another area of exploration for the study of this thesis, in the idea that decreased levels of cognitive mental capabilities may be indicative of increased probability of behaving in risky manners. While the theoretical relationship between risk-taking behavior increases with increased mental illness made sense, especially throughout the literature review, where studies revealed a higher propensity for risky sexual behavior among those with decreased mental cognitive capabilities, the data in this thesis found no statistical significance in a relationship between mental disabilities and fatality rates at a state level, with the slight exception of one age group in one mental illness variable. The mental illness variables that were explored were again from the NSDUH data; serious mental illness in the past year, any mental illness in the past year, at least one major depressive episode in the past year, and thoughts of suicide in the past year. In general the southeastern region was fairly close to the national level in all mental health characteristics. The only characteristic that was found to be slightly statistically significant with fatality rates at the state level was the 26 and older age group of serious mental illness in the past year, with a Pearson Correlation Coefficient of 0.326. In order to be statistically significant at the 95 percent confidence interval the Pearson Correlation Coefficient must have a magnitude greater than or equal to 0.3.

4.3.7 Educational Attainment

Two categories of educational attainment were explored for comparison between educational levels and fatality rates. Both categories were defined by the

للاستشارات المنارة
www.manaraa.com

U.S. Census Bureau as population 25 and older who has a high school diploma or equivalent, and population 25 and older with a Bachelor's degree or higher. The Pearson Correlation Coefficient calculated was the highest between the shares of population over 25 with a Bachelor's degree or higher and fatality rates, at a value of -0.742, indicating a strong inverse statistically significant correlation at a 95 percent confidence interval. This is an expected correlation, because in general, as a person's education level increases, their self-worth also increases, and their propensity to partake in risky behavior that may jeopardize their hard work in obtaining their education is greatly reduced. There is also a statistically significant inverse correlation of -0.345 between the shares of population that obtained their high school diploma or equivalent, however that correlation is not as strong as the higher education correlation. When compared to share of the population below the poverty level , the share of population who obtained their high school diploma is greatly inversely correlated (-0.774). This means that as the share of population that has completed high school increases, the share of population below poverty level decreases, which is an expected relationship. The last educational correlation coefficient that was calculated was the correlation between the share of population who completed their high school education, and the share of population that obtained a Bachelor's degree or higher. This direct correlation was statistically significant at a value of 0.407. With all the correlation coefficients taken into consideration, it was concluded that the characteristic that should be included in the regression model to estimate fatality rates is the share of population with a Bachelor's degree or higher at the age of 25.

المنارة للاستشارات
www.manaraa.com

4.4 Other Demographics Used for Regression

In order to have as reduce the unobserved or random component accounted for in the error term of a regression model, a couple other characteristics aside from the risk-taking characteristics being tested are included in the model. Characteristics that are known to affect the fatality rates, from previously reviewed literature, should be included so that the risk-taking characteristics are not being misrepresented in the fatality rate estimation. Transportation safety is a complex problem with numerous interconnected variables all having some type of contribution overall. Unfortunately, it is unrealistic to include every influencing factor in a thesis to estimate approximate fatality rates given the variation of independent variable characteristics by geography. This thesis used characteristics known to affect transportation safety in conjunction with several risk-taking characteristics to estimate the amount of the risk-taking characteristics have on the overall fatality rate at a state level. The demographic characteristics will also help to estimate more accurate marginal effect coefficients to the risk-taking characteristics in the linear regression model. For this model, the demographic characteristics included are share of the population born in state of residence, and unemployed share of population by state.

The share of population born in state of residence seems to be a moderately decent indicator of the rate of unfamiliar drivers on the roadway network. This is not implying that because you move to another state you are always an unfamiliar driver, however, visitors from the state of origin will be unfamiliar drivers, and the larger the share of residents born out of their state of residence, the larger the share of friends and family that will visit the current state of residence. Inversely if

المنارة للاستشارات
www.manaraa.com

an individual lives in the state they were born in, the chances of them being unfamiliar of the roadway network decreases. Familiarity of the roadway network includes, but is not limited to, knowing where crosswalks and rail crossings are located, knowing posted speed limits, school zones, senior zones, etc. and which exit to take off the interstate. The share of unemployed population is considered as one of the descriptive independent variables because the unemployed population generally drives much less than the share of the population that is employed. The reduction in travel contributes to the overall reduction in fatality rates because if an individual is not traveling, their chances of being fatally injured while traveling are significantly decreased via simple exposure rates. A report produced through the NHTSA in 2010 revealed that the Metropolitan Statistical Areas with the highest increase in unemployment between 2007 and 2008 also experienced the largest decrease in fatalities, and the Metropolitan Statistical Areas with the smallest increase in unemployment rates experienced the smallest decline in fatalities during the same time period, citing great reductions in crashes involving young drivers, multiple vehicle crashes and crashes which occurred on the weekends when most discretionary driving occurs (NHTSA, 2010).

Other studies such as "The Effects of Mandatory Seat Belt Laws on Driving Behavior and Traffic Fatalities," by Cohen and Einav used independent descriptive characteristics such as median income, mean age, share of black and Hispanic population, rural density, violent crimes, speed limit, and fuel tax to explore the differences in fatality rates by geography. "Gasoline Prices and Motor Vehicle Fatalities," by Grabowski and Morrisey used gasoline prices, license revocation, seat belt laws, speed limit, unemployment rate, and income per capita to estimate

المنارة للاستشارات
www.manaraa.com

fatality rates by state. The results of the estimation are often dependent on the geography the data is aggregated to. According to Clark and Avery (2010) due to aggregation bias "it is incorrect to assume that relationships existing at one level of analysis will necessarily demonstrate the same strength at another level' (Clark and Avery, 2010). For instance a variable that is known to have significant correlation at a Census Tract aggregate level may not display the same significance or even the same direction of relationship at a state level. Some other characteristics that are commonly used as independent variables to describe a dependent variable of fatality rates, but were not used in the regression analysis of this thesis include: race, income, traffic density, property crimes, fuel taxes, fuel consumption, average speed, vehicle expenditures, speed limit laws, gross national product, retail sales, etc. Several of these mentioned independent variables are inter-correlated, meaning it would not be meaningful nor correct to include all listed variables in one regression analysis. As mentioned previously, safety is a complex problem with multifaceted interrelated solutions which are not obvious nor easily solved, which is why fatalities still occur on the roadway network.

4.5 Linear Regression

It is of extreme importance to note that the linear regression formed for this thesis was formed at an aggregate state level. Aggregate level data is not ideal, as it is not as accurate nor is it always as representative as disaggregate data. For instance the average credit score of a specific city, Phoenix, Arizona is 737; however the average credit score for the state of Arizona is only 640, indicating that if an average state credit score is used to represent each city, the average

المنارة للاستشارات
www.manaraa.com

credit score for the city of Phoenix would be greatly underestimated. Unfortunately, for the variables being used for consideration in this thesis, such as credit score, smoking population, educational attainment, etc., consistent disaggregate data is not available. Aggregate data has the potential to have aggregation bias, where the correlations may appear to be statistically significant at an aggregate level but not at a disaggregate level, or the regression analysis may indicate a significantly different relationship between the dependent and independent variables than would be apparent if the data were evaluated at a disaggregate level (Clark and Avery, 2010). With the understanding that the risk-taking characteristics are at an aggregate state level, all calculations and conclusions should be used with caution.

There are always unknowns present in regression analyses, some are known unknowns and some are unapparent unknowns. In this thesis there are several characteristics which were not considered because the scope of this thesis was focused on risk-taking behaviors, and could not reasonably consider every impactful possible characteristic. Some unknowns which are known to affect fatality rates which were not considered in this thesis include types of vehicles driven, travel speeds, state traffic laws, emergency response capabilities, weather, topography, intersection density, time of day which the crash occurs, driving under the influence, rural and urban share of crashes, etc. The error term in the regression model attempts to account for all the characteristics which were not explored.

An estimated regression model of fatality rate as a function of average credit score, share of population over 25 with bachelor's degree or higher, share of population with overall poor health, share of population who reports always using a

www.manaraa.com

seat belt, share of population born in state of residency, and unemployed share of population is shown in Equation 8.

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + e \qquad \text{Equation 8}$$

where Y_i = fatality rate

X_{1i} = average credit score

X_{2i} = share of population over 25 with bachelor's degree or higher

X_{3i} = share of population with overall poor health

X_{4i} = share of population that reports always using a seat belt

X_{5i} = share of population born in state of residency

X_{6i} = unemployed share of population

e = error term to account for unknowns.

When all data was entered and calculated, the coefficients were determined and shown in Equation 9.

$$Y_i = 7.176 - 0.007X_{1i} - 0.018X_{2i} + 0.079X_{3i} - 0.005X_{4i} - 0.005X_{5i} - 0.046X_{6i} \qquad \text{Equation 9}$$

where the terms represent the same variables as indicated in Equation 8.

It is important to understand that the above calculated linear regression equation is using a limited number of variables, and as mentioned previously, safety, specifically fatality rates, are extremely complex and impossible to accurately measure with a limited number independent variables. The correlations, both known and unknown, make this problem too complex to solve with one linear regression equation. This thesis is an attempt at using the best available data to distinguish the amount of effect risk-taking independent variables have on fatality rates while also accounting for some demographic independent variables which are

المنارة للاستشارات
www.manaraa.com

known to effect fatality rates but are not too strongly correlated to the risk-taking variables being used.

The sign of the coefficient of each independent variable determines whether or not the dependent variable is directly or inversely related. If the sign of the coefficient of the independent variable is positive, then the independent variable is directly related to the dependent variable, meaning as the independent variable increases the dependent variable also increases marginally at a proportion equal to the magnitude of the coefficient, given all other variables are held constant. For instance, for each percent share increase of the adult population with poor health, the fatality rate of that geography should experience an increase of 0.079, given all other independent variables remain the same. Contrarily, if the sign of the independent variable is negative then the independent variable and the dependent variable have an inverse relationship, meaning as the independent variable increases, the dependent variable should decrease proportionately at the magnitude of the independent variable coefficient given all other characteristics remain the same. For instance, for each percent share increase of the population over 25 years of age that obtains a bachelor's degree or higher, the fatality rate should decrease 0.018; given all other independent variables remain constant.

It is also important to mention the error term which is present in the regression model. The error term helps to explain the variability in fatality rates when all independent characteristics are equal. Error terms are present in all regression models and are assumed to represent a normal distribution with a mean value of zero. The error term is considered the random or unobserved component in the regression analysis. Once the regression analysis is estimated, the error term is

المنارة للاستشارات
www.manaraa.com

no longer included and the effects of the variables that are not included in the model, or the unobserved characteristics, are captured in the constant term. Table 15 displays the parameter estimates, standard error of the estimate, and t statistic for each of the explanatory variables, along with goodness of fit measures.

Table 15 Linear Regression Variable Estimates and Goodness of Fit Measures

Explanatory variable	**Parameter estimate**	**Standard error (S.E.) of the estimate**	**t statistic**
Credit Score	-0.007	0.003	-2.169
≥25 yrs with Bachelor’s or higher	-0.018	0.006	-3.206
Overall Poor Health	0.079	0.024	3.264
Seat Belt Use	-0.005	0.004	-1.370
Residents born in state	-0.005	0.002	-2.702
Unemployed	-0.046	0.015	-3.140
Goodness of fit measures:			
Regression Sums of Squares (SSR)	3.381		
Residual Sums of Squares (SSE)	1.107		
Total Sums of Squares (SST)	4.488		
R^2	0.753		
Adjusted R^2	0.721		
Number of cases	52		

Credit score was calculated to have an inverse effect on fatality rates at the aggregate state level. This result was expected given the previously performed literature review which revealed that as a person’s fiscal responsibility increases, their credit score also increases. This increased credit score and increased fiscal responsibility is accompanied by a decreased likelihood of risk-taking behavior. As an individual’s likelihood of risk-taking behavior in financial matters decreases, their likelihood of driving in a risky manner should also decrease. In addition to driving in a safer manner, a fiscally responsible person is also more likely to keep their

المنارة للاستشارات
www.manaraa.com

vehicle properly maintained, such as getting regularly scheduled oil changes, replacing tires prior to balding, replacing brake-pads at regular intervals, etc. This regularly scheduled proper maintenance will reduce the likelihood of vehicle failure, and thus reduces the chances of a collision due to vehicle failure. While fatality rates are inclusive of all person types such as drivers, passengers, and pedestrians, etc. decreasing the propensity of risk-taking behavior would have a positive effect on all roadway network users.

The share of population with a Bachelor's degree or higher was calculated to have an inverse effect on fatality rates at the aggregate state level. This result was expected given the previously performed literature review which revealed that as an individual's education levels increase their understanding of consequences which accompany their actions also increases. Accompanying a better understanding of consequences for actions is a reduced likelihood of driving while intoxicated, distracted, at unsafe speeds, or without a seat belt. In addition, people with higher education levels are more likely exhibit healthy behaviors such as eating a healthy diet, exercising, refraining from smoking, all of which are examples of decreased risk-taking behaviors which also lead to increased life expectancy.

The share of population with overall poor health was calculated to have a direct relationship with fatality rates at the aggregate state level. This result was expected given the previous literature review which assumes general health to be related to chronic diseases, healthy behaviors, and access to preventative health-care services. Overall poor health can be caused by several factors which are also considered to be risk-taking behaviors such as eating an unhealthy diet, lack of exercise, being overweight, and smoking. Thus as risk taking behavior increases,

المنارة للاستشارات
www.manaraa.com

the chance of being classified as overall unhealthy also increases. This supports the original hypothesis that as risk-taking behaviors increase, fatality rates also increase.

The share of population which always wears a seat belt while driving was calculated to have an inverse relationship with fatality rates at an aggregate state level. Seat belt use, or rather lack of seat belt use is considered a risk-taking behavior which is inherently different than the other risk-taking behaviors being examined in this thesis. Seat belt use has been proven to reduce the severity of a motor vehicle crash when used properly, and is the only risk-taking behavior analyzed which has a direct effect on the injury severity of a vehicular crash. When considering the other risk-taking characteristics which were examined in the regression analysis, changing the proportionate share of population would not have a direct effect on fatality rates. For instance, increasing the average credit score of an individual does not inherently make them behave in a less risky manner thus would not directly cause them to drive more carefully. Unlike the other risk-taking characteristics reviewed however, increasing the share of the population that always wears their seat belt can directly impact the fatality rates by reducing the injury severity of collisions which occur.

The last two independent variables presented in the regression model were not risk-taking characteristics, instead were demographic characteristics used to help explain the variation in fatality rates. The share of population born in state of residency was calculated to have an inverse correlation to the fatality rate by state. This is an intuitive relationship because as previously stated, if a person resides in the state in which they were born they are less likely to be unfamiliar drivers on the

المنارة للاستشارات
www.manaraa.com

roadway network. As the share of unfamiliar drivers on the roadway network decreases, the variation in speed on that network should also decrease, and a reduction in variation of speed is associated with a lower chance of collision occurrence. In addition, a person born in their state of residence will likely know the location of high risk of collision areas such as crosswalks, rail at-grade crossings, etc. Finally, the share of unemployed population was calculated to an inverse relationship to fatality rates by state. This is an intuitive correlation because an unemployed individual will travel less than an employed individual, thus reducing their exposure risk. Trip reduction of the unemployed population would not only be due to less home-based work trips, but the lack of income associated with unemployment would likely also lead to a reduction in all types of trips. This reduction in trips equates to a decreased exposure rate, thus reducing the chances of being involved in a fatal collision. This increased unemployment has shown to lead to decreased crashes involving young drivers, multiple vehicle crashes, and weekend crashes, all leading to reduced fatalities (NHTSA, 2010).

المنارة للاستشارات
www.manaraa.com

CHAPTER 5:

CONCLUSIONS

Fatality rates in each of the eight states in the southeastern region of the U.S. have consistently been higher than the national average fatality rate in terms of fatalities per VMT, and fatalities per population. As of 2012, three of the eight southeastern states were ranked in the top ten of overall fatalities per capita in the nation. Safety is an incredibly complex problem affecting every aspect of the transportation sector. Each of the influencing characteristics associated with the safety of a transportation network are interconnected in such a complicated way which make a complete unanimous solution an impossible feat. With the complete understanding that no one solution is going to have the ability of eliminating all transportation fatalities which occur on the network, hypotheses are made to try to understand why some regions have higher fatality rates than other regions. While the southeastern region does have socio-economic and socio-demographic traits such as higher levels of poverty, higher share of elderly population, higher minority shares of population, and more vulnerable road users, which partially help to estimate why fatality rates are higher in this region of the nation, this thesis focused mostly non-conventional risk-taking characteristics as explanatory variables. Many risk-taking characteristics were found to have significant correlations to conventional characteristics used in previous literature to estimate

المنارة للاستشارات
www.manaraa.com

fatality rates at specific levels of geography, such as median income and share of population with a Bachelor's degree or higher. When two independent variables exhibit strong correlations, using both the correlated independent variables would not be of sound logic, and thus for the purposes of this thesis, median income was replaced with share of population with a Bachelor's degree or higher.

The hypothesis tested implies that if a person behaves in a risky manner in economic and health aspects of their life, risk is likely present is several aspects of their life, therefore that person is also expected to drive in a risky manner, and delay maintenance of their vehicle which, would in turn equate to more collisions and higher fatality rates. This is under the assumption that if a person displays risk-taking characteristics of any type, that person likely behaves in a risky manner in other aspects of their life. This assumption of risk-taking behavior is used as a great starting point to help explain variation in fatality rates in specific regions of the nation where risk-taking behaviors and fatality rates are both higher than national averages.

A breadth of risk-taking characteristics such as credit score, educational attainment, seat belt use, tobacco, alcohol and drug use, obesity, and overall health, were shown to have statistically significant bivariate correlations with fatality rates, as shown in Table A1 in the appendix. Four risk-taking characteristics were found to influence fatality rates at an integrated level when a linear regression model was formed; average credit score, educational attainment, overall health, and seat belt use. While one of the mentioned risk-taking characteristics - propensity to use a seat belt - is directly related to fatality rates, the other risk-

المنارة للاستشارات
www.manaraa.com

taking behaviors are indirectly related to fatality rates, such as credit score, educational attainment, and overall health.

Seat belt use has been shown to reduce the injury severity of a vehicular passenger when involved in a collision; therefore increasing the share of seat belt using population in a region such as the southeastern region of the U.S. would directly impact the fatality rates of the region. In the context of other risk-taking characteristics considered in this thesis, the relationship with fatality rates is not necessarily causal. Correlation is not causation; two variables that are statistically significantly correlated does not imply that changing one variable would cause a change in the other variable. For example, increasing the share of population that has a higher education may not directly lead to a reduction of fatality rates unless that increase in educational attainment is coupled with a reduction in overall sensation-seeking or risk-taking behavior. The correlation between fatality rates and educational attainment is due to the typical characteristics of an individual with a higher educational attainment, not the education level itself. As stated in the literature review of this thesis, a person with a higher education level is more likely to consider the consequences of their actions, have a higher self-worth, and have a higher household income, all of which are characteristics associated with decreased levels of risk-taking behavior. Increasing education levels in itself will not necessarily increase these traits associated with decreased risk-taking, however it is likely that as education levels increase awareness would also increase, decreasing overall risk0-taking behavior. Still, all interpretations of the calculated regression model from chapter four must be considered with caution.

المنارة للاستشارات
www.manaraa.com

Credit score is similar to educational attainment, in that there is not a direct relationship between credit score and fatality rates, however the literature review revealed that credit score increases are associated with likelihood of vehicle maintenance and cautious driving habits, which have the ability to influence fatality rates. As revealed in the literature review, a consumer who is prudent in their own financial matters is also expected to be more prudent in vehicle maintenance and display more cautious driving habits. It is not the increased credit score in itself that reduces the fatality rates; it is the underlying responsible characteristic of an individual that leads to a high credit score and reduced propensity to engage in risk-taking behavior. This is an indication that simply increasing the average credit score in a particular geography would not reduce the fatality rates in that geography, unless the increased credit score is coupled with changes in the typical traits that reduce risk-taking behavior.

Poor overall health is perhaps the most indirect characteristic which is related to risk-taking behaviors and correlated to fatality rates, at least at a state level geography. The literature review revealed that overall poor health is related to chronic diseases, unhealthy behaviors and lack of preventative health-care services such as regular check-ups, with the most common factors to overall poor health being specific risk-taking behaviors such as smoking, consuming an unhealthy diet, lack of exercise, and being overweight. Again, the distinction between correlation and causation must be fully understood. This correlation between poor overall health and fatality rates does not indicate that simply increasing the overall health levels of a population would directly decrease vehicular fatality rates. The increased health of the overall population would necessarily be coupled with an overall

المنارة للاستشارات
www.manaraa.com

decrease of risk-taking behaviors in order to have any impact on the fatality rates in the region. For instance, just because someone eats a healthy diet and exercises, thus increasing their overall health, does not mean that individual will not drive in a risky manner, nor does this indicate that person is more likely to survive a collision than a person who eats an unhealthy diet and does not exercise, however a healthy individual may be more attentive or less fatigued while driving, thus reducing their risk of collision while driving. The correlation should be interpreted as the likelihood of risk-taking behaviors increases, the chances of classification of overall poor health also increases, in addition, the probability of collision increases due to the increased risk-taking behavior.

It is important to reiterate that the linear regression model was formed using state level aggregate data, and therefore the chance of aggregate bias is introduced. Unfortunately, there is not much risk-taking characteristic disaggregate data available for analyses, leading to the requirement of using data aggregated to the state level. When data is aggregated at the state level in the U.S. the data points are then limited to 52 cases when the District of Columbia and the national average are also included as data points. To improve the usefulness of the linear regression model, more data points and more variables could be introduced; however this adds a level of difficulty beyond the scope of study for this thesis.

To reduce the driving related risk-taking behavior, measures which have previously been shown to be effective include making laws more comprehensive by changing non-existent or secondary laws to primary laws which are inclusive of all roadway users, coupled with increased enforcement, and increased perception of enforcement. Increasing enforcement is most effective when media is also

المنارة للاستشارات
www.manaraa.com

emphasizing the enforcement to increase the perception of enforcement as well. The increased enforcement should be placed on policies such as safety belt and helmet use, booster-seat use, speeding, and distracted driving such as texting while driving. Reducing these directly related risk-taking characteristics should produce the greatest associated decrease in fatality rates in the southeastern U.S.

In addition to reducing the risk-taking behaviors that have a direct effect on fatality rates, efforts should also be made to implement education and counseling to the share of population that is known to behave in risky manners. Education and counseling will not eliminate the share of population that behaves in a risky manner while driving; however it may help to reduce the risk-taking behaviors of those individuals who are not aware of the risk-taking characteristics they possess. Some individuals display risk-taking characteristics because they don't care, nor do they desire to reduce their amount of risk-taking behaviors. The implementation of counseling and educating services will not have much impact on individuals who do not want to change their habits, however there is likely a share of the population who displays risk-taking characteristics because they do not know any better, or are unaware of the consequences that may accompany their behavior. For the share of population who would behave in a less risky manner if they knew better, education and counseling could be beneficial. The counseling and education referred to should emphasize the reduction of risk-taking characteristics directly related to fatality rates such as increasing safety belt and helmet use, reducing distractions while driving, reducing driving under the influence, reducing speed, and driving defensively rather than aggressively. If education and counseling implementations

www.manaraa.com

reduce overall risk-taking behavior, then the fatality rates would also decrease, increasing the total safety of the roadway network as a whole.

Additional efforts focusing on the addition of more variables could significantly enhance the usefulness of the efforts put forth in this thesis. Increasing the number of variables included in the regression analysis would help to reduce the error associated with the unobserved characteristics and increase the usefulness of the results by including more suggestions of policy implications. In addition to increasing the number of variables, decreasing the size of data aggregation would help to reduce aggregation bias and possibly infer better focused policy implications. In addition, remediation actions are easier and less expensive at small geographies, rather than at the state level, and the aggregation of the data used in the analyses of this thesis does not allow for small geography associations and the subsequent targeted actions.

Carrying out the analyses in this thesis on sub-segments of the overall fatality data may enhance the usefulness of the linear regression estimation. For instance, comparing the independent risk-taking variables with only alcohol related fatalities may help to clarify the characteristics specifically associated to driving while intoxicated. Similarly sub segments such as urban versus rural or freeway versus non-freeway may help to distinguish what types of areas are most influenced by specific characteristics within specific designs. For instance most freeways are relatively constant over geographies, therefore the variation of fatality rates on freeways by state may show a better indication of the influence specific risk-taking traits of the population in that area have on fatality rates. A further exploration of daytime versus nighttime and vulnerable versus vehicular road user

المنارة للاستشارات
www.manaraa.com

fatalities may help to distinguish why the southeastern states have a higher pedestrian fatality rate when compared to the other states in the U.S. and what risk-taking characteristics are playing a significant role in the fatality rate differences.

This thesis can be used as a starting point for additional analysis that can assist states in moving closer to a zero traffic fatality goal. As previously mentioned, safety is a complex problem and numerous strategies will need to be deployed together to find solutions which work to reduce fatalities in each area. Reducing risk-taking behaviors -traits that are disproportionately common in the southeastern states - of drivers, pedestrians and bicyclists are a component of the myriad of activities to improve the transportation vehicles, infrastructure, enforcement and education efforts directed toward improving travel safety.

www.manaraa.com

REFERENCES

AAPOR (American Association for Public Opinion Research). (2011). *Standard Definitions: Final dispositions of case codes and outcome rates for surveys.* Retrieved from http://www.aapor.org/AAPORKentico/AAPOR_Main/media/MainSiteFiles/StandardDefinitions2011_1.pdf

American Insurance Association. *Conclusions from Major Credit-Based Insurance Scoring Studies.* Retrieved from http://www.naic.org/documents/committees_c_d_0909_AIA_Supplemental_Information.pdf

Arbabi S, Wahl WL, Hemmila MR, et al. The cushion effect. J Trauma 2003;54 (6):1090-1093.

Benjamin, M. NHTSA. (1999). *Aggressive Driving and the Law: A symposium.* Retrieved from http://www.nhtsa.gov/people/injury/aggressive/Symposium/lunch.html

CDC (Center for Disease Control and Prevention). (2013). *Behavioral Risk Factor Surveillance System.* Retrieved from http://www.cdc.gov/brfss/about/about_brfss.htm

CDC Recommendations for Improving Health through Transportation Policy. (2010). *Centers for Disease Control and Prevention.* Retrieved from http://www.cdc.gov/transportation/docs/final-cdc-transportation-recommendations-4-28-2010.pdf

Census. (2014). U.S. Census Bureau*. American Community Survey Design and Methodology.* Retrieved from http://www.census.gov/acs/www/methodology/methodology_main/

Chetty, R., Hendren, N., Kline, P., Saez, E. (2014). Where is the Land of Opportunity? The Geography of Intergenerational Mobility in the United States. *The National Bureau of Economic Research.*

Chwastiak, L. A., Rosenheck, R. A., & Kazis, L. E. (2011). Original research report: Association of Psychiatric Illness and Obesity, Physical Inactivity, and Smoking among a National Sample of Veterans. Psychosomatics, 52230-236. doi:10.1016/j.psym.2010.12.009

www.manaraa.com

Clark, W.A.V., Avery, K.L. (2010). The Effects of Data Aggregation in Statistical Analysis. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1538-4632.1976.tb00549.x/pdf

Cohen, A., Einav, L. (2001). The Effects of Mandatory Seat Belt Laws on Driving Behavior and Traffic Fatalities. Cambridge: Harvard Law School. Retrieved from http://www.law.harvard.edu/programs/olin_center/papers/pdf/341.pdf

Counter Measures That Work: A highway safety countermeasure guide for state highway safety offices. (2013). *National Highway Traffic Safety Administration*. Retrieved from https://www.google.com/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#

Cramer, C., Rueger, J. M., & Hoffmann, M. (2013). Fat or thin: Does it impact outcomes in polytrauma?. Trauma, 15(4), 301-307. doi:10.1177/1460408613497147

Dangerous by Design 2014. (2014). *Smart Growth America. National Complete Streets Coalition.* Retrieved from http://www.smartgrowthamerica.org/documents/dangerous-by-design-2014/dangerous-by-design-2014.pdf

Delgado, I. (2011) Modeling Roadside Safety Hazards to Predict Annual Crash Cost to Encroaching Vehicles in Rural Road Networks. *University of South Florida Graduate Dissertation.* Retrieved from http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=4250&context=etd

De Pauw, E., Daniels, S., Brijs, T., Elke, H., Geert, W. (2014). The Magnitude of the Regression to the Mean Effect in Traffic Crashes. Retrieved from http://www.ictct.org/migrated_2014/ictct_document_nr_834_24th%20ICTCT%20-Ellen%20de%20Pauw.pdf

Distracted Driving Laws. (2015). *Governors Highway Safety Administration.* Retrieved from http://www.ghsa.org/html/stateinfo/laws/cellphone_laws.html

Driver Distraction Program. (2010). *U.S. Department of Transportation.* National Highway Traffic Safety Administration. Motorcycles. Retrieved from https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0CCwQFjAC&url=http%3A%2F%2Fwww.nhtsa.gov%2Fstaticfiles%2Fnti%2Fdistracted_driving%2Fpdf%2F811299.pdf&ei=Z2TWVInkEa7esATF8oLQDQ&usg=AFQjCNHtO1j9n_no7qp0iImYBME0ylBonw&bvm=bv.85464276,d.cWc

المنارة للاستشارات
www.manaraa.com

Educational Testing Service. (2013). *Poverty and Education: Finding the way forward.* Retrieved from http://www.ets.org/s/research/pdf/poverty_and_education_report.pdf

Education Matters for Health. (2009). *Commission to Build a Healthier America.* Robert Wood Johnson Foundation. Issue Brief 6: Education and Health. Retrieved from http://www.commissiononhealth.org/PDF/c270deb3-ba42-4fbd-baeb-2cd65956f00e/Issue%20Brief%206%20Sept%2009%20-%20Education%20and%20Health.pdf

Eichelberger, A.H., Chouinard, A.O., Jermakian, J.S. (2012). Effects of Booster Seat Laws on Injury Risk Among Children in Crashes. *Insurance Institute for Highway Safety.* Arlington, Virginia: National Institute of Health. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/23137094

Explorable.com (May 2, 2009). Statistical Correlation. Retrieved Mar 19, 2015 Retrieved from https://explorable.com/statistical-correlation

FARS. Fatality Analysis Reporting System. (2013). Database and Manuals. Retrieved from http://www.nhtsa.gov/FARS

Federal Trade Commission. (2007). *Credit-Based Insurance Scores: Impacts on consumers of automobile insurance.* Retrieved from http://www.ftc.gov/sites/default/files/documents/reports/credit-based-insurance-scores-impacts-consumers-automobile-insurance-report-congress-federal-trade/p044804facta_report_credit-based_insurance_scores.pdf

Forbes. (2010). List: America's Most-Visited Cities. Retrieved from http://www.forbes.com/2010/04/28/tourism-new-york-lifestyle-travel-las-vegas-cities_slide_11.html

GHSA. (2015). *Governors Highway Safety Association.* Drunk Driving Laws. Retrieved from http://www.ghsa.org/html/stateinfo/laws/impaired_laws.html

Global Status Report on Road Safety. (2013). *World Health Organization*. Retrieved from http://www.who.int/violence_injury_prevention/road_safety_status/2013/en/

Governing.com. (2015). Governing Data: State Marijuana Laws Map. Retrieved from http://www.governing.com/gov-data/state-marijuana-laws-map-medical-recreational.html

Gruenewald, P. J., & Ponicki, W. R. (1995). Paper: The relationship of the retail availability of alcohol and alcohol sales to alcohol-related traffic crashes. Accident Analysis And Prevention, 27249-259. doi:10.1016/0001-4575(94)00067-V

المنارة للاستشارات
www.manaraa.com

Guiang, A.K. (2014). Study Indicates Bipolar, Schizophrenics are More Likely to Get Tested for HIV. *The Science Times.* Retrieved from http://www.sciencetimes.com/articles/1718/20141206/study-indicates-bipolar-schizophrenics-are-more-likely-to-test-positive-for-hiv.htm

Insurance Information Institute. (2014). Credit Scoring: The topic. Retrieved from http://www.iii.org/issue-update/credit-scoring

Jonah, B. A. (1997). Sensation seeking and risky driving: A review and synthesis of the literature. Accident Analysis And Prevention, 29(5), 651-665. doi:10.1016/S0001-4575(97)00017-1

Kent, A. (2009). Youth from Low-Income Families. *U.S. Department of Health & Human Services.* Retrieved from http://aspe.hhs.gov/hsp/09/vulnerableyouth/3/index.shtml

Levitt, S.D., Porter, J. (2001). Sample Selection in the Estimation of Air Bag and Seat Belt Effectiveness. Retrieved from http://pricetheory.uchicago.edu/levitt/Papers/LevittPorter2001.pdf

Litman, T. (2014). A New Transit Safety Narrative. *National Center for Transit Research:* University of South Florida. Retrieved from http://www.nctr.usf.edu/wp-content/uploads/2014/12/JPT17.4_Litman.pdf

Maralani, V. v. (2014). Understanding the links between education and smoking. Social Science Research, 4820-34.

Mayo Clinic. (2015). Heart Disease. Retrieved from http://www.mayoclinic.org/diseases-conditions/heart-disease/basics/causes/con-20034056

McLeod, S. A. (2012). Low Self Esteem. Retrieved from http://www.simplypsychology.org/self-esteem.html

McMillan, G. P., & Lapham, S. (2006). Legalized Sunday Packaged Alcohol Sales and Alcohol-Related Traffic Crashes and Crash Fatalities in New Mexico. American Journal Of Public Health, 96(11), 1944-1948.

Mental Health in the United States: Health risk behaviors and conditions among persons with depression – New Mexico 2003. (2005). *Center for Disease Control and Prevention.* Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5439a4.htm

Motorcycles. (2015). *Insurance Institute for Highway Safety.* Highway Loss Data Institute. Retrieved from http://www.iihs.org/iihs/topics/laws/helmetuse/helmethistory?topicName=Motorcycles#tableData

المنارة للاستشارات
www.manaraa.com

Motor Vehicle Crash Deaths in Metropolitan Areas – United States, 2009. (2012*). Center for Disease Control and Prevention*. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6128a2.htm#fig

MyFICO. (2015). Fair Isaac Corporation. Retrieved from http://www.myfico.com/crediteducation/whatsinyourscore.aspx

NHTSA. National Highway Traffic Safety Administration. (2015). Aggressive Driving. Retrieved from http://www.nhtsa.gov/Aggressive

NHTSA. National Highway Traffic Safety Administration. (2010). An Analysis of the Significant Decline in Motor Vehicle Traffic Fatalities in 2008. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/811346.pdf

NHTSA. National Highway Traffic Safety Administration. (2014). The Economic and Societal Impact of Motor Vehicle Crashes, 2010. Retrieved from http://www-nrd.nhtsa.dot.gov/pubs/812013.pdf

Photo Enforcement Program – Historical Perspective. (2006). *City of Renton, Wa.* Retrieved from http://rentonwa.gov/government/default.aspx?id=23876

Polzin, S.E., Pisarski, A.E., Spear, B., Long, L. (2013). Commuting in America 2013: The national report on commuting patterns and trends. Brief 10: Commuting mode choice. *American Association of State Highway and Transportation Officials.* Retrieved from http://traveltrends.transportation.org/Documents/CA10-4.pdf

Prochaska, J. J., Fromont, S. C., Delucchi, K., Young-Wolff, K. C., Benowitz, N. L., Hall, S., & ... Hall, S. M. (2014). Multiple risk-behavior profiles of smokers with serious mental illness and motivation for change. Health Psychology, 33(12), 1518-1529. doi:10.1037/a0035164

Research & Evaluation. (2014). *National Highway Traffic Safety Administration*. Retrieved from http://www.nhtsa.gov/Driving+Safety/Research+&+Evaluation

Reyes, R. (2013). Florida Motorcycle Deaths on the Rise. *The Tampa Tribune.* Retrieved from http://tbo.com/news/crime/florida-motorcycle-deaths-on-the-rise-b82483495z1

Rohrmann, B. (2002). Risk Attitude Scales: Concepts and questionnaires. Australia: University of Melbourne.

Ronis, C. (2014). MADD's Campaign has Strengthened Drunk Driving Laws in 24 States. Retrieved from http://www.madd.org/media-center/press-releases/2014/madds-campaign-has.html

المنارة للاستشارات
www.manaraa.com

Rune, E. (2013). Risk of Road Accident Associated with the Use of Drugs: A systematic review and meta-analysis of evidence from epidemiological studies. *Elsevier Journal of Accident Analysis and Prevention.* Retrieved from http://eds.a.ebscohost.com.ezproxy.lib.usf.edu/eds/detail/detail?vid=3&sid=3630075d-980b-479d-b397-123509020aea%40sessionmgr4005&hid=4205&bdata=JnNpdGU9ZWRzLWxpdmU%3d#db=edselp&AN=S0001457512002412

SAMHSA (Substance Abuse and Mental Health Services Administration). (2013). *NSDUH (National Survey of Drug Use and Health) Guide to State Tables and Summary of Small Area Estimation Methodology.* Retrieved from http://www.samhsa.gov/data/sites/default/files/NSDUHStateEst2012-2013-p1/Methodology/NSDUHsaeMethodology2013.htm

Satinder, K. P., & Black, A. (1984). Cannabis Use and Sensation-Seeking Orientation. Journal Of Psychology, 116(1), 101.

Small Area Income and Poverty Estimates. (2013). *United States Census Bureau.* Retrieved from: http://www.census.gov/did/www/saipe/data/interactive/#view=Mapping&utilBtn=&yLB=0&stLB=0&cLB=0&dLB=0&gLB=0&usSts_cbSelected=true&usTot_cbSelected=true&stateTot_cbSelected=true&pLB=0&multiYearSelected=false&multiYearAlertFlag=false&prStateFlag=false&invalidSDYearsFlag=false

Somasundaraswaran, K. (2010). The Road Safety: A Special Sign for Unfamiliar Drivers. *University of Southern Queensland.* Toowoomba, Australia. Retrieved from https://eprints.usq.edu.au/18474/1/Somasundaraswaran_AV.pdf

Southeastern Transportation Center. 2015. Retrieved from http://stc.utk.edu/

Statistical Analysis of Alcohol-Related Driving Trends, 1982-2005. (2008). *National Highway Traffic Safety Administration*. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/810942.pdf

Subramanian, Rajesh. Traffic Safety Facts. (2012). *National Highway Traffic Safety Administration*. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/811620.pdf

Tapert, S.F., Aarons, G.A., Sedlar, G.R., Brown, S.A. (2001). Adolescent Substance Use and Sexual Risk-Taking Behavior. *Elsevier Journal of Adolescent Health.* Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5439a4.htm

المنارة للاستشارات
www.manaraa.com

TCRP Report 102. (2004). Transit-Oriented Development in the United States: Experiences, challenges, and prospects. *Transportation Research Board.* Federal Transit Administration. Retrieved from http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_102.pdf

Traffic Safety Facts. (2013). Distracted Driving 2011. *National Highway Traffic Safety Administration*. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/811737.pdf

Traffic Safety Facts. (2013). Motorcycles. National Highway Traffic Safety Administration. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/811765.pdf

Traffic Safety Facts. (2014). 2013 Motor Vehicle Crashes: Overview. *National Highway Traffic Safety Administration*. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/812101.pdf

Traffic Safety Facts. (2014). Seat Belt Use in 2013 – Overall results. *National Highway Traffic Safety Administration*. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/811875.pdf

Trimpop, R.M. (1994). The Psychology of Risk Taking Behavior. The Netherlands: Elsevier Science.

Tull, M. Ph.D. (2014). *Risk-Taking.* Retrieved from http://ptsd.about.com/od/glossary/g/risktaking.htm

Use of Motorcycle Helmets: Universal Helmet Laws. (2014). *The Guide to Community Preventative Services.* Retrieved from http://www.thecommunityguide.org/mvoi/motorcyclehelmets/helmetlaws.html

U.S. Census Bureau. (2013). *State & County QuickFacts.* Retrieved from http://quickfacts.census.gov/qfd/states/00000.html

U.S. Census Bureau. (2010). Table 364. Coastline and Shoreline of the United States by State. Retrieved from http://www.census.gov/compendia/statab/2012/tables/12s0364.pdf

U.S. Climate Data. (2015). *Your Weather Service.* Retrieved from http://www.usclimatedata.com/climate/united-states/us

VisitFlorida. (2015). Research Facts. Retrieved from http://www.visitflorida.org/tools-resources/research/research-faq/

المنارة للاستشارات
www.manaraa.com

Wang, C. (2006). Fatal Crash Trends and Analysis in Southeastern States. *Georgia Institute of Technology Graduate Dissertation.* Retrieved from https://smartech.gatech.edu/bitstream/handle/1853/10544/wang_chunyan_200605_phd.pdf

WHO. (nd). Risk Factors for Chronic Respiratory Diseases. Retrieved from http://www.who.int/gard/publications/Risk%20factors.pdf

المنارة للاستشارات
www.manaraa.com

APPENDIX

Table A1 Individual Correlation Coefficients

Pearson Correlation Coefficient	Fatality Rate	Credit Score	Tobacco Use	Alcohol Use	Obese BMI	Poor Health	Bachelor Degree	Elderly Pop	Born In State	Mental Illness	Illicit Drug Use	Seat Belt Use	Unemployed
Fatality Rate	1	-.643**	.641**	-.577**	.617**	.668**	-.742**	.212	.188	.326*	-.532**	-.311*	-.125
Credit Score	-.643**	1	-.653**	.689**	-.770**	-.759**	.661**	-.012	-.272*	-.334*	.459**	-.032	-.327*
Tobacco Use	.641**	-.653**	1	-.428**	.794**	.734**	-.595**	.217	.397**	.409**	-.320*	-.248	.032
Alcohol Use	-.577**	.689**	-.428**	1	-.554**	-.729**	.629**	.117	-.255	-.430**	.601**	-.069	-.186
Obese BMI	.617**	-.770**	.794**	-.554**	1	.714**	-.741**	.178	.545**	.364**	-.569**	-.167	.020
Poor Health	.668**	-.759**	.734**	-.729**	.714**	1	-.682**	.194	.311*	.445**	-.328*	.079	.342*
Bachelor's Degree	-.742**	.661**	-.595**	.629**	-.741**	-.682**	1	-.222	-.364**	-.425**	.567**	.159	-.048
Elderly Pop	.212	-.012	.217	.117	.178	.194	-.222	1	.210	.098	.107	-.166	-.050
Born In State	.188	-.272*	.397**	-.255	.545**	.311*	-.364**	.210	1	.206	-.356**	-.156	-.177
Mental Illness	.326*	-.334*	.409**	-.430**	.364**	.445**	-.425**	.098	.206	1	-.067	-.128	.010
Illicit Drug Use	-.532**	.459**	-.320*	.601**	-.569**	-.328*	.567**	.107	-.356**	-.067	1	.233	.258
Seat Belt Use	-.311*	-.032	-.248	-.069	-.167	.079	.159	-.166	-.156	-.128	.233	1	.603**
Unemployed	-.125	-.327*	.032	-.186	.020	.342*	-.048	-.050	-.177	.010	.258	.603**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

www.manaraa.com