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Florida State University

In Partnership with Florida A&M University and University of North Florida

RESEARCH FINAL REPORT

Assessment of the Psychosocial Behavior Associated with Elderly Drivers to Reduce Their Involvement in Crashes

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Assessment of the Psychosocial Behavior Associated with Elderly Drivers to Reduce Their Involvement in Crashes

Final Report

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Disclaimer

The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the state of Florida Department of Transportation

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16. Abstract

Review of literature reveals that the focus of most traffic related research has been of the operations and safety of roadway, rather than on the distribution of the user. This paper focuses on senior drivers (aged 65+) whose driving abilities may weaken based on factors which are uncontrollable, some of which include their age, physical and sensory awareness, as well as health challenges. Consequently, these factors results in some behavioral habits which can be controlled. This research aims at identifying those psychosocial behaviors contributing to certain driver habits with the aim of controlling them. By conducting a survey, the behaviors that may produce savior incidences from controllable psychosocial behaviors with potentially dangerous consequences were identified. Also, a five years (2008-2012) crash severity analysis was also carried out particularly to create a binary model of attributes significant in the crashes involving seniors using the binary logistic regression analysis. The results suggested that the age, medical conditions among other attributes lead to some behaviors such as traffic violations which are significant attributes in the severity of crashes involving seniors. The findings by the research will enhance the understanding controllable and uncontrollable factors and its impact on the elderly crash frequency and its severity. The results can be used in improving the safety of senior, by reducing their involvement in crashes.

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INTRODUCTION

Background

There has been a stupendous demographic metamorphosis in the United States in recent times, findings from population census shows that the American society is aging. The elderly constitute nearly 13 percent of the population and the age group 65 and above is increasing in percentage of the population yearly. According to statistical projections by the year 2030, the population of the older people will further increase by 70 million as a result of the aging "baby boom generation". This translates to 21 percent of the entire population. Factors such as improvement in the health care system has improved life expectancy and more people live past age 85. The aging population has impacted on the number of licensed elderly drivers. A distribution of the proportion by age of licensed drivers across counties in Florida shows a high percentage of elderly drivers in all the counties. According to a report conducted in Framingham, Massachusetts by the University of Massachusetts in Boston, about two-thirds of seniors over the age of 80 still drives, spending more times behind the wheel compared to previous generations.

There hasn't been much research study dealing with the driver behavior and their external environment, especially relating to the pedestrian fatalities on the roadway, a good number of studies have focused on the driver behavior and the traffic control analysis relating to only drivers.

Problem Statement

Findings revealed that a vast majority of the aged drivers, drive and rely stiffly on automobiles for mobility. Due to unavailability of alternate means of transportation, older adults do not stop driving even when they know there is a need for cessation. Study shows that 80 percent of the trips made by older population (65 and above) are via automobile even as the likelihood of being involved in a crash increases as they age.

However, the performance of elderly drivers in the driving task has not been too satisfactory as high crash rate per mile driven has been identified by a number of studies among older drivers. Psychosocial behaviors has been identified as possible cause of crashes associated with elderly drivers. The ability of the older adult driver to safely control and/or navigate the vehicle which depends on some uncontrollable factors such as; age, gender and physical health (impairment in vision, loss of memory and other diagnosed medical conditions) weakens although it varies among individuals. Age brings about some physical and physiological changes which generally affect the ability of the older drivers to drive safely as the driving task requires the driver to interact with his/her vehicle, other vehicles in the traffic stream, the roadway and his/her environment as well as traffic control devices. This can only be successfully done by an individual with accurate motor and psychomotor skills, sharp information interpretation skills and sharp sensory capacity. According to a report conducted in Massachusetts, oftentimes elderly drivers mistake the gas pedal for the brake or get disoriented.

Some of the identified psychosocial behaviors is believed to contribute to some habits in elderly drivers which results in crashes. Some of the common behavior pattern associated with elderly drivers includes; risky driving behaviors, primary attention failures, mistakes that have potentially dangerous consequences, inattention, internal or external distractions etc.

Hypothesis

Psychosocial behavior is believed to contribute to some habits in elderly drivers which can result in crashes, some of the common behavior pattern associated with elderly drivers includes; risky driving behaviors, primary attention failures, mistakes that have potentially dangerous consequences, inattention, internal or external distractions etc. This study seeks to establish that some of the behavioral habits can be controlled and this will reduce the effect of the interaction between the controllable and the uncontrollable factors. In light of this, it is important to evaluate the effect of the identified psychosocial behavior on the ability of the elderly drivers to safely navigate the vehicles on the roadway.

Objectives and Scope

Previous research has been directed towards the general safety and operations of roadway with little focus on the distribution of users. This research will concentrate on a design driver, the older adult. Behavioral pattern identified with unsafe driving is to be classified as a characteristic of growing habits which if not managed can increase the fatality of the crashes involving elderly drivers. An in-depth understanding of the controllable psychosocial behaviors identified will help in modelling the pattern of crash involving elderly drivers, and help proffer a solution to the growing habits that causes the crashes involving elderly drivers in Florida. The research will analyze crashes in Florida involving elderly drivers and study the nature of those crashes with the aim of identifying the behavioral pattern of the drivers and controllable actions that resulted in a vast majority of those crashes, with the aim of developing a practice that can reduce crash involvement of elderly drivers.

Methodology

The data used in for the research was categorized into two which basically are the primary and secondary data. Data used for the purpose of this paper is still preliminary as data collection is still ongoing. The primary data set was obtained from a survey which was conducted to capture information from elderly drivers. The survey was prepared to capture information relating to the lapses, violations and mistakes believed to have potentially dangerous consequences. These three important category of questions have been designed to capture the behavioral pattern in the older driver that results in crashes. The potential dangers of the consequences of the behaviors discovered was used to predict other behaviors that may produce savior incidence mainly

destructing actions. These behaviors are germane and informational to address the dangers of engaging in such habits that can lead to potential crashes in among older drivers.
The secondary data which is a record of crash data obtained for 5 years (2008-2012) was analyzed. The data was analyzed to investigate the frequency of occurrence of elderly drivers in crashes. The data set consisted of 48,700 crashes involving elderly drivers in the year 2009 and 27,291 in the year 2010 on the roadways of Florida. Analysis of the data was done by categorizing the crashes into age groups with a class interval of 5 years starting from age 15 to age 65+ to identify the distribution of crashes among various age group and ensure that elderly drivers were not overrepresented in the occurrence of crashes.

With a key focus on the record of crashes involving elderly drivers which was achieved by sorting the data to show records for elderly drivers (aged 65+) only, some psychosocial characteristics were obtained from the records of the crash data and was analyzed individually. Some of the behaviors which was identified after a detailed review of the results obtained includes the gender of the driver, the zone of crash occurrence whether rural or urban, nature of the crash, intersection crashes, drug/alcohol use, at-fault driver etc.

Analysis of the survey results was carried out to identify the controllable behaviors associated with crashes involving elderly drivers. Also, from the analysis carried out on the crash data used for this research, the result pointed to some controllable behavioral pattern which is believed to be responsible for crashes involving elderly drivers. With the contributing behaviors corrected, the individual ability of older drivers to tune their body to the demands of the driving task is believed will improve.

Data Collection

The survey data was collected at the Tallahassee Senior Center which is the biggest senior Center in Leon County, Florida. Some data was also collected at the Smith-Williams Service center also located in Leon County, Florida. About 76 surveys were completed by senior drivers (aged 65+). The collected data is preliminary as data collection is still on-going, but for the purpose of this paper the collected data was used in the analysis. Figure 1 presented below shows the data collection area. Crash data from year 2008-2012 was obtained from the Florida Department of Transportation (FDOT). The crash headers which interprets the raw data was obtained alongside the crash data and minor differences due to change in the format of data preparation was addressed by carefully studying the headers and merging all the files.

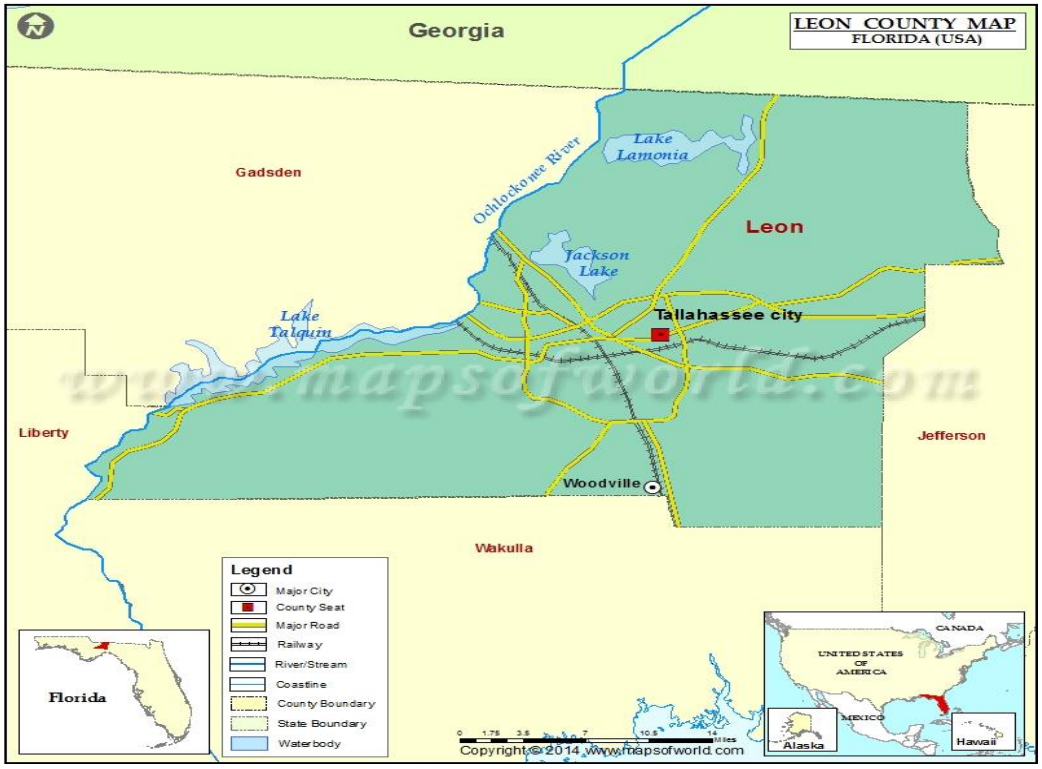

Figure 1 Data Collection Area

Survey Questions

Fourteen questions were asked in the surveys. Four of the questions were designed to obtain demographic information from the respondents and three of the questions were prepared to track information about the medical condition of the respondent, while seven other questions were prepared to track the behavior of the drivers as well as other risky action they engage in that can result in crashes.

Questions posed to investigate the medical condition of the senior respondents includes the clarity of their vision behind the wheels, mild or severe sicknesses such as diabetes, cancer, hypertension, arthritis, obesity etc., as well as special medical conditions resulting from smoking or drinking. Some of the questions also tracked the sensitivity and alertness of the senior drivers' in-terms of how often they almost collide with other vehicles on the roadway while queuing at an intersection. Other questions sought to track the action of the senior driver as regards running of red lights as well as driving above the speed limits without realizing. These behaviors are common mistakes with elderly drivers that often leads to crashes.

Data Analysis & Results

Analysis of Crash Data

Crash records obtained for a duration of 5 years (2008-2012) for rural and urban roads in the state of Florida was merged and cleaned using the python software. A descriptive statistical analysis was carried out on the continuous variables in the data set. The identified continuous variables includes the Average Annual Daily Traffic (AADT), the percentage of truck volume, the median width, the surface width, the shoulder width and the skid number. The results obtained are presented in Table 1 below.

Table 1 Descriptive Statistics of Continuous Variable Data

Variables	*AADT*	*Percent of truck volume*	*Median width*	*Surface width*	*Shoulder width*	*Skid number*	*Standard deviation*
Mean	47457.1	5.82	28.88	30.01	4.43	37.46	0.13
Standard deviation	39943.7	4.31	35.24	9.17	3.08	5.05	0.12
Minimum	450	0.10	2	9	1.0	18	6.0E-2
25th percentile	27000	3.22	14	24	2.0	34	0.11
50th percentile	38000	4.60	16	30	4.0	37	0.05
75th percentile	52500	6.73	22	36	5.0	40	0.19
Maximum	309000	81.56	31	84	37.0	68	2.94

From the plot of a crash severity distribution in Figure 2, fatal crashes involving senior drivers' accounts for about 7% of the total crashes recorded for the period of 5 years, with a major percentage of the crashes (51.7%) resulting in no injury whatsoever. 8.7% of the crashes witnessed non-incapacitating injuries which can be in form of minor bruises, psychological disturbance, dizziness or fainting. The fatalities classified as possible injury does not clearly state the extent of the fatality of the injury at the moment but the crash might result in a possible injury in the future and this accounts for 32.5% of the crashes.

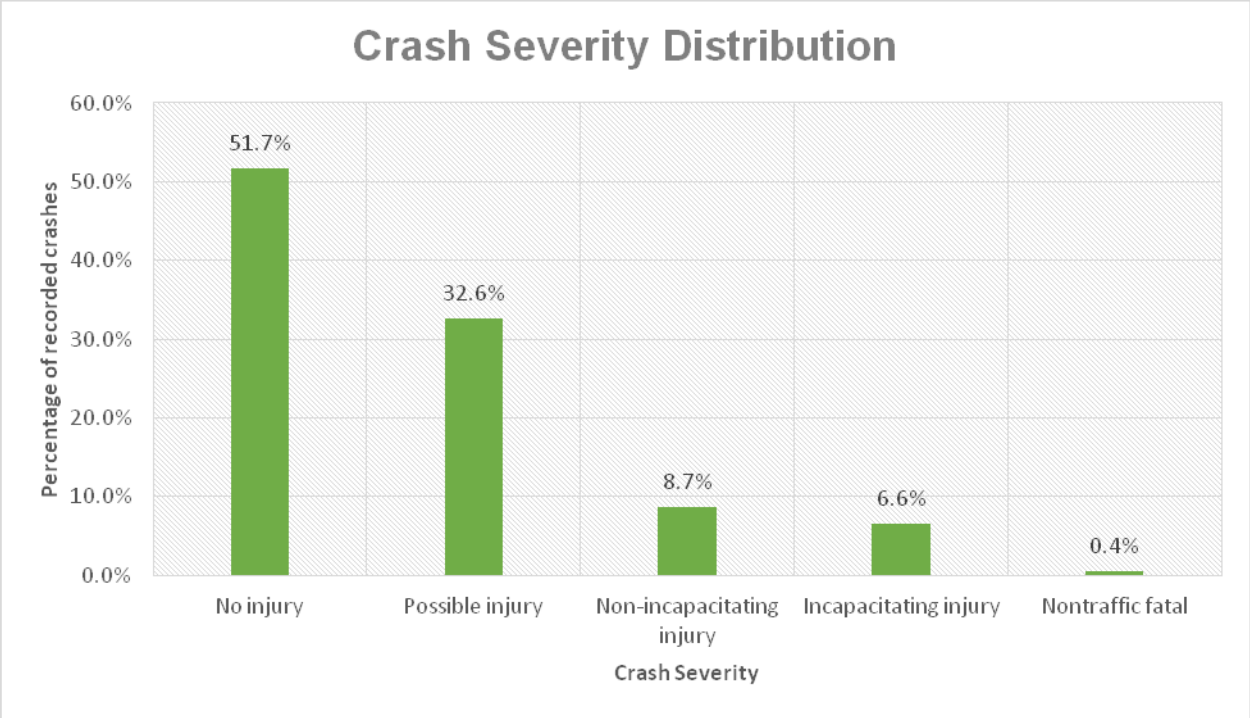

Figure 2 The Distribution of Crash Severity Levels

Crash Severity Modelling

A logistic regression analysis was conducted on the selected attributes for the purpose of this study to investigate the severity of crashes involving the elderly drivers with the aim of creating a model that correctly predicts the fatality of crashes involving elderly drivers [8], [16], [17]. A binary response of 0 or 1 was used in coding the attribute, this was done by classifying the injury level reported for every crash involving seniors. Table 2 presented below explains the code for modelling the severity of the crashes.

Table 2 Interpretation of the Attributes

Attribute Description

Variables	Description	Code for modeling
Alcohol	0= none, 1 = alcohol involved, 2 = drugs involved, 3 = alcohol and drugs involved, 4 = undetermined	1, 2 and 3 =1 else 0
Land use characteristics	Urban and rural	Rural = 1 else 0
Road characteristics	1 – divided, 2 – undivided	Divided 1 else 0
Safety belt usage	Belt or No belt	Usage = 0 else 1
Speed	Posted speed limit (categorical)	Less than 45 mph = 0 else 1

Age	Categorical	Below 65 = 1, 65 and greater = 0
Skid number	Continuous variable	Less than 28 = 0 else 1
Visibility	01 - clear, 02 - cloudy, 03 - rain, 04 - fog, 77 - all other conditions	Clear = 0 else 1
Shoulder width	Continuous variable	Continuous
Median width	Continuous variable	Continuous

The mathematical equation for the regression model is given by;

$$Logit(Y) = \log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_n X_n \quad (1)$$

Where; β_0, $\beta_1 \ldots \beta_n$ are the regression coefficients,

'Y' is an independent variable which represents the binary crash severity

And '*p'* is the probability of having a severe crash defined by;

$$p = \frac{1}{1+e^{-(\beta_0+\beta_i X)}} \quad (2)$$

The probability of a severe crash '*p'* is defines by

The odds ratio of the crash is given as described below

$$odds\_ratio = \left(\frac{odds\_of\_severe\_crashes}{odds\_of\_non\_severe\_crashes}\right) \quad \textbf{(3)}$$

Model Result

In modelling the crash data, the determination of the binary coding value was based on the explanations prepared with the crash data to explain the values in the data set for each header, the results from the descriptive statistical analysis of the data, as well as the crash severity distribution. The model was created using the MATLAB software testing the model at a 99 percent significance level and also at a 95 percent significance level. The results obtained are presented in the Table 3 below.

Table 3 Regression Model Result

Selected variables	*99% Significance*	*95% Significance*	*Odds ratio*
Safety belt usage	**0.71****	0.71	1.77
Alcohol	**0.76****	0.78	2.06
Speed	**0.63****	0.64	1.38
Visibility	-0.39	-0.42.	1.10
Land Use	**0.71****	0.71	1.83
Median Width	-0.29	**-0.33***	1.49

Age	0.31	**0.31***	1.21
Skid Number	-0.74	**-0.76***	0.26
Road Characteristics	-0.33	-0.35*	0.63
Percent of Trucks	1.42	1.53	0.08
Surface Width	-0.00076	-0.00091	0.63

****** Significant at 99% confidence interval*

******* Significant at 95% confidence interval*

From the results presented in Table 3 above, at 99 percent significance level, the variables discovered to be significant includes the Safety belt usage, alcohol consumption, speed and the land use. Testing the model at a 95 percent confidence interval, the significant variables includes the Visibility, the median width, the skid number and the road characteristics.

Survey Analysis

The results obtained from the paper questionnaire was translated into a binary response using a coding table as presented below. The basis for coding the response stemmed from the reality that the questions posed by the survey had multiple options and it was important to translate the results for easy analysis. Table 4 below describes the attributes tracked by the survey and the coding values.

Table 4 Description and Coding of Survey Attributes

Attributes	Meaning	CODE
Age	Respondents Age	Age class
Senior	Older than 65+	0 – Older than 65 1 – Below 65
Gender	Whether Respondent is Male or Female	M-Male F-Female
Education Level	Whether respondent has a university degree or not	1 – Does not have a college degree 0 – Has a college degree
Experienced	Respondent has been licensed for 4 years or lower	0 – driver is licensed for more than 4 years 1 – Driver is licensed for less than 4 years
Vision	Has good vision or poor vision	0 – Good vision 1 – Poor vision
Long distance driving	Respondent drive long distances	1 – Often & All the time 0 – Never & not often
When to stop	When respondent plans to stop driving	Age distribution

driving		
Medical condition	Respondents medical condition (Terminal diseases and others)	1 – Yes 0 – No
Transit bus usage	Respondents use of the mass transit buses	1 – Not often & Never 0 – Always & Most times
Smoking/Alcohol induced medical condition	Alcohol and/or smoking induced medical conditions	1 – Yes 0 – No
Most frequent driving time	Time of the day respondent drives most	M- Morning A- Afternoon N- Night

Analysis was carried out on the survey data to track important psychosocial attributes and the results obtained are presented below.

Medical condition

A medical condition is defined as a disease, illness or injury; any physiologic, mental or psychological condition or disorder but does not include any biological or psychological state which is within the range of normal human variation. From the results obtained from the analysis, it was discovered that about 43 percent of the senior respondents who are all licensed have a medical condition and 11 percent of them had bad vision. Figure 3(a) shows the results of the medical conditions of the senior respondents.

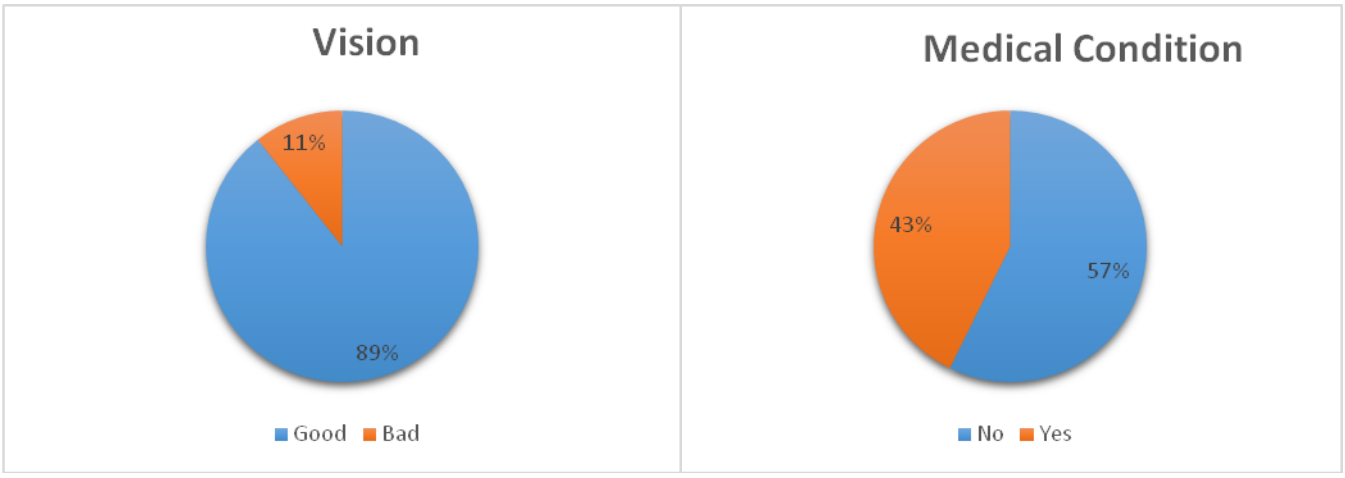

Figure 3(a) Medical condition of senior respondents

Traffic law violations

Common traffic law violations such as traffic signal violation and speed limit violation were investigated and the results shows that about 55 percent of the senior respondents violates traffic signals consciously and unconsciously while 29 percent of them drive above the speed limit. Some of the respondents claimed that they forget to stop at some un-signalized intersections. Figure 3(b) shows the results of the traffic violations of the senior respondents

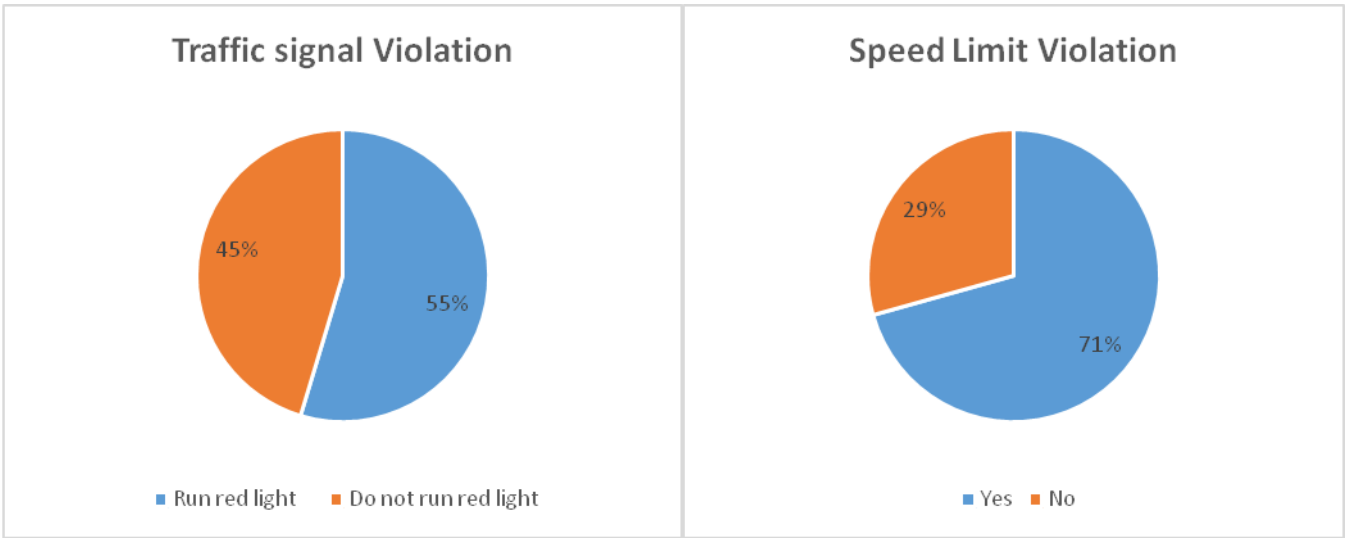

Figure 3(b) Medical condition of senior respondents

Alertness at intersections

A question in the survey designed to test the alertness of the senior drivers at an intersection was analyzed and the results showed that about 73% of the senior respondents are alert and watch out for the vehicle in front of them while about 27% of them often almost hit a vehicle in front of them while queuing at intersections.

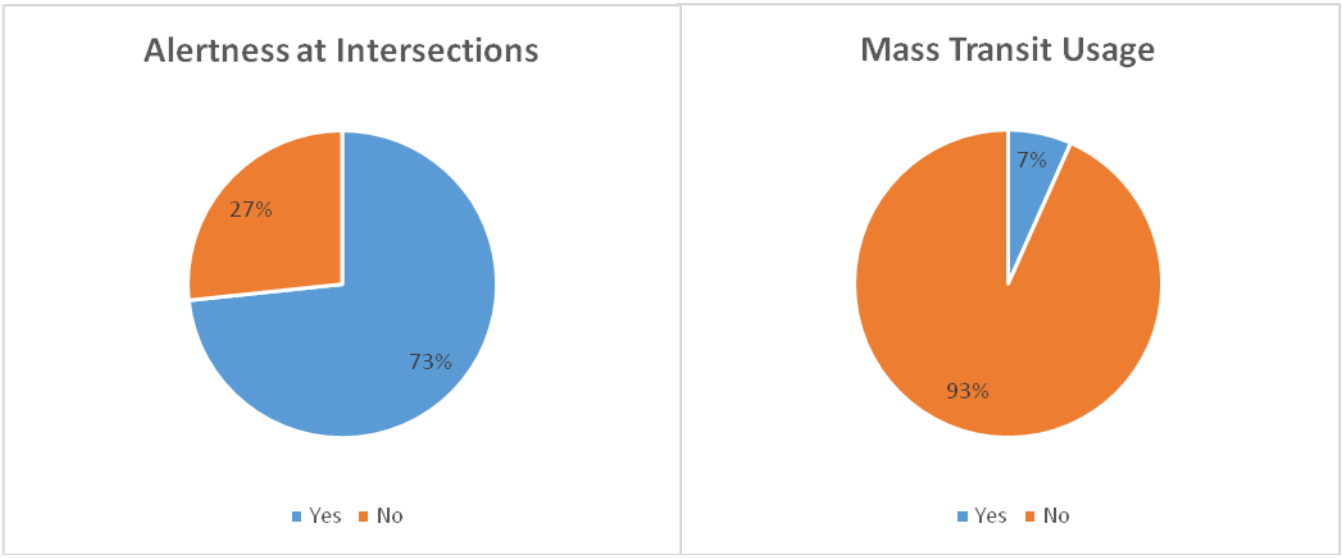

Figure 3(c) Mass transit Usage and Alertness

Mass transit usage

From the results obtained from the analysis, only 7 percent of the respondents used the citywide mass transit mode for transportation. A large 93 percent of them do not use the mass transit for transportation as they prefer driving.

Time of the day for most driving and driving frequency

From the results presented, 99 percent of the senior respondents' drives in the morning, 53% of them drives in the afternoon and 8 percent of them drive at Night. Only about 7 percent of them can drive during the day and at night. This shows that senior drivers strongly avoid driving when it is dark compared to daylight

Also, about 39 percent of the senior respondents drives all the time while travelling long distances. 5 percent of the respondents never travel long distances. About 27 percent often travel long distances and similarly 27 percent do not travel long distances very often. The bar chart presented in Figure 5 shows the most frequent driving time from the survey responses.

Age to relinquish driving privileges

The results Obtained from the survey analysis showed that a large number of senior drivers will like to continue driving for as long as they can. 72 percent of the respondents said they will continue driven even when they are ages 90+. 23 percent said they will relinquish their driving privileges between the ages of 86-90. 10 percent said they will stop driving between age class of 76-85 and only 4 percent of the respondents said they will relinquish their driving privileges between the ages of 65 and 75. This shows that elderly drivers prefers independence. Figure 5 presents a chart describing their responses.

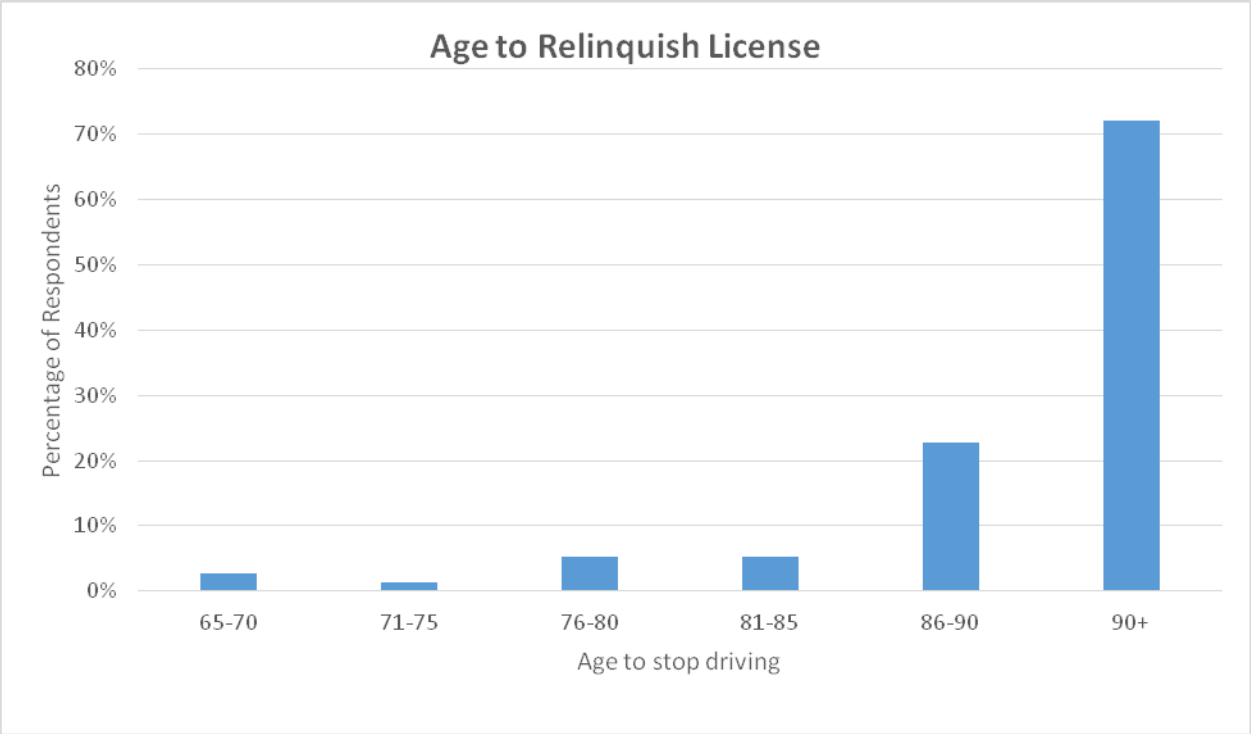

Figure 4 Age to relinquish driving privileges

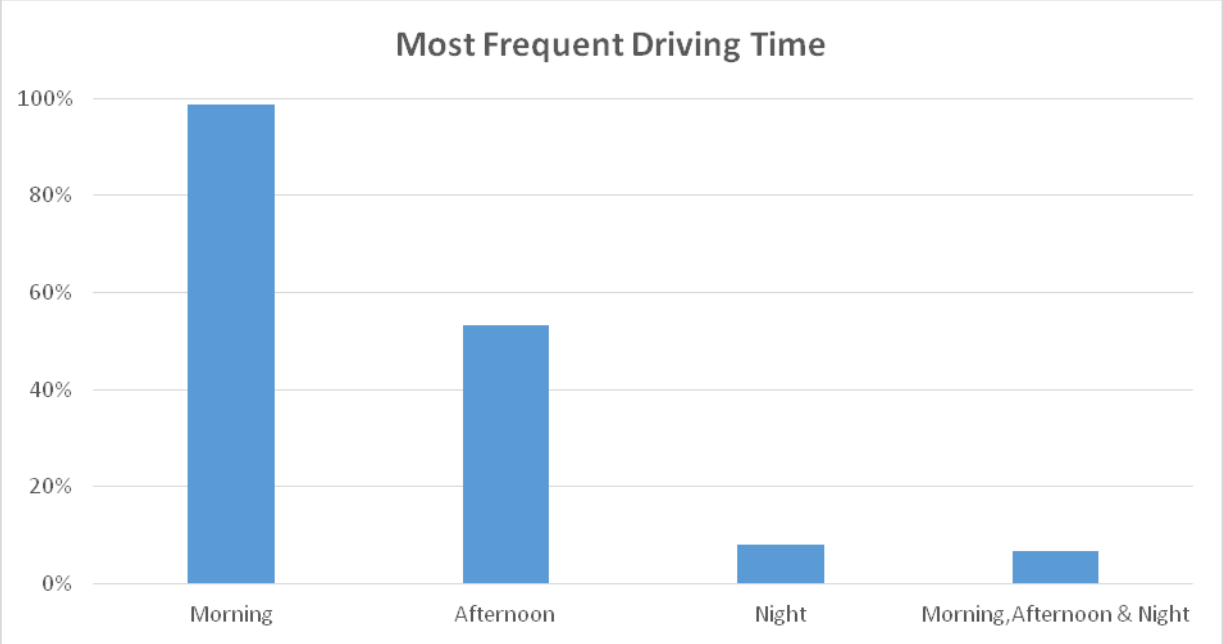

Figure 5. Showing the most frequent driving time

Conclusion

This study has investigated various psychosocial attributed believed to be responsible for crashes among senior drivers. It has also investigated the severity of a 5 year crash record involving senior drivers. The model developed from the crash severity analysis has identified a number of attributes to be significant in crashes involving senior drivers. Some of these attributes are as a result of behaviors believed to be commonly exhibited by senior drivers which results in crashes.

Age as a psychosocial attribute is believed to be responsible for many other behaviors exhibited by senior drivers. From the crash severity analysis, one of the significant factors found to be responsible for crashes is the age of the driver. The older the driver, the higher the probability of being involved in a severe crash. Also, behaviors such as driving above the speed limit and not paying adequate attention to traffic signals are violation behaviors which are significant in crashes involving senior drivers. This is in resonance with the results obtained from the crash severity analysis as the speed is significant with a 99% confidence interval.

Another psychosocial attribute found to be significant is the medical condition of the driver. A significant percentage of senior drivers have a medical condition or another which might stem from smoking and/or alcohol. Also, as seniors' age, there is a further deterioration in their sight. This greatly reduces the proficiency of their driving. The results from the crash severity analysis has presented visibility and alcohol usage as significant attributes. This establishes the medical condition of the senior driver as a psychosocial attribute responsible for crashes involving senior drivers. It can be inferred from the results that aging drivers do not plan on relinquishing their driving privileges due to the need for independence, it is therefore recommended that a self-

analysis should be used to encourage them to seek assistance after dropping below an assigned threshold.

It is important to note that in this study, preliminary data was used as a sample in the analysis and there may be a difference in the attributes if a larger sample is being used.

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Appendix A: Survey Questions

A Survey on Driver Behavior at Signalized Intersections with Pedestrian Signals

Dear Respondent,

The Transportation Program in the School of Architecture and Engineering Technology in collaboration with the FSU University Transportation Center is conducting a study to investigate drivers' behavior at signalized intersections that are equipped with pedestrian signals. Pedestrian signage indicators are primarily installed for pedestrian safety at intersections where the traffic flow is heavy. However, limited literature shows that drivers utilize pedestrian signals to estimate the amount of green time remaining to cross the intersection.

The survey will take 5 minutes to complete. Your individual responses are ***confidential.*** No names or other identifying information will be used in data analysis. Your responses are very important in this research study to examine the driver's behavior at signalized intersections. If you have any questions or comments about this study, please feel free to contact Dr. Doreen Kobelo at doreen.kobelo@famu.edu or Dr. Judith Mwakalonge at jmwakalo@scsu.edu or 803-536-8321.

Thank you very much for your time and cooperation.

Please carefully answer the following Driver Demographic questions as accurately as possible.

A. Age: ☐ *Under 20* ☐ *21 to 35* ☐ *36 to 50* ☐ *over 60*

B. ***Gender:*** ☐ *Male* ☐ *Female*

C. Education level ☐ *Below university* ☐ *University or above*

D. Years licensed ☐ *Less than 2 years* ☐ *2 to less than 4 years* ☐ *At least 4 years*

Please answer the following Driver Behavior questions.

Sample Pedestrian Signals

E. Do you use pedestrian signal to estimate the amount of green time left for you to cross the intersection?

☐ *Yes* ☐ *No*

F. When driving, do you notice or look for the presence of a pedestrian countdown signal as you approach an intersection?

☐ *Yes* ☐ *No*

G. Pedestrian countdown signals are meant for pedestrians. Do you use them as a driver?

☐ *Yes* ☐ *No*

H. Pedestrian signal help you to decide to (check all that apply)

☐ *Prepare to stop*
☐ *Cross the intersection*

I. When approaching very close to the intersection and the pedestrian countdown signal counts down near zero, which of the following would you most likely do? (check all that apply)

☐ *Speed up to clear intersection to avoid waiting for the next green phase*
☐ *Slow down to stop and wait for the next green phase*

J. Do you have any health condition resulting from alcohol and smoking?

☐ *Yes* ☐ *No*

K. Have you been diagnose of dementia in the past?

☐ *Yes* ☐ *No*

L. What time of the day do you drive most?

☐ *Morning*
☐ *Afternoon*
☐ *Night*

M. How often do you almost hit another car while queuing to enter an intersection?

☐ *Never* ☐ *Sometimes* ☐ *Often* ☐ *Very often*

N. How often do you miss "stop" or "give way" signs?

☐ *Never* ☐ *Sometimes* ☐ *Often* ☐ *Very often*

O. How often do you fail to read signs correctly at intersection and turn to wrong road?

☐ *Never* ☐ *Sometimes* ☐ *Often* ☐ *Very often*

P. How often do you exceed speed limit on highway without realizing?

☐ *Never* ☐ *Sometimes* ☐ *Often* ☐ *Very often*

Q. How often do you intentionally disregard speed limit?

☐ *Never* ☐ *Sometimes* ☐ *Often* ☐ *Very often*

R. How often do you skid while breaking?

☐ *Never* ☐ *Sometimes* ☐ *Often* ☐ *Very often*

S. How often do cross an intersection, knowing traffic has already turned?

☐ *Never* ☐ *Sometimes* ☐ *Often* ☐ *Very often*

Key: **Black** - health condition of respondent
Red - driving errors of respondent
Green - aggresive driving by respondent
Blue - highway code violation by respondent

Appendix B: Survey Code table

Titles	Meaning	CODE
Age	Respondents Age	Age class
Senior	Older than 65+	0 – Older than 65 1 – Below 65
Gender	Whether Respondent is Male or Female	M-Male F-Female
Education Level	Whether respondent has a university degree or not	1 – Does not have a college degree 0 – Has a college degree
Experienced	Respondent has been licensed for 4 years or lower	0 – driver is licensed for more than 4 years 1 – Driver is licensed for less than 4 years
Signal Usage	Respondent uses pedestrian signal while driving	1 – No 0 – Yes
Signal Help	Signal helps respondent in crossing the intersection	1 – No 0 – Yes
Decision	Does respondent speed up to cross or slow down and wait	1 – Speeds up 0 – Slows down
Vision	Has good vision or poor vision	0 – Good vision 1 – Poor vision
Long distance driving	Respondent drive long distances	1 – Often & All the time 0 – Never & not often
When to stop driving	When respondent plans to stop driving	Age as in survey
Medical condition	Respondents medical condition (Terminal diseases and others)	1 – Yes 0 – No
Transit bus usage	Respondents use of the mass transit buses	1 – Not often & Never 0 – Always & Most times
Smoking/Alcohol induced medical condition	Alcohol and/or smoking induced medical conditions	1 – Yes 0 – No
Most frequent driving time	Time of the day respondent drives most	M- Morning A-Afternoon N-Night
Speed Limit exceedance	Respondent's frequency of exceeding speed limits on highways	1 – Sometimes, Often & very often 0 – Never

Principal Investigator