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Increased Rate of Late-Night Motor Vehicle Fatalities Among Older Drivers Ages 55-79 in Georgia, From 1991-2010

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology
2014

Abstract

Increased Rate of Late-Night Motor Vehicle Fatalities Among Older Drivers Ages 55-79 in Georgia, From 1991-2010

By Rachel Anne B. Sumagpang

Background Late-night fatal crash rate for drivers age 55-75 and over has been increasing steadily from the early 1990s through mid-2000s. This study examined the role of headlight, distraction, and alcohol-related crashes in the increasing rate of fatal late-night crashes among older drivers from 1991-2010.

Methods Driver fatal crash rates for older drivers were calculated annually and in 5-year intervals: 1991-1995, 1996-2000, 2001-2005, and 2006-2010. Annual age-stratified rates were also calculated for gender, alcohol-related, headlight-related, distraction-related, and by location of the crash. Rate Ratios were calculated to compare fatal crash rates to determine if the trend of increasing rate of fatal nighttime crashes among older adults continued. Multiple linear regression was used to compute analysis of variance models to observe the difference among the multiple age categories of older drivers.

Results Late-night fatal crash rates steadily increased among older drivers 55-79, from 1991-2005, but decreased from 2006-2010. Though late-night fatal crash rates decreased, there was an overall increase from the first 5-year interval to the fourth 5-year interval, among drivers ages 55-79. Closer inspection of rate ratios by 5-year intervals indicated that this increase was restricted to three age groups: 55-59, 60-64, and 70-74. In contrast, multiple linear regression analysis indicated that there was a significant linear relationship between year and late-night, fatal crashes for drivers ages 55-79, but further inspection attributed this to increases by year only for drivers ages 55-59 and 75-79. None of the variables of interest were significantly associated with the late-night, fatal crash rate over time.

Conclusion With the increasing motor vehicle fatality rates among older drivers, it may be helpful to determine policy interventions specific to older drivers and examine the effectiveness of these policies on late-night fatal crash rate. Additional studies examining the role of distraction and headlights on late-night fatality, may help determine modifiable driving behaviors and factors relevant to an effective intervention to reduce driving injuries and death among older drivers

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ACKNOWLEDGEMENTS

I would like to express my gratitude to my advisor Dr. Nancy Thompson, you have been an inspirational mentor. Thank you for your guidance and direction in this research from beginning to end. Your advice and encouragement has meant a great deal to me both personally and professionally. I would also like to thank my supervisor, Archna Patel and fellow graduate research assistants who have worked with me on Project UPLIFT. You all have contributed to enriching my graduate education.

Words cannot express how grateful I am to my parents, sister, and the many relatives I am blessed with for all the love and support you've shown me up to this point of my life. Your prayers, blessings, and belief in my success has given me the strength to pursue my goals and overcome the obstacles in my path. I would also like to thank my friends who have become my family away from home. You've brought joy and laughter to me during these years and I am grateful for the gift of your friendship.

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Increased Rate of Late-Night Motor Vehicle Fatalities Among Older Drivers Ages 55-79 in Georgia, From 1991-2010

Background

Travel by motor vehicle is the primary method of transportation in the United States and remains a leading cause of injury and death for individuals of every age (1). Preliminary data indicates that approximately 34,080 individuals died from motor vehicle fatalities in 2012, representing a 5.3% increase compared to 2011. Also, more and more people are driving on the roads every year. According to the Federal Highway Administration (FHWA), there was about a 9.1 billion increase in vehicle miles traveled (VMT) in 2012 compared to 2011(2). Involvement in a motor vehicle crash yields consequences ranging from mild to debilitating injury to the most severe consequence: death. The resulting costs to the individual as well as impact on society makes motor vehicle fatalities of public health concern.

Although all drivers are at risk of injury and potentially death, statistics have shown that older drivers have a disproportionately higher fatality rate from motor vehicle crashes when compared to other drivers of adult age (3). The incidence of motor vehicle collisions involving injury and fatalities increases markedly after age 55 (4). During 2011, the population of persons 65 and older comprised 13 percent of the US population and 16 percent of all licensed drivers. In the same year, older individuals made up 8 percent of all traffic injuries and 17 percent of all motor vehicle fatalities (5). The percentage of drivers 65 and older is projected to rise to about 20 percent; concurrently the percentage of drivers 65 and older is projected to make up 25 percent of total motor vehicle fatalities by 2030 (6, 7).

Injury from motor vehicle collisions and resulting fatalities among older drivers are thought to be attributed, in part, to two factors: their increased crash rate per (VMT), and increased risk of fatality upon collision due to fragility (3). As noted, the population of older drivers is among those having the highest crash rates per VMT (4). At the same time, older individuals are the most likely to die upon involvement in a motor vehicle crash in comparison to all other age groups (1). Physical fragility is responsible for an estimated 60 to 95 percent of older driver fatality; which, on average, increases after age 60 (3). Another suggested risk factor for older adults is the decline in visual acuity that results from aging; visual field loss; medication use; impairment, both functional and cognitive; and chronic diseases such as diabetes and cardiovascular disease (8, 9). In light of these factors, concern regarding older driver safety has noticeably increased in recent years.

TADRA

In Georgia, the Teenage & Adult Driver Responsibility Act (TADRA) was instituted in July 1997. TADRA is a three step graduated licensing program directed towards teenage drivers (10). The first step includes obtaining a permit. Teenagers 15 or older can get their instructional permit after passing a written test. Once the permit is granted, the teen must drive with an older individual, 21 or over, who holds a valid driver’s license. Step two involves obtaining an intermediate license. To obtain in intermediate license, the teen must hold an instructional permit for at least a year and additionally pass a driving test. Once the license is granted certain restrictions must still be observed. The licensed teen cannot drive from midnight to 6 a.m., drive any passenger besides immediate family for the first six months, drive more than one passenger under 21 besides immediate family during the second six months, or drive more than 3 passengers under 21 besides immediate family after a year of obtaining their license. The third and final step is obtaining a full license. Individuals 18 or older can be granted the full license if they have fulfilled steps one and two and if during this time they did not commit a major traffic violation. TADRA's intent to prevent fatal crashes among teens targeted their limited driving experience, drinking and driving, and speeding (10). This policy was purposefully implemented to directly address the problem of what was the leading cause of death in the teenage population: vehicular crashes.

With funding from the Centers for Disease Control and Prevention through the Emory Center for Injury Control, Emory researchers were enlisted to evaluate the long-term effects of the TADRA law. They gathered fatality data from 5.5 years before TADRA was instituted, to 10.5 years after the passage of the law. While the focus of the evaluation was upon young drivers who began driving under the TADRA law, data for drivers ages 26-54 and drivers ages 55-75 were also reviewed as points of comparison. Upon examination of these data, the Emory evaluators noted that late-night fatal crash rate for drivers age 55-75 and over had been increasing steadily from the early 1990s through mid-2000s. During the first 5.5 years after TADRA, the late-night fatal crash rate in this age group increased by 15 % when compared to the 5.5 years prior to the implementation of TADRA; during the second 5 years (2003-2007), it increased another 12% (11).

In an effort to understand the problem of fatal late-night crashes among Georgia's older adults, the research team conducted interviews with police officers, American Association of Retired Persons (AARP) Driver Safety course instructors, and AARP Driver Safety course participants. The purpose of the interviews was to determine what factors these people thought might account for the increasing rate of fatal late-night crashes. From the interviews, three particular topics were suggested as probable reasons for increased rate of fatal crashes among older drivers: an increase in nighttime traffic; high intensity dispersion (HID) headlights; and distractions, particularly from electronic devices.

Nighttime

Nighttime driving is defined as driving between the hours of 6 pm to 6 am. Late-night driving for this study is defined as driving between the hours of 12 am to 5:59 am. Across the nation, approximately half (49%) of fatalities among passengers in a motor vehicle occur during night hours (12). Travel in the dark accounts for about 25 percent of total travel. Furthermore, the fatality rate per VMT is almost three times higher when comparing night to day travel (12-14). Even after adjusting for mileage, the nighttime fatality rate is still 2 to 4 times higher than fatality rate in the day (15).

The leading cause of collision and an important contributor to nighttime fatality rate is poor visibility (15-16). This is especially problematic for older drivers, for whom visual acuity is declining, as discussed above (8, 9). The effects of decreased illumination on a drivers poor visibility is further compounded by oncoming headlights, which produce a disabling glare.

Headlights

There are two main headlight systems: standard and HID. Standard headlights use incandescent bulbs which are comprised of a tungsten filament housed within a glass unit. As the electric current generates heat, it causes the filament to produce light. As temperature increases, the light becomes bluer and brighter. The bulb can be either evacuated or filled with a halogen gas, such as iodine, to prevent oxidation of the filament and prolong the life of the bulb (17). HID headlights are made up of a reflector, discharge lamp and electronic parts. This setup allows the lamp to produce 2 to 3 times the output of luminous power and appears brighter and bluer than the standard halogen-tungsten bulbs (17).

Sensitivity to headlight glare increases with age (17-18). HID headlights are an advantage for older drivers, allowing them to see farther and providing a longer response time. On the other hand, older drivers are disadvantaged when confronted by an oncoming vehicle with HID headlights. HID headlights can produce greater glare compared to the standard halogen-tungsten bulbs (17). If sufficient, the glare can effectively blind the driver of an oncoming car.

Distraction

With the development of technology throughout the years, distractions, especially while driving, is a growing concern. A distraction is defined as, “any activity that could divert a person's attention away from the primary task of driving” (19). Distractions endanger driver, passenger, and pedestrian alike. Technology-based distractions include: cell phone usage, texting, using GPS system, watching movies, or adjusting settings and knobs within the vehicle. Other distractions include eating or drinking, reading, grooming and talking to other passengers (19). Distractions are a main factor leading to motor vehicle crashes (20).

Alcohol

Alcohol is a substance that disrupts the brain and body. Drinking affects an individual's behavior, including the ability to make decisions and move with coordination (21-22). Even a blood alcohol concentration (BAC) of just .02 grams per deciliter is detrimental to drivers (21).

In the United States, it is illegal to drive with a (BAC) greater than or equal to .08 grams per deciliter (1). In 2008, Georgia was ranked 6th highest in the United States for alcohol-related motor vehicle deaths (1). Drivers having a BAC $\geq$ .08 g/dL usually drive during late-night hours compared to day or early night (1). Alcohol involvement is a lesser factor among motor vehicle crashes caused by older drivers compared to middle-aged and young drivers (4).

Gender

Male drivers have been positively associated with being involved in a fatal versus non-fatal motor vehicle crash (4). Vehicle related male death rates have been shown to be consistently higher than vehicle related death rates for women (23). Analysis of data from 1996-2006 found that motor vehicle fatalities were higher for males than females in all age groups, though the population ratio of male to female is approximately equal (24).

Location

It is thought that elderly individuals usually live in rural areas where the population is less dense (25). As population decreases, motor vehicle fatality rates have been known to usually increase (26). The population location demographics have been suggested as a possible risk factor for the increase in motor vehicle fatality among the elderly (25).

This was designed to further investigate factors associated with the increasing rate of fatal late-night crashes among older drivers in Georgia. More specifically, the study aimed to determine the role of headlight-related, distraction-related, and alcohol-involved crashes in the increasing rate of fatal late-night crashes among drivers ages 55-79 in Georgia from 1991-2005. It also aimed to ascertain if the increase in the rate of fatal late-night crashes among older adults in Georgia continued from 2006-2010.

METHODS

Fatality Analysis Reporting System (FARS)

Numerator data on driver fatal crashes were obtained from the Fatality Analysis Reporting System (FARS). These data are from the National Highway Traffic Safety Administration (NHTSA), which collects and records all motor vehicle crashes in the United States occurring on a public traffic way that resulted in the death of a person, motorist or non-motorist, within 30 days of the crash (27). FARS data are collected using a standard protocol by trained individuals from police accident reports, state vehicle registration and state driver licensing files, hospital medical and emergency medical service reports, vital statistics, death certificates, coroner and medical examiner reports and other state records (27).

FARS data includes detailed information regarding the individual, the vehicle, and the circumstances related to the crash. They are comprised of multiple levels of DataBase File(s) (DBFs) including but not limited to: accident, distract, person, vehicle, and vision. As time progresses, variables are added or deleted within the FARS data. Within the time of this study period, variables were added in 1997, 2009, and 2010. In 1997 and 2009, extra variables were added to calculate headlight and distraction-related fatal crashes. In 2010, a separate DBF for vision related factors affecting motor vehicle crash was formed and a separate DBF for distraction related factors affecting motor vehicle crash was also formed.

To obtain numerator data for the variables of interest, person and vehicle DBFs were merged for the years 1991 to 2009. Because of coding changes made in 2010, distract, person, vehicle and vision DBFs were merged in order to obtain numerator data for all variables of interest.

Measures

The FARS variables for which we abstracted data included the following:

Older Driver Fatal Crash. An older driver fatal crash is a motor vehicle crash involving a driver between the ages of 55-79 that results in death. The fatality could involve the driver, a passenger of any vehicle involved in the collision, a pedestrian, or any combination thereof within the same crash.

Time of day. The time of day that a fatal crash occurred is the hour the crash occurred. FARS collects this data as military time and categorizes the crash as occurring in the daytime or nighttime (27).

Nighttime Fatal Crash. A nighttime fatal crash is a driver fatal crash that occurred between 6:00 p.m. and 5:59 a.m.

Late-Night Fatal Crash. A late-night fatal crash is a driver fatal crash that occurred between 12:00 a.m. and 5:59 a.m.

Age. The age variable is defined as "the person's age at the time of the crash, in years, with respect to the person's last birthday" (27).

Sex. The sex variable, "identifies the sex of the person involved in the crash" (27).

Headlight-related crashes. Fatalities that were deemed 'headlight-related' were calculated from personal and driver level variables. Any variable categorized as reflected glare, bright sunlight, or headlights were analyzed to count the number of headlight-related crashes.

Distraction-related crashes. A driving distraction is defined as any activity that diverts attention from the act of driving to any other activity. According to the NHTSA, this includes being lost in thought or daydreaming while driving. Driving distractions include: talking, eating, drinking, smoking, being inattentive or daydreaming, cell or car phone use, fax machines, computer, printer, two way radio, head up display, adjusting audio, climate or other vehicular controls, moving objects within the vehicle, on board navigation, distractions from other occupants or moving objects inside or outsides the driver's vehicle (27).

Alcohol-related crashes. Fatalities that were deemed 'alcohol-related' were calculated from two variables within the FARS data: DRINKING and ALC_RES. DRINKING is a categorical yes or no variable that, "reflects the judgment of law enforcement as to whether alcohol was involved for this person" (27). ALC_RES reflects the actual value of the blood alcohol concentration (BAC) test. ALC_RES results greater than 0 and less than or equal to 94 were counted as alcohol-related. Beginning in 2004, an ALC_RES result of 98 signified a positive preliminary breath test (PBT) and was also counted as alcohol related (27).

Urban/Rural Location of crash. Whether the location of the fatal crash was urban or rural was determined by the functional classification of the road where the collision occurred. FARS variable ROAD_FNC determines whether the crash occurred in a rural or urban location based on road function. The road function system is classified from the highest to the lowest levels of the interstate, arterial, collector, and local road respectively. The interstate is comprised of arterial roads; providing the most mobility and the greatest speeds. Arterials include roads such as freeways and multiple lane highways that supplement the interstate. Collectors connect local streets with arterials (28).

FARS variable ROAD_FNC determines whether the crash occurred in a rural location based on the principal or minor arterial, the minor or major collector, the local road or street, or any other roadway classified as rural (27). ROAD_FNC determines whether the crash occurred in an urban location based on the principal arterial such as an interstate, freeway, and expressway or the minor arterial, collector, local road or street, or any other roadway classified as urban (27).

Georgia Crash Analysis Statistics and Information (CASI)

Denominator data on annual number of driver's licenses issued in Georgia by age were collected from the Georgia Department of Transportation's Crash Analysis, Statistics & Information Report. Annual driver's license data by age are collected and maintained by the Georgia Department of Motor Vehicle Safety (DMVS) and verified with the local county license application office (26). Because FARS and CASI data do not have unique individual identifiers, the Emory University Institutional Review Board granted an exemption to the review process for this research project.

Data analysis

Late-night driver, stratified fatal crash rates

Older driver fatal crash rates per 100,000 were calculated annually, from 1991 to 2010, by taking the numerator of late-night fatal crashes and dividing by the total number of licensed drivers (valid and suspended) the same age, then multiplied by 100,000. Driver fatal crash rates for older drivers were also calculated in 5-year intervals: 1991-1995, 1996-2000, 2001-2005, and 2006-2010.

Annual age-stratified rates were also calculated for gender, alcohol-related, headlight-related, distraction-related, and by location of the crash.

Rate Ratios

Rate Ratios (RRs) were calculated to compare fatal crash rates for 1991-2005 and 2006-2010 to determine if the trend of increasing rate of fatal nighttime crashes among older adults continued. Age stratified RRs were also calculated for total fatalities by gender, alcohol-related, headlight-related, distraction-related, and by location of crash.

Multiple Linear Regression

All analyses were completed using SAS (version 9.3, Cary, NC). Multiple linear regression was used to compute analysis of variance models to observe the difference among the multiple age categories of older drivers.

Four models were used to run multiple linear regression. The first two models collapsed all ages into one category; older drivers ages 55-79. The first model included the independent variables: year, late-night alcohol-related crash rate, late-night distraction-related crash rate, late-night headlight-related crash rate, late-night male fatal crash rate, and late-night rural fatal crash rate. The second model included all independent variables, excluding year.

The remaining two models were each run separately, stratifying by age category: 55-59, 60-64, 65-69, 70-74, and 75-79. The third model included the independent variables year, late-night alcohol-related crash rate, late-night distraction-related crash rate, late-night headlight-related crash rate, late-night male fatal crash rate, and late-night rural fatal crash rate. The fourth model included all independent variables, excluding year.

RESULTS

Late-Night Driver Fatal Crash Rates per 100,000 person-years

Older drivers ages 55-79, as a group, had an increased late-night fatal crash rate in the fourth 5-year interval (2006-2010) when compared to the first 5-year (1991-1995) as shown in Table 1. The rate increased to 1.75 per 100,000 person-years among older drivers ages 55-79 in the second 5-year interval compared to the first (RR=1.40). Again, the rate increased, to 1.93 per 100,000 person-years in the third 5-year interval compared to the second 5-year interval (RR=1.10). There was a slight decrease in the late-night fatal crash rate for drivers 22-79 in the fourth 5-year interval to 1.73 per 100,000 person-years, compared to the third 5-year interval (RR=0.90). In spite of the decrease, late-night fatal crash rates still showed an overall increase among drivers ages 55-79 from the first 5-year interval to the fourth 5-year interval (RR=1.38).

Older drivers ages 55-64 and 70-74 had an increased late-night fatal crash rate from 2006-2010 when compared with those of the same age in 1991-1995, as shown in Table 2. The rate ratios comparing 2006-2010 to 1991-1995 were 1.47, 1.89, and 1.74 for drivers ages 55-59, 60-64, and 70-74 respectively.

In the first 5-year interval (1991-1995), 21 late-night fatal crashes occurred among drivers 55-59 (1.06 per 100,000 person-years). The late-night fatal crash rate for 55-59 year old drivers increased to 2.41 per 100,000 person-years (n=40, RR= 1.50) from the first 5-year interval to the second 5-year interval (1996-2000). The late-night fatal crash rates stayed relatively consistent (2.42 per 100,000 person-years) when comparing the third 5-year interval (2001-2005) to the second 5-year interval (n=56, RR=1.00) for drivers ages 55-59. There was a slight decrease in the late-night fatal crash rate for drivers 55-59 in the fourth 5-year interval (2006-2010) to 2.36 per 100,000 person-years, compared to the third 5-year interval (n=62, RR=0.98). In spite of the decrease, late-night fatal crash rates still showed an overall increase among drivers ages 55-59 from the first 5-year interval to the fourth 5-year interval (RR=1.47).

Among drivers ages 60-64, 11 late-night fatal crashes occurred in the first 5-year interval (1.00 per 100,000 person-years). The late-night fatal crash rates increased to 1.90 per 100,000 person-years (n=24, RR= 1.91) among drivers ages 60-64 in the second 5-year interval compared to the first. The late-night fatal crash rate increased again, to 2.41 per 100,000 person-years (n=40, RR=1.27) among drivers ages 60-64, when comparing the third 5-year interval with the second. There was a slight decrease in the late-night fatal crash rate among drivers ages 60-64 in the fourth 5-year interval to 1.89 per 100,000 person-years compared to the third 5-year interval (n=42, RR=0.78). Again, however, the late-night fatal crash rate among drivers ages 60-64 still increased from the first 5-year interval to the fourth 5-year interval (RR=1.89).

Among drivers ages 65-69, 14 late-night fatal crashes occurred in the first 5-year interval (1.49 per 100,000 person-years). The late-night fatal crash rate slightly decreased to 1.46 per 100,000 person-years (n=15, RR=0.98) among drivers ages 65-69 in the second 5-year interval compared to the first. The late-night fatal crash rate continued to decrease when comparing the third 5-year interval with the second, to 1.07 per 100,000 person-years (n=13, RR=0.73) among drivers ages 65-69. There was a slight increase in the late-night fatal crash rate in the fourth 5-year interval to 1.16 per 100,000 person-years among drivers ages 65-69, compared to the third 5-year interval (n=18, RR=1.08).

Overall, there was a decrease in the late-night fatal crash rate for drivers 65-69 from the first 5-year interval to the fourth 5-year interval (RR=0.78).

Late-night fatal crash rates consistently increased among drivers 70-74 from the first 5-year interval to the fourth 5-year interval. Among drivers 70-74, 7 late-night fatal crashes occurred in the first 5-year interval (0.95 per 100,000 person-years). The late-night fatal crash rate for drivers ages 70-74 increased to 1.21 per 100,000 person-years (n=10, RR=1.27) in the second 5-year interval. The late-night fatal crash rates continued to increase among drivers ages 70-74 when comparing the third 5-year interval with the second, to 1.51 per 100,000 person-years (n=14, RR=1.25). The late-night fatal crash rate increased again among drivers ages 70-74 in the fourth 5-year interval, to 1.65 per 100,000 person-years, compared to the third 5-year interval (n=18, RR=1.10). Overall, the late-night fatal crash rate among drivers ages 70-74 increased from the first 5-year interval to the fourth 5-year interval (RR=1.74).

Among drivers ages 75-79, 4 late-night fatal crashes occurred in the first 5-year interval (0.84 per 100,000 person-years). The late-night fatal crash rate slightly decreased among drivers 75-79 to 0.84 per 100,000 person-years (n=5, RR=0.99) in the second 5-year interval compared to the first. The late-night fatal crash rate sharply increased among drivers ages 75-79 in the third 5-year interval to 1.17 per 100,000 person-years (n=13, RR=0.73). Subsequently, there was a dramatic decrease in the late-night fatal crash rate among drivers 75-79 in the fourth 5-year interval, to 0.39 per 100,000 person-years, compared to the third 5-year interval (n=3, RR=0.33). Overall, there was a decrease in the late-night fatal crash rate among drivers 75-79 when comparing the first 5-year interval to the fourth 5-year interval (RR=0.46).

Headlight-related Crash Rates per 100,000 person-years

Zero headlight-related late-night crashes occurred among older drivers 55-79 within all four 5-year intervals: 1991-2010. The rate of headlight-related, late-night crashes was consistent for all age groups across the period studied.

Distraction-related Crash Rates per 100,000 person-years

Zero distraction-related late-night crashes occurred among older drivers 55-79 within the first three 5-year intervals: 1991-2005. There were 2 distraction-related late-night crashes in the fourth 5-year interval. The first distraction-related late-night fatal crash occurred in 2008 among older drivers ages 60-64. This equates to a rate of 0.23 per 100,000 person-years among drivers 60-64 in 2008. The distraction-related late-night rate among all older drivers ages 55-79 was 0.06 per 100,000 person-years, in 2008. The second distraction-related late-night fatal crash occurred in 2010 among older drivers 55-59. This equates to a rate of 0.18 per 100,000 person-years among drivers 55-59 in 2010. The distraction-related late-night rate among all older drivers ages 55-79 was 0.06 per 100,000 person-years, in 2010. The 5-year interval rate containing the 2 distraction-related crashes was calculated to be 0.02 per 100,000 person-years. Overall, distraction-related late-night rate increased among drivers ages 55-79, from 0 to .02 per 100,000 person-years, from the first 5-year interval to the fourth 5-year interval,

Alcohol-related Crash Rates per 100,000 person-years

Only older drivers 60-64 showed an increased late-night alcohol-related fatal crash rate from 2006-2010 when compared with those of the same age in 1991-1995. As shown in Table 3, the rate ratios comparing 2006-2010 to 1991-1995 range from 0.00 to 1.16.

In the first 5-year interval, 3 alcohol-related, late-night fatal crashes occurred among drivers 55-59 (0.23 per 100,000 person-years). The alcohol-related, late-night fatal crash rate for 55-59 year old drivers increased to 0.42 per 100,000 person-years (n=7, RR= 1.84) from the first 5-year interval to the second 5-year interval. Alcohol-related late-night fatal crash rates stayed relatively consistent (0.43 per 100,000 person-years) when comparing the third to the second 5-year interval (n=10, RR=1.02). The alcohol-related, late-night fatal crash rate reached the lowest point in the fourth 5-year interval, at 0.19 per 100,000 person-years (n=5, RR=0.44). Overall, the alcohol-related, late-night fatal crash rate among drivers ages 55-59 decreased when comparing the first 5-year interval to the fourth 5-year interval (RR= 0.83).

Among drivers ages 60-64, 3 alcohol-related, late-night fatal crashes occurred in the first 5-year interval (0.27 per 100,000 person-years). The alcohol-related, late-night fatal crash rate decreased to 0.16 per 100,000 person-years (n=2, RR= 0.58) in the second 5-year interval compared to the first. The alcohol-related, late-night fatal crash rate increased during the third 5-year interval compared with the second 5-year interval to 0.54 per 100,000 person-years (n=9, RR=3.42). There was a decrease in the alcohol-related, late-night fatal crash rate in the fourth 5-year interval to 0.31 per 100,000 person-years compared to the third 5-year interval (n=7, RR=0.58). Overall, there was an increase in the alcohol-related, late-night fatal crash rate among drivers ages 60-64 when comparing the first 5-year interval to the fourth 5-year interval (RR=1.16).

Among drivers ages 65-69, 2 alcohol-related late-night fatal crashes occurred in the first 5-year interval (0.21 per 100,000 person-years). The alcohol-related late-night fatal crash rate decreased to 0.10 per 100,000 person-years (n=1, RR=0.46) in the second 5-year interval compared to the first. The alcohol-related, late-night fatal crash rate increased when comparing the third 5-year interval with the second to 0.17 per 100,000 person-years (n=2, RR=1.69). There were zero alcohol-related late-night fatalities in the fourth 5-year interval. Overall, the alcohol-related, late-night fatal crash rate decreased among drivers ages 65-69 when comparing the first 5-year interval to the fourth 5-year interval (RR= 0.00).

Among drivers ages 70-74, 1 alcohol-related late-night fatal crash occurred in the first 5-year interval (0.14 per 100,000 person-years). The alcohol-related late-night fatal crash rate increased to 0.36 per 100,000 person-years (n=3, RR=2.67) in the second 5-year interval. The alcohol-related late-night fatal crash rate decreased when comparing the third 5-year interval with the second, to 0.11 per 100,000 person-years (n=1, RR=0.30). The alcohol-related late-night fatal crash rate reached the lowest point, 0.09 per 100,000 person-years (n=1, RR=0.85), in the fourth 5-year interval. Overall, the alcohol-related, late-night fatal crash rate decreased among drivers ages 70-74 when comparing the first 5-year interval to the fourth 5-year interval (RR= 0.68).

Older drivers 75-79 had the lowest alcohol-related late-night fatal crash rate among all age groups. Zero alcohol-related late-night fatal crashes occurred from 1991 to 2010 among drivers ages 75-79.

Studies have shown that older drivers drink and drive less than other adult drivers (18-19). The low alcohol-related, late-night fatality rates and the fact that the alcohol-related, late-night fatality rates are decreasing are consistent with the literature.

Multiple Linear Regression

As described in the Methods section, two models were run for all ages combined and for each age group. The results of these models are presented below, and summarized in Table 4.

Models for Ages 55-79 Combined

With Year Controlled. The dependent variable was late-night, fatal crash rate. B0= Intercept. The independent variables were: X1= Year; X2= Late-night, alcohol-related crash rate (55-79); X3= Late-night, distraction-related crash rate (55-79); X4= Late-night, headlight-related crash rate (55-79); X5= Late-night, male fatal crash rate (55-79); and X6= Late-night, rural fatal crash rate (55-79).

This model was statistically significant at $\alpha=0.05$ (F= 28.16, p-value <.0001). There was a significant linear relationship between year and late-night, fatal crash rate (t=2.15, p-value=.0498). There was also a significant linear relationship between late-night, male fatal crash rate and late-night, fatal crash rate (t=5.64, p-value <.0001). The variables year and late-night, male fatal crash rate explained 88 % of the variation within late-night, fatal crash rate among older drivers ages 55-79 from 1991 through 2010 (Adj R^2=.88).

Without Year Controlled. The dependent variable was late-night, fatal crash rate. B0= Intercept. The independent variables were: X1= Late-night, alcohol-related crash rate (55-79); X2= Late-night, distraction-related crash rate (55-79); X3= Late-night, headlight-related crash rate (55-79); X4= Late-night, male fatal crash rate (55-79); and X5= Late-night, rural fatal crash rate (55-79).

This model was statistically significant at α=0.05 (F= 27.45, p-value <.0001). There was a significant linear relationship between late-night, male fatal crash rate and late-night fatal crash rate (t=6.16, p-value <.0001). Late-night, male fatal crash rate explained 85% of the variation within late-Night, fatal crash rate among older drivers 55-79 from 1991 through 2010 (Adj R^2=.85).

Though late-night, male fatal crash rate was significant in both models for older drivers ages 55-79, the beta estimates for late-night, distraction-related crash rate, late-night, male fatal crash rate, and late-night, rural fatal crash rate increased when year was not controlled for. This indicates that these variables explained some of the variation that the variable year explained, when present in the model, within late night fatal crash rate among older drivers ages 55-79 from 1991 through 2010.

Models for Each Age Group

The dependent variable for each age group was late-night, fatal crash rate for that age group. B0= Intercept. In addition to year (when applicable), the independent variables were: X1= Late-night, alcohol-related crash rate for the selected age group; X2= Late-night, distraction-related crash rate for the selected age group; X3= Late-night, headlight-related crash rate for the selected age group; X4= Late-night, male fatal crash rate for the selected age group; and X5= Late-night rural fatal crash rate for the selected age group.

<u>*Ages 55-59 with Year Controlled*</u>. This model was statistically significant at α=0.05 (F= 9.53, p-value=.0004). There was a significant linear relationship between year and late-night, fatal crash rate (t=2.54, p-value=.0235). There was

also a significant linear relationship between late-night, male fatal crash rate and late-night, fatal crash rate (t=4.79, p-value=.0003). The variables year and late-night, male fatal crash rate explained 69% of the variation within Late-Night, fatal crash rate among older drivers 55-59 between 1991 to 2010 (Adj R^2=.69).

Ages 55-59 without Year Controlled. This model was statistically significant at α=0.05 (F= 7.55, p-value=.0015). There was a significant linear relationship between late-night, male fatal crash rate and late-night fatal crash rate (t=4.48, p-value=.0004). The variable late-night, male fatal crash rate explained 58% of the variation within Late-Night, fatal crash rate among older drivers 55-59 from 1991 to 2010 (Adj R^2=.58).

Among older drivers ages 55-59, the late-night, male fatal crash rate was significant in both models. The beta estimates for late-night, alcohol-related fatal crash rate, late-night, distraction-related crash rate, late-night, male fatal crash rate, and late-night, rural fatal crash rate increased when year was not controlled for. These variables explain some of the variation that the variable year explained, when present in the model, within late night fatal crash rate among older drivers ages 55-59 from 1991 through 2010.

Ages 60-64 with Year Controlled. This model was statistically significant at α=0.05 (F= 4.90, p-value=.0085). There was a significant linear relationship between late-night, male fatal crash rate and late-night, fatal crash rate (t=3.38, p-value=.0045). The variable late-night, male fatal crash rate explained 51% of the variation within late-night, fatal crash rate among older drivers 60-64 from 1991 to 2010 (Adj R^2=.51).

Ages 60-64 without Year Controlled. This model was statistically significant at α=0.05 (F= 6.54, p-value=.003). There was a significant linear relationship between late-night, male fatal crash rate and late-night, fatal crash rate (t=4.30, p-value=.0006). The variable late-night, male fatal crash rate explained 54% of variation within late-night, fatal crash rate among older drivers 60-64 from 1991 to 2010 (Adj R^2=.54).

Ages 65-69 with Year Controlled. This model was not statistically significant at α=0.05 (p-value=.0506).

Ages 65-69 without Year Controlled. This model was not statistically significant at α=0.05 (p-value=.2395).

Ages 70-74 with Year Controlled. This model was statistically significant at α=0.05 (F= 3.17, p-value=.0447). There was a significant linear relationship between late-night, male fatal crash rate and late-night, fatal crash rate (t=2.27, p-value=.0382). The variable late-night, male fatal crash rate explained 31% of the variation within late-night, fatal crash rate among older drivers 70-74 from 1991 through 2010 (Adj R^2=.31).

Ages 70-74 without Year Controlled. This model was statistically significant at α=0.05 (F= 4.07, p-value=.0251). There was a significant linear relationship between late-night, male fatal crash rate and late-night fatal crash rate (t=2.90, p-value=.0105). The variable late-night, male fatal crash rate explained

33% of the variation within late-night, fatal crash rate among older drivers 70-74 from 1991 through 2010 (Adj R^2=.33).

Ages 75-79 with Year Controlled. This model was statistically significant at α=0.05 (F= 3.85, p-value=.0301). There was a significant linear relationship between year and late-night, fatal crash rate (t=2.55, p-value=.0214. The variable year explained 31% of the variation in late-night, fatal crash rate among drivers ages 75-79 from 1991 through 2010 (Adj R^2=.31).

Ages 75-79 without Year Controlled. This model was not statistically significant at α=0.05 (p-value=.1796).

DISCUSSION

Summary of Findings

This study documented an increase in late-night, fatal crashes among older drivers ages 55-79. Late-night fatal crash rates steadily increased from 1991-2005, but decreased from 2006-2010. Though late-night fatal crash rates decreased, there was an overall increase among drivers ages 55-79 from the first 5-year interval to the fourth 5-year interval. Closer inspection of rate ratios by 5-year intervals indicated that this increase was restricted to three age groups: 55-59, 60-64, and 70-75. Using this method, drivers ages 65-69 and 75-79 did not evidence an increase over the time period studied. In contrast, multiple linear regression analysis indicated that there was a significant linear relationship between year and late-night, fatal crashes for drivers ages 55-79, but further inspection attributed this to increases by year only for drivers ages 55-59 and 75-79.

There are two possible reasons for the difference between these results and those found in the TADRA evaluation. The first reason is that the TADRA evaluation used census data for the denominators, rather than the number of licensed drivers. Thus, if a greater number of older Georgians have been retaining their licenses over time, the TADRA results would artificially inflate the rates in later years. The second possible reason for the difference in findings is that this analysis used a slightly different time frame than the TADRA analysis. While the TADRA evaluation looked at data from 1992-2007, this analysis included data from 1991-2010.

This study addressed two specific research questions. The first research question asked whether the increase over time was the result of increasing use of HID headlights, distracted driving, or alcohol involvement. The answer to this question is no. None of these variables were significantly associated with the late-night, fatal crash rate over time.

The second research question asked whether the increase in fatal crash rate continued from 2006-2010. The rate decreased in the 2006-2010 time period for drivers ages 55-59, 60-69, and 75-79. In contrast, it increased among those ages 65-69 and 70-74. The only age group in which there was a consistent increase across the time period studied was the 70-74 year age group. The decrease that occurred from 2006-2010 in three of the age groups may be one contributor to the inability to replicate the TADRA evaluation results in this study.

Limitations and Strengths

This study is not without limitations. One limitation is that the late-night, fatal crash data from FARS capture crashes resulting in a fatality; while we are studying older drivers, the fatality may not have been an older person. Furthermore, the late-night fatal crash rate for older drivers captures fatal crashes in which there was an older driver involved, whether or not that driver was at fault.

An additional limitation is the use of licensed drivers as the denominator for the rates. Having a license does not mean one is driving, let alone driving during late-night hours. As a result, the rates in this study are probably underestimates of the risk for older drivers.

Other potential limitation include the way some of the variables of interest were coded within FARS. The FARS system coded headlight factors in two general categories:

1) Headlights were compromised or were not functioning as they were supposed to before the crash or 2) Headlights were a factor in the crash via reflected glare, bright sunlight, or headlights. This study examined only those fatalities within the second category to determine the role of headlights in older diver, late-night fatalities. Because the study was limited to late-night hours, findings were attributed to headlights and not reflected glare or bright sunlight, although this could have occurred with an early sunrise. This may have led to a misclassification of headlight-related fatalities.

As time goes on and we progress technologically, more factors are potential variables to be included in the FARS data. Distractions in the FARS data have changed over time. In 1991, distractions included only six options including: inattention and careless driving, cell phones, fax machines, computers, on-board navigation systems, two way radio, and head up display. Some distractions were discontinued in 2001 and some were reintroduced and included in other categories. By 2010, FARS coding changed and included sixteen potential distraction options. This may have underestimated the role of distraction-related fatalities, especially in the earlier years of this study.

Recommendations

Concern regarding older driver safety has understandably increased in recent years. The number of licensed older drivers is continually growing. There was a 23 percent increase in licensed older drivers in the ten year span, 1999 to 2009 (29-31). Studies have examined the role of vision acuity and visual impairment as risk factors for motor vehicle crashes among older adults (7, 15). Few studies have examined how big a part night driving has in motor vehicle fatalities involving older drivers. This may be because drivers with submaximal vision function usually restrict their driving and these selfregulating drivers tend to be older adults (32). Certain recommendations that are thought to be protective with regards to older driver safety including: seat belt use, driving under favorable conditions, planning the route ahead of time, having annual eye checkups, avoiding chemicals such as alcohol, over the counter and prescription medicines that would cause impairment while driving, and avoiding distractions while driving. Future research should examine the extent to which seniors are following these recommendations. Research might also explore the degree to which seniors, when driving at night, have encountered problems such as headlight glare.

Most of the success in reducing motor vehicle fatalities have been among teens. This has been attributed to the implementation of policies regarding drinking and driving, and also implementation of a graduated licensing system in some states (10-11). With the increasing motor vehicle fatality rates among older drivers, it may be helpful to determine policy interventions specific to older drivers and examine the effectiveness of these policies on late-night fatal crash rate (33). While reducing older driver crash risk, it is important to take into account concerns regarding mobility and quality of life. Additional studies examining the role of distraction and headlights on late-night fatality, may help determine modifiable driving behaviors and factors relevant to an effective intervention to reduce driving injuries and death among older drivers.

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TABLES

Table 1. Rates of Older Driver Ages 55-79 Late-Night Fatal Crashes in Georgia From 1991-2010, 5-Year Intervals

	Rate	[1]Rate Ratio	[2]Rate Ratio	[3]Rate Ratio
5-Year Intervals				
1st	1.25			
2nd	1.75	1.40		
3rd	1.93	1.54	1.10	
4th	1.73	1.38	0.99	0.90

[1]Rate Ratio compares the respective row 5-year interval with the 1st 5-year interval

[2]Rate Ratio compares the respective row 5-year interval with the 2nd 5-year interval

[3]Rate Ratio compares the respective row 5-year interval with the 3rd 5-year interval

Table 2. Rates of Late-Night Fatal Crashes in Georgia From 1991-2010, 5-Year Intervals by age

	1st	2nd	3rd	4th
	1991-1995	1996-2000	2001-2005	2006-2010
Age				
55 to 59	1.60	2.41	2.42	2.36
60 to 64	1.00	1.90	2.41	1.89
65 to 69	1.49	1.46	1.07	1.16
70 to 74	0.95	1.21	1.51	1.65
75 to 79	0.84	0.83	1.17	0.39

Table 3. Rates of Alcohol-Related, Late-Night Fatal Crashes in Georgia From 1991-2010, 5-Year Intervals by age

	1st			2nd			3rd			4th		
	Population	N	Rate	Population	N	Rate	Population	N	Rate	Population	N	Rate
Age												
55 to 59	1,311,305	3	0.23	1,662,834	7	0.42	2,317,589	10	0.43	2,629,474	5	0.19
60 to 64	1,103,325	3	0.27	1,259,932	2	0.16	1,656,858	9	0.54	2,225,261	7	0.31
65 to 69	937,221	2	0.21	1,025,750	1	0.10	1,211,112	2	0.17	1,554,624	0	0.00
70 to 74	735,852	1	0.14	827,195	3	0.36	927,082	1	0.11	1,087,956	1	0.09
75 to 79	474,052	0	0.00	598,949	0	0.00	683,768	0	0.00	773,579	0	0.00

Table 4. Multiple Linear Regression Parameter Estimates (βs) for Independent Variables, Collapsed and Stratified by age, Including and Excluding Year

	Dependent Variable: Late-Night Fatal Crash Rate											
	Age 55-79		Age 55-59		Age 60-64		Age 65-69		Age 70-74		Age 75-79	
Independent Variable	β	β	β	β	β	β	β	β	β	β	β	β
Year	* 0.019	--	* 0.034	--	-0.003	--	0.052	--	0.017	--	* 0.042	--
Late-Night Alcohol-Related Crash Rate	0.028	-0.110	-0.007	0.022	-0.376	-0.354	0.333	-0.500	-0.116	-0.260	0.000	0.000
Late-Night Distraction-Related Crash Rate	-1.345	2.058	-3.369	-0.528	-0.749	-0.835	0.000	0.000	0.000	0.000	0.000	0.000
Late-Night Headlight-Related Crash Rate	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Late-Night Male Crash Rate	* 0.735	* 0.836	* 0.486	* 0.524	* 0.979	* 0.953	0.209	0.608	* 0.697	* 0.802	0.104	0.082
Late-Night Rural Crash Rate	0.312	0.328	-0.182	-0.028	-0.367	-0.356	0.112	-0.38	-0.338	-0.335	0.182	0.174

* Indicates a significant p-value at α=.05 level