U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

NHTSA

DOT HS 812 486

April 2018

Older Driver Compliance With License Restrictions

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Suggested APA Format Citation:

Joyce, J., Lococo, K. H., Gish, K. W., Mastromatto, T., Stutts, J., Thomas, D., & Blomberg, R. (2018, April). *Older driver compliance with license restrictions* (Report No. DOT HS 812 486). Washington, DC: National Highway Traffic Safety Administration.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 412 486		

4. Title and Subtitle	5. Report Date
Older Driver Compliance With License Restrictions	April 2018
	6. performing Organization Code

7. Author(s)	8. performing Organization Report No.
John Joyce, Kathy H. Lococo, Kenneth W. Gish, Tia Mastromatto, Jane Stutts, Dennis Thomas, and Richard Blomberg	

9. performing Organization Name and Address	10. Work Unit No. (TRAIS)
TransAnalytics, LLC 336 West Broad Street Quakertown, PA 18951 and Dunlap and Associates, Inc. 110 Lenox Avenue Stamford, CT 06906	11. Contract or Grant No. DTNH2209D00135-0003

12. Sponsoring Agency Name and Address	13. Type of Report and period Covered
Office of Behavioral Safety Research National Highway Traffic Safety Administration 1200 New Jersey Avenue, SE Washington, DC 20590	Final Report
	14. Sponsoring Agency Code NPD-320

15. Supplementary Notes

Dr. Kathy Sifrit was the NHTSA Task Order Manager on this project.

16. Abstract

To safely extend licensure for older drivers with marginal impairments, State driver licensing agencies may impose behavioral restrictions in lieu of suspension to preserve mobility. Examples include driving only in daylight, avoiding complex road types, speed limitations, and proximity to home. This project surveyed driver restriction practices and characteristics of imposed driving restrictions among older drivers in several participating States while naturalistic data provided information about driving behavior of restricted and unrestricted older drivers. Information gathered in a literature review, discussions among subject matter experts, a collection of demographic and performance data from four participating States, and a field study of driving exposure among adults 70 and older support a broader understanding of restricted licensing practices, driver compliance, and safety effects. Older drivers in the study generally complied with imposed restrictions, although such restrictions were seldom employed by licensing authorities. Crash rates were lower for restricted drivers after, as compared to before their restrictions, though not as low as those observed among similar, unrestricted licensees. This finding echoed similar observations in the research literature. A naturalistic study of driving exposure demonstrated that drivers with imposed restrictions remained in compliance during a one-month observation period. Furthermore, t-tests revealed that participants with license restrictions drove significantly less often, more slowly, and for shorter distances as compared to unrestricted drivers of similar age.

17. Key Words	18. Distribution Statement
Driver, older, aging, licensing, restriction, function, safety	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161. www.ntis.gov

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	68	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

ACKNOWLEDGEMENTS

The authors wish to thank the following people and their organizations for their essential contributions to this project.

Christine Nizer, Motor Vehicle Administrator, Maryland Motor Vehicle Administration

Nancy Snowden (retired), Maryland Motor Vehicle Administration

Timothy Kerns, Charles Mathias, Jr. National Study Center for Trauma and EMS

Elin Schold Davis, OTR/L, CDRS

Deena Garrison Jones, OTR/L, CDRS

Mike McCaskill, Florida Department of Motor Vehicles

Diane Martin, Iowa Department of Transportation

Richard Holcomb, Commissioner, Virginia Department of Motor Vehicles

Millicent Ford, Virginia Department of Motor Vehicles

Jackie Branche, Virginia Department of Motor Vehicles

Lam Phan, Virginia Department of Motor Vehicles

April Rogers, Virginia Department of Motor Vehicles

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List of Acronyms and Abbreviations

AAA ..... American Automobile Association
(The AAA no longer uses the full title, only the abbreviation)
AAAFTS ..... American Automobile Association Foundation for Traffic Safety
AAMVA ..... American Association of Motor Vehicle Administrators
AARP ..... American Association of Retired persons
(The AARP no longer uses the full title, only the abbreviation)
AVS ..... Application Visualization System
CDRS ..... certified driver rehabilitation specialist
CODES ..... Crash Outcome Data Evaluation System
DAVID ..... Driver and Vehicle Information Database
DMV ..... Department of Motor Vehicles
DRS ..... Driver Rehabilitation Specialist
DVLA ..... Driver and Vehicle Licensing Agency
FHWA ..... Federal Highway Administration
IRB ..... Institutional Review Board
OMB ..... Office of Management and Budget
OTR/L ..... occupational therapist, registered, licensed
PI ..... principal investigator
SDPE ..... Supplemental Driving performance Evaluation
SPSS ..... Statistical Package for the Social Science

Executive Summary

The objectives of this project were to review States' behavioral driver license restriction practices, to explore the extent to which drivers accept and comply with these restrictions, and to determine the effects or such restrictions on restricted drivers' mobility and their crash rates. Examples of behavioral restrictions include daylight driving only, not exceeding a certain maximum speed, only driving on roadways with speed limits of 45 mph or lower, no interstate/highway driving, and only driving to certain specified destinations or within a certain radius of one's home. The intent of such restrictions is to lower the crash risk for older drivers with functional impairments by reducing the demands of the driving task to better match their compromised driving abilities.

The project addressed processes that some State driver license agencies followed when imposing such restrictions, how often States imposed various restriction types, how the crash and violation experience of restricted drivers compared to that of similarly aged unrestricted drivers, and the exposure of age-matched restricted and unrestricted older drivers. Project tasks included: reviewing recent literature on the topic, convening an expert panel that included teams of driver evaluators from several States, accessing and analyzing driver licensing, crash, and citation data from four States, and instrumenting the vehicles of older drivers with and without license restrictions in a naturalistic field study.

The literature review covered a dozen recent studies from within and outside the U.S. addressing behavioral license restrictions. It revealed that drivers with behavioral license restrictions had higher pre-restriction crash rates than age-matched controls, and although their rates declined post-restriction, they remained higher than those of unrestricted drivers. This suggests that restrictions partially compensated for the functional declines associated with increased crash risk. Drivers tended to accept and comply with such restrictions, especially in lieu of license suspension or revocation.

The driving evaluator panel described restricted licensing practices. Participants included a driver licensing administrator, law enforcement official, and driver rehabilitation specialist from each of three States: Florida, Iowa, and Virginia. California was unable to send a team of panelists but instead provided written information about their practices. Panelists discussed the process of identifying and evaluating drivers, options available for license restrictions, drivers' reactions to having their license restricted, and whether license restrictions were a viable approach to preserving mobility without sacrificing safety.

Panelists provided insights that raised important issues and provided valuable guidance and context to the project's overall goal of examining the usefulness of restrictions for preserving the mobility and safety of older drivers. Florida had recently implemented an automated system for reporting potential at-risk drivers to Driver Medical Review that resulted in a marked increase in the number of referred drivers. Panelists generally agreed that training was helpful in encouraging law enforcement to make needed traffic stops and/or write citations to bring a potential at-risk drivers to the attention of licensing authorities. Iowa's practice of requiring drivers over 70 to renew their licenses in person every 2 years provided increased opportunities for license examiners to identify a potential at-risk driver. License administrators believed that older drivers generally complied with their restrictions, but recognized that enforcement

opportunities were limited, so they did not have evidence that this was true. A law enforcement official suggested that DMVs provide educational opportunities or make printed information available to newly restricted drivers to enhance compliance.

Virginia's practice of sometimes requiring drivers to seek professional evaluation by a driver rehabilitation specialist (DRS) presented an additional hurdle for drivers wishing to preserve their licenses, since costs were generally borne by drivers and not reimbursed by insurance. Panelists noted that driver licensing officials as well as physicians needed to be familiar with the services provided by driver rehabilitation specialists.

The State data analysis undertaken in this research sought to determine (1) how often the four study States (Florida, Iowa, Maryland, and Virginia) imposed restrictions on older drivers' licenses, (2) the characteristics of drivers receiving the restrictions, (3) the effects of the restrictions on older drivers' crash rates, and (4) drivers' compliance with their restrictions. Note that the list of study States differs slightly from the States included in the panel discussed above. Key findings were that less than 2% of licensed older drivers in Virginia, and less than 1% of those in Iowa, Florida, and Maryland had behavioral restrictions on their licenses, with "daylight driving only" being the most common restriction in each State except Maryland, where this restriction was only available to drivers in the State's low-vision program. Overall, the restricted drivers were considerably older than their unrestricted counterparts (roughly three-quarters were 80 and older) and were more likely to be female. Consistent with prior published research, restricted drivers were found to have higher annual crash rates than their unrestricted counterparts. However, annual crash rates for drivers with just a restriction to driving only in daylight were elevated by less than 20%, whereas the rates for drivers with other types of restrictions (primarily speed-related and/or geographic restrictions) were three to four times higher than those of controls.

The State data compared pre-restriction versus post-restriction crash rates, which showed mixed results. Whereas the crash rates of Iowa and Maryland drivers declined after imposition of their restrictions, those for Virginia drivers increased slightly. In Iowa, imposition of a speed and/or geographic restriction was associated with a reduction in crash rates by almost one-quarter, while a daylight-driving-only restriction had little effect. Analyses of crash-involved drivers showed that participants generally complied with restrictions, although those with restrictions in addition to daylight driving only were more likely to violate their restrictions.

Lastly, the research team compared exposure of restricted and unrestricted older drivers. Analyses showed that the restriction group took fewer trips, drove slower, for shorter distances, and less frequently during the hours from 10 a.m. to 3 p.m. All participants in the restriction group complied with their formal license restriction during the one-month observation period.

The results support the DMV panelists' position that restricting drivers in lieu of suspending their licenses does not pose an unacceptable safety risk, yet does help preserve mobility. Subject to the data limitations acknowledged herein, the findings in this study offer insights that may help guide State licensing authorities in setting policies and practices for balancing safety and mobility among their growing aging populations.

Introduction

A 2010 estimate by the Federal Highway Administration (FHWA) revealed that there were more than 210 million licensed drivers in the United States, of whom about 16 percent, or 33.7 million people, were 65 or older (FHWA, 2011). The proportion of older drivers is anticipated to grow to more than one in five over the next 20 to 30 years as the population ages and as the current cohort of drivers continues driving longer than previous generations (Lyman, Ferguson, Braver, & Williams, 2002). This growth in the number of older drivers fuels concern that functional declines associated with normal aging or medical conditions related to aging will lead to increased crashes and resultant injuries and deaths. At the same time, people in the United States depend heavily on automobile travel, so the inability to drive poses risks to health and quality of life. In this context, most health and safety professionals agree that mobility preservation, *when safely possible,* is a desirable goal for licensing agencies and is important both to the affected individuals and to the greater population.

License restriction policies provide driver licensing agencies a means to preserve licensure when a driver's functional abilities are compromised. A common license restriction requires people with reduced visual acuity to wear corrective lenses while driving. Other restrictions require drivers to compensate for impairment by altering how they interact with the vehicle; for example, requiring a driver to only drive a vehicle with an automatic transmission, hand controls, or pedal extensions.

In addition to these types of restrictions, licensing agencies may base restrictions on behavioral changes intended to mitigate risk through altering the type or extent of exposure. Restricted drivers may be required, for example, to limit their driving to lower speed roadways, for a shorter period of time, during daylight hours only, or to specified destinations or trip purposes, in an attempt to better match the demands of the driving task to the person's capacity to drive safely. The present study focuses on these types of *behavioral* license restrictions that limit driving locations or conditions; throughout this report, the term "restrictions" will refer to behavioral restrictions.

A review of available literature served as the starting point for this investigation. A panel comprising driver license evaluators from States that used behavioral license restrictions to balance safety and mobility concerns, along with recognized experts in the field of older driver safety and mobility, provided further insight into current use of driving restrictions. Researchers then analyzed driver licensing and crash data from Florida, Iowa, Maryland, and Virginia to derive demographic and performance measures for restricted versus non-restricted drivers.

The research team determined that they needed to observe compliance by restricted drivers and the effect of restrictions on driving. The retrospective data obtained from the four participating States, while helpful, were incomplete. Crashes fortunately remain rare events, and at least anecdotally, law enforcement officers often elect to give an older driver an informal warning (which left no record) instead of writing a ticket for an infraction of a traffic regulation. Investigators selected Virginia to observe and compare the exposure of restricted versus unrestricted drivers after considering the size of the potential subject pool, licensing policy, data accessibility, and the compactness of the catchment area.

Literature Review

At the outset of the study, researchers conducted a brief review of the published literature to determine whether similar studies had been conducted that could inform the current effort. The review was limited to peer-reviewed studies on the topic of license restrictions for older drivers published from 2000 to 2010. The search included the databases TRIS, PsycInfo, PubMed, ScienceDirect, and Elsevier's literature and the Internet search gateway, SciVerse. Keywords included the following terms with the asterisk indicating truncation: old*, elder*, senior, aged, and mature when combined with the term driver*. Search algorithms combined these terms with the following: licens*, evaluat*, assess*, examin*, reexamin*, retest*; impair*; disease*, function*, restrict*, mobility, safety, crash, accident, and citation.

Researchers also scanned websites of several organizations identified during the database searches for new publications not yet indexed along with new information on the topic. United States-based websites included the AAA Foundation for Traffic Safety, AARP, Insurance Institute for Highway Safety, National Highway Traffic Safety Administration, and the California Department of Motor Vehicles. Foreign websites included the Swedish National Road and Transport Research Institute; AustRoads (Australia and New Zealand); Monash University Accident Research Centre (Australia); Centre for Accident Research and Road Safety-Queensland (Australia); and the United Kingdom Driver and Vehicle Licensing Agency. Two Internet sites were particularly useful. In the United States, the AAA Foundation for Traffic Safety had organized information on State policies and practices affecting older and medically-at-risk drivers on its Driver Licensing Policies and Practices website (http://lpp.seniordrivers.org/lpp/). The United Kingdom Driver and Vehicle Licensing Agency had organized information in an online format, including a site for researchers and another for medical professionals (www.dft.gov.uk/dvla/medical.aspx).

These searches yielded several dozen potentially relevant studies. Project staff reviewed abstracts or summaries of the studies to identify those most relevant to the current effort and obtained copies of the full documents for review. A review form was developed that included the following elements: study citation; study aim or purpose; study type, method or design; study population; analysis and results; quality assessment; and relevance to the present work. A total of 12 studies were ultimately reviewed and documented; 7 U.S. studies, and 5 that were conducted elsewhere. Appendix A contains a synopsis of each study included in the literature review.

Findings from studies addressing behavioral licensing restrictions were consistent across the United States and other countries. Aside from corrective lens restrictions, only a small percentage of drivers had driver license restrictions. In addition, findings regarding the safety impacts of restrictions were remarkably similar across studies. Notably, restricted drivers tended to have more crashes and violations before their restrictions were imposed than did their unrestricted counterparts. In many instances, pre-restriction crash rates were double those for control groups, which suggests the licensing agencies are indeed identifying risky drivers. After the restrictions were in place, the crash rates of the restricted drivers dropped substantially. However, crash rates for the control groups also dropped, and in most instances the crash rates for the restricted drivers remained higher than the control group rates. This latter finding

suggests that there is a natural reduction in crashes associated with age, perhaps due to reduced exposure from self-limitation. The fact that restricted drivers' rates still exceeded those of control drivers in most instances suggests the restrictions are not able to fully compensate for the functional losses that ultimately led to the drivers' restrictions.

Also notable across studies was the high level of compliance with restrictions. Studies that examined time of day of crashes reported that drivers had very few crashes during the restricted times.

Studies that focused on the emotional impact of restrictions found that older drivers often accepted the need for restrictions and few were hostile toward the process. Most drivers preferred a restricted license to no license at all. In contrast, more than two thirds of drivers whose licenses were revoked responded that they were "angry" or "very angry" with the licensing agency. They also reported greater difficulty with conducting their daily activities.

Driver Evaluator Panel

The research team convened a driver evaluator panel to obtain input directly from practitioners at the State level about restricted licensing for older/medically impaired drivers. The panel also included older driver safety researchers. Invited panelists met for a one-day meeting in Washington, DC, to address the following questions:

1. How did candidates for license restriction come to the attention of the licensing authority? Who could impose a license restriction, and what process was involved?
2. Other than corrective lenses, what types of restrictions were available, and which were most commonly applied for drivers 65 and older? Under what circumstances were such restrictions *not* applied? What types of medical conditions were most common among drivers receiving restricted licenses?
3. How did older drivers react to having their licenses restricted?
4. What types of restrictions were associated with the highest compliance by older drivers? What measures, enforcement or otherwise, were in place to promote compliance with restrictions? What methods existed to detect noncompliance?
5. Did driving restrictions preserve mobility at the cost of safety?

Panel Composition and Selection

Panel participants included a licensing administrator, a driver rehabilitation specialist, and a law enforcement officer from each of three States.

- The *licensing administrators* described the process for imposing restrictions, including the sources of driver referrals, mitigating considerations and rationale for imposition, and the overall processes resulting in restriction.
- The *driver rehabilitation specialists* (DRSs) provided input regarding candidates for restriction and the response from the licensing system to recommendations regarding evaluated drivers from a perspective not available to the licensing administrator.
- *Law enforcement* officials provided their views both with respect to identifying and referring candidates for licensing restriction and enforcement of restrictions.

In addition, three physicians regularly involved in the medical evaluation of older drivers who were also authors of studies pertaining to older driver safety and mobility preservation participated on the panel as did a representative of the American Association of Motor Vehicle Administrators (AAMVA), a plenary organization of licensing authorities in the United States and Canada.

The panelist teams were recruited from California, Florida, Iowa, and Virginia. These States were selected because they had large populations of drivers 65 and older, could implement a variety of restriction types, and were recommended by NHTSA regional administrators as interested and willing to cooperate in research activities.

The project principal investigator(P.I.) contacted a licensing representative from each State, described the project, and invited them to assemble a team from their State to provide a full-range view of the restriction practices in that State. All but California sent representatives who participated in the panel. However, the chief of the Driver Safety Branch in California prepared a written description of the State's restriction processes and provided it to the P.I. for inclusion in this report. Appendix B.1 presents a list of all 13 panelists and their affiliations.

Two weeks before the meeting, the P.I. provided the panelists with the results of the literature review and a draft meeting agenda. The meeting was conducted in Washington, D.C. on May 24, 2011. Appendix B.2 contains the meeting agenda. A professional transcription service (audio) recorded and transcribed the panel's discussion. The P.I. moderated the meeting with assistance of other project staff.

Findings from the Panel

Identifying Candidate Drivers

The panelists indicated that restrictions designed to reduce exposure to high risk situations by altering driving behavior are often triggered by referral to medical review. All the panel States accepted referrals from law enforcement, the courts, medical providers, licensing counter personnel, family members, concerned citizens, and self-report during license renewal. Other avenues of referral included the Department of the Blind and Visually Impaired (Virginia), DMV Hearing Officer reports following insurance monitoring hearings (Virginia), review of traffic collision reports (California), and reports from occupational and physical therapists (Iowa).

In Florida, referrals from physicians and law enforcement officers were considered valid without further research as these were expert sources. Hearing officers researched referrals from other sources by speaking with family members and/or neighbors and interviewing the driver in his or her home to determine the validity of the referral. During the interview the officer might administer a set of common, standardized tests, such as the Mini Mental Status Exam for cognitive function. The hearing officer then provided a written report to the Medical Review Department summarizing the results of the investigation and recommendations for any further DMV testing or physician examination.

Law enforcement officers in Florida historically completed DMV forms to report potential at-risk drivers. Because officers indicated that the process of downloading, completing, and submitting these reports was too cumbersome, Florida initiated the Driver and Vehicle Information Database (DAVID). At the time of this report, Florida law enforcement officers were able to access the database through laptops in police vehicles. The database contained photo identification, driving record, and insurance information of all licensed drivers in the State. The first screen of the database displayed a message about medical referral. An officer observing signs of medical impairment during an encounter with the driver could click a box on that form to send an immediate referral to the Medical Review Department. Referrals from law enforcement had increased substantially since the initiation of this system, resulting in a backlog of cases to be reviewed.

There was some discussion among the panelists about whether law enforcement officers were reluctant to cite and/or report an older driver, especially in rural areas lacking alternative transportation. Some law enforcement panelists indicated that officers received training about the driver re-examination process and the importance of making referrals. One described certain actions, such as driving too slowly or not maintaining lane position, which might trigger a traffic stop. Once a stop was made, officers had the opportunity to observe the driver for physical impairments, poor judgment, poor coordination, slow reflexes, confusion, or other indicators that a referral was needed.

Panelists also discussed whether law enforcement officers received feedback on the outcomes of their referrals. Generally, law enforcement panelists said that they did not receive feedback on their reports, although Iowa was in the process of changing this process so that referring officers would receive such information. One officer indicated that feedback would not influence his referral behavior; his job was to get unsafe drivers off the street. Similar to arresting a drunk driver regardless of whether previous arrests had resulted in convictions, he would refer a medically impaired driver regardless of whether prior referrals had resulted in license actions. It was his job to refer the driver, and medical review's job to evaluate fitness to drive. An officer from a second State concurred.

A medical review representative noted that while her office would prefer to provide the outcome of the medical review process to the referring officers, it lacked the time and personnel to do so. Medical review personnel only contacted a reporting officer if the referral form lacked a description of the behavior that triggered the referral. An officer indicated that, although he would like to know the outcome, it would not affect future referrals. At the same time, he acknowledged that other, less experienced officers might have chosen not to make referrals if they believed medical reviews did not result in changes to the driving licensure.

The participating law enforcement officers were asked whether, following a traffic stop, they were more likely to refer a potential medically at-risk driver, write a citation, or do both. One stated that for a multiple-vehicle crash, he would write the citation *and* refer the driver. However, for a single-vehicle crash he may choose only to refer the driver for medical review. In general, the decision to cite a driver was left to officer discretion. The critical issue was to ensure both the driver's and the public's safety.

The law enforcement panelists were also asked if they were more likely to refer an older driver in lieu of issuing a citation and more likely to cite younger drivers when making a stop. One said that if he stopped someone for a safety violation, he would issue a summons regardless of driver age. However, he indicated that he could not speak for all officers and that some might be more likely to write warnings instead of citations to correct a situation. Researchers in the room noted that this limits the accuracy of citation data for determining compliance with license restrictions because it can mask instances where people have driven outside of their restrictions. The licensing representative from Iowa indicated that when they train law enforcement about medical referrals, they recommend also giving a citation. This allows the licensing agency to take action based on multiple violations, and it helps in identifying problem drivers. An officer indicated that officers in his State had discretion based on the nature of the violation and on

driver age. He commented that the DOT kept track of only crashes termed "law form" crashes, which resulted in an injury or involved alcohol or drugs.

Restriction Process

States differed regarding who could impose license restrictions and the processes for imposing the restrictions. While the medical review process frequently resulted in restrictions, in some cases restrictions could also be imposed by counter personnel in response to observed impairments or test results. Daylight driving only restrictions could be imposed without medical review in all four participating States if visual acuity test results were below a minimum standard and/or a vision specialist recommended against nighttime driving. However, for other types of restrictions, requirements varied:

- In Iowa, license examiners could impose other restrictions they deemed appropriate following a road test. For example, drivers unable to pass a standard road test could opt to be tested on familiar roadways near their homes with the understanding that a radius restriction would be added to their license if they passed.

- In Virginia, the imposition of restrictions other than corrective lenses and daylight driving only had to be preceded by driver medical review. In addition, drivers undergoing medical review could not be road tested until their physician had submitted a favorable report and medical review had ordered the road test.

- In California, DMV employees had the authority to place restrictions on licenses when warranted. Among the DMV employees authorized were hearing officers, senior motor vehicle technicians, DMV examiners, and managers trained to review documents.

The Virginia driver licensing representative indicated that when the Medical Review Department received a referral, departmental nurses reviewed the report to determine whether there was cause to require the driver to obtain a medical examination. If so, the nurses mailed the driver a letter describing the requirement, which stated they had 30 days to comply or their license would be suspended. Upon receiving the physician's report, the department could impose restrictions based on the physician's recommendations. Depending on the diagnosis and the physician's comments, medical review could also require the driver to undergo evaluation and rehabilitation by a private driver rehabilitation specialist (DRS). A DRS evaluation might also be required if the physician was uncertain about the patient's fitness to drive. If the DRS determined that a person was not safe to drive, the DMV would suspend the person's license without administering a road test. Drivers cleared to drive by their physicians or the DRS were still required to pass a 45-minute DMV driving test conducted by an examiner trained to examine drivers with medical conditions before any restrictions were applied to their license. Where a mileage from home restriction was recommended, examiners required the drivers to demonstrate that they could safely drive from their home to the locations they frequented (e.g., store, doctor).

In contrast to the re-examination road tests given in Virginia, many re-examination road tests in Florida were conducted on closed courses, since driver license offices were often located on multi-lane high-speed roadways and deemed too dangerous to road test potentially impaired

drivers. In California, drivers could be asked to take a more rigorous 30- to 40-minute road test, the Supplemental Driving Performance Evaluation, designed specifically to assess fitness to drive in potential medically at-risk populations. This was frequently used along with review of driver records and reports from medical evaluations and vision examinations to determine appropriate license restrictions.

A panelist noted that most physicians were not aware of driver rehabilitation specialists and that physicians needed information about the services these professionals provide. A panelist from Iowa noted that the DMV trained physicians about medical conditions that could impair driving and that the physicians were pleased to learn that DRSs were equipped to make driving determinations. Panelists agreed that many physicians may not report for fear of losing their patients.

Restriction Types

Table 1summarizes restrictions reported to be available in the panel States at the time of data collection. Of the various restrictions, daylight driving only (or no nighttime driving) was reported to be imposed the most frequently.

Table 1. Available License Restrictions in Participating Panel States

State	Daylight Only/No Nighttime	Speed and/or Road Type	Radius or Range From Home	When Accompanied Only	Other/Customized Restrictions
California	X	X			X[1]
Florida[2]	X				
Iowa	X	X	X		X
Virginia	X	X	X	X	X

[1] California had an area restriction but did not generally impose radius from home restrictions.
[2]Florida law allowed for other restrictions, but daylight driving was the only restriction typically imposed.

A project researcher asked about medication-related restrictions such as those requiring drivers to take a particular medication or that people only drive if they take medications as prescribed. The Virginia and Iowa panelists noted that their State physician reports contained a question asking whether the patient was compliant with his or her medication regimen. If the person was not compliant, the DMV suspended the license until the driver demonstrated compliance to the physician. If the physician indicated that the driver *was* compliant with medications and was otherwise fit to drive, the Virginia DMV could require periodic medical reports at 3, 6, 12, or 24 months to verify that the driver remained compliant. This generally applied to drivers with new medication regimens, those with prescriptions for multiple psychotropic medications, and other drivers whose physicians indicated should have periodic medical reviews. However, panelists reported no restrictions based on specific medications. One DMV representative said the DMV's responsibility was to ensure that drivers did not pose a risk to themselves or other road users.

A panelist noted that driver rehabilitation specialists often recommended restrictions that were impossible to implement such as a driving duration or no left turns. When a driver rehabilitation specialist recommended time limits of 20 to 30 minutes for drivers with limited concentration skills, the licensing agency has instead imposed a 5-mile or 10-mile radius from home license restriction. Agencies also could not enforce a no-left-turn recommendation.

Florida had considered restricting older drivers from driving during high-risk time periods, similar to their time restrictions for teen drivers. AARP, however, lobbied against such legislation for older drivers. A physician panelist noted that medically impaired older drivers had reported avoiding driving during rush hour periods, so such a restriction may not result in a safety benefit as drivers already avoided these times.

All four States provided for restrictions for drivers with early stage dementia but not for those in more advanced stages. In Iowa these drivers were required to follow up with their physician and be road tested again in two to three months. Florida drivers with mild dementia could be allowed to drive if they were able to pass a driving evaluation, but they had to be re-examined at least every year. The Florida DMV did not normally offer restricted licenses to drivers with dementia or other cognitive deficits. One DRS panelist would only recommend a radius from home restriction for a cognitively impaired person if she knew the person had family members who would support compliance with the restriction. She considered such restrictions valuable in that they allowed drivers mobility within a familiar area, which should pose fewer cognitive challenges.

Medical conditions reported to be most commonly associated with restricted licenses included seizures, losses of consciousness, stroke, dementia, and visual conditions such as macular degeneration. Iowa evaluated each individual's function at each renewal to determine whether the driver was coping successfully with the condition, so the individual could continue driving safely.

In Virginia, the most frequent medical conditions triggering a medical review were loss of consciousness and seizures, followed by dementia. Periodic review requirements were common among drivers with mild dementia and drivers with a history of seizures. Virginia statute (based on Medical Advisory Board recommendation) mandated 6-month review cycles for drivers with dementia, and 1-year review cycles for drivers with seizure disorders.

The DRS indicated that Florida's DMV Medical Advisory Board reviewed DRS reports and nearly always enacted the DRS's recommendations for restriction. If the restricted driver was subsequently involved in a crash, the crash report triggered a medical re-evaluation. The Florida driver licensing representative reported that examiners were trained about progressive conditions; when a driver self-reported such a condition or an examiner observed signs of limitations possibly related to the conditions, he or she would require a re-examination.

Restricted Drivers' Reactions

Panel members indicated that drivers generally accepted license restrictions, especially once they understood that the restrictions were in lieu of suspension. A license administrator

reported seeing less anger with restricted licenses than with suspended licenses. If drivers complained about being restricted to a radius near home, she offered them the option to take the standard road test. Most drivers accepted the restriction because they did not want to take the standard test.

One DRS noted that a driver for whom she had recommended restrictions called repeatedly to berate her. The DRS finally explained that the alternative to restrictions was no driving. The driver had not thought of that and never called again. Panelists noted that the less insight drivers had into their limitations (for example, drivers with cognitive disorders), the more likely they were to be angry when receiving a restricted license.

A medical review panelist said that suspended drivers often wished they could get restricted licenses. A license administrator said that most suspended drivers did not request restricted licenses because they did not know it was an option. Several panelists indicated that physicians were often unaware of the option of restricted licenses, particularly in smaller communities. One physician indicated that the Missouri medical review form completed by physicians contained a list of possible restrictions and check boxes. This raised physicians' awareness of restriction options.

Panelists stressed the importance of being compassionate when restricting or suspending a license, particularly for people living in rural areas who needed assistance in meeting their transportation needs outside of the restrictions. They noted that brainstorming options with them, such as making an agreement with a friend or neighbor to drive the restricted person in exchange for gas money, could be helpful.

Iowa and Florida panelists described initiatives in their States to help drivers plan for their driving retirement. In Florida, this initiative was offered as part of the Florida GrandDriver Program.[1] In Iowa, drivers unable to pass the standard road test were given the option of taking the test on familiar roadways near their homes with the understanding that if they passed, their license would be restricted to this limited area. Providing this service increased Iowa's examiner case load, but the DMV considered it worth the effort.

Compliance

Panel members believed that older drivers generally complied with their license restrictions, but they could offer little supporting evidence. They were unable to offer suggestions for measuring and/or promoting compliance with licensing restrictions but raised the following points:

- Older adults were most likely to comply with the daytime-only restriction. It was easy to understand and remember, and many older drivers already self-restricted to daylight only.
- Although many older drivers self-impose "no freeway driving" and "sunrise to sunset" restrictions, they may comply more consistently with formal restrictions.

[1] See http://www.flhsmv.gov/FloridaGrandDriver/

- The only way to determine non-compliance was when an officer stopped a driver for an infraction and noticed that s/he was driving outside of their restriction. However, being stopped by law enforcement is a relatively rare event.

A law enforcement panelist suggested that compliance could be increased by requiring drivers with restrictions to attend an educational seminar that would discuss the consequences of violating restrictions (license suspensions, fines, and possible liability for harming someone). DMVs could implement this education at the time of referral because law enforcement is not likely to follow up to see that drivers are compliant.

Mobility Versus Safety

DMV panelists firmly believed that restricting drivers in lieu of suspending their licenses *did not* pose a traffic safety threat. A license administrator noted that she had seen drivers perform much better when driving in a familiar area near their home as compared to their performance on the standardized test. She stressed that the DMV did suspend licenses when necessary for safety. Panelists pointed out that drivers who had undergone rehabilitation and were deemed safe to drive by a DRS were not licensed to drive with restrictions unless they demonstrated that they could drive safely. If the DRS, the driver's physician, or the licensing specialist did not believe the person could drive safely, the driver's license was suspended.

A DRS explained that a full evaluation included clinical testing (vision, perception, cognition, physical abilities, and reaction time) and test driving (which could occur over several sessions). After evaluation, the DRS considered whether the person's driving suggested they were at elevated risk of being involved in a crash; if so, the DRS recommended they stop driving. If the DRS considered the driver to be competent in particular environments or times based on observations during driving sessions, she recommended license restrictions. The evaluation vehicle had a dual brake, so the DRS could let errors play out as they naturally would without fear of harming the vehicle, its occupants, or other road users, to illustrate deficits to the drivers. The DRS noted that such a comprehensive assessment justified her recommendations of restrictions, cessation, or full licensure.

One panelist noted that while the DMV sought to keep older adults driving as long as they could do so safely to help preserve their independence, the State was responsible for the safety of all road users. A restricted license was not provided if doing so put the driver or the motoring public at risk. Public safety had priority over a driver's right to independence. If an evaluator determined that a driver was not able to drive safely, the DMV withdrew the person's license.

State Data Analysis

A primary goal of the project was to analyze State driver licensing, crash, and driver citation data to determine the frequency with which various restrictions were imposed on the licenses of older drivers, the extent to which noncompliance could be documented or inferred from the crash and/or citation data, and how crash and citation rates for restricted drivers compared with those of non-restricted drivers (or drivers with a corrective lens restriction only). The States included in these analyses were Florida, Iowa, Maryland, and Virginia.

Methods

The research team started with the list compiled for recruiting panelist teams from the States. A team member contacted the license administrator in each of 8 recommended States to ascertain that the required data were available and State officials willing to participate. The project team sought States where specific restriction types could be identified electronically and data files that included driver license status and crash and citation reports could be linked and provided to project staff for analysis.

Once data access requirements were met and project liaisons established, a researcher spoke with a contact person in each State regarding its processes that might result in a restricted license. Researchers also requested a frequency distribution of each State's coded license restrictions, which were not counts of restricted drivers since drivers could operate under more than a single restriction. The selected States included the three from the expert panel (Florida, Iowa, and Virginia) plus the addition of Maryland.

Whereas three of the selected States—Florida, Iowa, and Virginia—stored their restriction data in coded format, in Maryland restrictions were grouped under a single indicator shared with many other unrelated driving restrictions (e.g., under 21 alcohol restriction, ignition interlock, and assistive equipment restrictions). These records required more effort by project staff to identify those with the restrictions of interest.

The research team reviewed the State-provided frequency data from Florida, Iowa, and Virginia, and the team generated a list of license numbers for restricted drivers in Maryland. The project team requested extraction of selected variables from the driver licensing, crash, and citation records for all drivers 65 and older as of January 1, 2012, having one or more of the targeted license restrictions. Table 2 lists the data elements requested from each State.

Given the dearth of prior analyses regarding restrictions of this type, researchers were unable to anticipate whether affected drivers would be clustered by sex, age, geography, or in some other manner. Rather than asking for the case driver extraction and following that with another request for a control population extraction, researchers elected to oversample the possible control population so that each State could meet all data requested at once. The research team decided to randomly select a control population that was at least five times the case driver population from the restriction counts obtained earlier from each State. In practice, control population sample sizes provided by the States varied from 4.4 (for Maryland) to 19.1 (for Iowa) times their corresponding case population of restricted drivers. For example, Florida provided a control population 10 times the case population. Thus, since Florida had reported a total of over

10,000 drivers with license restrictions, most of which were daylight driving only, the Florida DMV randomly selected a control population of 100,000 drivers 65 and older. Control drivers' and case drivers' data were combined into a single "target list" with cases differentiated from controls on the basis of their restriction status. More detailed information is included in the sample data extraction request provided in Appendix C.

Table 2. Data Elements Requested From the States

DMV Records	Crash Records	Citation Records
Driver License Number (or other unique identifier)	Driver License Number (or other unique identifier)	Driver License Number (or other unique identifier)
Date/Year of Birth	Crash Date	Citation Date
Sex	Crash Time of Day	Citation Time of Day
Race indicator	Crash Location (city/county)	Citation Location County
Residential City	Driver Condition	Infraction/Charge Code
Residential County	Driver Contributing Factors	Infraction/Charge (verbal)
Residential ZIP code	Number of Vehicles Involved in Crash	Disposition
License Class	Crash Configuration (head-on, side impact, etc.)	
License Issue Date	First Harmful Event	
Original License Issue Date	Most Harmful Event	
License Expiration Date	Roadway Feature (intersection, non-intersection, etc.)	
License Restrictions	Posted Speed Limit	
Restriction Imposition Date	Vehicle Maneuver/Action	
Driver Convictions (including date and description)	Driver Injury Severity	
Driving Record Crash Indicators	Crash Injury Severity (most severe injury of all crash victims)	

Results

Initial Frequency Counts for Restrictions

Contacts in the four participating States provided the following information regarding their State's use of license restrictions:

Florida - Per communication with the assistant deputy director, Credentialing Services, Motorist Services, on Nov. 1, 2011, "Daylight Driving Only" was the only restriction the State used. The restriction was imposed as a result of the medical review process or based on documentation. Medical Review accepted referrals from anyone. The Medical Advisory Board determined when a restriction was to be imposed, and its decision could be appealed by the driver.
Iowa - Per communication with the Office of Driver Services, Iowa Department of Transportation, on Sept. 2, 2011, three restrictions were imposed regularly on drivers. Those

restrictions were "No Night Driving," "No Interstate Driving," and "Maximum Speed 35 mph." **Maryland** - Per analysis of the restriction database table on Nov. 20, 2011, Daylight Only restrictions were imposed principally in connection with Maryland's Low-Vision Program. **Virginia** - Per telephone communication with the Virginia DMV on Nov. 1, 2011, restriction types in Virginia included Daylight Only, Road Type or Speed, Radius of Home, and Passenger Required. Daylight Driving Only could be imposed by counter renewal personnel based on vision report. All others followed or resulted from medical review.

The presentation of results that follows is organized around the following research questions:

- How many older (65+) drivers' licenses in each State were restricted? Given that each State imposed a range of restrictions, how many older drivers had restrictions of each type?
- How did the population of restricted older drivers differ from all licensed older drivers with respect to age and sex?
- How did the crash and violation history of restricted older drivers compare to that of non-restricted older drivers?
- Did the imposition of restrictions reduce older drivers' crash rates?
- Did older drivers comply with their license restrictions?

Number of Restricted Drivers

Table 3 contains information on the number of restricted drivers age 65 and older in each of the four States. The numbers represent a snapshot as of the date the data were extracted, which was between January and May 2012. Virginia and Florida had by far the largest numbers of restricted drivers, each totaling over 10,000 drivers. Virginia also had the largest percentage of its older licensed driver population with restrictions.

Table 3. Number of Drivers Age 65+ with License Restrictions

Restriction Type	Iowa	Virginia	Florida	Maryland
Daylight Only/No Nighttime	2,173 (79.3%)	13,286 (96.5%)	13,640 (100.0%)	42 (14.2%)
Speed Limit/Travel Speed	848 (30.9%)	620 (4.5%)	--	167 (56.6%)
Geographic/Radius from Home/ Trip Purpose (MD only)	797 (29.1%)	401 (2.9%)	--	201 (68.1%)
Total Restricted Drivers [1]	**2,736**	**13,761**	**13,640**	**295**
Estimated Licensed Driver Population Age 65+ [2]	370,968	807,561	2,744,378	557,898
Percent Restricted	0.74%	1.70%	0.50%	0.05%

[1] Total is less than the column total because drivers frequently had more than one restriction.
[2] "Licensed Total Drivers, by Age 1/2010," Sept 2011, Sheet 5 of 6, Table DL-22. Retrieved from www.fhwa.dot.gov/policyinformation/statistics/2010/dl22.cfm. Based on the latest Census population figures, which can vary substantially from a State's own estimates.

Still, at less than two percent of licensed older drivers in Virginia, and less than one percent in the other States, it is clear that license restrictions were uncommon among older drivers. Daylight-driving-only restrictions, either alone or in conjunction with other restrictions, were the most common restrictions in Virginia and Iowa. As described earlier, this is likely because license examiners in these States could levy them as part of the normal license renewal process. In Maryland, where daylight-only restrictions were primarily available to drivers in a low vision program, they are less common. Restrictions other than daylight were most prominent in the Iowa and Maryland data. Well over half of Maryland's restricted drivers, and nearly a third of Iowa's, had speed or area-related restrictions.

Comparison of Restricted and Unrestricted Drivers by Age and Sex

Table 4 shows the age and sex distribution of restricted older drivers as compared to a randomly selected control sample of unrestricted drivers of similar age in each of the four States. As expected, restricted drivers were older than their unrestricted counterparts and, with the exception of Maryland, more likely to be female. Figure 1 summarizes results with respect to age among all drivers 65 and older as does Figure 2 with respect to sex. Across the study States, *among older drivers,* those with restrictions were more likely than those without restrictions to be 80 or older. Florida had the highest percentage of restricted drivers 80 and older (78.8%), followed by Iowa (74.8%), Virginia (72.9%), and Maryland (66.1%). Maryland was also the only State in which equal proportions of male and female older drivers had restrictions.

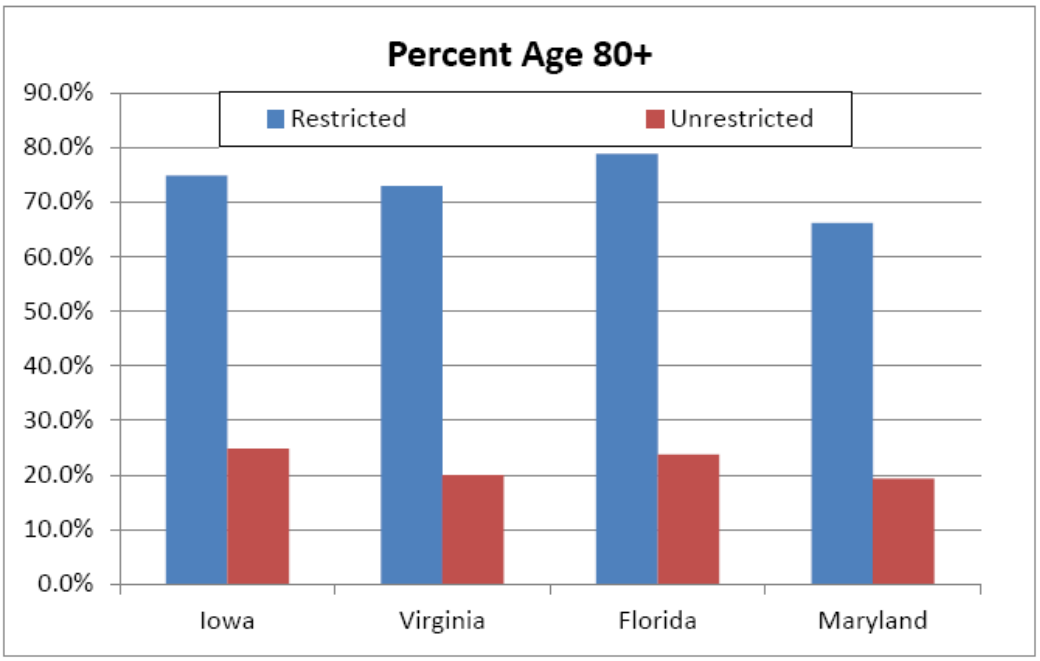


Figure 1. Percentages of restricted and unrestricted older drivers who were age 80+.

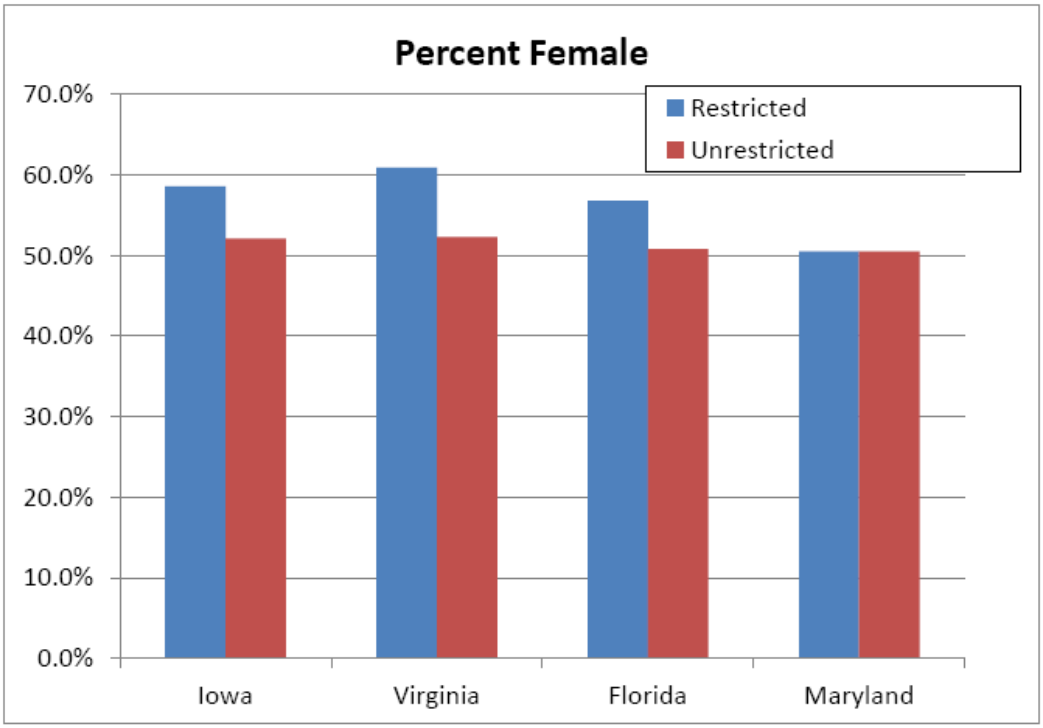


Figure 2. Percentages of restricted and unrestricted older drivers who were female.

Table 4. Distribution of Restricted and Unrestricted Older Drivers by Age and Sex for Each of the Four Study States

4a. Iowa

Age	Restricted Drivers			Unrestricted Drivers		
	Male	Female	Total	Male	Female	Total
65-69	63 (51.6%)	59 (48.4%)	122 (100%)	7,927 (49.6%)	8,059 (50.4%)	15,986 (100%)
70-74	70 (45.2%)	85 (54.8%)	155 (100%)	6,564 (49.0%)	6,831 (51.0%)	13,395 (100%)
75-79	156 (37.7%)	258 (62.3%)	414 (100%)	4,706 (47.6%)	5,173 (52.4%)	9,879 (100%)
80-84	270 (40.8%)	391 (59.2%)	661 (100%)	3,322 (44.7%)	4.116 (55.3%)	7,438 (100%)
85+	574 (41.5%)	810 (58.5%)	1,384 (100%)	2,522 (45.4%)	3,039 (54.6%)	5,561 (100%)
Total	1,133 (41.4%)	1,603 (58.6%)	2,736 (100%)	25,041 (47.9%)	27,218 (52.1%)	52,259 (100%)

4b. Virginia

Age	Restricted Drivers			Unrestricted Drivers		
	Male	Female	Total	Male	Female	Total
65-69	330 (42.0%)	456 (58.0%)	786 (100%)	13,172 (49.2%)	13,600 (50.8%)	26,772 (100%)
70-74	460 (41.7%)	644 (58.3%)	1,104 (100%)	8,622 (47.9%)	9,361 (52.1%)	17,983 (100%)
75-79	706 (38.3%)	1,138 (61.7%)	1,844 (100%)	5,940 (47.6%)	6,535 (52.4%)	12,475 (100%)
80-84	1,356 (37.2%)	2,291 (62.8%)	3,647 (100%)	3,829 (45.5%)	4,589 (54.5%)	8,418 (100%)
85+	2,534 (39.7%)	3,846 (60.3%)	6,380 (100%)	2,576 (44.0%)	3,273 (56.0%)	5,849 (100%)
Total	5,386 (39.1%)	8,375 (60.9%)	13,761 (100%)	34,139 (47.7%)	37,358 (52.3%)	71,497 (100%)

4c. Florida

Age	Restricted Drivers			Unrestricted Drivers		
	Male	Female	Total	Male	Female	Total
65-69	262 (49.3%)	269 (50.7%)	531 (100%)	16,040 (49.2%)	16,576 (50.8%)	32,616 (100%)
70-74	400 (44.2%)	504 (55.8%)	904 (6.6%)	13,522 (49.9%)	13,582 (50.1%)	27,104 (100%)
75-79	652 (44.7%)	806 (55.3%)	1,458 (10.7%)	9,865 (49.4%)	10,091 (50.6%)	19,956 (100%)
80-84	1,319 (42.1%)	1,816 (57.9%)	3,135 (23.0%)	6,859 (48.6%)	7,246 (51.4%)	14,105 (100%)
85+	3,253 (42.7%)	4,359 (57.3%)	7,612 (55.8%)	5,071 (47.8%)	5,529 (52.2%)	10,600 (100%)
Total	5,886 (43.2%)	7,754 (56.8%)	13,640 (100%)	51,357 (49.2%)	53,024 (50.8%)	104,381 (100%)

4d. Maryland

Age	Restricted Drivers			Unrestricted Drivers		
	Male	Female	Total	Male	Female	Total
65-69	19 (57.6%)	14 (42.4%)	33 (100%)	263 (50.2%)	261 (49.8%)	524 (40.6%)
70-74	19 (55.9%)	15 (44.1%)	34 (100%)	155 (48.3%)	166 (51.7%)	321 (24.8%)
75-79	15 (45.5%)	18 (54.5%)	33 (100%)	88 (44.4%)	110 (55.6%)	198 (15.3%)
80-84	33 (43.4%)	43 (58.7%)	76 (100%)	62 (43.7%)	80 (56.3%)	142 (11.0%)
85+	60 (41.4%)	59 (58.6%)	119 (100%)	47 (43.9%)	60 (56.1%)	107 (8.3%)
Total	146 (49.5%)	149 (50.5%)	295 (100%)	615 (49.5%)	677 (50.5%)	1,292 (100%)

[1] Age based on date of data extraction. Maryland data excluded 205 restricted drivers who were deceased at the time of the data extraction.

Crashes and Violations

To compare crash rates of drivers with and without license restrictions, the researchers calculated overall crash involvement rates per year of driving exposure. The periods of crash data for each State were:

- Iowa: June 2007 – May 2012
- Virginia: January 2006 – December 2010
- Florida: January 2006 – December 2010
- Maryland: January 2005 – December 2010

If the driver's initial restriction occurred after the start period for the crash data, then their exposure (and crash involvement) was only considered from the time of the restriction forward. Since the Maryland data included drivers who died during the study period, the end date for these drivers was their date of death; for all other States, the exposure end date was the end period for the crash data. Drivers who were not yet 65 at the start of the period for which crash data were available were excluded from these analyses, which reduced the numbers of drivers in both the restricted and control samples.

Table 5 presents overall crash rates per year of licensure for the study population of drivers with license restrictions and for unrestricted controls. Also shown are restriction-specific crash rates where available. All restricted drivers' crashes were post implementation of restriction except for Florida, where date of restriction imposition was unavailable. Maryland results were not broken down by restriction type due to small sample sizes. Figure 3 summarizes overall crash results, and Figure 4 provides restriction-specific crash rates.

Table 5. Post Restriction Crash Rates

5a. Iowa

Study Group	Number of Crashes	Number of Drivers in Sample	Years of Available Data	Crash Rate Per Year
Any Restriction (daylight + others)	510	2,614	12,061.18	0.0423
ONLY Daylight Restriction	153	1,338	6,126.15	0.0250
Radius, Max Speed, Road Type, No Interstate	357	1,276	5,935.03	0.0602
Control	4,000	36,273	181,365.00	0.0221

5b. Virginia

Study Group	Number of Crashes	Number of Drivers in Sample	Years of Available Data	Crash Rate Per Year
Any Restriction (daylight + others)	682	12,455	27,910.58	0.0244
ONLY Daylight Restriction	524	11,765	25,797.21	0.0203
Radius, Max Speed, Road Type, No Interstate	158	690	2,113.37	0.0748
Control	3,949	40,542	202,710.00	0.0195

5c. Florida

Study Group	Number of Crashes	Number of Drivers in Sample	Years of Available Data	Crash Rate Per Year
ONLY Daylight Crashes (includes pre- and post-restriction crashes)	1,101	12,917	64,585.00	0.0171
Control	4,533	63,435	317,175.00	0.0143

5d. Maryland

Study Group	Number of Crashes	Number of Drivers in Sample	Years of Available Data	Crash Rate Per Year
Any Restriction	25	349	1,324.17	0.0189
Control	67	598	3,588.00	0.0187

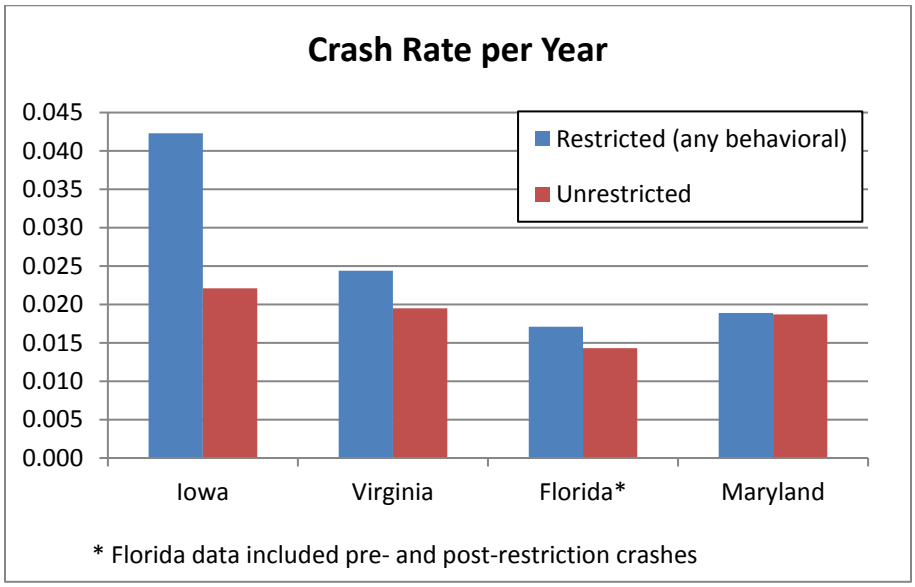


Figure 3. Annual crash rates for restricted and unrestricted drivers 65 and older.

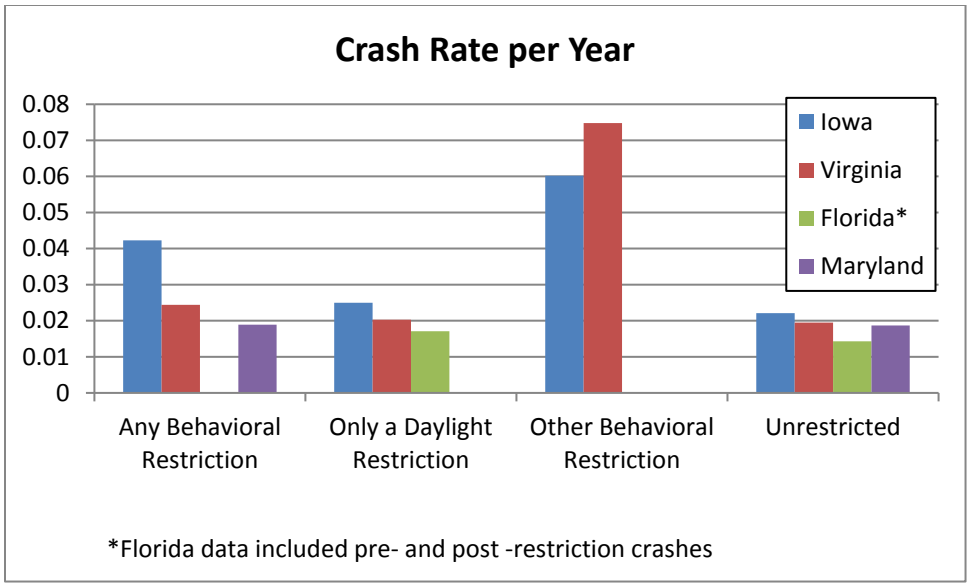
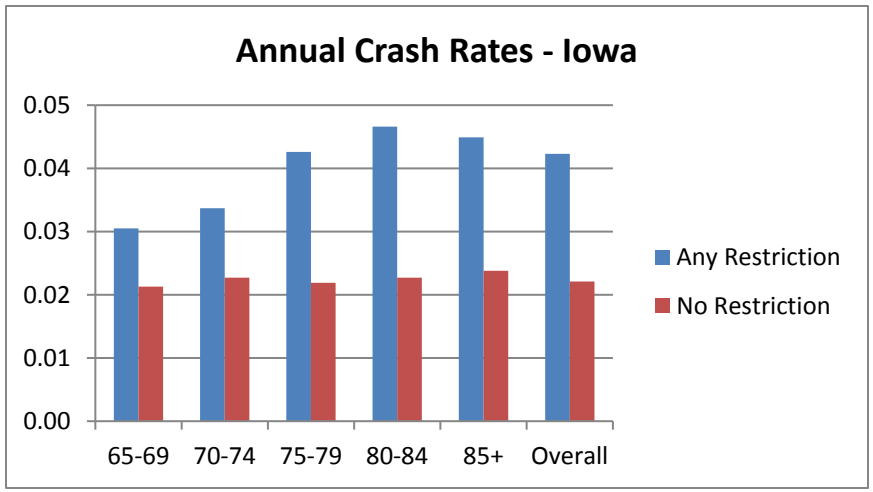


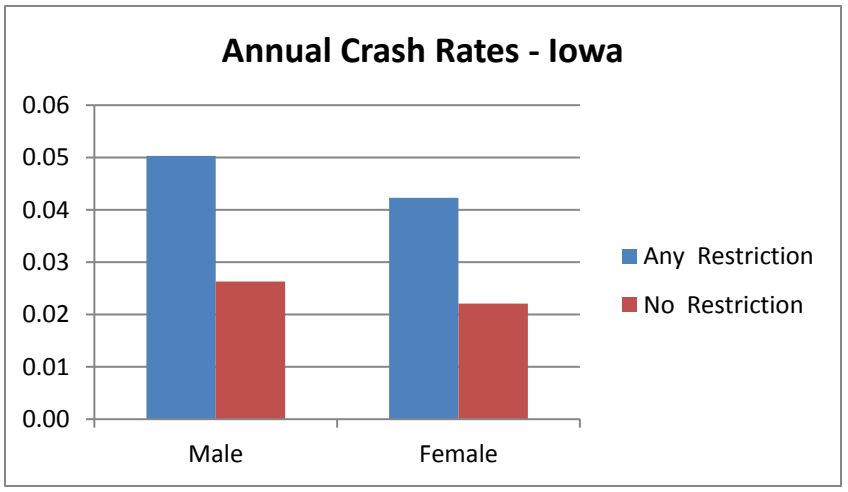
Figure 4. Annual crash rates for restricted drivers 65 and older, by type of restriction.

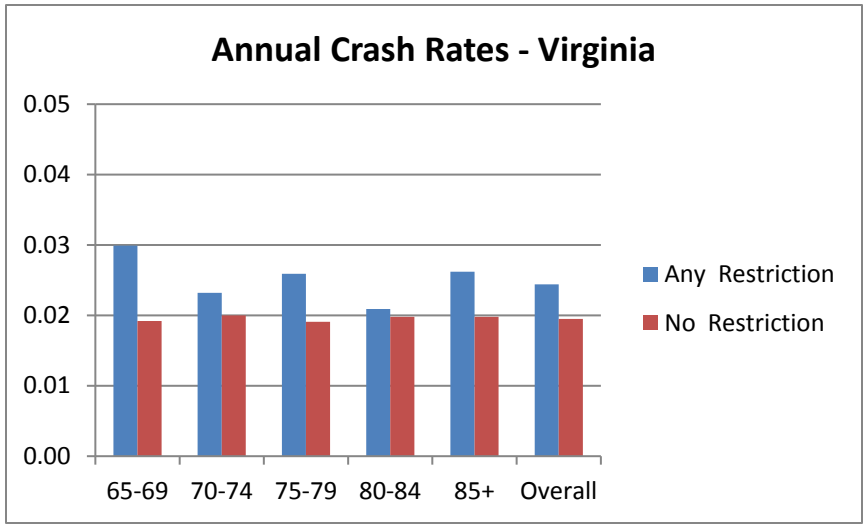
These results show that restricted older drivers generally had higher crash rates than their unrestricted counterparts. Rates were particularly high in Iowa, while Maryland rates were nearly identical. The results separated by restriction type help to explain these differences. As shown in Figure 4, the crash rate for drivers with *only* a daylight restriction closely mirrored that of the overall driving population. In contrast, drivers who had one or more of the other types of license restrictions—based on either speed or geography—had crash rates three times those of unrestricted drivers. A higher proportion of Iowa's restricted drivers had one of these "other" restrictions, which likely accounts for their higher crash rate in the "any restriction" category.

As noted above, restricted drivers tended to be in the high end of the older driver cohort. Thus, the restricted drivers' higher crash rates, especially among drivers with restrictions other than daylight only, may reflect effects of age rather than functional limitations that led to a license restriction. To examine this possibility, age-cohort specific crash rates were calculated for restricted versus unrestricted drivers in Iowa and Virginia. (The Florida data only included daylight restricted drivers, and the Maryland data were too sparse to disaggregate by age.) Rates were calculated by licensed driver population without regard to driving exposure since exposure data was not available. (Supporting statistical tables for Figure 5 and Figure 6 are available in Appendix D.)

The data showed no effect of age for *unrestricted* drivers. Unrestricted drivers had similar crash rates regardless of age-cohort. The crash rate among *restricted* drivers appears to increase with age in Iowa but shows no effect in Virginia (see Figure 5). Given that much higher percentages of Iowa drivers had restrictions that went beyond daylight driving, this suggests that functional limitations that result in restrictions to driving in a specific area or on low speed roads, as opposed to age per se, may contribute to Iowa restricted drivers' crash rates increasing as age increases.







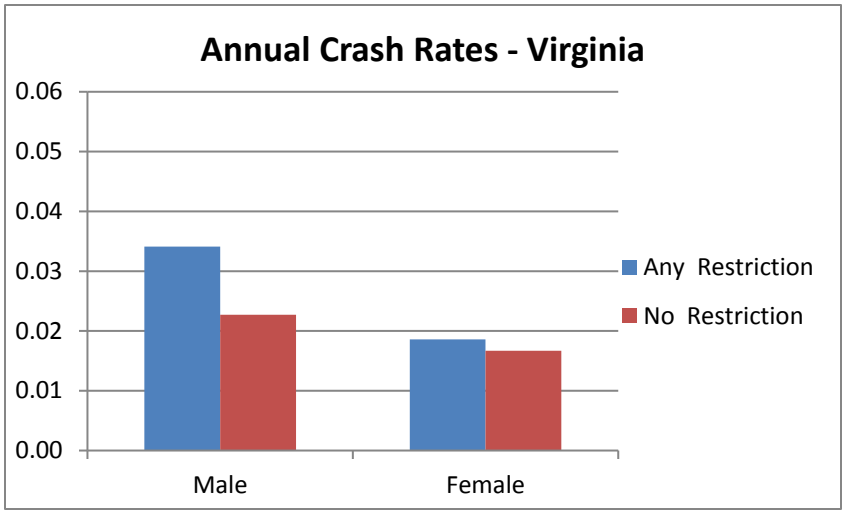


Figure 5. Annual crash rates for older drivers with and without behavioral license restrictions, by age of driver.

Figure 6. Annual crash rates for older drivers with and without behavioral license restrictions, by sex of driver.

With respect to driver sex (Figure 6), in Iowa both male and female restricted older drivers had an almost two-fold higher crash rate than unrestricted older drivers. In Virginia the ratio of restricted to unrestricted annual crash rates for male older drivers was 1.5, while the corresponding ratio for female older drivers was 1.1. Thus, there was virtually no difference in crash rates for restricted and unrestricted female Virginia drivers.

Only Virginia and Maryland were able to provide citation data within the project time, and neither State reported enough cases to support useful analysis. Virginia reported three citations among its restricted drivers from November 2008 to December 2011, and Maryland reported two from January 2005 to December 2010.

Effects of License Restrictions Crash Rates

In addition to comparing the crash rates of restricted and unrestricted drivers, the study compared rates for restricted drivers pre- and post-restriction for the subset of drivers who received their restriction during the study period (see Table 6 and Figure 7). Florida was unable to provide information on the date of restriction imposition, so those data were not included in the analyses.

In Iowa, drivers with *only* a daylight driving restriction showed no change in their post-restriction crash rates; however, drivers who had other types of restrictions (e.g., restrictions based on speed or geography) showed a decline of about 23%. Because many older drivers are believed to self-restrict driving at night, these results are consistent with expectations that imposed restrictions on nighttime driving would be less likely to yield observable change. Although Maryland results were not broken down by restriction type due to small sample sizes, crash rates for restricted drivers were also lower post-restriction. However, the Maryland findings should be interpreted with caution because the number of crashes was small. In contrast, Virginia drivers had increased crash rates post-restriction across all restriction categories.

Table 6. Older Drivers' Crash Rates Pre- and Post-License Restriction

6a. Iowa

Study Group		Number of Crashes	Number of Drivers in Sample	Years of Available Data	Crash Rate Per Year
Any Restriction	Pre	51	426	1,008.82	0.0506
	Post	49	426	1,121.18	0.0437
ONLY Daylight Restriction	Pre	13	228	563.85	0.0231
	Post	13	228	576.15	0.0226
Radius, Max Speed, Road Type, No Interstate	Pre	38	198	444.97	0.0854
	Post	36	198	545.03	0.0661

6b. Virginia

Study Group		Number of Crashes	Number of Drivers in Sample	Years of Available Data	Crash Rate Per Year
Any Restriction	Pre	751	10,940	34,364.42	0.0219
	Post	499	10,940	20,335.58	0.0245
ONLY Daylight Restriction	Pre	659	10,393	33,027.79	0.0120
	Post	389	10,393	18,937.21	0.0205
Radius, Max Speed, Road Type, No Interstate	Pre	92	547	1,336.63	0.0689
	Post	110	547	1,398.37	0.0787

6c. Maryland

Study Group		Number of Crashes	Number of Drivers in Sample	Years of Available Data	Crash Rate Per Year
Any Restriction	Pre	47	219	643.62	0.0730
	Post	10	219	585.92	0.0171

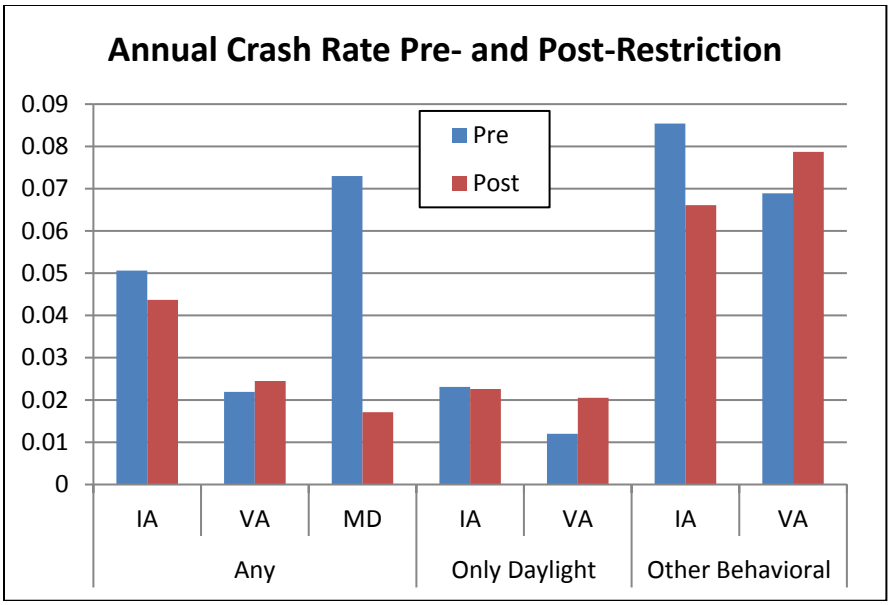


Figure 7. Comparison of older driver annual crash rates pre- and post-implementation of a license restriction.

Older Driver Compliance with License Restrictions

The final objective for this phase of the project was to examine State crash and citation data related to older drivers' compliance with their restrictions. Unfortunately, the necessary violation and citation data was either ambiguous or unavailable.

In the absence of violation and citation data, the approach to this task was limited to examining restricted older drivers' crash reports for evidence of non-compliance with their restrictions. This proved most feasible for drivers with daylight driving only restrictions since information on time of day and/or light condition at the time of the crash was generally available from the police crash reports. It was less practicable for drivers with speed-related restrictions because police-estimated travel speed prior to a crash can be unreliable. Also it was not always possible to distinguish drivers with a speed restriction that prohibited them from driving on roadways above a certain posted speed limit from those who were restricted from operating their vehicles above a certain maximum speed. For example, a driver with a 45 mph maximum *travel speed* restriction might legally drive on a 55 mph roadway as long as he or she did not go over 45 mph. Finally, without specific information on the home addresses of the restricted drivers and the locations of their crashes, it was not possible to assess compliance with geographic or area restrictions.

Table 7 summarizes available compliance data for drivers with daylight-only-driving restrictions in Iowa and Virginia. (The absence of date of restriction precluded compliance analysis based on the Florida data, and Maryland restricted drivers had too few reported crashes to support analysis.) For these analyses, drivers with daytime-only restrictions were separated into two groups: those with *only* a daytime restriction and those with a daytime plus one or more other restrictions. These two groups were separated because drivers with additional restrictions were likely to be more functionally impaired than those with only a daytime restriction, and

compliance may have differed as a function of impairment. The Iowa dataset did not include a light condition variable, so daylight was estimated based on time of crash.[2]

Table 7. Restricted Drivers' Crashes by Restriction Type and Lighting Condition

7a. Iowa

Restriction Type	Light Condition (Estimated Based on Time of Crash)			Total
	Day	Dawn or Dusk	Dark	
Only Daytime	144 (94.1%)	4 (2.6%)	5 (3.3%)	153 (100%)
Daytime Plus at Least 1 Other Restriction*	149 (90.3%)	2 (1.2%)	14 (8.5%)	165 (100%)
Total	293 (92.1%)	6 (1.9%)	19 (6%)	318 (100%)

7b. Virginia

Restriction Type	Light Condition (Police-Reported)			Total
	Day	Dawn or Dusk	Dark	
Only Daytime	479 (89.5%)	31 (5.8%)	25 (4.7%)	535 (100%)
Daytime Plus at Least 1 Other Restriction *	53 (80.3%)	5 (7.6%)	8 (12.1%)	66 (100%)
Total	532 (88.5%)	36 (6.0%)	33 (5.5%)	601 (100%)

*Included radius, maximum speed, roadway type, no interstate

As shown in Table 7a, 3% of the crashes involving daytime-only restricted drivers in Iowa occurred after dark, a violation of the restriction, and 3% occurred in the approximately 30-minute period just after sunset or before sunrise (civil twilight), a possible violation of the restriction. A much higher proportion of crashes involving drivers with daytime plus other restrictions occurred during hours of darkness (9%), with two additional crashes (1%) at dusk or dawn, indicating possible violations.

[2] Iowa's daytime-only restriction States that drivers may not drive when headlights are required. Iowa Code §321.384 Subsection 1 States that "lighted lamps are required at any time from sunrise to sunset." Based on this language, if a driver crashed after sunset or before sunrise, he or she was assumed to be violating their daytime-only restriction. Monthly calendars at www.sunrisesunset.com were used to identify sunrise and sunset times, using Des Moines as the location of interest, as it is in the center of the State (a check of sunrise and sunset times for Council Bluffs on the western border of the State showed an increase of 9 minutes over the times used for this analysis in Des Moines. In Davenport on the eastern border of the State, sunrise and sunset times were 12 minutes earlier than in Des Moines.) If a crash occurred after sunrise and before sunset, "Light Condition" was coded as "day." If it occurred in the period between sunset and evening civil twilight (approximately 30 minutes after sunset), Light Condition was coded as "dusk." Crashes occurring in the period between morning civil twilight and sunrise (approximately 30 minutes before sunrise) were coded as "dawn." Light Condition was coded as "dark" for crashes occurring between evening civil twilight and morning civil twilight.

Results for Virginia drivers (Table 7b), based on the investigating officer's reported light condition at the time of the crash, showed higher rates of non-compliance than Iowa. For the daytime only restricted group, 5% of crashes occurred after dark (non-compliance) and 6% during dusk or dawn (possible non-compliance). The percentages for crashes involving drivers with a daytime plus other restriction were 12% occurring after dark and an additional 8% occurring at dusk or dawn.

Table 8 lists details regarding Iowa crashes involving drivers with only a daytime restriction (Table 8a) who experienced crashes during hours of twilight or darkness, and Table 8b lists similar details for Iowa crashes involving drivers with a daytime restriction plus at least one other restriction. Among those with only a daytime restriction, four of the drivers were male, and five were female (one female was involved in two crashes). Of the 16 drivers with daytime restriction plus at least one other restriction, 13 were males (81%) and 3 were females (19%). Also note that four of the crashes in Table 8a and one in Table 8b occurred during dawn or dusk, meaning that they could have been in compliance if they were close to their destinations at the time of the crashes.

Table 8. Iowa Drivers Who Crashed During Non-Daylight Hours Following Imposition of a Daytime-Only Restriction.

8a. Iowa Drivers With a Daylight-Only Restriction

Crash #	Driver Age	Sex	Crash Date	Crash Time	Sunrise Time	Sunset Time	Civil Twilight	Light Condition
1	77.7	Male	19-Oct-07	7:10 AM	7:31 AM	6:28 PM	7:03 AM	Dawn
2	78.4	Female	16-Nov-11	4:55 PM	7:05 AM	4:54 PM	5:24 PM	Dusk
3	82.2	Female	17-Nov-09	5:01 PM	7:06 AM	4:53 PM	5:23 PM	Dusk
4	85.7	Female	19-Dec-07	5:08 PM	7:37 AM	4:46 PM	5:18 PM	Dusk
5	83.9	Female	06-Nov-09	5:35 PM	6:52 AM	5:04 PM	5:33 PM	Dark
6	77.3	Male	18-Nov-07	5:35 PM	7:07 AM	4:52 PM	5:22 PM	Dark
7	84.2	Female	08-Nov-11	5:47 PM	6:55 AM	5:02 PM	5:31 PM	Dark
8	90.5	Male	30-Dec-10	7:00 PM	7:41 AM	4:53 PM	5:24 PM	Dark
9	86.2	Male	15-Sep-11	8:20 PM	6:55 AM	7:25 PM	7:53 PM	Dark

Crash # 3 and #7 involved the same driver.

8b. Iowa Drivers With a Daylight-Only Plus at Least One Other Restriction

Crash #	Driver Age	Sex	Crash Date	Crash Time of Day	Sunrise Time	Sunset Time	Civil Twilight	Light Condition
1	75.3	Male	03-Nov-07	12:20 AM	7:49 AM	6:07 PM	7:20 AM	Dark
2	82.6	Male	06-Nov-07	12:50 AM	6:52 AM	5:04 PM	6:23 AM	Dark
3	88.8	Male	07-Jan-12	6:55 AM	7:41 AM	4:59 PM	7:10 AM	Dark
4	73.0	Male	21-Dec-07	4:53 PM	7:38 AM	4:47 PM	5:19 PM	Dusk
5	84.3	Male	30-Dec-09	5:44 PM	7:41 AM	4:53 PM	5:24 PM	Dark
6	80.2	Female	09-Dec-08	6:18 PM	7:29 AM	4:44 PM	5:16 PM	Dark
7	81.2	Male	14-Jan-09	7:40 PM	7:40 AM	5:07 PM	5:37 PM	Dark
8	81.5	Male	04-Oct-07	7:41 PM	7:14 AM	6:52 PM	7:20 PM	Dark
9	94.2	Male	10-Dec-09	8:05 PM	7:30 AM	4:44 PM	5:16 PM	Dark
10	81.3	Male	27-Aug-08	8:21 PM	6:35 AM	7:57 PM	8:25 PM	Dusk
11	77.4	Male	28-Sep-07	8:24 PM	7:08 AM	7:02 PM	7:30 PM	Dark
12	85.7	Female	12-Sep-07	8:30 PM	6:52 AM	7:30 PM	7:58 PM	Dark
13	80.8	Male	12-Oct-07	8:30 PM	7:23 AM	6:39 PM	7:07 PM	Dark
14	75.9	Female	23-Oct-10	10:03 PM	7:36 AM	6:22 PM	6:50 PM	Dark
15	83.9	Male	10-Jul-09	11:17 PM	5:50 AM	8:50 PM	9:23 PM	Dark
16	84.3	Male	01-Apr-10	11:49 PM	6:57 AM	7:39 PM	8:07 PM	Dark

These results demonstrate that Iowa older drivers generally complied with their daylight-only restrictions as evidenced by the relatively small number of crashes. However, those with additional restrictions, which may suggest greater functional impairment, were at greater risk of crashing in violation of their daylight restriction than those with daylight only restrictions. The data did not address whether this indicated *increased driving exposure* in violation of their daylight restriction.

An examination of Iowa older driver compliance with **speed-related** restrictions relied on a comparison of maximum speed restrictions (which could be either a maximum travel speed *or* a maximum roadway speed limit) with posted speeds on the roadway where the crash occurred. In Iowa the 848 drivers with speed-related restrictions were involved in 146 post-restriction crashes over the 5-year period of crash data. Posted speed limit information was available for 134 of these crashes. Of the 134 crashes, 29 (22%) occurred on roadways with posted speed limits that were higher than the speeds permitted by the license restriction. Table 9 presents additional detail for these 29 crashes.

Table 9. Iowa Drivers Who Crashed on Roadways With a Posted Speed Limit Greater Than Their Maximum Speed Restriction.

Crash #	Age at Crash Date	Sex	Crash Date	Max Speed Restriction	Posted Speed Where Crash Occurred
1	82.4	Male	10/16/2010	35	55
2	80.1	Male	8/25/2011	35	55
3	87.4	Female	5/24/2011	35	40
4	84.5	Male	5/13/2011	35	55
5	80.7	Female	4/14/2009	35	40
6	77.4	Male	9/28/2007	35	55
7	80.8	Male	10/12/2007	35	50
8	85.0	Male	12/30/2011	35	55
9	81.5	Male	10/4/2007	35	55
10	90.0	Male	1/31/2008	35	55
11	98.4	Male	5/10/2011	35	55
12	86.3	Male	1/16/2009	35	45
13	83.5	Female	6/26/2007	35	55
14	82.3	Male	12/4/2008	35	40
15	88.7	Female	8/1/2010	35	55
16	70.5	Male	12/28/2009	35	65
17	81.5	Male	9/16/2011	35	55
18	82.0	Male	1/13/2011	35	55
19	87.9	Male	4/9/2010	35	65
20	79.1	Male	7/3/2010	35	55
21	68.8	Male	5/15/2010	35	65
22	73.0	Male	12/21/2007	35	45
23	87.7	Female	11/17/2011	35	45
24	84.4	Male	4/24/2008	45	65
25	90.6	Male	5/7/2012	35	55
26	67.3	Male	9/8/2010	35	45
27	74.0	Male	9/10/2009	35	55
28	74.8	Male	6/16/2010	35	50
29	92.8	Female	9/10/2011	35	45

All but one of the crashes involved drivers restricted to a maximum speed of 35 mph. Of the 29 drivers, 23 were male, and 6 were female. For 8 of the crashes, the posted speed limit was 10 or fewer miles per hour above their driver's maximum speed restriction. The remaining 21 crashes occurred on roadways with posted speed limits at least 15 miles over their drivers' maximum speed restriction. Of these 21 crashes, 19 involved male drivers.

Since drivers with maximum travel speed restrictions may legally drive on roadways with higher posted speed limits, these results at best present an "upper bound" for the percent of crash involved drivers in violation of their speed-related restriction. Certainly one might question drivers with 35 mph maximum speed restrictions operating vehicles on 55 mph (or higher speed) roadways; however, more detailed information on the specific nature of the drivers' restrictions would be needed prior to drawing conclusions regarding compliance.

As seen in Table 10, information on the specific type of speed restriction was available in Virginia, but reported crashes where posted speed exceeded permissible by restriction were rare. In the five crashes, two drivers were male, and three were female. For 4 of the 5 crashes, the posted speed limit was 10 or fewer miles per hour above their drivers' maximum speed restrictions.

Table 10. Virginia Drivers Who Crashed on Roadways With a Posted Speed Limit Greater Than Their Maximum Posted Speed Restrictions

Crash #	Age at Crash Date	Sex	Crash Date	Maximum Posted Speed Permitted by Restriction	Posted Speed Limit Where Crash Occurred
1	81	M	09/28/2010	45	65
2	88	F	05/19/2008	45	55
3	83	F	10/02/2007	45	55
4	73	M	03/23/2006	45	55
5	81	F	11/29/2005	45	55

As a final note regarding older driver compliance with license restrictions, even if more detailed speed and/or light condition data were available, restriction violations at the time of a crash would remain an imperfect proxy for violations in one's everyday driving. This is because any driver, or driving, characteristics associated with crash involvement will bias the true compliance estimates.

Field Study of Exposure Among Restricted and Unrestricted Drivers

A naturalistic study of the influence of license restrictions on the exposure of drivers 70 and older complemented the earlier project activities to provide a better understanding of the extent to which restricted older drivers comply with such restrictions.[3] The analyses also document the effects such restrictions may have in terms of limiting mobility.

Methods

The research team requested assistance from the Virginia Department of Motor Vehicles (VADMV) in multiple phases of the naturalistic study. The research team identified two geographic areas where the logistics for data collection were most favorable (see Figure 8). The VADMV informed the team that 372 drivers 70 and older with one or more of the restrictions of interest (type of road, speed, or distance from home) resided in the two areas.

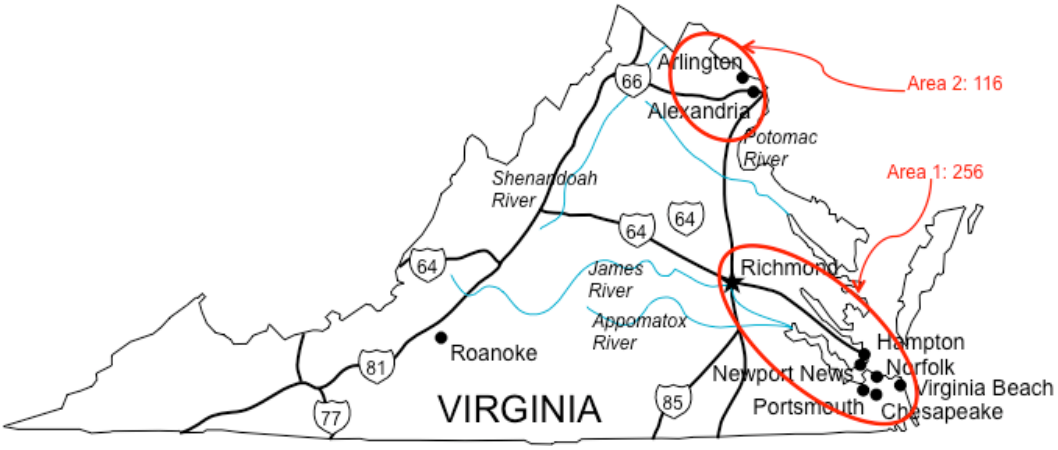


Figure 8. Recruitment areas for drivers with license restrictions**.**

Participant recruitment. Once the project had received approval from the IRB and from OMB, the research team began recruiting participants. A goal was to recruit comparable distributions of males and females 70 and older with similar average age between groups. The initial plan was to recruit two groups of 40 drivers each:

- Group 1: Restricted drivers, having one or more State-imposed restrictions on their license;
- Group 2: Controls with neither State-imposed restrictions nor recommendations from a health care professional to limit their exposure (other than to avoid nighttime driving).

In order to provide adequate data for analysis, participation was limited to those who self-reported driving at least five trips per week. Drivers with a diagnosis of dementia, and those whose only restrictions were to daytime driving, were excluded from the study.

[3] Because prevalence of cognitive decline increases with age, we advanced the minimum age of this cohort from 65 to 70 years old for greater influence of cognitive issues without unduly restricting the available population for study.

The recruitment effort began by drafting a letter requesting research participation that the Virginia DMV distributed to drivers who met the study inclusion criteria and resided in the areas (ZIP codes) of interest. This letter briefly explained the study's purpose and procedures, referred the recipient to an enclosure where a payment for study participation was described, and provided a toll-free number for interested older drivers to use to contact the research team for more information and/or to enroll in the study**.** The letter emphasized that ***"study participation will NOT affect your license status in any way,"*** and that ***"the DMV will NOT be privy to data collected for participating individuals"*** (see Appendix E).

At the research team's request, the VA DMV mailed out recruitment letters targeting a pool of 277 Group 1 and 600 age-matched, randomly-selected Group 2 drivers. The mailings were sent in four waves spaced approximately 6 weeks apart. The first was addressed to 100 controls. The following three waves each targeted one-third of the available pool of restricted older drivers and one-third of the remaining controls targeted in the study. The mailings resulted in a total of 40 responses. Of these, 12 failed to pass a qualifying interview and 4 initially enrolled in the study then later withdrew. The remaining sample of 24 drivers included five drivers in Group 1 (imposed restrictions) and 19 drivers in Group 2 (unrestricted controls).

Data collection. Researchers installed in-vehicle data collection systems including a GPS logger and a camera in drivers' own cars to obtain one month of driving exposure data for all participants, who were instructed to drive as per their usual habits. Data collection was designed to address the following questions:

a) To what extent do restricted drivers comply with the State restrictions?
b) In cases where they fail to comply, do restricted drivers limit driving under the specified conditions compared to control group members? Do the restrictions reduce, if not eliminate, driving under potentially risky conditions?
c) Do restricted drivers drive less than controls in terms of:
    1. Miles traveled?
    2. Number of trips?
    3. Unique destinations and/or travel on unfamiliar routes?

Technicians performed data collection system installations at participants' homes, or if the driver preferred, at a convenient public meeting place. All installations (and removals) were performed by a trained technician, who first obtained the driver's signature on the IRB-approved informed consent form. A manual described how to perform all required procedures, and technicians received in-depth training in these procedures prior to the first system installation.

The GPS data logger was a GeoChron Blue (Figure 9). Data this device recorded provided for direct measures (or allowed for derived measures) of:

- total trips;
- distance per trip;
- duration (time) of each trip;
- time of day and day of week of each trip;

Figure 9. GPS data logger.

- average and maximum speeds driven on each trip;
- routes driven;
- type(s) of roads traveled upon;
- and posted speed limits on those roads.

The logger, mounted out of sight of the driver, saved data onto an SD card at a sampling rate of 1 Hz and was set to automatically record when it received power via a switched vehicle-independent power source. When each participant completed his/her month of data collection, the technician removed the system from the driver's car, backed up the SD card data to a laptop, and mailed the SD card to the PI for coding and analysis.

The system camera, a Mobius Actioncam, provided a means of verifying that the participant was the person driving the car on each trip before data were coded. The camera was mounted near the right edge of the windshield, low enough to avoid occlusion from the visor. The lens was directed towards the driver's face, with a horizontal capture angle of approximately 90 degrees. The camera's image resolution was 848 x 480, and its sampling rate was also 1 Hz. It was triggered at vehicle start-up by a motion detector. In addition to verifying driver identity, the images collected by the camera provided useful trip information such as weather condition (wet/dry), and they supplemented the GPS logger data to increase the confidence of coding road type and light condition. The camera employed an internal time stamp that was synchronized to the GPS time.

GPS data were imported into a database (Microsoft Access) and analyzed to directly yield a number of exposure measures, including miles traveled and number of trips, and to derive additional variables of interest (e.g., average trip speed). Participants' frequency of travel on specific routes (and to unique destinations) was determined through visual inspection viewed in the Google Earth mapping program; the latitude and longitude coordinates in the GPS files for each trip were automatically copied and saved.

Data coding. A video of each trip was produced from the 1 Hz image data by animating sequential still-frames; the resulting AVS (Application Visualization System) files were coded by a trained research assistant.[4] The same research assistant coded all of the video files for all participants to ensure consistency. Analysts coded the following based on GPS and/or camera data for each trip:

1. start time;
2. end time;
3. trip duration (minutes);
4. start location;
5. end location;
6. distance (total miles driven);
7. average speed;
8. maximum speed;
9. miles travelled speed limits greater than 45 mph;
10. miles traveled on highways and interstates;

[4] The data coder, who viewed images of drivers' faces, obtained certification through the Collaborative Institutional Training Initiative (CITI) course for Human Subjects Research in the social and behavioral sciences.

11. radius from home;
12. number of left turns;
13. day/night;
14. passengers;
15. adverse weather (rain);
16. seat belt use; and
17. miscellaneous notes.

Valid trips. A valid trip consisted of a visible participant and a clear starting and stopping point. Trips with a driver other than the participant, data collection device maintenance, instances where the camera was activated but vehicle was not in motion (e.g., parked in driveway or garage), and/or cases where the driver was not visible or the GPS file recorded a distance of 0.0 miles were coded as invalid.

For each valid trip, the coder entered the trip start time to the offset of the ignition, which defined the trip end time. If a driver stopped at more than one destination per trip (where the ignition was turned off, then turned on again after an interval of at least three minutes), each segment was coded as a separate trip. On occasion, what appeared to be separate segments resulted from the GPS signal briefly dropping out (~30 s) then being reacquired. If the coder could confirm route continuity through observation of the driver's clothes, and road surroundings, these segments were joined to form a single trip.

Distance. The coder used Google Earth's ruler function to follow the route point-by-point to determine distance in miles. Zooming allowed the coder to adjust the ruler's path for the most accurate result.

Duration. The coder compared trip start time and end time to calculate total time spent driving. Each video file was viewed frame-by-frame to ensure the trip was uninterrupted.

Start location/end destination. The coder used both the video and GPS files to determine each trip's start location and end destination. The date the trip started and ended was recorded.

Average speed. The coder used data in the GPS file to calculate the average driving speed (miles per hour) during the course of each trip for all speeds greater than 3 mph.

Maximum speed. The calculation of the fastest speed driven during each trip was based on data in the GPS file.

Road type. Google Earth's *Street View* supported determining road type. The coder used website www.virginiaroads.org to verify posted speed limits and the Google Earth ruler function to determine distance driven in miles, on roads with (1) a posted speed limit over 45 mph and (2) highways/interstates. The research team defined highways/interstates as roads with speed limits of 55 mph or greater and with concrete dividers, ramps for on/off access, and/or no intersections.

Radius. To determine Radius from home for each trip, the coder place-marked the subject's home and determined the radius distance to the destination in miles using the Google Earth ruler function. Place-marking common destinations ensured radius consistency.

Left turns. GPS files supported documenting the number of left turns per trip was coded using the KML files. A left turn included a movement at a three- or four-leg intersection; left turns into mid-block or residential driveways were excluded.

Time of day. The coder recorded on the trip start time from the video file, which allowed the coder to determine whether a trip was taken at night.

Passengers. The coder used the video file to code if (one or more) passengers were present for the trip.

Adverse weather (rain). The coder identified rain by the observing the video file for conditions and windshield wipers use; rain during any part of the trip resulted in the trip weather conditions being coded as, "rain."

Seat belt. The coder examined the video file to determine whether drivers used their seat belts on each trip.

Miscellaneous. The coder noted noteworthy or potentially relevant aspects of trips not captured by the above variables. Some examples include a driver traveling to a repeated destination using a novel route, or police activity.

Results

Analysts conducted significance testing using two-tailed *t*-tests with the conventional alpha value of 0.05, as well as F-tests to determine whether to apply equal- or unequal-variance tests. Fisher's Exact tests were applied to categorical data to examine differences between groups.

Participant characteristics. As noted earlier, 24 participants were initially enrolled in the naturalistic exposure study. However, GPS data were missing/corrupted, and thus discarded, for 2 control group participants. Summary statistics below describe the 22 participants (17 Control, 5 Restriction) with valid exposure data. Table 11 shows the number of participants in each group and the type of license restriction when applicable.

Table 11. Group Assignment and Type of License Restriction

Group/Restriction	N
Control	**17**
Restriction	**5**
25 mile Radius of home	1
30 mile Radius of home	1
No Interstates	3
Grand Total	**22**

Age and sex. The 22 drivers ranged in age from 68 to 90 at the time of their first trip; although the intent was to restrict the sample to drivers 70 and older, a 68-year-old's data was inadvertently included. Given the small sample size, the research team opted to retain this

participant's data. The restriction and control groups did not appear to differ significantly in age (see Table 12). The study sample as a whole was approximately three-quarters male, with a similar distribution in each group (see Table 13). Analysts did not conduct significance testing for driver distribution by sex due to the small sample size.

Table 12. Participant Age, by Group

Group	N	Minimum	Maximum	Average	Standard Deviation
Control	17	68	86	77	5.14
Restriction	5	71	90	82	8.29
Totals	**22**	**68**	**90**	**78**	**6.12**

Table 13. Participant Sex, by Group

Group	N	Female	Male
Control	17	29%	71%
Restriction	5	20%	80%
Totals	**22**	**27%**	**73%**

Exposure data analysis. As seen in Table 14 the number of trips per participant ranged from 42 to 133 across the sample, with the Restriction group making significantly fewer trips per person, on average ($p = 0.041$).

Table 14. Number of Trips per Person, by Group

Group	N	Minimum	Maximum	Average	Standard Deviation
Control	17	43	133	87.12	30.52
Restriction	5	42	84	55.80	16.25
Grand Total	**22**	**42**	**133**	**80**	**30.67**

Total trips, aggregated for each participant, included minimums, maximums, and averages for duration (minutes), speed (mph), and distance (miles); and percentage of total miles or trips for each road type, night/rain, time of day and distance bands. The coder analyzed the start and end location for each car start and counted the frequency of matching start/end locations in combination. On a few occasions participants traveled from the same start location to the same end location but took a different route. These occasions were noted and marked as separate occurrences. Each occurrence of start/end location combinations was considered a unique trip.

Table 15 shows group averages for the exposure variables, as well as the results of significance testing. Analysts used Student's *t*-tests assuming equal variance unless otherwise noted. As seen in this table, the restriction group took fewer trips, drove slower and for shorter distances, and drove less frequently during the hours of 10 am and 3 pm. Figure 10 and Figure 11 show maximum and average values by group for trip speed and trip distance, respectively, while Figure 12 compares percent of total trips between 10 a.m. and 3 p.m. by group. The data show that ***all participants in the Restriction group complied with their license restriction*** during the course of the study, and all but one wore their seatbelts for each trip.

Table 15. Exposure Data Summary, Group Averages and T-Test Results

		Group Averages			*Two* Sample T-Test Results		
		Control	Restriction	Total Sample	*t*	df	*p*
	N	17	5	22	-	-	-
	Age	77	81.8	78.1	-1.60	20	0.126
	Trips per Person	87.1	55.8	80.0	2.18	20	0.041
	Trip Occurrence	3.4	4.5	3.7	-0.92	20	0.364
	Average Left Turns per Trip	1.3	1.2	1.3	0.84	20	0.410
Minutes	Minimum Duration	1.6	2.4	1.8	-1.60	20	0.124
	Maximum Duration	112.3	22.7	91.9	1.41	16.1*	0.177
	Average Duration	12.6	9.9	12.0	1.20	19.9*	0.059
Miles Per Hour	Minimum Average Speed	10.5	13.1	11.1	-1.07	20	0.298
	Maximum Average Speed	49.6	36.5	46.6	2.25	20	0.036
	Average Average Speed	26.6	25.9	26.4	0.33	20	0.742
	Minimum Maximum Speed	19.9	23.8	20.8	-0.78	20	0.444
	Maximum Maximum Speed	70.3	62.9	68.6	1.65	20	0.114
	Average Maximum Speed	47.4	46.1	47.1	0.42	20	0.673
Miles	Minimum Distance	0.2	0.4	0.2	-1.30	4.1*	0.260
	Maximum Distance	39.8	9.5	33.0	2.36	17.0*	0.030
	Average Distance	5.2	3.5	4.8	1.18	20	0.253
	Minimum Radius from Home	0.5	0.6	0.5	-0.15	20	0.878
	Maximum Radius from Home	45.6	6.5	36.7	1.80	16.1*	0.090
	Average Radius from Home	10.5	2.7	8.7	1.79	16.3*	0.091
% of Total Miles	Posted Speed Limit > 45 MPH	35.5%	14.9%	30.9%	1.41	20	0.172
	Highway/Interstate	26.7%	10.9%	23.1%	1.26	20	0.221
% of Total Trips	Night	7.6%	5.5%	7.1%	0.63	20	0.535
	Passenger(s)	26.7%	35.1%	28.6%	-0.55	0	0.567
	Rain	8.4%	7.6%	8.2%	0.18	20	0.856
	Unique Occurrence	48.4%	47.1%	48.1%	0.14	20	0.889
	Before 10 am	16.3%	23.4%	18.0%	-0.55	4.48*	0.609
	10 am - 3 pm	51.8%	39.2%	48.8%	2.32	19**	0.031
	3 pm - 8 pm	26.9%	32.6%	28.2%	-0.64	19**	0.532
	After 8 pm	4.7%	4.7%	4.7%	-0.02	19**	0.988
	< = 1 Mile	19.1%	14.6%	18.0%	0.55	20	0.584
	1 - 2.5 Miles	24.7%	33.6%	26.7%	-0.99	20	0.335
	2.5 - 5 Miles	29.7%	26.2%	28.9%	0.38	20	0.707
	5 - 10 Miles	17.3%	23.0%	18.6%	-0.37	4.6*	0.728
	10- 20 Miles	5.1%	2.6%	4.5%	0.70	20	0.493
	> 20 Miles	3.6%	0.0%	2.8%	-	-	-

* Welch's t-test for unequal variance

**Excludes one control where time of day data was missing for all trips

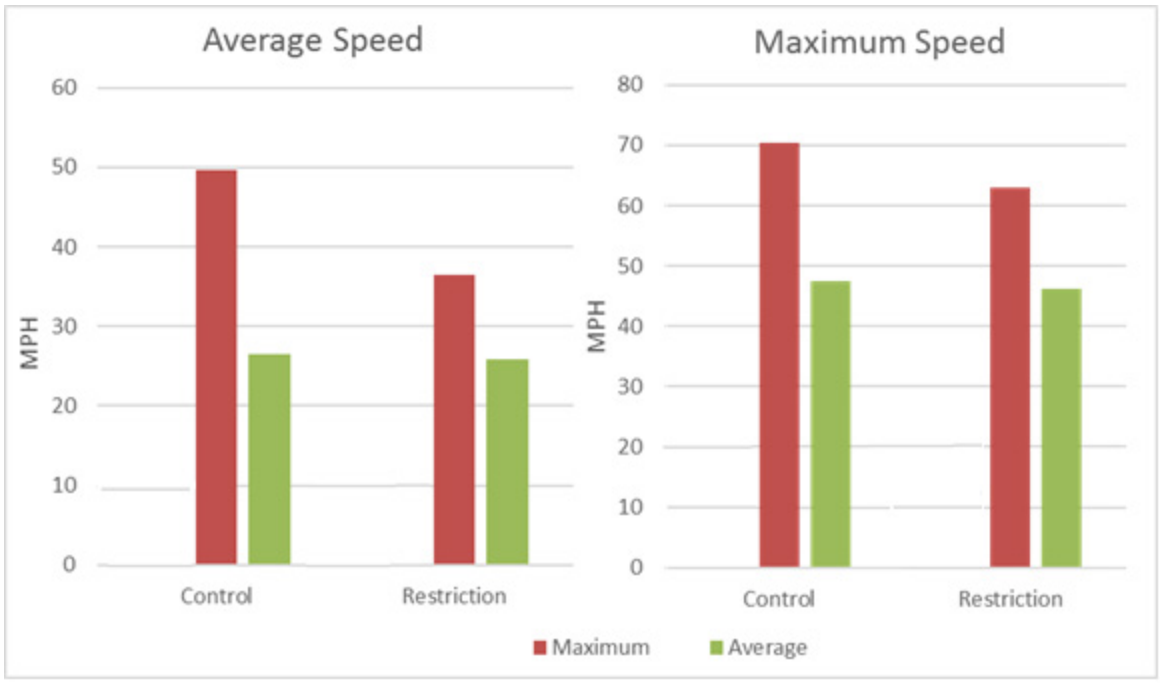


Figure 10. Trip speed.

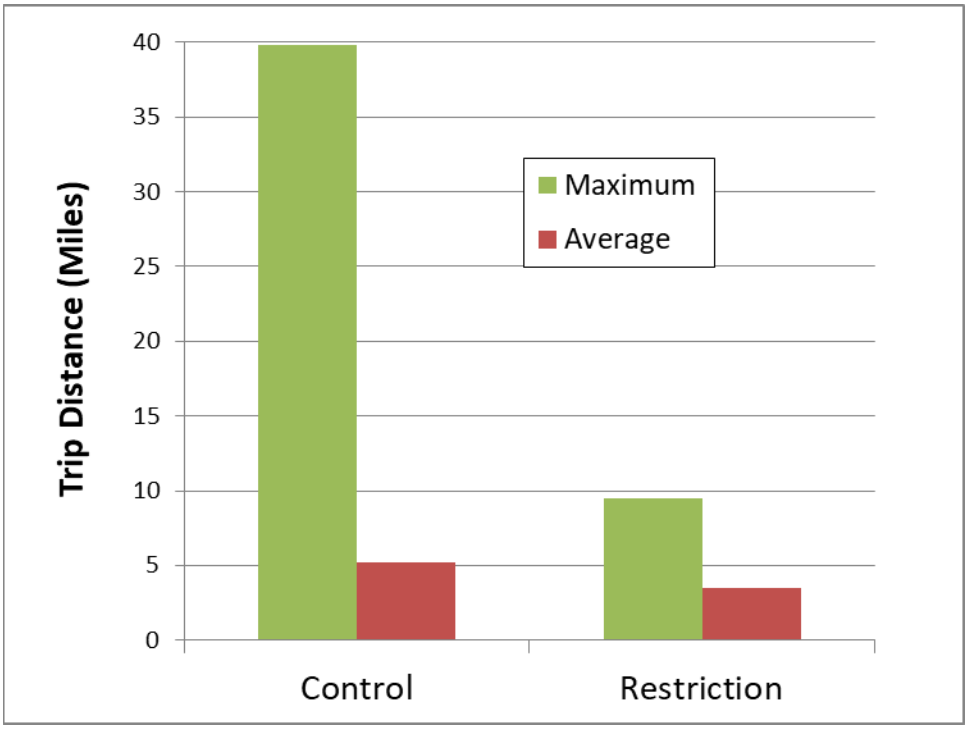


Figure 11. Trip distance in miles.

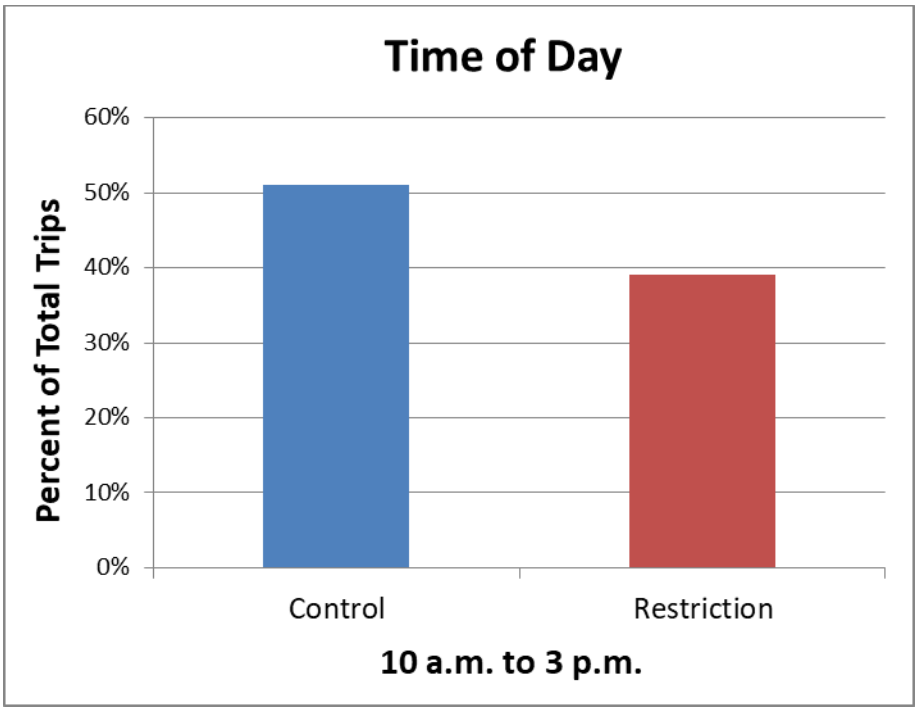


Figure 12. Percentage of trips by time of day.

Conclusions and Discussion

With the aging of the driver population and older adults' reliance on cars, State driver licensing authorities endeavor to preserve licensure for drivers experiencing modest functional impairment that may undermine their driving capabilities. In some instances, States may apply one or more restrictions to a driver's license in lieu of a suspension or revocation in order to balance the driver's mobility needs with safety concerns. This study focused on the extent to which restricted drivers comply with license restrictions and if those restrictions result in preserving these drivers' safety and mobility.

Enforcement of restrictions is no different than that of licensing rules generally. The licensing authority issues a restricted license and expects the driver to comply. Law enforcement officers identify and cite drivers who are out of compliance, and courts offer the opportunity for the cited driver to be heard prior to sanctions for noncompliance. The driver's sense of investment in the social compact expressed in laws, and the fear of sanction for getting caught, are expected to foster compliance. Logically, officers have an easier time detecting a driver who commits an obvious violation, such as running a red light, than one who violates a license restriction. Such non-obvious violations are impossible to detect through observing driving behavior.

Additionally, because sanction is punishment, officers have expressed reluctance to write a ticket for an older driver who may have just forgotten about the restriction. As a result, citations are likely to provide a poor source of evidence of noncompliance; the meager count of citations for driving in violation of restrictions bears this out.

Crashes may provide a better measure of compliance for a least a couple of reasons. Crashes involving older drivers are more likely to result in a serious injury, and therefore rise to the reporting threshold, as a result of the older driver's fragility. Officers may be less likely to let personal feelings noted above influence crash reporting. Crash reports provided greater evidence of violations among drivers with daylight only and posted speed restrictions. The crash data indicate that drivers were more likely to comply with daylight-only restrictions and were more likely to violate speed- or geography-based restrictions.

The greater rate of violation by drivers with restrictions other than daylight-only may have resulted from the conditions those restrictions were intended to address. If travel speed restrictions and restriction to familiar locales were intended to address cognitive impairment, some of these drivers may have lacked insight regarding their deficits and/or forgotten about the restrictions.

While these data show compliance hovering around 95% among restricted drivers, these findings are based on crash data. Because crashes are rare events, the findings may not generalize to the population of restricted drivers. Further, the analyses did not control for exposure.

The naturalistic study of driver exposure indicated that the restriction group behaved differently from the unrestricted group. Drivers in the restricted group took fewer trips, drove slower and for shorter distances, and drove less frequently between 10 a.m. and 3 p.m. than did those in the unrestricted group. This suggests that the restricted group also restricted their total exposure by taking fewer and shorter trips, which suggests that the higher crash rates for drivers

with restrictions other than daylight-only was not the result of simply driving more. The findings also suggest that drivers in the restriction group changed how and when they drive compared to the unrestricted group.

The limited citation data provided no evidence of restriction violations. However, the panel discussion summarized above suggested that such citations may under-report violations, so the dearth of citations may not mean that drivers comply with their restrictions.

The findings from this study agree with those seen in the available literature. Participants' crash rates fell after restrictions were imposed but continued to exceed the rates of non-restricted drivers of similar age. Again, the numbers of crashes included in the analyses was small due to the rarity of license restrictions and of crashes.

A limitation of the project was the difficulty in obtaining sufficient data to address the research questions, especially with respect to recruiting participants with restricted licenses for naturalistic data collection. To address this limitation future research might combine data across States to produce a larger pool of restricted drivers while also maximizing the number of years of crash data.

Finally, there is a need to study the effectiveness of license restrictions, particularly speed and geographic restrictions, for drivers living in urban versus rural areas. Presently, there is no objective data to guide licensing agencies' decisions about which restrictions are most effective in which environments. While individual licensing decisions must be made on a case-by-case basis, evidence-based guidelines (in this and other areas) could improve the process and bring greater consistency across jurisdictions.

References

AAA Foundation for Traffic Safety. (2016, September 12). Driver Licenses Policies and Practices. (Web page). Washington, DC: Author. Retrieved from http://lpp.seniordrivers.org/index.cfm?selection=visionreqs

Braitman, K. A., Chaudhary, N. K., & McCartt, A. T. (2010). *Restricted licensing among older drivers in Iowa.* Arlington, VA: Insurance Institute for Highway Safety.

Cheung, I., & McCartt, A. T. (2010, June). *Declines in fatal crashes of older drivers: Changes in crash risk and survivability.* Arlington, VA: Insurance Institute for Highway Safety.

Federal Highway Administration. (2011, September). Distribution of Licensed Drivers – 2010 by Sex and percentage in Each Age Group and Relation to Population (Web page, Highway Statistics Series, Table DL-20). Washington, DC: Author. Retrieved from www.fhwa.dot.gov/policyinformation/statistics/2010/dl20.cfm

Langford, J. and Koppel, S. (2011). License restrictions as an under-used strategy in managing older driver safety. *Accident Analysis and Prevention*, *43*:487-493.

TransAnalytics, LLC. (2011, July). *Medical review process and license disposition of drivers referred by law enforcement and other sources in Virginia*. (Report No. DOT HS 811 484). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/sites/nhtsa.dot.gov/files/811484.pdf

Lyman, S., Ferguson, S. A., Braver, E. R., & Williams, A. F. (2002). Older driver involvements in police reported crashes and fatal crashes: trends and projections. *Injury Prevention*, *8*: 116-120.

Marshall, S. C., Spasoff, R., Nair, R., & van Walraven, C. (2002). Restricted driver licensing for medical impairments: Does it work? *Canadian Medical Association Journal*, *167*(7): 747-751.

Marshall, S. C., Man-Son-Hing, M., Molnar, F., Wilson, K. G., & Blair, R. (2007). The Acceptability to Older Drivers of Different Types of Licensing Restriction. *Accident Analysis and Prevention*, *39*(4): 776-793.

Marta, M. R., & Geruschat, D. (2004). Equal protection, the ADA, and driving with low vision: A legal analysis. *Journal of Visual Impairment & Blindness*, *98*(10): 654-667.

McGwin, G., McCartt, A. T., Braitman, K. A., & Owsley, C. (2008). Survey of older drivers' experiences with Florida's mandatory vision re-screening law for licensure. *Ophthalmic Epidemiology*, *15*: 121-127.

Nasvadi, G. C., & Wister, A. (2009). Do restricted driver's licenses lower crash risk among older drivers? A survival analysis of insurance data from British Columbia. *The Gerontologist*, *49*(4): 474-478.

Rudman, D. D., Friedland, J., Chipman, M., & Sciortino, P. (2006). Holding on and letting go: the perspectives of pre-seniors and seniors on driving self-regulation in later life. *Canadian Journal of Aging, 25*(1): 56-76.

Salzberg, P., & Moffat, J. (1998). *The Washington State Department of Licensing special exam program: An evaluation.* Olympia, WA: Washington Traffic Safety Commission.

Stutts, J. C., Stewart, J. R., & Van Heusen-Causey, S. (2000). *An evaluation of restricted licensing for North Carolina's older drivers.* Chapel Hill, NC: University of North Carolina Highway Safety Research Center.

Sutts, J. C., & Wilkins, J. W. (2012, April). *Keeping seniors safe and mobile: An evaluation of a local drive test option.* Washington, DC: AAA Foundation for Traffic Safety.

Thomas, F. D., Blomberg, R. D., Knodler, M., & Romoser, M. R. E. (2013, September). *Safety outcomes of licensing procedures for older drivers.* (Report No. DOT HS 811 833). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/sites/nhtsa.dot.gov/files/811833.pdf

Vernon, D. D., Diller, E. M., Cook, L. J., Reading, J. C., Suruda, A. J., & Dean, M. D. (2002). Evaluating the crash and citation rates of Utah drivers licensed with medical conditions, 1992-1996. *Accident Analysis and Prevention, 34*(2): 237-246.

Winter, S. E. (1997). *Effects of license restriction on older drivers and those close to them*. (Paper presented at the 1997 Annual Meeting of the Transportation Research Board). Washington, DC: Transportation Research Board.

Appendix A: Synopsis of Studies Included in Literature Review

U.S. Studies of Restricted Licensing

A recent study by **Braitman, Chaudhary, and McCartt (2010)** examined Iowa's restricted license practices for older drivers. This study attempted to determine whether Iowa's license restriction program identified older drivers who were at greater crash risk; the study also assessed older drivers' compliance with license restrictions. A total of 522 drivers age 70 and older participated in two telephone surveys about their driving activities prior to and approximately six months after renewing their license. This total included 235 drivers who were not required to take a road test and whose licenses were not restricted; 216 drivers who were road tested but whose licenses remained unrestricted; 70 drivers who were road tested and given a daytime driving only, speed, or geographic area restriction; and six drivers whose licenses following a road test were suspended. The study found that restricted and suspended drivers were older, had more visual impairments, took more prescription medications, and had more physical mobility limitations than unrestricted drivers. The survey also showed that even before they had been restricted, the restricted drivers were driving fewer miles, less often at night, and less often on high-speed roads compared to unrestricted drivers. After restrictions were placed on them, the restricted drivers reported greater mileage decreases than did the unrestricted drivers. Most drivers reported that they complied with the restrictions.

Salzberg and Moffat (1998) studied whether the granting of restricted licenses to drivers with serious impairments compromises public safety. Specifically, the study was conducted to evaluate the effectiveness of the Washington State Special Exam Program for reducing collision involvement risk of drivers with medical, vision, and physical impairments. A total of 449 drivers who underwent a special exam during 1994 were compared to a matched control sample of drivers. A special exam included an in-depth interview and an extended or specialized on-road drive test, typically conducted near the driver's residence. Sixty-nine of the 449 special exam group drivers failed the special exam and 380 passed. The most common outcome of the special exam was imposition of driving restrictions such as time of day, area (e.g., within an x-mile radius of residence, within city limits only, no freeway driving); and equipment (e.g., corrective lenses, hand controls, outside vehicle mirrors, power steering, power brakes). Crash and violation records of drivers who underwent the special exam were compared to those of the control group for a period of 1.75 years before the exam to 3.25 years after the exam (5 years total). Crash and violation rates were calculated to describe the number of incidents per 100 subjects per year. For drivers who passed the exam, restrictions were imposed as follows: no restrictions (6.3%); area/time (9.7%); equipment (16.6%); and both area/time and equipment (67.4%). Those drivers who passed the special exam had a pre-exam crash rate of 7.07 compared to a rate of 3.82 for all of the controls. Both groups saw a reduction in crash rates post-exam, with those passing the exam having a rate of 3.24 compared to 1.17 for the controls. Violation rates showed a similar trend. Notably, of the 65 post-exam violations committed by the exam group, only two (3%) occurred outside of a driver's area and/or time restriction, and of 40 total post-exam collisions, only two (5%) were outside of a driver's restrictions. Of the 40 collisions in the exam group, 27 were at-fault (68%) compared to 1 of 17 (6%) of the control group collisions.

Stutts, Stewart, and Van Heusen-Causey (2000) conducted a North Carolina-based study with three major objectives: (1) to evaluate existing N.C. practices in regard to restricted licensing for older drivers and its effects on safety; (2) to determine older drivers' knowledge and attitudes toward restricted licensing; and (3) to obtain input from driver license examiners regarding restricted licenses as a potential tool for helping some older adults drive safely longer. Results showed that among drivers age 65 and older, only 1.2% had a speed restriction, 1.2% a time of day restriction, and 0.14% a radius restriction on their license. Other very specialized restrictions included automatic transmission (0.12%), accompanied by a passenger (0.10%), and power steering, wheel knobs, hand controls, or other special equipment (0.7% total). Analyses showed that any restriction other than corrective lenses was associated with a statistically higher crash risk after controlling for driver age, sex, and population density. Drivers with no restriction or corrective lenses only were reported to have a 3-year crash rate of .117, compared to 1.65 for drivers with all other restrictions (a relative risk of 1.4). For all restriction types, however, crash risk was less than the risk associated with being male or living in a high population density county.

Also for the study, phone interviews were completed with 610 older drivers. Two-thirds of the unrestricted drivers interviewed, and 39% of the restricted drivers interviewed, were unaware of restrictions other than corrective lenses that the DMV might place on a license. More importantly, a significant percentage of those interviewed appeared unaware of the restrictions currently in place on their own license: only 81% correctly self-reported no restrictions, 65% daytime driving only restrictions, 70% speed restrictions, and 43% radius restrictions. For the 121 participants who self-reported a restriction other than corrective lenses, 67% agreed that the restriction was appropriate for them, and 69% said that it did not make it harder for them to meet their transportation needs. In addition, 77% of participants strongly agreed, and an additional 19% somewhat agreed, with the Statement that they would rather have a restricted license than no license at all.

Lastly, a paper-and-pencil survey was mailed to all 92 head driver license examiners in the State. Responses were obtained from 38 examiners. In general, the examiners felt adequately trained to assess older drivers and place appropriate restrictions on their license, although nearly half the examiners expressed interest in additional training, primarily with respect to medical conditions and medications. Some examiners expressed frustration that license restrictions were either linked to vision test performance or imposed by the Medical Review Board, thus limiting their input to the process.

Vernon, Diller, Cook, Reading, Suruda, & Dean (2002) evaluated the crash and citation rates of drivers of all ages in Utah (not just older drivers) reporting medical conditions to the DMV and drivers with restricted licenses issued by the DMV. This retrospective case-control study matched drivers reporting medical conditions to a sample of controls from the general driving population. Crash and violation rates per 10,000 days licensed were calculated for each medical condition group based on five years of citation and crash data. Drivers reporting medical conditions had higher crash rates, especially for at-fault crashes. Citation rates varied by the type of medical condition reported, with some medical conditions actually associated with lower citation rates than controls, while other medical conditions showed much higher citation rates compared to controls. Restricted drivers did not appear to differ much from unrestricted drivers

for crashes or citations. The findings also suggested that at least some drivers who had been excluded from driving (license suspended or revoked) by the DMV were still driving since their citation and crash rates were greater than zero.

Winter (1997) used a self-report survey to examine the impact of California's restricted license program for older adults. The study examined the mobility consequences of license restriction vs. revocation; the emotional reaction to license restriction vs. revocation; changes in health and driving habits; alternative modes of transportation used; and attitudes toward the DMV. Study participants included 65 drivers 60 and older who had recently been re-examined at a California DMV office in the San Jose area. The researcher administered the surveys individually to participants in their own homes. Of the surveyed drivers, 25 retained their licenses without any restrictions, 10 received new restrictions, and 30 drivers had their licenses revoked. Drivers in the restricted group received from one to four new restrictions. There were five types of restrictions: no nighttime driving (7 drivers); area restrictions (4 drivers); corrective lenses (4 drivers), no freeway driving (4 drivers); and time of day restrictions other than daytime only (2 drivers).

When asked if they had difficulty getting to any of six "necessary" destinations (grocery store, post office, doctor's office/hospital, work, drug store, or other), only one person in the restricted group reported difficulty getting to any place (doctor's office/hospital). In comparison, 83% of the revoked group reported difficulty reaching the grocery store, 70% the doctor's office/hospital, 37% the drug store, and 23% the post office. Regarding their feelings about the DMV's decision to restrict or revoke the license, 50% of the revoked drivers were "very angry" and 17% were "somewhat angry." In contrast, only one person in the restricted group was "somewhat angry" and none reported being "very angry." No one in the restricted group reported that their health had worsened, compared to 27% of the revoked group. Regarding fairness of the DMV staff, 96% of the no restriction group and 80% of the restricted group reported that the staff was "somewhat" or "very" fair, compared to only 27% of the revoked group.

Marta and Geruschat (2004) described the potential for drivers to demand a restricted license in lieu of suspension or revocation. Generally, the process by which a licensee acquires a restricted license begins when the regulator becomes aware of an impairment. This triggers an evaluation followed by an agency licensing decision. Except for the election to cooperate, the driver's role in the process is passive. The study suggests that drivers facing suspension or revocation may demand a restricted license instead under the auspices of the Americans with Disabilities Act, introducing new aspects to the existing process.

McGwin, McCartt, & Braitman (2008) documented the license renewal experiences of Florida drivers age 80 and older required to pass a visual acuity test to renew their license. Florida's mandatory vision screening law (effective Jan 1, 2004) requires all drivers 80 and older who are renewing their licenses in person, or extending them by mail, to pass a DMV-administered acuity test or submit a certificate from a physician or optometrist showing that they have passed a vision screening within the prior year. This study conducted a telephone survey of drivers 80 and older within one year of their scheduled license expiration date. A total of 1,242 Florida-licensed drivers 80 and older eligible for license renewal participated. The study found

that the majority (80.2%) of those eligible for license renewal had attempted to renew their license and 88.0% of those attempting to renew succeeded the first time they tried.

Relevant to the current study, about one in five applicants opted not to renew his/her license rather than undergo review. About half (51.4%) of drivers who did not seek renewal said they thought they would fail the vision test; other frequently reported reasons given were medical problems (43.8%), do not need a car (31.7%), and not safe (18.3%). Almost all (99.5%) of those choosing not to renew their license reported using transportation alternatives. Those drivers not seeking renewal were significantly older, more likely to be female, and less likely to live in a residential home compared to those who were able to renew their license. They also had significantly poorer scores on the Orientation-Memory-Concentration test (indicating more impairment) and reported significantly more chronic medical conditions.

Studies Outside the United States

Langford and Koppel (2011) examined the frequency and types of restrictions imposed on the licenses of older drivers in Victoria, Australia, along with any resulting safety benefits. The authors focused on the following restrictions: corrective lenses; automatic transmission only; no night driving; driving only within a specified distance from home; driving only in specified areas; and need to wear a hearing aid while driving. Controls were defined as drivers with no restrictions on their licenses. There were a total of 409,640 drivers in the study with 32,301 (7.9%) having one restriction, 631 (.15%) having two restrictions, and 376,708 (92.0%) with no restrictions. Overall, 96.3% of restricted drivers had corrective lens restrictions; 2.4% an automatic transmission only restriction; and only 1% had one of the other restrictions listed above. Crash rates (crashes per 10,000 driver-years) were lower after the imposition of a restriction for drivers with the following restrictions: any restriction; wearing of corrective lenses; only driving within a specified distance of home; no nighttime driving; and driving in specified areas only. Crash rates were higher after the imposition of the restriction for drivers required to drive an automatic transmission vehicle and those required to wear a hearing aid while driving. Due to small sample sizes, however, only the overall and corrective lens results attained statistical significance. Interestingly, crash rates were also much lower for the control group in the after period. Overall, restricted drivers showed no or only modestly elevated crash risk after restrictions were imposed compared to the no restriction group.

Marshall, Spasoff, Nair, & van Walraven (2002) conducted a study to evaluate the crash and violation rates among Canadian drivers in Saskatchewan with restricted licenses compared to rates in the general population, and compared crash and traffic violation rates before and after driving restrictions were imposed. Driving restrictions were classified as either *licensing restrictions* (e.g., required vision testing for renewal) or *driving restrictions* (e.g., time of day, radius from home). Of the 703,758 eligible drivers, 23,185 (3.3%) had a restriction at some point during the study period. Of these 23,185, 86.6% had a licensing restriction only, 8.7% had both a licensing and a driving restriction, and 4.8% had a driving restriction only. Restricted drivers were more likely than unrestricted drivers to be male, older, and to reside in a rural area. Results showed restricted drivers to have a significantly higher crash rate than unrestricted drivers (IRR=1.14), but a lower rate of convictions for traffic violations (IRR=0.93). The authors point out that although higher, the crash rate for restricted drivers was still lower than that associated with being male (IRR=2.01) or living in an urban area (IRR=1.38). ARIMA

time series modeling was used to examine changes in crash and violation rates following imposition of a restriction. These results showed significant decreases of 0.7 crashes per 1,000 drivers per week associated with driving restrictions, and 0.2 crashes per 1,000 drivers per week associated with licensing restrictions. The effect of restrictions on violations was smaller, but still statistically significant for all driving restrictions combined and for licensing restrictions combined.

More recently, **Marshall, Man-Son-Hing, Molnar, Wilson, & Blair (2007)** completed a study in Ottawa, Canada, to determine the acceptability of various driving restrictions to older drivers. Eleven specific restrictions were examined: corrective lenses required; driving with specific vehicle adaptations; permitted to drive only if has regular Ministry of Transportation (MTO) assessments; permitted to drive during daylight hours only; avoiding driving on major highways; avoiding driving during rush hour; avoiding making left turns; avoiding driving on roads with speed limit greater than 60 km/h; driving to specific destinations only; driving within 10-km radius of home only; and driving with another licensed driver only. Researchers conducted face-to-face interviews with drivers. After providing basic demographic data and completing a mental screening, subjects were asked to evaluate the acceptability of the 11 driving restrictions using a modified gamble technique. The technique examined participants' acceptance of each restriction by identifying the level of risk they would accept for permanently losing their license if they did not accept the restriction. The higher the probability of complete license loss the respondent was willing to take, the higher the acceptability of the licensing restriction. Eighty-six licensed drivers 65 or older participated. In general, participants were more accepting of restrictions that did not adversely impact their autonomy and ability to access the community. The participants were most accepting of regular assessment by the MTO, driving with vehicle adaptations, and daytime driving only. Less acceptable restrictions included avoidance of roads with a speed limit greater than 60 km/h, limitation of destinations, driving only within a 10-km radius of home, and requirement of another licensed driver in the vehicle. Results generally did not vary by sex or urban/rural residence, with the exception that women were less supportive of any requirement that they drive only when accompanied by another licensed driver, and people living in rural areas were less accepting of being restricted to driving on roads with a speed limit of 60 km/h or less.

Nasvadi and Wister (2009) completed a study using crash data from the Insurance Company of British Columbia to compare at-fault crash rates for restricted versus unrestricted drivers over a time period of 6.5 years. Drivers were identified as restricted if they had one or more of the following three types of age-related restrictions on their license: (1) restricted speed (not to exceed 80 km/h, no highway driving, etc.); (2) restricted geographical radius, or (3) restricted time of day of travel (daylight hours only, no rush hour). The study included data from all licensed drivers in British Columbia age 66 or older as of January 1, 1999 (N=151,284). Of these, 2.5% had one of the identified age-related restrictions on their license at the start of the study, and an additional 2.2% had restrictions placed on their license during the course of the study. The average age of restricted drivers was 78.1, compared to 74.1 for unrestricted drivers. Restricted drivers were also more likely than unrestricted drivers to be men (61.2% versus 54.1%). Data were analyzed to assess differences in time from reissuance of the driver's license to time of *first at-fault crash*. Results showed that older drivers who eventually had a restriction placed on their license had a higher pre-restriction crash rate than those who continued to drive

unrestricted. Restricted drivers' mean number of crashes declined from before to after the restrictions were placed, and after adjusting for age and sex, restricted drivers were 11% less likely to crash than unrestricted drivers. Notably, restriction for daylight driving only was associated with a 51% decrease in crashes, while speed restrictions were associated with a smaller, non-significant decrease in crashes. There was no difference in the severity of the crashes occurring for restricted and unrestricted drivers. Pertaining to compliance with restrictions, only 3.1% of crashes involving drivers restricted to daylight-only driving occurred during times when it was probably dark, suggesting general compliance with the restriction.

Rudman, Friedland, Chipman, & Sciortino (2006) examined the experiences and perspectives on driving of well elderly individuals in Ontario, Canada, who did not have a medical condition that required reporting by a physician to a regulatory body. The study attempted to explore if and how intrapersonal, interpersonal, and environmental factors influence the driving behaviors and decisions of aging drivers. A sample of pre-senior drivers (55 to 64 years old), senior drivers (65 and older), and ex-drivers (65 and older) participated in focus groups. The themes that emerged from the focus groups were: the practical and symbolic meaning of driving; monitoring and regulating the self; whose opinion merits consideration; and the need for better testing procedures. All are relevant to the implementation of license restrictions.

Appendix B: 1. Driver Evaluation Panelists

Florida	**Sandra C. Lambert, Director** Florida Department of Highway Safety and Motor Vehicles Division of Driver Licenses **Desiree Lanford, MOT, OTR/L, CDRS** University of Florida Public Health and Health Professions Department of Occupational Therapy Institute for Mobility, Activity, and Participation (I-MAP) **Lt. William (Bill) Leeper** Florida Department of Highway Safety and Motor Vehicles Public Affairs Officer for Northeast Florida
Iowa	**Kim Snook, Director of Driver Services** Iowa Department of Transportation Office of Driver Services **Sue T. Knapp, CDRS, OTR/L** Occupational Therapist, Physical Medicine and Rehabilitation Methodist Outpatient Therapy **Jeff Cayler** Chief of Police Carroll Police Department
Virginia	**Jacquelin Branche, R. N.** Healthcare Compliance Officer DMV Medical Review Services **Mary Breister, CDRS** Woodrow Wilson Rehabilitation Center **Sgt. Eric Penree** Virginia State Police Area Commander for Arlington County
Physician Researchers	**David B. Carr, M.D**. Associate Professor of Medicine and Neurology, Washington University at St. Louis Clinical Director, Division of Geriatrics and Nutritional Science Medical Director, The Rehabilitation Institute of St. Louis (TRISL) Medical Advisory Board Physician, Missouri Department of Revenue/Driver Licensing **Richard Marottoli, M.D.** Associate Professor of Medicine (Geriatrics), Yale University School of Medicine Medical Advisory Board Physician, Connecticut Department of Motor Vehicles **Shawn Marshall, M.D., MSc, FRCPC** Clinical Investigator, Clinical Epidemiology, Ottawa Hospital Research Institute Investigator, Institute for Rehabilitation Research & Dev., The Ottawa Hospital Rehab Centre Associate Professor in the Department of Medicine, University of Ottawa Director of Electromyography Laboratory, The Ottawa Hospital Rehabilitation Centre Medical Director, Acquired Brain Injury Rehab Program, The Ottawa Hospital Rehab. Centre
AAMVA	**Thomas Manuel** Program Director, Driver Fitness

Appendix B: 2. Panel Meeting Agenda

7:30 - 8:30 a.m.	Continental Breakfast at Hotel
8:30 – 9:00	Introduction of Project and Panelists
9:00 – 9:45	Summary of Findings from Literature Review
9:45 – 10:45	Discussion Topic #1. How do (older) drivers who are candidates for license restriction come to the attention of the licensing authority? Who can impose a license restriction, and what process (or processes) are involved?
10:45 – 11:00	Break
11:00 - 12:00	Discussion Topic #2. How do older drivers react to having their license restricted?
12:00 – 1:00 p.m.	Buffet Lunch at Hotel
1:00 – 2:00 p.m.	Discussion Topic #3. Other than corrective lenses, what types of restrictions are available within each participating State, and which are most commonly applied for drivers aged 65 and older? Under what circumstances or conditions would such restrictions *not* be applied? What types of medical conditions are most common among drivers receiving restricted licenses?
2:00 to 3:15	Discussion Topic #4. What types of restrictions are associated with the highest compliance by older drivers? What measures, enforcement or otherwise, are in place to promote compliance with restrictions? What methods exist to detect noncompliance?
3:15 – 3:30	Break
3:30 – 4:30	Discussion Topic #5. Do license restrictions preserve mobility at the cost of safety?
5:00	Final Announcements and Adjournment

Appendix C: Sample Data Request to States - Florida

The intention of this design is to provide an extraction request that can be executed at one time. We recognize that your response to this request will require a significant effort and appreciate your contributions to the project.

My plan is to identify the subject population by restriction code and describe the selection process for the control population. I anticipate the results will arrive in the form of several tables, i.e., a DMV table (or two or three as necessary), a crash table, and a citation table for the entire combined SUBJECT and CONTROL populations.

I am assuming that the Florida database stores restriction information in a dedicated table which would permit multiple restrictions associated with a single driver license number.

We suggest that the following steps be followed in preparing the data extraction:

1. Please compile a SUBJECT LIST of driver license numbers that satisfy the following criteria and record the count of driver license numbers on that list:

> **ALL <u>currently-licensed</u> drivers whose <u>date of birth occurred on or before January 1, 1947</u>**
> AND
> **Where a "DAYLIGHT DRIVING ONLY" restriction (Restriction Code "E") is applied to that license.**

2. Please compile a CONTROL LIST of 100,000 driver license numbers for comparison that satisfy the following criteria. The CONTROL list represents a sample of non-restricted drivers and must be selected from among the greater licensed driver population by a RANDOM process. Please record a description of the randomization process for later use.

> **RANDOM selection of 100,000 from among ALL currently-licensed drivers whose date of birth occurred on or before January 1, 1947**
> **AND**
> **Where a "DAYLIGHT DRIVING ONLY" restriction (Restriction Code "E") is <u>NOT</u> applied to that license.**

If Florida does not have a handy method for making a random selection, it could use a pseudo-random method like selecting on the last two digits of the Driver License Number. Because the soundex license numbering system doesn't use these digits uniformly, some two-digit selections will yield higher counts than others. The digit pair "17" will very likely yield a sufficient count.

3. Please **combine** the SUBJECT LIST and the CONTROL LIST to make the **TARGET LIST**. The TARGET LIST identifies the records to extract. Once the two populations have been identified by driver license number, the following extractions can be performed ONCE for the combined populations (because the subjects can be distinguished from the controls by the presence of the specific restrictions of interest.)

4. For all the driver license numbers in the **TARGET LIST**, please EXTRACT into as many tables as necessary to accommodate the records:

From the DMV records
Driver License Number
Date of birth
Sex
Race
City of Residence
County of Residence
Zipcode (5 digits)
License Class
License Issue Date
Original License Issue Date (if available)
License Expiration Date
License Restrictions * **
Restriction Imposition Date **
Driving Convictions * ** (including date and description)
Driving Record Crash Indicators

From CRASH records
Driver License Number
Crash Date
Crash Hour
Crash Minute
Crash AMPM
Crash County Code
Crash Lighting Condition
Crash Injury Severity* (Worst of all crash victims)
Crash Fault Code
Vehicle Posted Speed
Vehicle Fault Code
DOT At Intersection*
Driver Physical Defects*
Driver 1st Contributing Cause*
Driver Action
Driver Injury Severity
Driver Recommended Re-Exam

From CITATION records
Driver License Number
Citation Date
Citation Time of Day
Citation Location County
Infraction/Charge Code*

Infraction/Charge (verbal)
Disposition

* A look-up table may be necessary if coded

** It may be appropriate to create a second table to carry multiples of this item.

5. Please describe the data layout as necessary so the structure of the supplied data may be understood and analyzed, including table names, column names, and delimiters used.

6. Please include all necessary **LOOK-UP TABLES** necessary for decoding DMV, CRASH and CITATION record contents.

7. Please provide a written description of the **RANDOMIZATION METHOD** used to select the CONTROL subject list.

Appendix D: Crash Rates for Restricted and Unrestricted Drivers by Age and Sex – Supplemental Table

D.1. Iowa

Study Group		Restricted				Control			
		Number of Crashes*	Total Drivers in Sample	Years of Data	Crash Rate Per Year	Number of Crashes	Total Drivers in Sample	Years of Data	Crash Rate Per Year
65-69	Males	11	70	316.52	0.03475	848	6,564	32,820.00	0.02584
	Females	10	85	371.69	0.02690	576	6,831	34,155.00	0.01686
	Subtotal	21	155	688.21	0.03051	1,424	13,395	66,975.00	0.02126
70-74	Males	31	156	690.86	0.04487	628	4,706	23,530.00	0.02669
	Females	32	258	1,178.11	0.02716	494	5,173	25,865.00	0.01910
	Subtotal	63	414	1,868.97	0.03371	1,122	9,879	49,395.00	0.02271
75-79	Males	55	270	1,183.20	0.04648	437	3,320	16,600.00	0.02633
	Females	72	391	1,798.29	0.04004	378	4,116	20,580.00	0.01837
	Subtotal	127	661	2,981.49	0.04260	815	7,436	37,180.00	0.02192
80-84	Males	80	310	1,442.44	0.05546	248	1,879	9,395.00	0.02640
	Females	91	474	2,226.83	0.04087	216	2,213	11,065.00	0.01952
	Subtotal	171	784	3,669.26	0.04660	464	4,092	20,460.00	0.02268
85+	Males	69	264	1,257.55	0.05487	87	645	3,225.00	0.02698
	Females	59	336	1,595.72	0.03697	88	826	4,130.00	0.02131
	Subtotal	128	600	2,853.26	0.04486	175	1,471	7,355.00	0.02379
Males Total		246	1,070	4,891	0.05030	2,248	17,114	85,570	0.02627
Females Total		264	1,544	7,171	0.03682	1,752	19,159	95,795	0.01829
Total		510	2,614	12,061	0.04228	4,000	36,273	181,365	0.02205

*Following imposition of restrictions, for Restricted Group

D.**2. Virginia**

Study Group		Restricted				Control			
		Total Drivers in Sample	**Number of Crashes***	**Years of Data**	**Crashes Per Year**	**Total Drivers in Sample**	**Number of Crashes**	**Years of Data**	**Crashes Per Year**
65-69	Males	509	43	1,244.57	0.03455	6,564	902	40,195.00	0.02244
	Females	679	41	1,565.85	0.02618	6,831	695	43,080.00	0.01613
	Subtotal	1188	84	2,810.42	0.02989	13,395	1,597	83,275.00	0.01918
70-74	Males	877	64	1,700.48	0.03764	4,706	628	27,430.00	0.02289
	Females	1,489	43	2,905.61	0.01480	5,173	540	30,965.00	0.01744
	Subtotal	2366	107	4,606.10	0.02323	9,879	1,168	58,395.00	0.02000
75-79	Males	1,404	101	2,780.01	0.03633	3,320	369	17,045.00	0.02165
	Females	2,341	104	5,137.99	0.02024	4,116	354	20,725.00	0.01708
	Subtotal	3745	205	7,917.99	0.02589	7,436	723	37,770.00	0.01914
80-84	Males	1,368	85	2,978.62	0.02854	1,879	189	7,850.00	0.02408
	Females	2,103	86	5,202.03	0.01653	2,213	176	10,580.00	0.01664
	Subtotal	3471	171	8,180.65	0.02090	4,092	365	18,430.00	0.01980
85+	Males	716	64	1,759.93	0.03637	645	60	2,330.00	0.02575
	Females	969	51	2,635.50	0.01935	826	36	2,510.00	0.01434
	Subtotal	1685	115	4,395.42	0.02616	1,471	96	4,840.00	0.01983
Males Total		4,874	357	10,464	0.03412	17,114	2,148	94,850	0.02265
Females Total		7,581	325	17,447	0.01863	19,159	1,801	107,860	0.01670
Total		12,455	682	27,911	0.02444	36,273	3,949	202,710	0.01948

*Following imposition of restrictions, for Restricted Group

Appendix E: Recruitment Letter

COMMONWEALTH of VIRGINIA

Department of Motor Vehicles

2300 West Broad Street

July 26, 2013

Richard D. Holcomb
Commissioner

Post Office Box 27412
Richmond, VA 23269-0001

Virginia Driver
Virginia Address
Virginia City, State Zip

Dear Mr./Ms. Driver,

The Commonwealth of Virginia has a history of promoting highway safety through research. The National Highway Traffic Safety Administration (NHTSA) has partnered with the private sector firm TransAnalytics, LLC, to conduct a voluntary research study involving Virginia drivers. The voluntary research study is described more fully in the NHTSA/TransAnalytics produced Fact Sheet enclosed with this letter. NHTSA and TransAnalytics are requesting your voluntary participation in their research. This is not a research study conducted by the Commonwealth of Virginia or the Department of Motor Vehicles (DMV).

If you ***volunteer*** to participate in the NHTSA/TransAnalytics' study, you can be certain that:

1. Your participation will have absolutely no effect on your driver's license in any way, now or ever;
2. The Virginia Department of Motor Vehicles will not receive any information about your driving from this study;
3. Your participation will make a difference, by helping Virginia and the nation to preserve safety and mobility for all our road users.
4. Participation is totally **voluntary**; you are not required to participate.

The Virginia DMV is not involved in conducting this research study. DMV has not provided your name or disclosed any information about you to NHTSA or TransAnalytics. DMV is sending this letter to let you know about this voluntary research opportunity so you can decide if you would like to participate.

If you'd like to learn more about the voluntary study, please complete and sign the form at the bottom of this page. Mail the entire page in the enclosed, postage-paid envelope. This will allow a researcher from TransAnalytics, LLC, to call you to answer any questions you have, and enroll you in the study.

Thank you, and *Drive Safely*.

David L. Pierce, Director
Data Management Services

Daytime Phone: ___ ___ ___ - ___ ___ ___ - ___ ___ ___ ___ Ext: _____

Best time to call: _____ Signature: _____

TransAnalytics, LLC
www.transanalytics.com

nhtsa
National Highway Traffic Safety Administration

FACT SHEET

Voluntary Naturalistic Study of Driving

The National Highway Traffic Safety Administration (NHTSA) has sponsored research to understand driving behavior in Virginia. To support this work, the Virginia Department of Motor Vehicles (DMV) in accordance with Va. Code §46.2-209 has agreed to send letters to drivers in the Commonwealth. We are inviting you to participate in this voluntary study. Joining the voluntary study is simple, it won't disrupt your daily routine, and you'll receive $100 for completion (paid from federal research funds through TransAnalytics and NHTSA, not by the Commonwealth of Virginia).

If you *volunteer* to participate in this study, you can be certain that:

1. Your voluntary participation will have absolutely no effect on your driver's license in any way, now or ever;
2. The Virginia DMV will NOT receive any information about your driving from this study;
3. You will receive $100 for your completed participation (paid from federal research funds through TransAnalytics and NHTSA, not by the Commonwealth of Virginia); *and*
4. Your voluntary participation will make a difference, by helping Virginia and the nation to preserve safety and mobility for all our road users.

Participation is totally voluntary, and you can change your mind and stop at any time by contacting TransAnalytics.

In this research, you will be asked to drive according to your normal habits. At a time and place convenient to you, a researcher from TransAnalytics will install a GPS data logger in your car that records each trip you take for a month. A miniature camera will also be installed to take snapshots that confirm *you* are the driver because it is important that only *your* trips are analyzed in this study. The trip information recorded by the GPS devices will be combined with that of other drivers, and will be analyzed and reported to NHTSA only on a group basis – *without* revealing any individual names or license numbers. All snapshots from the camera will be destroyed at the end of the study.

The GPS device and the camera will be professionally installed and will be completely removed at the end of one month of recording travel data. Installation and removal can take place at a location of your choice. The researchers are covered by insurance to ensure that your car will not be harmed in any way. Upon removal, after one month, there will be nothing left behind and there will be no indications that the GPS unit and camera had ever been installed. At this time the researchers will give you a $100 Walmart Giftcard as a *Thank You* for participating. The $100 is paid from federal research funds through TransAnalytics and NHTSA, not by the Commonwealth of Virginia.

Virginia DMV will not receive any information about your driving, and participation will have absolutely no effect on your driver's license, now or ever. Researchers conducting this voluntary study will remove your name and any identifying information before they give the data they've collected to NHTSA. No one else will receive any data collected during this study. Any publications from this research will only report group statistics. Individual information will never be reported.

At your request, researchers will call you at the time of day and telephone number you provide on the reply form. Those researchers are from TransAnalytics, LLC, a company in Quakertown, PA, that is managing this research project under contract to NHTSA. When you are contacted, your caller ID will either say "TRANSANALYTICS" or will display one of our company phone numbers: 215-538-3820, 215-538-3822, or 215-538-3835. TransAnalytics and NHTSA *hope you will volunteer to participate in their important safety research study!*

DOT HS 812 486
April 2018

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

13396-041918-v12