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Licensing Procedures for Older Drivers

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16. Abstract

This study examined the driver licensing procedures in all 50 States as they apply to the older (65+) driver. A literature review examined reports of possible declines in older driver capabilities and the ability of a driver licensing agency to screen for them. The review also covered studies of licensing policies and procedures that had the potential ability to reduce older driver crash rates. Four special emphasis States (Illinois, Iowa, Kansas, and New Hampshire) were selected for further study because their mix of policies and procedures could theoretically enhance safety. All 4 required shorter renewal periods, in-person renewal, and vision testing for older drivers. In addition, Illinois and New Hampshire were the only States to mandate a road test for every renewal. Six comparison States were identified (Indiana, Minnesota, Missouri, Nebraska, Vermont, and Wisconsin). Each of the 4 special emphasis and 6 comparison States were treated as a separate case study. A detailed process evaluation was conducted in the emphasis States, and discussions were held with licensing agency managers, license office staff, and older drivers. Managers and staff believed their procedures positively affected safety. Older drivers did not feel unfairly treated and recognized the need for additional screening and self-limitation. Crash measures showed stable or declining crash rates per population for older driver ages in all 10 States. Crashes per licensed driver showed a differential pattern for Illinois and New Hampshire, the 2 States that re-test all drivers 75 and older, as compared to the other 8 States, which could simply be the effect of removing people who do not drive from the license rolls in these 2 States. Additional research to attempt to describe more fully the data patterns uncovered and ways to overcome existing screening limitations, e.g., better vision testing equipment, appears warranted.

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- Illinois
- Indiana
- Iowa
- Kansas
- Minnesota
- Missouri
- Nebraska
- New Hampshire
- Vermont
- Wisconsin

EXECUTIVE SUMMARY

Introduction

The population of adults 65 and older is the fastest growing demographic in the United States (Bayam, Liebowitz, & Agresti, 2005). It is estimated that by 2030, drivers over 65 will represent a quarter of total driver fatalities – up from around 14.4% in 2002 (Lyman, Ferguson, Braver, & Williams, 2002). When comparing the crash rates per mile driven of various age groups, the data resemble a U-shaped curve. Young drivers have the highest crash rate, which drops as drivers leave their teens. After age 25, the crash rate remains low until around age 70 when it begins to increase again. This U-shaped trend on crashes per mile driven has been found in many studies in many countries (e.g., Bryer, 2000; Cook, Knight, Olson, Nechodom, & Dean, 2000; Emsbach & Friedel, 1999; Lyman et al., 2002).

Given the increase in crash rates around age 70, there should be a significant safety benefit in identifying potential problem older drivers before they are involved in a serious crash. The driver licensing process is one potential point for an intervention.

Approach

The current study first conducted a review of research related to older drivers using a variety of journal and report databases. The review focused on research into cognitive, visual-perceptual, psychomotor, and mobility factors related to the safety of older drivers. The review also examined research on how driver licensing policies and procedures affected older driver safety in the United States and abroad. The next step involved examining driver licensing procedures across the United States to identify States that had licensing procedures that may improve senior driver safety. Four States, Illinois, Iowa, Kansas, and New Hampshire, were selected as special emphasis States for in-depth review.

These four States all have at least one licensing policy or procedure not widely used in the balance of the States that could theoretically affect older driver safety. The in-depth review of each State involved discussions with licensing managers, licensing staff, and older drivers who recently went through the license renewal process. Analyses compared crash rates for these four emphasis States with six other comparison States to see if any safety benefits could be identified in the emphasis States.

Literature Review

A review of research related to older drivers using journal and report databases focused on cognitive, visual-perceptual, psychomotor, and mobility factors related to the safety of older drivers. The review also examined crash statistics for older drivers that demonstrate the types of crashes older drivers were typically involved in, and how driving cessation affected the lives of older adults. The review included studies on how driver licensing policies and procedures affected older driver safety in the United States and abroad.

Discussions with Staff and Older Drivers

Discussions held with licensing department management and staff in each of the emphasis States indicated that the staff used the various tools available to them to screen older

drivers. Licensing staff in each State the indicated that they thought their particular approach had a positive impact on older driver safety. The older drivers who provided information after completing their transactions at the licensing offices shared this positive sentiment. Most were supportive and accepted the States' efforts to ensure older drivers were able to safely operate a motor vehicle. Many of the older drivers recognized that their abilities were deteriorating, but still wanted to drive to maintain their independence. However, they accepted decisions made by the licensing authority, and many indicated they would stop driving on their own if they or others (usually family members) felt they were a threat on the roadway.

Older Drivers' Crash and Fatality Rates

Researchers obtained crash data for each State except New Hampshire and Vermont from NHTSA's State Data System (SDS). New Hampshire and Vermont provided data from State records. Four to five years' worth of data were available for each State, but the available years varied by State. Driver age was obtained from the crash records. Five-year age groups were created, and all crashes for drivers in that age group were tallied across all years of available data.

Each State provided driver license counts by year, which researchers used to calculate the number of crashes per 1,000 licensed drivers. Population for each age group, derived from U. S. Census estimates for the years of available crash data, provided the data to compute crashes per 1,000 population for each age group within a State.

Figure ES-1 shows the crashes per 1,000 licensed drivers for the four emphasis States, and Figure ES-2 shows the crashes per 1,000 licensed drivers for the comparison States. Illinois and New Hampshire had a different crash rate pattern per licensed driver starting around age 75, beyond which the crash rate started to rise. Iowa shows a very slight increase, but not as much as Illinois and New Hampshire. Of the 6 comparison States, only Missouri shows a slight increase in crash rates per licensed driver starting around age 70, but the increase was not as pronounced as for the three emphasis States, and the rate began to decrease for the oldest driver group.

An examination of the percentage of the population licensed for each age group revealed that those States showing this crash rate increase trend had a much lower percentage of the population licensed for the older age groups, especially for those 85 and older. For example, in Illinois only 32% of drivers 85 and older were licensed, whereas Indiana had 62% licensed for the same age group. These results should be interpreted with caution because of the questionable accuracy of the license counts provided by the States. Some States had more licensed drivers than population for some age groups, which suggests the data may contain substantial biases.

A more stable measure of crashes in the States may be the crashes per 1,000 population. Figures ES-3 and ES-4 provide plots of the crash rates for the emphasis States and comparison States, respectively. The crash rate plots show similar patterns across all States with the crashes per 1,000 population continuing a downward trend with age. Some of the States show a flattening of the curve around age 70, but all of the States show a steep drop in crashes per 1,000 drivers 85 and older.

Figure ES-1. Emphasis States: Crashes per 1,000 licensed drivers

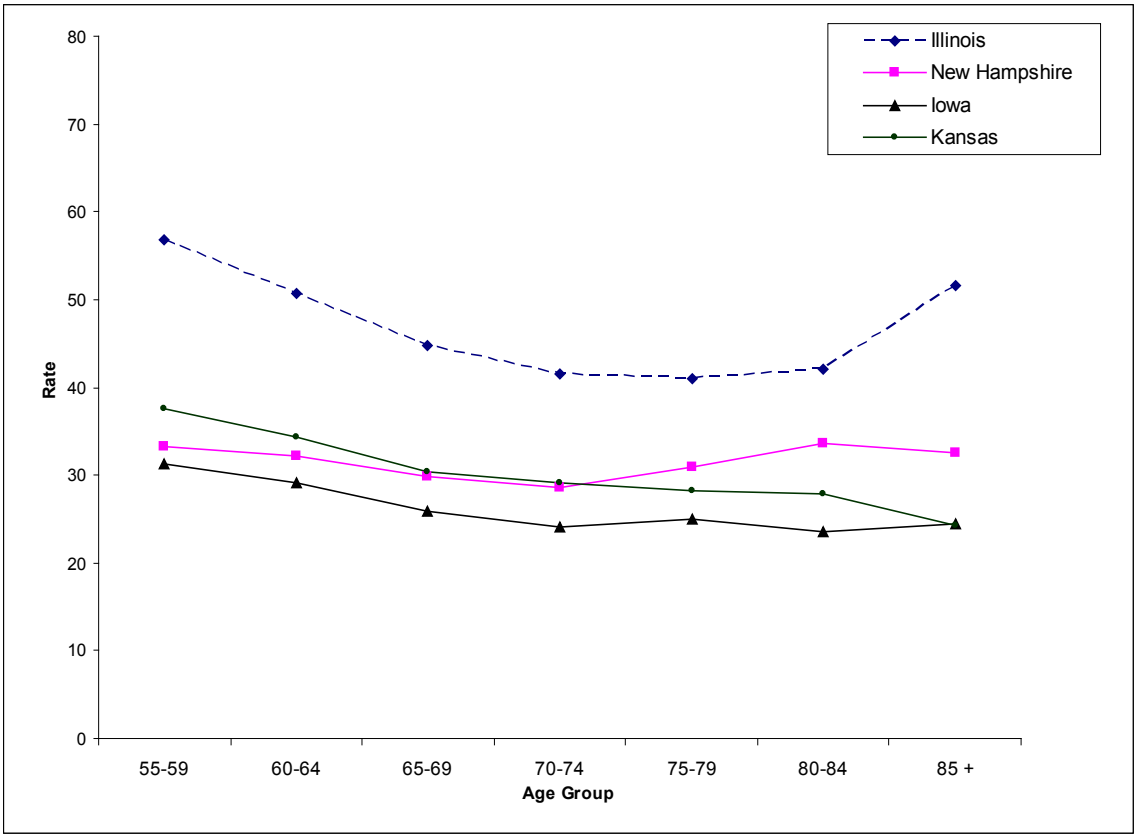


Figure ES-2. Comparison States: Crashes per 1,000 licensed drivers

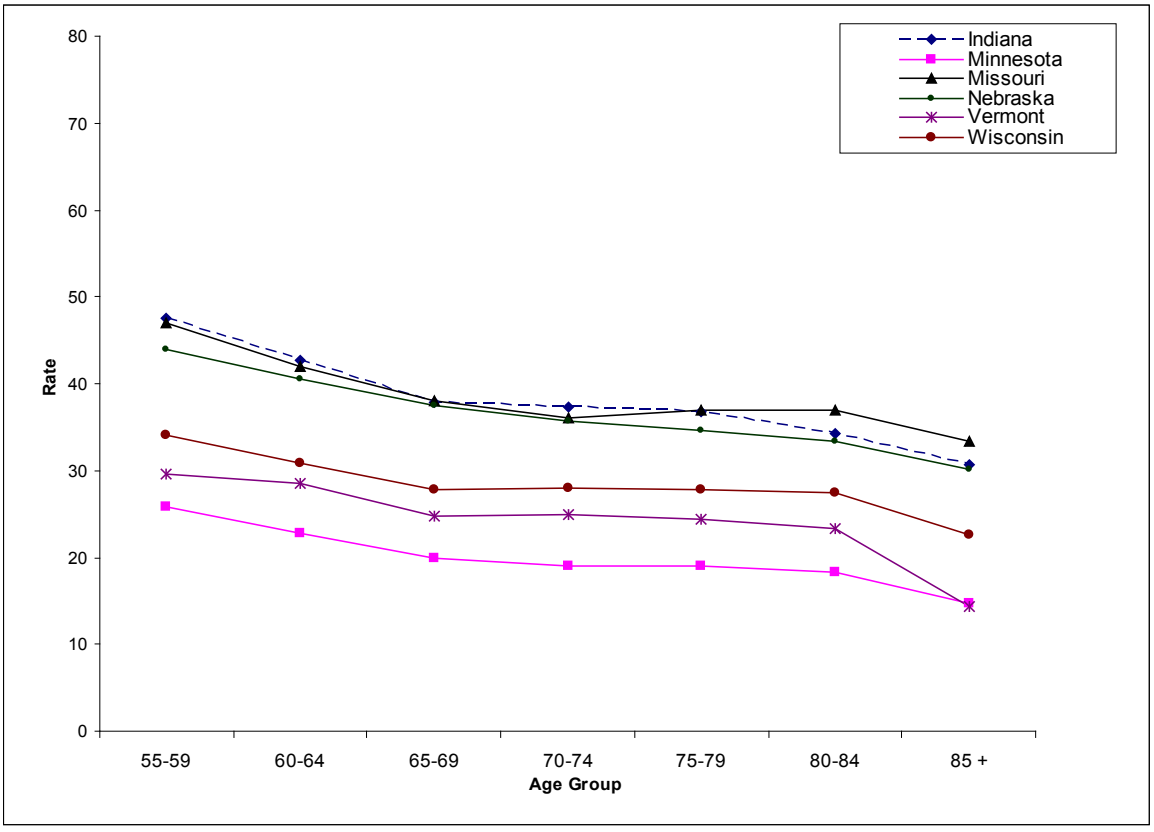


Figure ES-3. Emphasis States: Crashes per 1,000 population

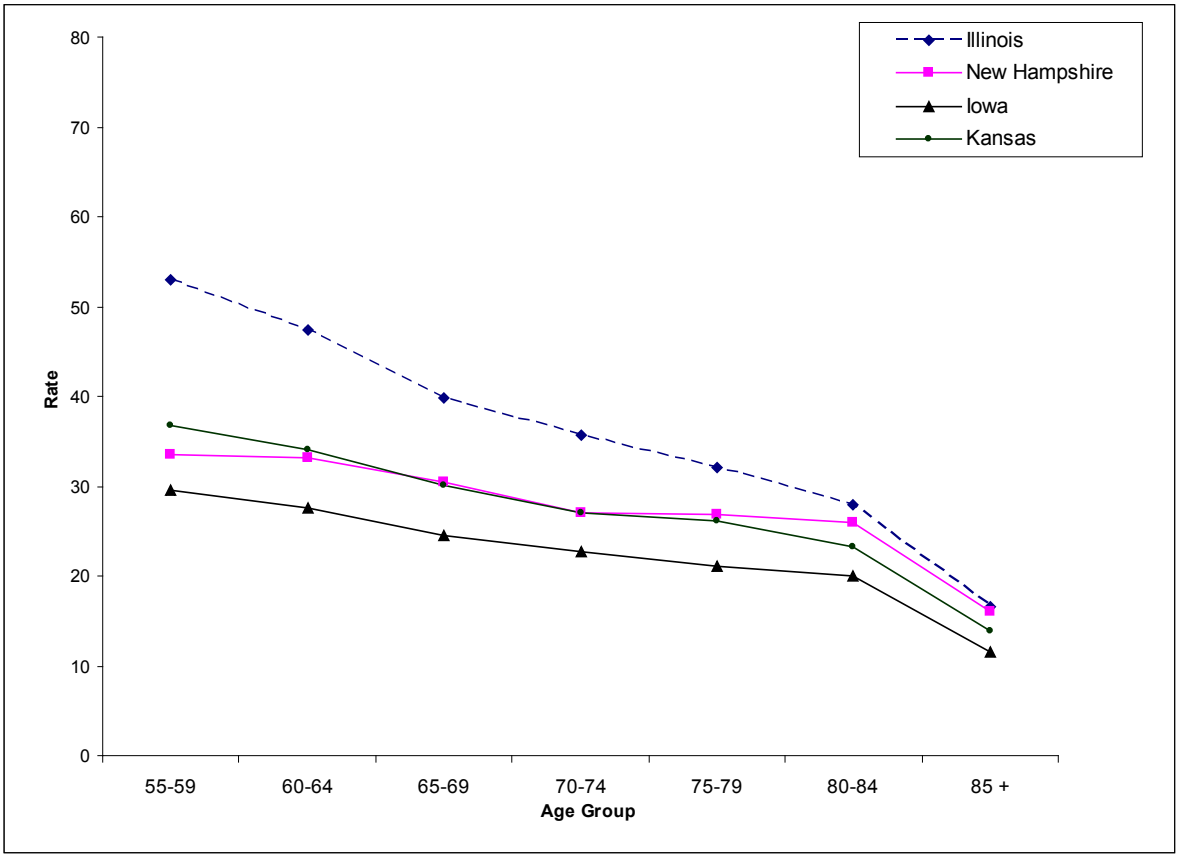
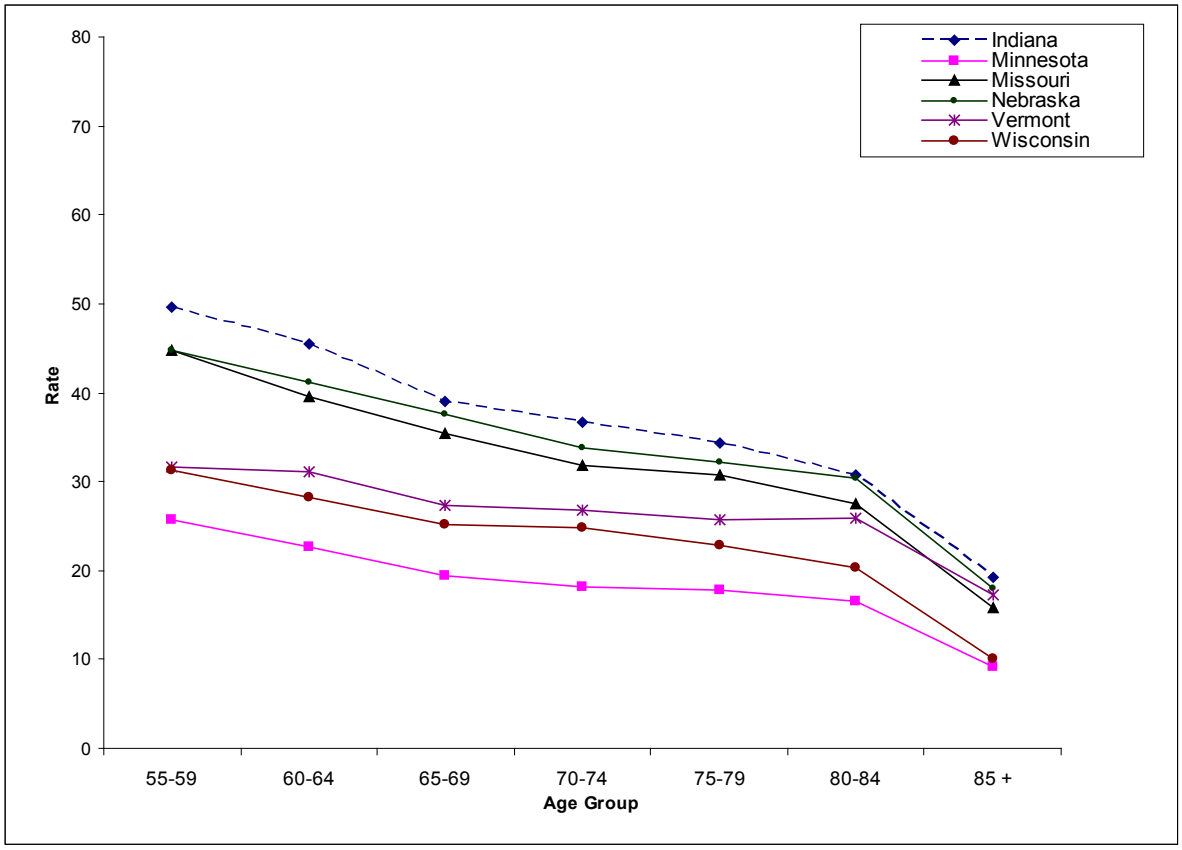


Figure ES-4. Comparison States: Crashes per 1,000 population



Driver fatality data from the Fatality Analysis Reporting System (FARS) for each State were collected to match the years of available crash data. Only data for fatally injured drivers with a known age were included. Fatality rates were calculated per 100,000 licensed drivers and per 100,000 population for each State.

For driver fatalities per 100,000 licensed drivers, Illinois, New Hampshire, and Iowa show virtually the same U-shaped pattern with the curves reaching their lowest points around age 65-69 or 70-74 and increasing thereafter, especially for those 85 and older. Kansas showed a similar pattern, although the increase was not as pronounced after age 65-69. Missouri, Nebraska, and Wisconsin data followed a U-shaped curve similar to that seen for Illinois, New Hampshire, and Iowa, although the spike at age 85 and older was not as pronounced for these three comparison States. Indiana, Minnesota, and Vermont did not show as marked an increase after age 65-69 as the other States, although Indiana showed a spike for the oldest driver group.

For driver fatalities per 100,000 population, Iowa and Kansas showed similar patterns, reaching low points at age 70-74 before rising at age 75-79 and then declining for 85 and older. New Hampshire reached a low point at age 65-69 and then increased steadily from there on. Illinois reached a low point at 65-69 and remained relatively flat from that point on. Missouri, Nebraska, and Wisconsin had similar patterns of fatalities with spikes at 80-84. Vermont showed a spike at 70-74, and Indiana and Minnesota fatalities per 100,000 population declined after 65-69.

Discussion

The examination of the licensing practices in the various States as they pertained to older drivers did not uncover remarkable differences. Varying renewal periods and a requirement to appear at a licensing office were some basic discriminatory variables. Based on the literature and the pattern of State practices, the requirement for a road test on every renewal over age 75 (only Illinois and New Hampshire) was of particular interest.

Overall, the data collected in this study led to the conclusion that the implementation of licensing practices in the special emphasis States followed the intent of State rules and regulations. In addition to implementing the system as intended, staff members appeared to believe that their systems were fair, reasonable, and that they improved safety.

Contrary to what some might expect, the discussions with older drivers in the special emphasis States provided no evidence that they believed they were treated unfairly or that the special licensing procedures applicable to them were ineffective. Overall, older drivers understood that the aging process had the potential to compromise their driving ability and safety. They appeared willing to be screened and most were confident that their abilities had not eroded to the point of creating a safety problem. Many of the older drivers expressed the belief that their years of driving experience would compensate for any degradation in faculties such as reaction time or range of motion.

The lack of clearly different licensing approaches across the States as well as the nature and quality of the available crash and licensure data prevented using inferential statistical tests among the States. Using crashes per population and crashes per licensed driver as surrogates was reasonable, but both denominator variables suffered from data uncertainties. Notwithstanding data limitations, several noteworthy patterns emerged in the crash data. The first is the general downward trend in crashes per population with increasing age. A second pattern of note was the sharp reduction in the percentage of licensed drivers as age increased beyond 65. The most striking pattern was the differential shape of the crashes per licensed driver curves for Illinois and New Hampshire when compared to all of the other States. This suggests an influence of the mandatory road test. It is not necessarily counter-intuitive that both States display an increase in crashes per licensed driver at the oldest ages while still showing a decrease in crashes per population consistent with the other States. This could simply be the effect of removing older people who do not drive from the license rolls.

The study findings led to a number of questions that warrant further research. However, nothing found in the current investigation implies the need for an immediate response to counter a safety issue.

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1. INTRODUCTION

This is the final report of a study titled *Safety Outcomes of Licensing Procedures for Older Drivers* conducted by Dunlap and Associates, Inc., under Task Order 007 of Contract Number DTNH22-05-D-35043 from the National Highway Traffic Safety Administration (NHTSA).

1.1 Background

The population of adults 65 and older is the fastest growing demographic in the United States (Bayam, Liebowitz, & Agresti, 2005). By 2030, drivers over 65 are projected to represent a quarter of total driver fatalities – up from around 14.4% in 2002 (Lyman, Ferguson, Braver, & Williams, 2002). When comparing the crash rates per mile driven of various age groups, the data resemble a U-shaped curve. Young drivers have the highest crash rate, which drops as drivers leave their teens and, after age 25, the rate stays about the same until around age 70 when it begins to increase again. This U-shaped trend has been found across studies in many countries (e.g., Bryer, 2000; Cook, Knight, Olson, Nechodom, & Dean, 2000; Emsbach & Friedel, 1999; Lyman et al., 2002).

Given the reported increase in crash rates around age 70, there would appear to be a safety benefit in being able to identify potential problem older drivers before they are involved in a serious crash. The driver licensing process may provide a point for intervention, and many States have implemented licensing procedures in an attempt to address the problem. The study reported herein explored the various licensing processes across the United States and selected four States, Illinois, Iowa, Kansas, and New Hampshire, for more in-depth review. These four States each have at least one licensing policy or procedure that is not widely used in the balance of the States and could affect older driver safety. The in-depth review of each State involved discussions with licensing staff and with older drivers who recently went through the license renewal process. Analyses compared crash rates for these four emphasis States with six comparison States to shed light on whether the interventions led to a safety benefit.

1.2 Study Objectives

This study was concerned with driver licensing procedures that are either specifically aimed at or may differentially affect older drivers. The focus was on how these licensing procedures impact the older driver crash rates in the study States as well as their effect on the attitudes of older drivers and licensing staff. The project's objectives were to:

- Identify safety benefits or unintended consequences of licensing policies specific to older drivers.
- Conduct a process evaluation on driver license renewal policies and procedures that applied to the general public and those that applied specifically to older drivers across the United States.
- Collect information about licensing processes and procedures from each of the States as well as the District of Columbia.

- Select special emphasis States for a more comprehensive examination of general and older driver licensing procedures.

- Conduct discussions with licensing officials, older drivers who have recently renewed their licenses, and older adults who no longer driver in each of the special emphasis States.
- Analyze rates of older driver crashes in the special emphasis States in order to determine the safety benefits associated with the various licensing procedures.

2. APPROACH

In order to achieve the project's objectives, the research team completed a number of preparatory and data collection tasks, including:

- A literature review.
- A review and cataloging of State driver license renewal policies and procedures.
- The selection of special emphasis States that had implemented policies or procedures for the licensing of older drivers that were not widely in use and had the potential to improve safety.
- An in-depth review of licensing procedures in special emphasis States that covered discussions with:
    - State-level license agency management;
    - license examiners and administrative staff; and
    - older drivers who had recently completed the license renewal process.
- Analyses of crash rates by driver age in the special emphasis States and a selected group of comparison States.

The following sections describe each of these tasks in more depth. A section of the report describes each special emphasis State and comparison State separately. These sections summarize licensing procedures that may affect older drivers, as well as discussions with licensing personnel and older drivers in the emphasis States. Finally, the results of the crash analyses for each State are presented. A general discussion section reflects on the implications of the study's findings.

2.1 Literature Review

A review of research related to older drivers using journal and report databases focused on cognitive, visual-perceptual, psychomotor, and mobility factors related to the safety of older drivers. The review also examined crash statistics for older drivers that demonstrated the types of crashes older drivers were typically involved in, as well as the effects of driving cessation on the lives of older adults. The review examined research on how driver licensing policies and procedures affect older driver safety in the United States and abroad.

2.2 Review of Driver Licensing Policies for Older Drivers and Selection of Special Emphasis States

The American Medical Association and NHTSA developed *The Physician's Guide to Assessing and Counseling Older Drivers* in 2003. This guide included a chapter on *State Licensing Requirements and Licensing Laws* that outlined each State's general licensing procedures and any specific requirements for older drivers. The current study updated this chapter based on information available from the States, either from materials available on the various licensing authorities' websites, in their driver's manuals or handbooks, or through conversations with State officials.

This information, combined with findings from the literature review, served as the basis for the selection of the four special emphasis States for this study: Illinois, Iowa, Kansas, and New Hampshire. Each of these States had at least one regulation or policy that went beyond what the "average" State was doing with respect to older drivers' license renewal. Research staff conducted in-depth reviews of the licensing policies in each special emphasis State via site visits with State agency management staff and licensing office managers and staff. The licensing policies and site visits are summarized separately later in the report for each State.

Another six States were selected as "comparison" States. These States were from the same regions as the special emphasis States and included a wide variety of "typical" licensing policies. The comparison States included Indiana, Minnesota, Missouri, Nebraska, Vermont, and Wisconsin. No site visits were conducted for these States, but researchers held telephone discussions with State-level personnel, and culled information from their websites. The licensing policies of these comparison States are briefly summarized, and the same crash analyses conducted for the special emphasis States were also conducted for these six States.

2.3 In-Depth Review of Driver Licensing Procedures in the Emphasis States

Meetings with licensing management staff from each special emphasis State provided greater insight into the licensing policies and procedures. Discussions centered on State policies regarding age-based renewal policies and procedures for older drivers and how these policies were implemented. Discussions included any other programs (e.g., training programs, educational programs) the State sponsored or to which the State referred drivers. The responsibilities of various licensing office staff and training for the staff were also covered.

After this initial meeting with State-level management staff, project personnel visited four driver licensing offices in each State to observe the licensing procedures. Discussions were held with licensing personnel at the offices and older drivers who had just completed the license renewal process. The licensing management selected licensing offices that represented the range of types of offices across the State. In all four cases, project staff visited small, medium, and large offices. Discussions with the staff focused on how they implemented the policies and their opinions as to policy effectiveness. Discussions with older drivers focused on their experiences with the renewal process. Summaries of the discussions with the office licensing staff and older drivers are found in each State's section later in the report.

2.4 Crash and Fatality Rates by Driver Age

NHTSA's State Data System (SDS) supplied crash data for each State except New Hampshire and Vermont. The SDS standardizes each State's crash files, however, the system does not necessarily contain the same years of data for all States or may have incomplete data for some years in some States. Please note that crash reporting requirements can vary greatly across States. Therefore, even though the SDS data were "standardized," the data had bias associated with them given differences within each State's crash records system. New Hampshire and Vermont were not included in the SDS. Crash data was provided for these two States from State records. The years of available crash data used in this study are listed below for each State.

- Illinois 2003-2007
- Iowa 2004-2008

- Kansas 2003-2007
- New Hampshire 2004-2008
- Indiana 2003-2007
- Minnesota 2002, 2004-2007
- Missouri 2003-2006
- Nebraska 2003-2007
- Vermont 2004-2008
- Wisconsin 2003-2006

Analysts created five-year driver age groups and tallied all crashes for drivers in each age group across all years of available data. These crash totals by age group were used to calculate crashes per 1,000 population and per 1,000 licensed drivers for each State.

U. S. Census estimates for years coinciding with the years of available crash data provided the population for each age group. Population counts were summed across the selected years. The summed crash counts across all of the years for each age group were then divided by the summed population counts across all years for the corresponding age group and multiplied by 1,000 to obtain the number of crashes per 1,000 population for each age group.

Each State provided driver license counts by age and year. Many of the States provided printouts of license counts by single year of age, while others only had counts by age class intervals (e.g., 60- to 64-year-olds). Drivers may have been double-counted if they had additional endorsements on a driver's license (e.g., a regular operator's license with a motorcycle endorsement). This may have been the cause of some States indicating well over 100% of the population licensed for some age groups (see Table 1). Other possible explanations include inaccurate Census estimates based on extrapolations and errors in the license counts. The research team did not reach a definitive conclusion on the high licensure rates. Some States were missing one or more years of interest; analysts extrapolated from other years' data to fill in the gaps. The summed crash counts across all of the years for each age group were divided by the summed license counts across all years for the corresponding age group and multiplied by 1,000 to calculate "crashes per 1,000 licensed drivers."

Analysts accessed driver fatality data from the Fatality Analysis Reporting System (FARS). Data for each State were collected to match the years of available non-fatal crash data. The analyses included only data for fatally injured drivers whose age was known. Fatality rates were calculated per 100,000 licensed drivers and per 100,000 population for each State. Given the irregularities in the licensure rates described above, please use caution in interpreting the rates per licensed driver.

Each State's section of this report contains graphs with crashes per 1,000 population, crashes per 1,000 licensed drivers, driver fatalities per 100,000 population, and driver fatalities per 100,000 licensed drivers plotted for five-year age groups beginning with age 55. The Appendix contains plots for all ages of licensed drivers 20 and older. Given the myriad of data biases associated with the crash data, population counts, driver license counts, and inherent differences in driving environments and laws across States, no statistical comparisons were made among the States. The "Comparison" section of this report provides tables and graphs of the above data categories with data from all States included to enable visual comparisons. The discussion section of the report focuses on the nature of the crash curves within each State and what differences among the States might mean relative to the licensing procedures for older drivers in those States.

Table 1. Percentage of population licensed by age group

	20 - 24 years	25 - 29 years	30 - 34 years	35 - 39 years	40 - 44 years	45 - 49 years	50 - 54 years	55 - 59 years	60 - 64 years	65 - 69 years	70 - 74 years	75 - 79 years	80 - 84 years	85 + years
Emphasis States														
Illinois	84.20	89.44	85.57	88.97	89.20	90.52	92.60	93.29	93.42	89.09	85.70	78.01	66.40	32.24
Iowa	81.24	90.41	90.42	91.46	91.46	93.28	93.28	94.43	94.41	94.83	94.82	84.61	84.62	46.72
Kansas	87.00	96.18	96.03	93.26	91.77	94.15	96.40	97.95	99.02	99.10	92.81	92.40	83.38	57.03
New Hampshire	100.50	105.38	103.67	100.30	99.43	100.65	101.96	101.01	102.95	102.28	94.49	86.74	77.57	49.33
Comparison States														
Indiana	92.65	98.82	96.07	97.29	94.57	98.24	102.12	104.37	106.50	103.10	98.52	93.37	89.63	62.62
Minnesota	92.41	99.08	94.60	94.23	93.77	96.26	97.66	99.04	99.58	98.24	95.42	93.38	90.26	62.72
Missouri	88.59	92.89	93.77	93.53	92.99	94.18	95.08	95.05	94.27	93.37	88.04	83.27	74.43	47.50
Nebraska	94.86	105.91	101.52	99.27	97.91	98.26	99.96	101.65	101.37	99.84	94.99	92.64	91.27	59.65
Vermont	98.96	126.54	128.86	115.96	107.81	106.85	106.94	107.03	109.03	110.66	107.81	105.23	110.45	120.50
Wisconsin	83.38	90.59	95.66	94.26	93.61	92.76	93.02	91.59	91.31	90.49	88.82	82.17	73.93	44.24

Note: Some States had over 100% of the estimated population licensed for some age groups. Researchers verified the license count information with States and re-examined the Census data. Even the though the numbers in the Table were verified with the various data sources, the reader should interpret them with caution.

3. LITERATURE REVIEW

The literature covering the effects of aging specifically related to driving or to tasks that are critical to driving is extensive. Therefore, the literature review was limited to studies related to crashes involving older drivers and to the aging effects and remedial actions most relevant to a State driver licensing agency.

The literature indicates that drivers 75 to 79 are involved in crashes approximately two to three times as often as drivers 65 to 69 (Assailly, BoninGuillaume, Mohr, Parola, Grandjean, & Frances, 2006; Bayam, Liebowitz, & Agresti, 2005; Bryer, 2000; Emsbach & Friedel, 1999; Lyman et al., 2002; Ryan, Legge, & Rosman, 1998), and they are three times as likely to be killed in a crash (Bryer, 2000; Lyman et al., 2002). The types of crashes older drivers are involved in differ from those of younger drivers. Drivers over 70 are involved in more side-impact or angled-impact crashes than any other crash types. These crashes usually occur at merges, left or right turns in intersections, turns into an available gap in cross-traffic, and lane changes. In most of the above situations, hazards materialize peripherally (Bayam et al., 2005; Lyman et al., 2002; Ryan et al., 1998).

As people age, maintaining situational awareness while driving may become more difficult. Advancing age typically coincides with declines in cognitive, physical and psychomotor abilities that can make it more difficult for older drivers to adequately scan the environment around their vehicle, to make decisions based upon that information, and to react to sudden changes. Older drivers tend to be somewhat aware of the effect these changes can have on their driving (Hakamies-Blomqvist, 1996). Many older drivers incorporate some compensatory behaviors in their driving. These include slowing down, braking earlier, limiting the conditions or times of day in which they drive, or in some cases, voluntarily giving up driving (DeCarlo, Scilley, Wells & Owsley, 2003; Eby, Trombley, Molnar, & Shope, 1998). The decision to self-limit driving typically does not come easily. Older adults and their families must balance safety, health and quality of life when considering driving cessation, as the ability to drive has been linked to emotional and cognitive health, as well as to physical health and well-being (DeCarlo et al., 2003; Rudman, Friedland, Chipman, & Sciortino, 2006; Yamashita, Iijima, & Kobayashi, 1999; Yassuda, Wilson, & von Mering, 1997).

The following literature review sections explore research into limitations specific to older drivers. A section then discusses studies of driver licensing procedures and how they may affect senior driver safety.

3.1 Factors Related to Older Driver Safety

Young drivers' at-fault in crashes are often attributed to inexperience and an inability to reliably predict hazards (Pradhan et al., 2005). Older drivers' at-fault in crashes tend to be attributed to their increasing difficulty in scanning for or process information efficiently combined with slowed reaction time (Kramer, Hahn, Irwin, & Theeuwes, 1999; MacDougall & Moore, 2005; Nieuwenhuis, Ridderinkhof, deJong, Kok, & van der Molen, 2000). Some evidence indicates older drivers underestimate the degree to which cognitive and physical decline can affect their driving (Talbot et al., 2005; Yassuda et al., 1997). As a result, older drivers compensate appropriately in some areas, such as when risks develop directly in front of

the vehicle but may undercompensate in other areas, such as peripheral scanning. This section discusses the types of crashes older drivers are involved in and factors that may influence older drivers' ability to detect hazards in certain situations.

3.1.1 Crash Statistics and Trends

According to data compiled for NHSTA by Cerrelli (1998), drivers over 75 have a crash rate based on miles travelled that is nearly double that of experienced drivers 25 to 65. However, these data take into account all crash types. In order to gain some insight into situations most risky for older drivers, it is necessary to categorize the data by crash type. Bryer (2000) found that older drivers were over-represented in angled-impact crashes while younger drivers were most likely to be involved in crashes involving elements directly ahead of the car. Stutts, Martell, and Staplin (2009) also found that drivers over 61 had disproportionately more crashes involving left turns than other age groups.

Cook, Knight, Olson, Nechodom, and Dean (2000) found that failure-to-yield was the root crash cause 3.9 times more often with older drivers than with younger drivers. An improper turn was likely to be the cause of the crash 2.5 times as often for older drivers as for younger drivers. Finally, failure to properly search during a left turn was likely to be the root cause 2.3 times as often for older drivers compared to younger drivers. Conversely, high speed was likely to be the root cause only 0.6 times as often for older drivers compared to younger drivers. Crashes due to lack of visibility at night were only 0.4 times as likely to be the root cause of crashes for older drivers.

Other studies had similar findings. Research by Chandraratna and Stamatiadis (2003) found that maneuvers made by older drivers that were most likely to lead to crashes were left turns, gap acceptance situations, and high-speed lane changes. All of these maneuvers can lead to angled-impact crashes and each involves some degree of processing of peripheral information. The literature provides evidence of older drivers' diminished ability to perceive and process peripheral information that can lead to higher crash rates (Ball, Beard, Roenker, Miller, & Griggs, 1988; Ball, Owsley, Sloane, Roenker, & Bruni, 1993).

In addition to elevated crash rates, older drivers were also more likely to be killed in an automobile accident when compared to younger age groups (Bayam, Liebowitz, & Agresti, 2005; Bryer, 2000; Cook et al., 2000; Evans, 1991; Hakamies-Blomqvist, 1996; Lyman, Ferguson, Braver, & Williams, 2002; Rosman, 2001). Drivers 75 to 79 were 3.5 times more likely to be killed in an automobile crash than drivers 30 to 65 years old. This ratio jumped to 9.5 after age 80.

3.1.2 Cognitive Factors Related to Older Drivers

Typically, a driver must correctly perceive, process, and then act upon a large amount of information in order to navigate safely through the environment. Drivers must properly prioritize cues in order to make good decisions based upon the pertinent information. Age-related deficits associated with cognitive processing limitations can impair a person's ability to scan effectively and process information in the environment.

Sustained attention, or vigilance, is the ability to maintain attention on specific information that is critical to the task at hand while simultaneously ignoring information that is irrelevant to the task (Eby, Trombley, Molnar, & Shope, 1998; Parasuraman & Nestor, 1991). Often multiple critical pieces of information compete for a driver's attention. For instance, a driver may need to monitor other cars, curves, pedestrians, obstacles, lane position, vehicle gauges, and roadway conditions. Some studies have shown that as humans age, their ability to remain vigilant while driving decreases (Parasuraman & Nestor, 1991). One study by Campagne, Pebayle, and Muzet (2004) found that unlike younger drivers, older drivers' total errors and error severity were correlated with lower vigilance as measured by an electroencephalograph.

These findings are consistent with research on divided attention—the ability to focus attention on two or more tasks simultaneously (Eby et al., 1998; Andersen, Cisneros, Saidpour, & Atchley, 2000; Brouwer, Waterink, Vanwolffelaar,, & Rothengatter, 1991). Research has shown that, compared to younger participants, older adults allocated more attentional resources to encode and retrieve information in divided attention tasks (Sit & Fisk, 1999; Strayer & Drews, 2004). Crook, West, and Larabee (1993) tested older drivers' divided attention abilities. Researchers asked participants to drive while engaged in a secondary task of monitoring weather and traffic information on the radio. When these tasks were performed simultaneously, older adults scored significantly worse than younger participants in driving performance and information recall.

Research has shown that older drivers may have decrements in selective attention, the ability to attend to important cues while ignoring irrelevant ones (Eby et al., 1998). Many studies have shown a negative correlation between selective attention ability and number of crashes (e.g., Avolio, Kroeck,, & Panek, 1985; Ranney & Pulling, 1989), and other studies have reported that older adults have poorer selective attention abilities than their younger counterparts (Maylor & Lavie, 1998; Parasuraman, 1991). Older adults have more difficulty ignoring or inhibiting irrelevant information. These decrements in inhibition increase with age, making older drivers more susceptible to distraction, thereby missing critical information in their driving environment (Bolstad & Hess, 2000; Gamboz, Russo,, & Fox, 2000; Kramer, Hann, Irwin, & Theeuwes, 1999; Nieuwenhuis, Ridderinkhof, Jong, Kok, & van der Molen, 2000).

The speed at which information is processed plays an important role in keeping drivers out of crashes. A driver must incorporate information about driving hazards into his or her situational assessment and then react quickly. Older adults have a diminished capacity for processing information compared to younger adults. Research has attributed this in large part to an age-related decline in short-term memory capacity (Ball, 1997; Bolstad & Hess, 2000; Cerella, 1990). The fewer items a person can hold in short-term memory, the longer it will take them to process a fixed amount of information. This could result in an increase in the time a driver needs to process information and react to a hazard, leading to increased probability of a crash.

In general, working memory, short-term memory, long-term memory, and speed-of-processing performance all decrease with advancing age (Hoyer & Verhaeghen, 2006). Salthouse (1985) reported that the positive correlation between age and response time averaged 0.45 over 50 correlations from 39 separate studies. For drivers over 60, crash risk has been positively correlated with information processing time, indicating elevated crash risk for those people who

take longer to process information (Eby et al., 1998; Klavora & Heslegrave, 2002; West, Crook, & Barron, 1992).

3.1.3 Visual Perceptual Factors

As people age, visual quality tends to decrease. Visual acuity, or the ability to see sharp details or small objects, decreases substantially with age (Kroemer & Grandjean, 1997). Reduced visual acuity makes reading signs more difficult and can lead to a delay in a driver's ability to perceive/recognize important information such as a red traffic light or potential hazards ahead. Often corrective lenses remedy visual acuity deficits. However, in some cases, such as with an odd-shaped cornea, corrective lenses provide only limited correction in some depths of the visual field (Schieber, 2006).

Visual contrast sensitivity also tends to decrease with age (Kroemer & Grandjean, 1997; Schieber, 2006). Contrast sensitivity is the ability to perceive differences in luminance. The more similar two areas are in luminance, the more difficult it is to discriminate between the two (Kroemer & Grandjean, 1997). As a person gets older, this ability to discriminate between similar luminance levels decreases. Studies have provided evidence that aging is associated with a dramatic decrease in rod density in the eye (Curcio, Millican, Allen, & Kalina, 1993; Schieber, 2006). While cones in the retina are sensitive to light from a wide range of the color spectrum, rods are sensitive to short wavelengths (blue and violet). Sensitivity to short wavelengths makes rods primarily responsible for our ability to see in dim light (Proctor & van Zandt, 1994). The onset of cataracts can contribute to both decreased visual acuity (blurred vision) and contrast sensitivity (clouded vision) (Schieber, 2006). Decreased contrast sensitivity makes it more difficult to discriminate objects in dim light, thus older drivers may have more difficulty reading signs or detecting hazards in low light conditions.

Glaucoma and macular degeneration are age-related diseases of the eye that can contribute to dramatic decreases in the visual field. Glaucoma involves an increase in the fluid pressure in the eye caused by a decrease in the flow of fluid out of the eye. This increased eye pressure can cause damage to the optic nerve. Left untreated, glaucoma can cause a gradual decrease in the quality of one's peripheral vision and result in tunnel vision (NIH Senior Health, 2007). Research has shown that drivers with moderate or severe glaucoma were significantly more likely to be involved in a crash than are drivers with mild or no glaucoma symptoms (McGwin et al., 2005; Owsley, Stalvey, Wells, & Sloane, 1999).

Age-related macular degeneration (AMD) is a disease that results in the loss of central vision and later, blindness. AMD comes in two varieties – dry and wet. In dry AMD the cells in the macula, which supports central vision, gradually die. Wet AMD involves an increase in the growth of small blood vessels behind the macula. These fragile blood vessels rupture, filling the immediate area with blood and causing loss of central vision (Patient Education Institute, 2007). According to the Patient Education Institute (2007), 90% of AMD cases are of the dry variety. However, 90% of AMD cases that lead to doctor mandated driving cessation are of the wet variety.

The ability to judge the speed and time-to-arrival of other vehicles and objects in the driving environment also changes with age. In a study by Staplin (1995), older drivers tended to be more accurate in choosing appropriate turning gaps in a steady stream of traffic, but had some

difficulty judging the speed of oncoming vehicles when there was a solitary vehicle in the oncoming stream. In this situation, the older driver must rely upon a judgment of distance rather than velocity of the opponent vehicle, and drivers tend to underestimate the "time-to-arrival" of oncoming vehicles, which decreased the chances of a traffic conflict since they were less likely to pull out (Staplin, Lococo, & Sim, 1993). The same applied when older drivers approached a stop sign; they tended to underestimate their arrival time at stop signs, resulting in earlier breaking (Andersen et al., 2000).

These finding suggest that, as long as an older driver is aware of the presence of an opposing vehicle, his or her decisions tend to favor being conservative. While this may result in a few honks from impatient drivers behind them, it serves to keep the older driver from pulling out when an oncoming vehicle is too close. However, older drivers are overrepresented in errors at intersections during turns, resulting in an increase in side-impacts for drivers over 70 (Bryer, 2000; Ryan et al., 1998). These crashes primarily occur when older drivers first fail to detect the presence of the other vehicle driving opposite and parallel to them. According to data reported by Hakamies-Blomqvist (1994), 44% of older drivers (compared to 26% of younger drivers) were unaware of the other vehicle before it hit them. This, combined with the fact that after age 70 the rate of side impacts increases while the rate of other types of crashes such as head-on, rear-end, single vehicle and side-swipes decreases or stays constant, suggests that failure to detect motion in the periphery of the visual field coupled with a decrease in the scanning efficiency undermine older drivers' safety.

Age-related declines in cognitive (e.g., processing speed, workload, attention, dementia) and visual (e.g., acuity, contrast sensitivity, cataracts, glaucoma, macular degeneration) abilities can combine to effectively reduce a person's functional field of vision (Ball, Beard, Roenker, Miller, & Griggs, 1988; Ball, Owsley, Sloane, Roenker, & Bruni, 1993). With a decline in cognitive ability, especially processing speed and cognitive workload, a driver can maintain fewer chunks of information in memory, and take longer to process information. The driver may process information in the central part of the visual field first at the expense of information in the periphery.

Research has shown useful field of view (UFOV) to be a reliable predictor of crashes in older adults (Ball & Owsley, 1991; Bowers, Peli, Elgin, McGwin, & Owsley, 2005; Clay, Wadley, Edwards, Roth, Roenker, & Ball, 2005; Owsley, Ball, Sloane, Roenker, & Bruni, 1991; Perryman & Fitten, 1996; Wood, 2002). In a limited correlation study, Ball and Owsley (1991) found that UFOV was as good a predictor of older driver crashes as more traditional tests of mental status. In a larger study conducted a few years later, Ball et al. (1993) found that drivers with substantial reduction in UFOV were six times as likely to have been involved in one or more crashes in the previous five years as drivers who had minimal or no UFOV reduction. A meta-analysis by Clay et al. (2005) found that the measure was repeatable as a predictor of negative driving outcomes.

3.1.4 Psychomotor and Mobility Factors

People normally experience a decrease in the range of motion of the joints, tendons and muscles as they age (Malfetti, 1985). Mobility of the neck and torso, which are particularly important to driving, are no exception (Eby et al., 1998). Research has shown that reduced flexibility of the neck and torso contributes to an increased likelihood of a crash (McPherson,

Michael, Ostrow, & Shaffron, 1988; McPherson, Ostrow, Shaffron, & Yeater, 1989). Isler, Parsonson, & Hansson (1997) found that the decreased ability to move one's head significantly reduced the distance at which drivers perceived oncoming vehicles.

Yee (1985) reported that 21% of drivers over 65 reported some degree of discomfort or stiffness when moving their neck or torso. Cranney et al. (2005) found that 50% of respondents reported some difficulty with driving due to limited flexibility and discomfort due to arthritis. Of these, 9.3% reported "quite a bit" or "a great deal" of difficulty driving with their physical problems. Bulstrode (1987) found that older drivers who reported joint discomfort tended to minimize their head movements and instead relied on a passenger to check for oncoming traffic for them, or positioned the car at intersections at such an angle as to be able to see more clearly down the road.

Decision-reaction time is the time it takes to perceive a stimulus, process the stimulus, choose a response, and execute the chosen response (Eby et al., 1998). As discussed in a previous section, decreases in cognitive function related to processing speed, UFOV and visual quality can increase the time it takes to perceive and process a stimulus. Decrements in motor control and muscle strength can increase the time a driver needs to execute a response (Eby et al., 1998; McGill, Yingling, & Peach, 1999). No correlation between simple reaction time and crash involvement has been established. However, increases in choice reaction time have been shown to be related to increased crash rates (Mihal & Barrett, 1976).

3.2 Older Drivers and the Impact of Driving Cessation

For many older drivers, possessing the ability to drive goes beyond simply transporting oneself from "Point A" to "Point B." For some, the ability to drive is closely linked to perceived independence, the ability to take care of oneself, and quality of life (Chipman, Payne, & McDonough, 1998; Rudman et al., 2006). It is not surprising that many older drivers resist attempts to evaluate their driving abilities. Removing driving privileges from older drivers sometimes leads to intense fighting and resentment between family members (Rudman et al., 2006). The concerns of older adults in this regard are warranted. Revoking driving privileges from older adults has shown to be related to increased mortality rates (Yamashita et al., 1999).

This section discusses the issues of quality of life, self-assessment of driving abilities, and older drivers' attempts at self-regulation and compensation, focusing on how these issues affect older drivers' perceptions and decisions. When making decisions about whether to revoke an older driver's license, licensing authorities, family members, and physicians need to be sensitive to these issues.

3.2.1 Older Drivers and Self-Rating

Research has shown that older drivers tend to overrate their driving abilities (Cooper, 1990; Holland, 1993; Freund, Colgrove, Burke, & McLeod, 2005), although this tendency is not exclusive to older adults. All age groups have an inclination towards self-bias when comparing their driving skills to those of their "average" peers and other age groups. The self-bias in older drivers tends to increase with number of years of driving experience (Holland, 1993). Freund et al., (2005) found that 52.9% of older drivers who considered themselves "a lot better" than other drivers demonstrated unsafe driving performance in a 30-minute driving simulation. They

reported a significant negative correlation between drivers' self-ratings and simulated driving performance. Marottoli and Richardson (1998) found that self-ratings of drivers over 70 were not correlated with on-road driving performance or with history of adverse driving events. Those with high confidence in their driving ability were typically no better than drivers who reported themselves as being average drivers.

Cooper (1990) investigated the types and contributing factors of crashes involving older drivers, and older adults' attitudes towards their driving ability and found that 31.5% of drivers over 70 reported being "much better" drivers than their peers. However, drivers who claimed to be much better drivers had similar crash rates to those who rated themselves to be "about the same" as their peers. Older drivers in the study failed to recognize failure-to-yield as their primary driving fault. When asked, most responded that they "failed to stop at stop signs" the most often. These reports were inconsistent with police crash reports for the 65 to 74 age group for which 32.6% of crashes were related to failure-to-yield while only 6.4% were due to failure to obey a control device (e.g., stop sign).

3.2.2 Driving Cessation and Quality of Life

The ability to drive has been linked to older adults' emotional, cognitive, and physical well-being (DeCarlo, Scilley, Wells, & Owsley, 2003; Rudman, Friedland, Chipman, & Sciortino, 2006; Yamashita, Iijima, & Kobayashi, 1999; Yassuda, Wilson, & von Mering, 1997). For older adults who lack other transportation alternatives, the revocation of a driver's license can lead to higher rates of depression, cognitive decline, and in some cases may hasten the death of an older adult (Yamashita et al., 1999).

Although they may overrate their abilities compared to others, many older drivers recognize their functional declines and incorporate some compensatory behavior into their driving. Those who perceive that they are putting themselves or others at a significant risk may decide to cease driving, but this is not always the case. A study by Talbot et al. (2005) found that out of a population of older drivers who had received a dementia diagnosis as specified by the DSM IV criteria, 22% continued to drive, and, of these, 63% drove daily, 71% drove unaccompanied, and 31% reported a crash.

Many older adults who cease driving report a sense of losing their independence and ability to take care of themselves (Ragland, Satariano, & MacLeod, 2004). Often the responsibility of providing support to these individuals falls to family members, either personally or through hiring help. Those who cease driving often move to a retirement community or home (Kostyniuk & Shope, 2003).

These kinds of support structures are not available to some older adults, or the older adults are not aware of the alternatives available to them. In these situations, quality of life can decrease significantly. Driving cessation has been associated with decreased out-of-home activity (Marottoli et al., 2000). Older adults who are homebound have higher rates of depression and mortality than their more mobile peers. This risk is highest among rural and low-income people (Yamashita et al., 1999; Marottoli et al, 1997). An engaged lifestyle is important to maintaining emotional and cognitive well-being. Studies have shown that increased activity outside of the home coupled with activities that challenge the older adult mentally and physically

are associated with better cognitive and physical health (Hultsch, Hertzog, Small, & Dixon, 1999; Lawton, Moss, Winter, & Hoffman, 2002).

3.3 License Renewal for Older Drivers

The methods used to evaluate older drivers vary from State-to-State and include in-person renewal, more frequent or more easily triggered road tests, and shorter renewal periods (Grabowski, Campbell, & Morrisey, 2004). Few of these strategies have been evaluated, and the findings from the research that has been conducted are not always straightforward. This section focuses on research into the efficacy of licensing laws, screening methods, and intervention strategies and their impact on older driver safety. In order to be comprehensive, the section includes information on licensing practices in the European Union (EU) and Australia.

3.3.1 Analysis of Licensure Laws for Older Drivers

Shipp (1998) conducted an analysis of State license renewal policies and their effect on crash and fatality rates among older drivers. Data from 1989 to 1991 showed that 15 States only measured visual acuity upon renewal and 10 States had no vision test requirement for older drivers. Only four States required a road test. Seven States had a requirement for medical doctors to report at-risk drivers. Ten States had mail renewal options for older drivers. A regression analysis of these variables and their effect on crash and fatality rates showed that only vision screening was associated with lower fatality rates. Shipp recommend mandatory State-level vision screening requirements in order to reduce crashes and fatalities. Few States have changed their licensing laws since 1990, so these results may still hold true (Grabowski, Campbell, & Morrisey, 2004).

Other studies have reported different results. Grabowski, Campbell and Morrisey (2004) analyzed the effect of State licensing procedures on driver fatalities and crashes and did not find an effect of vision screening on older driver fatality rates. They found that States with in-person renewal had lower fatality rates than States that did not. They concluded that with in-person renewal, licensing agency workers could flag some potentially unsafe drivers. Factors such as vision tests, road tests, and more frequent renewals were not associated with additional safety benefits.

The literature shows that the United States is not alone in its inconsistency in older driver license renewal procedures. The EU has considerable divergence among its 15 (at the time) member nations in older driver screening and evaluation. White and O'Neill (2000) administered a questionnaire to licensing agencies in EU member nations. They found that seven member countries had no formal policies addressing older adults with advanced Alzheimer's or other forms of dementia and that nine did not require physicians to report illnesses to the licensing agency. Five member nations had no separate policy governing the relicensing of older drivers, and only five had a formal driver assessment center.

In a study of license renewal procedures in Australia, Langford, Fitzharris, Newstead, and Koppel (2004) reported similar variability among the Australian States. Victoria, Australia had no age-based assessment program in place while New South Wales, Tasmania, Western Australia, and South Australia had relatively stringent mandatory requirements in place for older drivers. Langford et al. (2004) found that the Australian States with more stringent licensing

requirements had a lower percentage of their older population licensed than did Victoria. However, overall crash and fatalities *per population* were not notably different among Victoria and those States that had the more stringent requirements. Perhaps most intriguing, when crashes and fatalities *per licensed driver* were examined, States with the stringent requirements for older drivers actually had significantly higher crash and fatalities rates compared to Victoria. Based on these findings, Langford et al. (2004) came to the conclusion that the stringent licensing requirements were not producing the desired safety benefit.

It is clear from the literature that no particular type of screen or test will reliably lead to a decrease in crashes or injury rates. The aforementioned studies came to different conclusions about the impact of the various screening methods. Interrelationships among variables, as well as significant variability in data sources, likely contributed to the disparate results in these studies.

3.3.2 Older Driver Screening

A license agency employee, therapist, or physician can assess an older adult's ability to drive in a number of ways. An agency may administer vision, cognitive, and psychomotor tests to assess a driver's reaction time, their ability to multi-task, and how well they can detect, process and make decisions in a timely manner while driving. On-road tests can a more specific estimate of a driver's capabilities. Several studies have assessed how well these tests predict the likelihood of a crash. Tests that correlate with crash risk should be an effective in identifying at-risk older drivers.

Cognitive and psychomotor tests may be useful in assessing older drivers' abilities. DeRaedt and Ponjaert-Kristoffersen (2001) compared the results of several neuropsychological tests to driving performance. They found that tests predicted performance of specific driving maneuvers. While many studies lump crashes into a single category, the strength of this study was that the authors analyzed crash types separately to find the best predictor for each crash category. The authors over-sampled drivers who were more likely to crash than the general population – namely drivers who were referred for evaluation by a physician or family member. Sixty-three percent of the study participants reported crashes in the previous year. UFOV was the best predictor of crashes in which the driver failed to yield to traffic coming from the right; the on-road Test Ride for Investigating Practical fitness-to- drive – Belgian version (TRIP) was also a good predictor of crashes in this category. The TRIP is a detailed evaluation of fitness to drive that is based on 11 dimensions: lateral position on the road, lane position change, distance from the car in front, speed, visual behavior and communication, traffic signals, mechanical operations, anticipation, understanding, turning left and joining the traffic stream. The paper-folding task predicted crashes involving left turns with traffic coming from the right (Salthouse et al., 1985), the visual TRIP scale was the best predictor of rear-end and side-swipe crashes.

Janke and Eberhard (1998) conducted a study in a licensing agency setting in an effort to develop a battery of non-driving tests that would correlate well with driving performance. The authors proposed breaking driver evaluation into three tiers of evaluations with only drivers who failed one tier proceeding to the next. The three tiers were:

- **Tier 1 Evaluations** – A battery of simple psychological and psychomotor tests administered by the licensing agency. People who failed the Tier 1 evaluation would be referred to Tier 2.

- **Tier 2 Evaluations** – More in-depth psychological, psychomotor, perceptual, and information processing tests that would be administered by a licensed clinician in a setting outside the licensing agency. Drivers who failed this tier would be referred to more in-depth field drive evaluations in Tier 3.

- **Tier 3 Evaluations** – Field drives administered by a clinician certified as a driving instructor. The authors proposed two versions of the test. The Modified Driving Performance Evaluation (MDPE) to be run on a pre-determined course around the administrating agency's office, and the Area Driving Performance Evaluation (ADPE) would begin at the driver's home and be limited to areas the person normally drives.

Janke (2001) evaluated a battery of tests to fulfill the requirements listed above and to assess the predictive ability of each over the course of two separate studies. Tier 1 evaluations included knowledge tests, Snellen test, Pelli-Robson test, and a checklist measure of objectively defined observable problems. Tier 2 evaluations included perceptual response time (PRT), auto-trail test, cue recognition, and the waypoint test. Tier 3 evaluations included the supplemental DPE (containing all aspects of the MDPE). Contrast sensitivity was the most promising Tier 1 measure. The cue 1 test was the best Tier 2 evaluation for distinguishing between referrals. For Tier 3 tests, the MDPE was best at distinguishing populations.

Marottoli et al. (1998) conducted a similar study with the objective of developing a battery of easily-administered tests that assessed a wide range of functional abilities and correlated those with self-reported adverse driving events. In a survey, 125 participants reported recent adverse driving events. The study correlated visual, cognitive and physical factors with driving performance. Adverse driving events included crashes, moving violations, and stops by the police. Five factors were statistically significant predictors of self-reported adverse driving events. Those factors were:

Vision:	Near visual acuity (P = .024)
Cognition:	Number cancellation (P = .006)
Physical:	Neck rotation (P = .001) Finger flexion (P = .015) Tweezer test (P = .038).

Even if in-office tests prove to be predictive of driving ability, licensing agencies generally require an on-road test of a driver's skills. Field drives provide an evaluator the opportunity to see how a driver reacts in a real driving environment and may be the most accurate means of assessing driving performance. Disadvantages are that field drives are time consuming and expensive. Field drives are often used to evaluate skills of older drivers who fail screening tests during license renewal or who have been referred by family or a physician (Shipp, 1998; Adler, Rottunda, & Dysken, 2005; Freund et al., 2005).

Di Stefano and Macdonald (2003) conducted a field study of older drivers in Australia. The authors reviewed results of 533 road tests conducted in Victoria, Australia. Although there were no testing requirements for drivers of any age, drivers considered to be at-risk could be

referred for evaluation. The referrals included drivers across the age range. License Testing Officers (LTOs) met each driver at his or her home. LTOs gave drivers an opportunity to get used to the test vehicle, which contained a dual braking mechanism for the LTO in case an intervention was necessary. The drivers chose their routes in order to make the test represented the driver's normal driving habits. Testing typically lasted from 30 to 45 minutes. LTOs scored drivers based upon the Victorian entry-level driving assessment called the Programmed Observation License Assessment (Di Stefano & Macdonald, 2003). Forty-nine percent of the drivers who were referred failed the driving test. The most common error was failure to yield right-of-way when negotiating an intersection and the second was excessive speed. An instance of LTO intervention (emergency braking, taking steering wheel, etc.) was the primary indicator of a failed test. Finally, for older drivers, error in intersection negotiation was the best predictor of a failed test followed by poor lane position, speed maintenance, and maintaining a proper margin of safety with the car in front.

An article by Justiss, Mann, Stav, and Velozo (2006) described an evaluation of a comprehensive on-road evaluation test. Ninety-five drivers over 65 participated in the study that rated drivers on a scale of 0 to 3 on a series of attributes during a fixed-route on-road test. These attributes included vehicle position, lane maintenance, speed regulation, yielding, signaling, visual scanning, adjustment to stimuli/traffic signs, and gap acceptance. Researchers measured drivers' cognitive ability using the Mini Mental Status Exam (see Adler et al., 2005). The results of the evaluation correlated well with other methods of driver evaluation (Justiss et al., 2006).

3.4 Literature Review Summary

Older drivers were over-represented in angled-impact crashes. Researchers have attributed this primarily to advancing age-related cognitive and physical decline. Declines in neck and torso mobility can make it more difficult for the older adult to turn and look to the sides of the car to monitor for oncoming vehicles. Deteriorating visual quality can make it difficult for older drivers to see at night and in low contrast conditions. Age-related cognitive decline may make it more difficult for older drivers to process information efficiently. However, while older drivers may recognize their limitations and incorporate compensatory behaviors such as driving slower, avoiding driving at night, in bad weather, or driving shorter distances, in some instances they may not be compensate enough.

Based on research in the area, a focus on the following areas of age-related functional deficits may help to identify older drivers who have an elevated crash risk:

- Vision
- Attention/vigilance
- Speed-of-processing information
- Memory
- Psychomotor skills.

3.5 Implications for the Current Study

The literature review revealed a paucity of studies that have examined the safety impact of licensing procedures aimed at the older driver. Evidence is mounting, however, that older adults may experience physical and cognitive decrements that impair driving. The age at which these decrements appear varies substantially. Driver licensing authorities must often screen and evaluate older adults' driving skills, and restrict or revoke licenses of those who pose an unacceptable risk to themselves and to other road users.

4. SPECIAL EMPHASIS STATES

The selected special emphasis States were Illinois, Iowa, Kansas, and New Hampshire. Each State was selected because it had at least one regulation or policy that went beyond what most States were doing with regard to older drivers' license renewal. Table 2 lists the licensing policies at the time of this study in the four special emphasis States that might positively affect older driver safety. Some of these policies were specifically age-based while others were not. Please note that the licensing procedures in each State may have changed since this study's data collection activities.

Table 2. Licensing Policies/Activities in the Four Emphasis States

State	Policies/Activities
Illinois	• Drivers under 75 must renew in-person every other cycle • All renewals were in-person for drivers over 75 • Vision screening at every in-person renewal • Renewal cycle reduced to 2 years for drivers 81-86; reduced to every year for those 87 or older • On-road test at renewal for drivers over 75 • Written test every 8 years unless driver had clean driving record • Immunity available to reporting physicians • Anonymity available for people reporting driver • Older driver specialist in licensing agency • Medical review unit in licensing agency • Local drive test near driver's home available for restricted license if population of town was less than 3,500 • Rules-of-the-road classes for older drivers • Super Senior events
Iowa	• In-person renewal for all ages • Vision screening at every renewal • Renewal cycle reduced to 2 years for drivers over 70 • Sensitivity training for licensing staff • License examiner could require road test at any time • Local drive test near driver's home available for restricted license • Physicians granted immunity for reporting • Drivers over age 80 who contributed to a crash re-examined • Iowa ID card free if driver surrendered license • Some free education classes for older drivers • Medical review unit in licensing agency
Kansas	• In-person renewal for all ages • Vision screening at every renewal • Renewal cycle reduced to 4 years for drivers older than 65 • Written test for all renewals • License examiner could require road test at any time • Local drive test near driver's home available for restricted license • Medical review unit in licensing agency
New Hampshire	• In-person renewals for all ages • Vision screening at every renewal • On-road test at renewal for drivers over 75 • Local drive test near driver's home available for restricted license • Could refer to driver training program tailored to older drivers

5. ILLINOIS

Illinois was selected as a special emphasis State primarily because it required in-person and more frequent renewals that included on-road driving tests for drivers 75 and older. The State provided some licensing and driver training services for older drivers not found in other States.

5.1 Licensing Policies and Activities Affecting Older Drivers

At the time of this study, driver licensing was the responsibility of the Driver Services Department (DSD) within the Office of the Illinois Secretary of State. DSD had an older driver specialist who oversaw many of the activities pertaining to licensing older drivers.

Illinois had a license renewal cycle that varied depending on a driver's age. For drivers under 75, the basic renewal cycle was every four years. A driver with a clean driving record could renew online or by mail every other cycle (i.e., a driver was required to appear at a licensing office every eight years). A vision screening was required for every in-person renewal; a vision test from an eye care professional (optometrist or ophthalmologist) was accepted in lieu of the in-office vision screening. A written test was required every eight years unless the driver had a clean record. A written test could also be required at random, and any driving under the influence charges prompted a written test at every renewal from that point forward.

Drivers 75 and older were required to renew licenses in person for every 4-year renewal cycle. These drivers had to pass vision screenings and an on-road exams at every renewal. For drivers 81 to 86, the renewal cycle was reduced to every two years, and drivers 87 and older were required to renew their licenses every year. A driver who failed the on-road test six times was required to obtain a medical report from a personal physician.

Although most older drivers chose to complete the drive test at the licensing office, they could request a "local drive" test in which an examiner would come to the driver's home and administer the on-road test on a specific route requested by the individual. Only drivers living in towns of fewer than 3,500 residents were eligible for such a test. Drivers who passed the local drive test were restricted to driving only on the route on which the test was conducted.

Potentially risky drivers of any age could be reported to DSD in a number of ways. Physicians were provided immunity if they reported a driver. Anyone reporting a driver could remain anonymous. The DSD accepted reports from doctors, the courts, and other DMVs, as well as a variety of driving and occupational professionals the State considered qualified to identify potentially risky drivers.

The DSD maintained a medical review staff who reviewed more than 55,000 cases per year, a large percentage of which were older drivers. The State also had a Medical Advisory Board that handled 600 to 1,000 cases per year.

Illinois offered a number of additional services specifically for older drivers. The State operated "Super Senior Events" where older drivers could take a *Rules of the Road Course*, complete the written test and vision screening, and, in many locations, schedule a road test. The Super Senior Events used a mobile licensing van and often were conducted at special events

(e.g., State fair) popular among older adults. The Super Senior Events took place at an estimated 305 sites per year, and an additional 530 mobile unit visits were made per year. Licensing staff gave about 1,000 *Rules of the Road* courses every year that averaged about 10 people per class. These courses were tailored to older drivers and were advertised with posters and press releases. In addition to the classic *Rules of the Road*, these courses outlined the process for the license renewal including test requirements and medical forms.

5.2 Discussions with Licensing Staff

On November 17-19, 2009, research staff held discussions with driver licensing staff at four driver licensing offices in Illinois to discuss the driver licensing process. The DSD selected the offices to be representative of licensing offices across the State. They included:

- Chicago North - A large urban office with high flow rate;
- Schaumburg - A medium-sized suburban office with moderate flow rate;
- Taylorville - A small rural office with low flow rate; and
- Quincy - A medium-sized rural office with moderate flow rate.

Thirty-two licensing staff members, including regional supervisors, office directors, and license examiners, provided views about the State's driver licensing procedures that pertained to older drivers. Staff members provided insights into how their licensing system worked and gave opinions as to its effectiveness for improving safety. Consistent themes emerged from the discussions.

Pertaining to job responsibilities interactions with older drivers who came in for license renewals, staff members noted that:

- Everyone performed all in-office functions, but only regional supervisors or office directors handled local drives.
- When drivers came in on referrals, license staff procedures did not differ based on driver age. All referrals, regardless of driver age, received the same level of scrutiny.

In terms of their opinions about the safety effects of the drive test at age 75 and shorter renewal cycles based on age, common responses indicated that the staff thought:

- 75 was a good age to start the drive test;
- The drive test was a good refresher for older drivers;
- The annual renewal after age 86 was appropriate given how quickly abilities can decline; and
- The reduced renewal cycle at age 81 should perhaps begin at a younger age because older adults' functional status can change quickly.

Regarding the local drive process and other activities that the State employed to make the licensing process more accessible to older drivers:

- Local drives were rare; most staff did not have experience giving one.
- The mobile renewal stations were widely used, especially in urban areas, but they did not offer local drives from the mobile units.

Staff expressed a number of viewpoints regarding licensing procedures and activities (other than the road test) that could affect safety:

- While staff members considered testing beneficial, written tests did not seem to screen out problem drivers. Staff noted the tests prompted many older drivers to refresh their knowledge, but did not support making the written test mandatory for all license renewals.
- Older drivers tended to be anxious about the written test, particularly when administered by computer.
- A number of older drivers had difficulty using the vision screening equipment, and many preferred to consult their own eye professionals.
- Older drivers generally liked the *Rules of the Road* course given by the DSD; those who took the course seemed to have an easier time with the written test, and with the entire licensing process.

Although staff shared responsibilities within the office, it was not initially clear what, if any, training they received directly related to licensing of older drivers. Staff indicated that:

- Staff received no official training specific to older adults; and
- Their general training and on-the-job tips from supervisors were sufficient to address older adults' needs.

Although the licensing process was the same for everyone, regardless of age, license examiners indicated that they had developed some techniques for working with older drivers, including:

- Pointing left and right for upcoming turns when giving the road test to clarify the route instructions;
- Speaking loudly;
- Going over directions ahead of time;
- Watching for a driver's inability to find an item, such as an insurance card, as a possible cue of cognitive problems; and
- Giving older adults priority in line and being more patient with older drivers.

Licensing staff approved of the licensing process for older drivers and thought many of their procedures enhanced older drivers' understanding of the process. Specifically, staff indicated that:

- The DSD sent letters with renewal notices that prepared older drivers for license renewal procedures, although not everyone read the letters before they came into the office.
- Older drivers who took the *Rules of the Road* course were better prepared when they came into the office.

Although generally satisfied with the licensing procedures and testing for older drivers, staff members had a number of comments about how the process could be improved:

- Staff considered the testing beneficial, and noted that written tests helped identify drivers with cognitive impairments.
- Some people may have passed the screening when they should not have, or the examiner expected the older driver's abilities to deteriorate very soon to a point where the driver would not pass the screening.
- Staff members expressed concerns about some elements of the process, including:
    - Using the same road course for each road test attempt.
    - No requirement to take the road test at the licensing office nearest the driver's home. As a result, people from high traffic areas passed the test in quiet rural areas. They may not have been able to drive safely in their home area.
    - No limit on the number of road test failures.
    - Allowing drivers who failed the road test to retain their current license until it expired.
    - No link between the issuance of handicapped placards and the driver qualification processes. Knowledge of medical conditions that warranted a handicap placard could alert staff to conditions that could affect driving safety.

Staff members indicated that they had little leeway in assessing the medical condition of drivers, although they did not necessarily want the authority to refer drivers for medical reasons. The staff noted that:

- A staff member could only make a medical referral for drivers who answered "yes" to one of the medical questions on the renewal form. They could not make a referral based on observation of drivers exhibiting functional limitations (e.g., confusion or difficulty walking).
- Doctors and police could and did make effective referrals.
- The central office in Springfield handled all interactions with referrals from doctors and police.

Overall, the licensing staff was confident that Illinois crash rates reflected the safety impact of the State's driver improvement and driver screening activities.

5.3 Discussions with Older Drivers

On November 17 - 19, 2009, the research team held discussions with 28 older drivers (15 males and 13 females) at the four driver licensing offices in Illinois. The drivers had just completed the license renewal process in one of the licensing office locations. The older drivers' comments are summarized below by topic.

Drivers ranged in age from 63 to 86. Many indicated they did little to no driving while a few drove more than 30,000 miles per year. Some only drove alone, but others always had a passenger (usually a spouse) in the vehicle. In general, the older drivers indicated they preferred to avoid driving:

- At night;
- During inclement weather;
- In heavy or congested urban traffic; and

- On highways.

These drivers were satisfied with the driver licensing process. Drivers over 75 were aware of the special procedures for drivers in their age group, but were sometimes unaware of shorter renewal cycles that applied to the next age bracket. Although all of the drivers passed the road test, a few had concerns about the process, including anxiety about the written and/or the road test, or worrying that they might fail for a small error.

Almost all of the discussion participants under 75 were aware of the required drive test at age 75, and none expressed concerns about passing in the future. Similarly, almost all were aware of the reduced renewal cycle starting at age 81.

Drivers understood why the State had different licensing policies for older drivers, often noting that some people develop cognitive and physical problems with age. Drivers specifically cited changes in vision, reflexes, and stamina as areas that might affect driving safety. However, none expressed concerns with the vision screening. Roughly a third thought a written test was necessary but should triggered by a person's driving record, not age. The older drivers thought the road test was fair, and agreed that 75 was the correct age to start the road test.

A number of the drivers said they took the State-provided training course on Rules of the Road; many took it multiple times. Others indicated having read the driver's manual in preparation for the tests.

None of the participants reported that anyone had suggested they stop driving, but most said stopping driving would greatly affect their lives. However, those who drove rarely or who had family nearby said it was less of a problem. The most common things that would lead a person to stop driving were:

- Physical/health problems;
- Feeling unsafe;
- A bad crash; or
- A doctor's recommendation to stop driving.

Although all of the drivers indicated they still drove, they were aware of alternative modes of transportation for older residents in their areas. They noted that:

- Alternative transportation did not exist in many areas;
- Some had a family member to drive them; and
- Some mentioned buses and taxis for older adults.

While most participants did not report using strategies or equipment to improve safety, a few indicated that they:

- Used additional outside mirrors;
- Bought a new car with better equipment; and/or
- Always drove slightly below the speed limit.

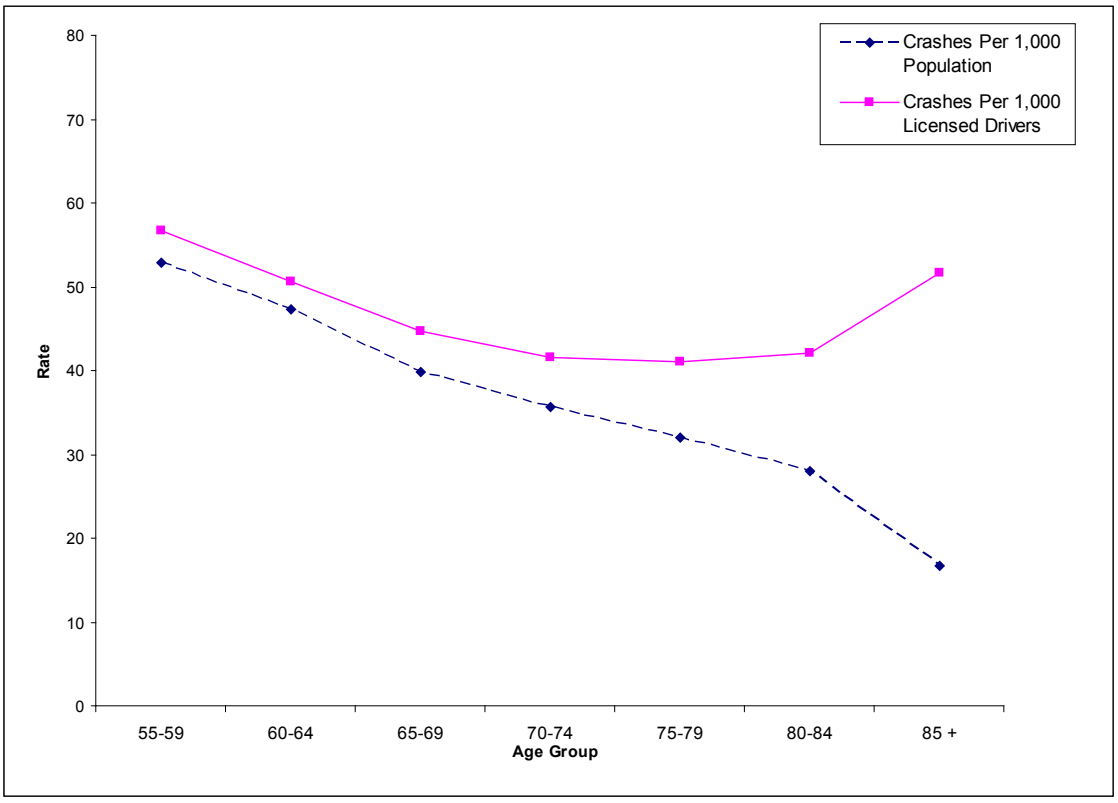
5.4 Crash and Fatality Rate Profile

Figure 1 shows the Illinois crash profile per 1,000 population and per 1,000 licensed drivers by 5-year age groups for the years 2003-2007.[1] Crashes per 1,000 population showed a steep decline with driver age. The decline is steady until age 85 when it drops fairly sharply with only 16.6 crashes per 1,000 population for those 85 and older.

Given that the number of drivers licensed in Illinois was always less than the population estimates as shown in Figure 2, the crashes per 1,000 licensed drivers was always greater than crashes per 1,000 population. Crashes per 1,000 licensed drivers also showed a sharp decline until age 65 when the rates started to level off. The rates bottomed out at age 75 at 41.0 and then increased to 51.6 for the oldest age group.

Taken in concert with the decline in licensure rate for drivers 85 and older (32.2% of population licensed), it is not surprising to see a sharp increase in crashes per 1,000 licensed drivers since the denominator (number of licensed drivers) has been reduced compared to the other age groups. It is important to note that even though the crash rate per 1,000 licensed drivers in Illinois increased for drivers older than 75, crashes per population after age 75 continued to decline.

Figure 1. Illinois Crashes per 1,000 Licensed Drivers and 1,000 Population



[1] The figures in the main body of the report show profiles for drivers 55 and older in order to focus attention on older ages. The Appendix to the report contains these same figures expanded to all licensed drivers aged 20 and older. Figures in the Appendix carry the same numbers as those in the text but preceded by the letter "A." Thus, for example, Figure A-1 presents the same information for all drivers 20 and older that can be found in Figure 1 for drivers 55 and older.

Figure 2. Percentage Licensed by Age Group in Illinois

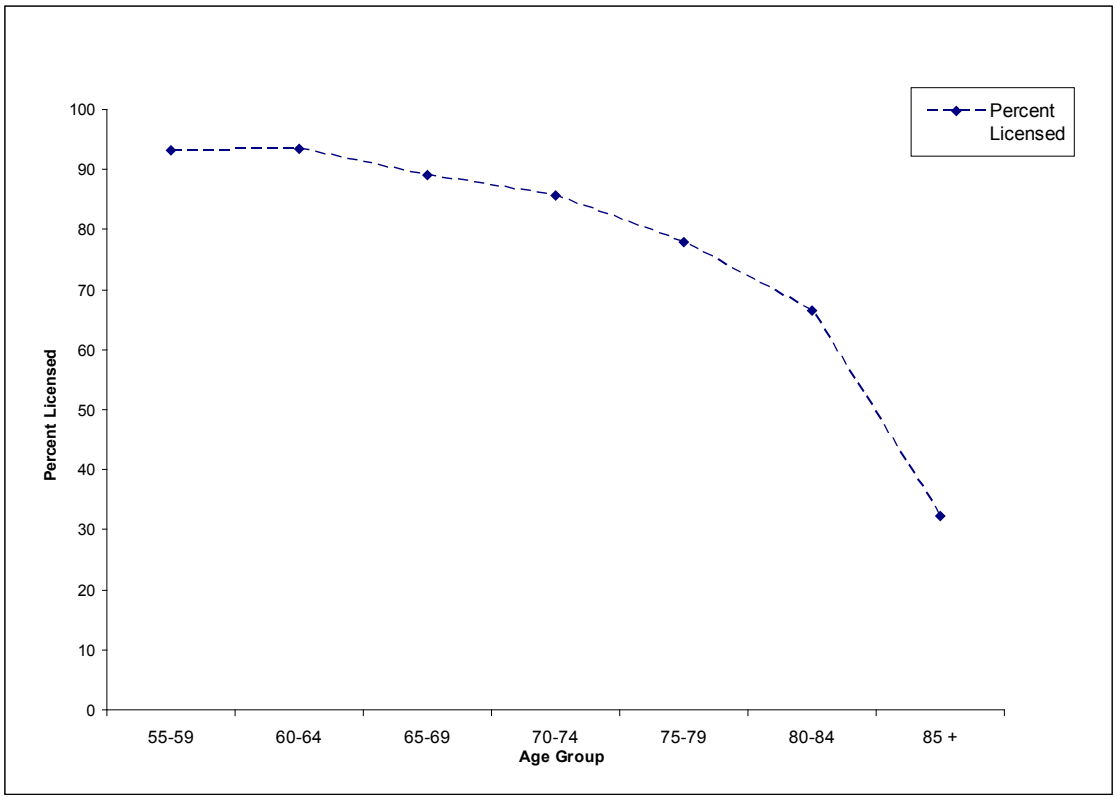
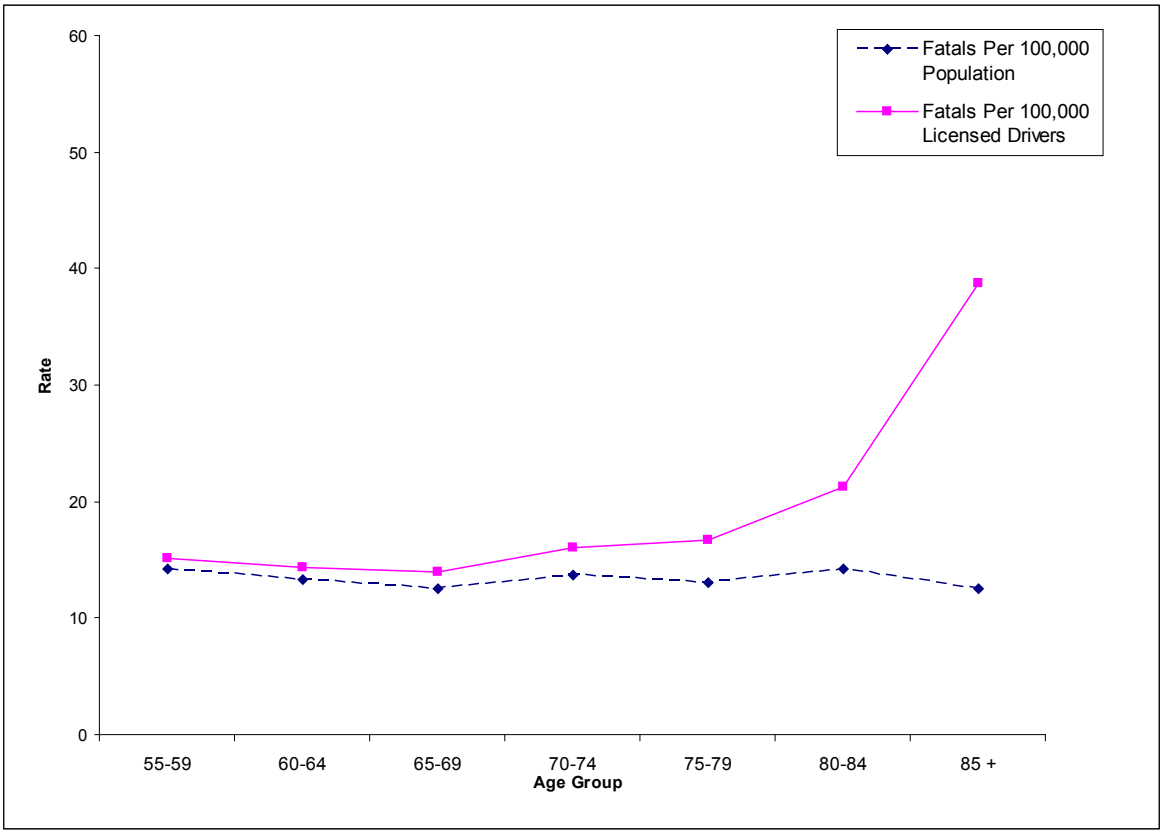


Figure 3 shows the driver fatality rates per 100,000 licensed drivers and per 100,000 population for the various age brackets in Illinois. The fatality rate per 100,000 population remained fairly flat for drivers 55 and older. The fatality rate per 100,000 licensed drivers bottomed out at 14.0, but then showed a marked increase thereafter as would be expected from the sharp decline in licensed drivers, reaching a high of 38.8 fatalities per 100,000 licensed drivers for drivers 85 and older.

Figure 3. Illinois Driver Fatalities per 100,000 Licensed Drivers and 100,000 Population



6. IOWA

The research team selected Iowa as a special emphasis State because it required more frequent renewals for older drivers that included vision screening, and provided training for licensing staff members to help them understand older drivers' needs.

6.1 Licensing Policies and Activities Affecting Older Drivers

The Motor Vehicles Division (MVD) of the Iowa Department of Transportation was responsible for managing driver licensing in the State. Iowa had 18 MVD sites and 81 county offices that provided licensing services. County personnel, trained by the State, could give on-road drive tests.

Iowa required all drivers to renew in person, with a 5-year renewal cycle for drivers over 18 and under 70 and a 2-year cycle for drivers over 70. The State required a vision test at every license renewal but allowed drivers to provide vision test results from an eye care professional in lieu of the in-office vision screening.

Iowa provided licensing staff with training that specifically addressed issues related to older drivers. The training incorporated activities that demonstrated what drivers with conditions commonly associated with aging (e.g., limited field of vision, reduced tactile sensitivity) might experience. It included instruction on how to approach drivers and discuss medical conditions that could affect driving safety.

Iowa licensing staff could require a drive test at any time, regardless of driver age. Staff members often held private discussions with a driver to help determine whether an on-road drive test was warranted. If a driver refused to take the drive test, the examiner could decline to renew the license. If an individual failed an on-road drive test, his or her license was suspended immediately, but the individual could legally drive for another 30 days before trying again to renew the license. Iowa could administer "local drive" tests in which license examiners tested drivers on the roads where they usually drove. There was no cost to the driver for this test. Drivers who passed local drive tests received a restricted license that limited the roadways and time of day a person was allowed to drive. Drivers could attempt the local drive up to three times.

The MVD accepted physician referrals of drivers with physical or cognitive conditions that could affect driving, and the State provided the physician immunity. The MVD office staff first reviewed a physician referral and determined whether it warranted further investigation by the central medical review team. The medical review team reviewed the report and generally made a decision without submitting the referral to the MAB. The MAB, an unpaid, anonymous group of physicians from the Iowa Medical Society, reviewed medical/vision reports and made recommendations about an individual's ability to drive safely. A driver was notified in writing of the medical review team's decision; a driver's license could be suspended immediately if warranted. Examiners could require a road test based on physical or cognitive conditions. The MVD accepted referrals from the courts, other licensing agencies, police, and family members, but the information was not anonymous or confidential. Drivers of all ages were required to take

the vision, knowledge and road test if a police officer recommended it. Older drivers who contributed to a crash had to be re-examined.

The MVD has held voluntary education programs in the past that provided older drivers with information about functional limitations they may face and how to deal with them. A driver who surrendered his/her license received a free Iowa ID card.

6.2 Discussions with Licensing Staff

On September 15-16, 2009, researchers held discussions with licensing staff at four driver licensing offices in Iowa. The MVD selected offices representative of licensing offices across the State and included:

- Ankeny - A large office in a suburb just north of Des Moines;
- Cedar Rapids - A medium-sized office located in a shopping center;
- Spencer - A small office inside a shopping center; and
- Sioux City - A large facility serving all of Sioux City.

Licensing staff members included supervisors, license examiners, and counter staff. Most MVD office personnel rotated among the various duties (greeter, clerk, camera operator, and tester) throughout the day.

Virtually all staff members noted the following regarding their job responsibilities and how they interacted with older drivers renewing licenses:

- All staff members performed all in-office functions.
- There was no difference in procedures based on age or for referrals.
- Only supervisors handled appeals.

When discussing the impact of the shorter renewal cycle on senior driver safety, staff members noted that:

- The two-year cycle allowed monitoring drivers over time, especially in smaller stations where staff members were likely to know the drivers.
- Staff members had an opportunity to observe the driver's functioning, interact with the driver, and assess the need for a road test (line drive). Cues that might prompt a line drive included:
    - Unsteadiness;
    - Confusion;
    - Reliance on a companion;
    - Inability to extract license from wallet/purse;
    - Frailty; and
    - Specific medications and health conditions.
- The 2-year interval, together with the ability to require more frequent appearances if warranted, improved safety.

All staff members were quick to note that the vision testing was a screening tool and was not a definitive assessment of visual capabilities. Some other staff thoughts about the vision screening included:

- It identified those who needed professional vision testing.
- Screening was good for all ages. Since vision declines with age, there may be a differential benefit for older drivers.
- While drivers of all ages occasionally had difficulty using the vision screening machines, older drivers tended to have more problems with them, and therefore generated more false alarms.
- Vision screening alone could not be used to justify a line drive.
- To the extent that the screening removed people with substandard vision from the road, safety should benefit.

Staff noted that they only performed a small number of local drivers on an as-needed basis. They considered these drives effective when circumstances were appropriate (e.g., willing driver, capable under familiar circumstances), but the staff generally thought that there were not enough of the local drives given to affect statewide crash numbers; line drives was much more common.

When discussing line drives, staff noted that:

- They were used frequently, but some tests were deferred, especially if all the examiners were busy.
- Tests were given whenever staff was concerned about the driver's ability.
- The majority of the line drives were given to older drivers, but they were conducted in other situations where the driver's ability was in doubt, e.g., following strokes or orthopedic injuries.
- Staff conducted line drives before they requested a report from a physician.
- Line drives were an effective means of assessing driving performance.
- A high percentage of drivers failed their first line drive, often due to "rusty" skills in drivers who had not driven in a long time.
- Some drivers elected to surrender their license altogether rather than take the line drive.

Regarding other procedures that staff members used with older drivers, staff identified these techniques:

- Holding isolated conversations away from family members or friends;
- Asking about medical conditions and other issues; making small talk;
- Asking drivers to read aloud the printed rules statement on the counter;
- Observing drivers as they drove in (where possible); and
- Working as a team to flag potential problems for assessment.

Iowa licensing staff mentioned participating in several training sessions focused on older drivers and issues that may affect their driving safety. Staff members felt that these training sessions prepared them well to interact with older drivers. The training sessions included:

- Sensitivity/empathy training using special goggles and gloves to simulate age;
- Presentations by physicians;
- Discussions of older adults' capabilities and limitations;
- On-the-job training from supervisors and more experienced peers;
- Regular team meetings; and
- Technical support from headquarters

In general, staff felt that older drivers were aware of license renewal process, accepted it, and considered it fair. They felt that the high awareness arose, at least in part, from word of mouth in the older adult community. Staff members noted that a driver acting defensive about the process was a cue of a potential problem.

Staff realized that some potentially unsafe drivers would receive license renewals. They were quick to note, however, that these potentially risky drivers would be screened again in at most two years, and sooner if referred. Some of the staff thought that requiring a road test of everyone might help, but others asserted that the current screening plus the staff's ability to require a line drive accomplished the same thing, especially since drivers might pick their best days to come in for a required road test. Some staff members noted that requiring a road test might make some drivers nervous, but the biggest concern was with the administrative burden it would put on the office. Similarly, most did not think a written test would provide a safety benefit. Most of the staff indicated that they did not report many drivers for medical review.

In conclusion, the staff overwhelmingly said their procedures increased safety, although some thought that they could do more with added interventions such as a mandatory road test, required training for older drivers, or stricter pass criteria.

6.3 Discussions with Older Drivers

On September 15-16, 2009, the research staff held discussions with older drivers at the four driver licensing offices in Iowa to discuss the driver licensing process. Participants, who had just completed the license renewal process, included 52 older adults (21 males, 31 females) who ranged in age from 63 to 93. Some reported they did not drive at all while others were professional drivers and drove over 100,000 miles per year.

Some drivers only drove alone, but others always had a passenger (usually a spouse) in the vehicle. Most of the older drivers indicated they avoided driving in the following conditions:

- Night;
- Snow, ice, other bad weather; and
- Freeways, big cities.

Drivers had a favorable opinion of the licensing process. Most were comfortable with the vision screening, although some who had vision problems were concerned about not passing. One person said he did not know he was blind in one eye until he took the screening.

When discussing the licensing procedures that were different for older drivers, most accepted the reduced renewal cycle and many thought it was appropriate given that conditions can arise quickly for older drivers. Most were not in favor requiring a written test, saying that it would be most appropriate for people who had a poor driving record. A few thought such a test would be a good refresher, and 70 would be the right age to start. Similarly, some opposed to requiring an on-road test, while others thought it would be a good idea. Most thought age 75 was most appropriate for requiring a road test, but others still favored linking it to a driver's driving record.

Virtually none of the older drivers was aware that they could request a local drive. Many said they would accept a restricted license if they had to, but others felt that local drives and restricted licenses were a bad idea; if a person could not drive everywhere, they should not be driving at all. Along those same lines, most people mentioned poor driving by others as a major problem and indicated that they, themselves, did not have any difficulties driving. A few of the older drivers said they had trouble with vision and reaction time but still drove without using any special strategies. A number of the people said not being able to drive would have a major impact on their lives, but others said it would not affect them as much since they already drove very little or had others who could drive them around. None of the drivers ever had anyone ask them to stop driving, and the most commonly cited reasons that would lead a person to stop driving were:

- Having a crash (usually at-fault) or a near-crash;
- If licensing staff told them to stop driving;
- Health issues – especially related to vision; and
- Nervousness or a loss of confidence.

Most of the drivers said they had not taken a driver training course in recent years. A few took driving courses required for their trade (professional truck driver, bus driver, State Park Service).

6.4 Discussions With Older Drivers Who Took Local or Line Drives

Eleven older drivers (6 males, 5 females) whom the State had required to take driving tests, either a local drive or a line drive at the licensing office, participated in conversations about their experiences with the driving test. Drivers' ages ranged from 74 to 97.

All respondents had recently taken the test, and everyone indicated they had only taken the test once this time around to pass – some had taken the test in the past as well. While all passed the test, some had restrictions imposed. Only one person had taken the test near home; the remainder taking the test at the license office.

Most reported driving less than 100 miles per week, with the highest at 250 miles per week. Most of the drivers indicated that they did not like to drive in inclement weather, at night, on the highway, in cities, in unfamiliar places, or in any situation where they might injure themselves or someone else. Some drove with passengers while others did not.

Most of the drivers in the discussions had restrictions placed on driving after the driving test, but a number indicated that some of the restrictions were the result of an earlier test. Restrictions included corrective lenses, mirrors, daytime only, must drive below 50 mph, or must drive only within five miles of home. Most did not feel as though restrictions affected them much, if at all. They considered the restrictions manageable (e.g., wear glasses when you drive) and encompassed things that they did prior to the restrictions being imposed. Most considered the restrictions fair given their limitations and that following the restrictions was something that they should be doing anyway and noted that limited driving was better than no driving.

The drivers indicated that the reduced renewal cycle for older drivers was fair. Some agreed it was necessary, but had less to do with age since many older adults drive safely. Some felt that driving problems have more to do with the health of the person than age and some indicated that there should be a more appropriate reason for the test than just age (e.g., if someone has recently received many tickets).

Most drivers said they would support a mandatory driving test, and suggested an age range for initiating the testing of 70 to 85. Some said testing might be deferred to even older ages since older people are in better health longer. Others said testing should be related to a person's driving record.

Most of the drivers said they had no age-related driving problems, but a few said their children had suggested they stop driving. Others said that they would take a physician's suggestion to stop driving seriously, but felt they would know when to stop driving.

None of these drivers had taken a driving course recently, and most were not interested because they did not think they needed one. Some simply said that there would not be any benefit to taking a driving course, but others said they would take a course for an insurance rate reduction.

6.5 Crash and Fatality Rate Profile

Figure 4 shows the Iowa crash profile per 1,000 population and per 1,000 licensed drivers by 5-year age groups for the years 2004-2008. Crashes per 1,000 population showed a steady decline with driver age until 85 when a fairly sharp drop occurred with only 11.5 crashes per 1,000 population for those 85 and older.

The percentage of drivers licensed by age group was always less than 100% (see Figure 5), so crashes per 1,000 licensed drivers was always greater than crashes per 1,000 population. Crashes per 1,000 licensed drivers showed a decline until age 70 when the crash rate reached 24.0. There was then a slight increase for 75-year-olds followed by a slight decrease for 80-year-olds, and another slight increase for the oldest group. Iowa showed only slight increases in crashes per 1,000 licensed drivers 85 and older even though the licensure rate dropped to 46.7%.

Figure 4. Iowa Crashes per 1,000 Licensed Drivers and 1,000 Population

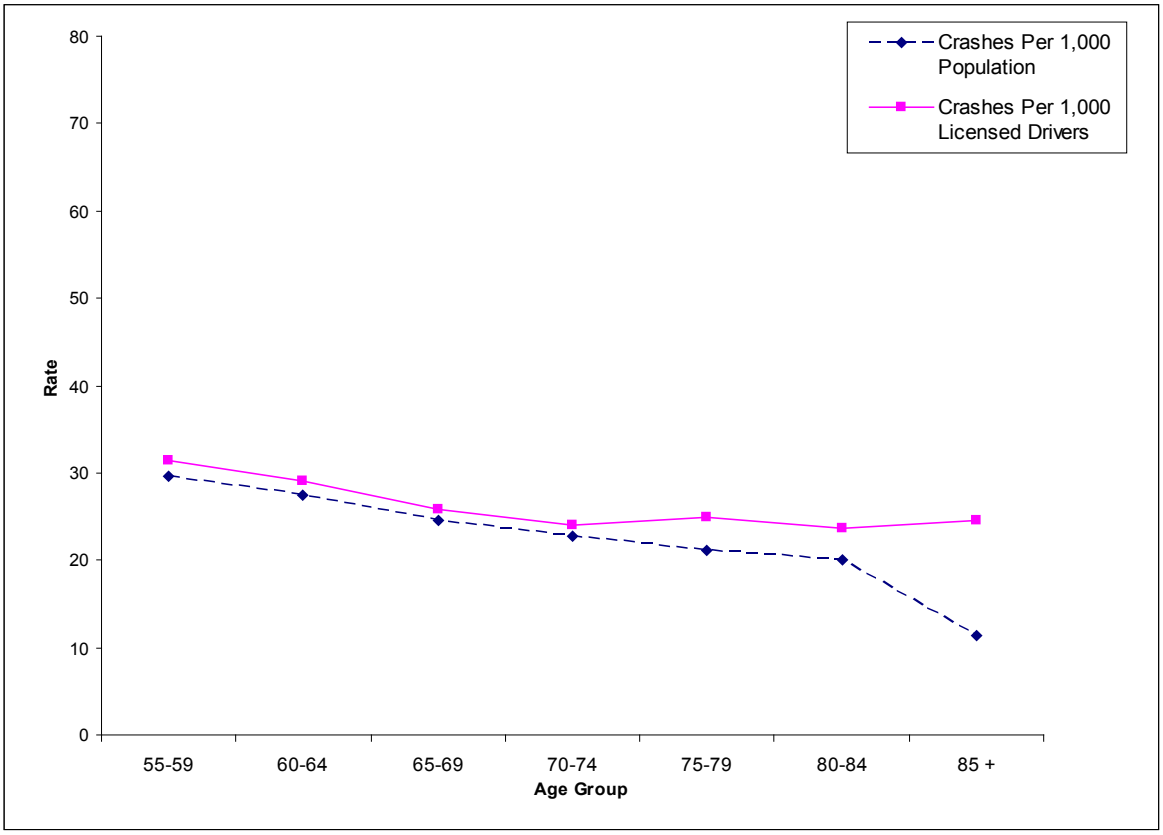


Figure 6 shows the Iowa driver fatality rates per 100,000 licensed drivers and per 100,000 population. The fatality rate per 100,000 population dropped to a low of 16.9 at age 70-74 and then increased for 75-84-year-olds before dropping slightly again for those 85 and older. The fatality rate per 100,000 licensed drivers showed a similar low point at age 70-74 where it bottomed out at 17.9 but increased markedly thereafter, reaching a high of 41.8 fatalities per 100,000 licensed drivers for those 85 and older.

Figure 5. Percentage Licensed by Age Group in Iowa

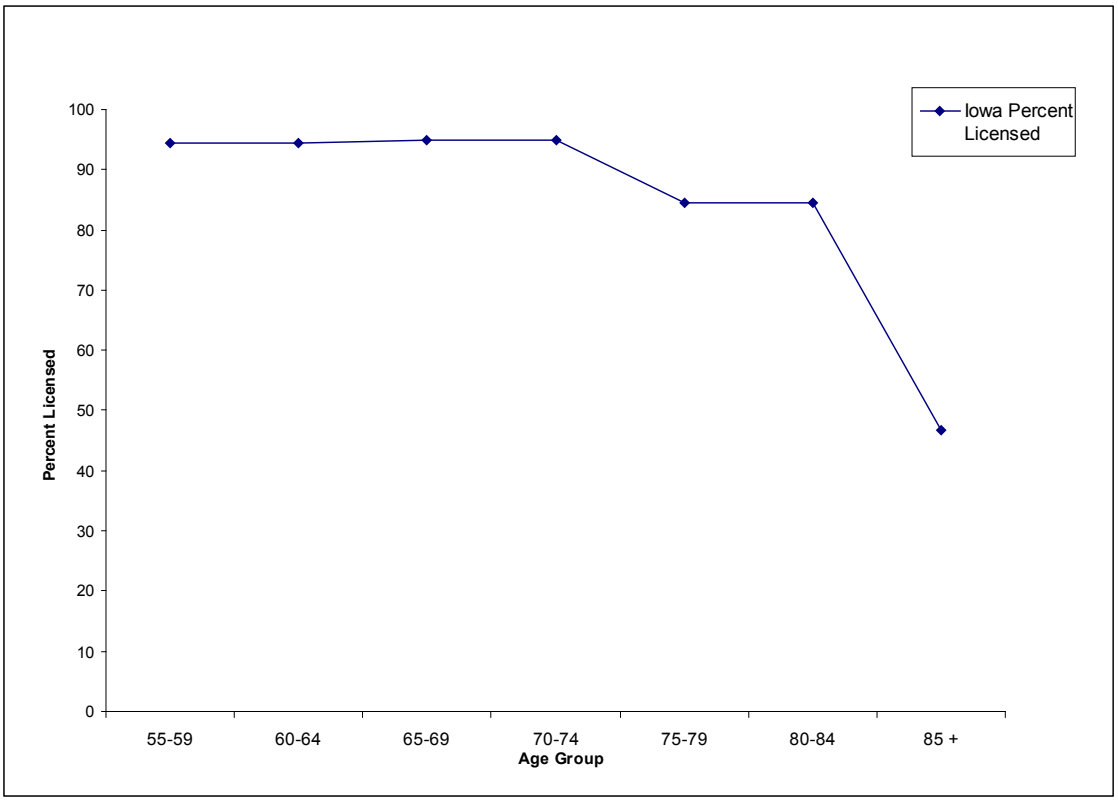
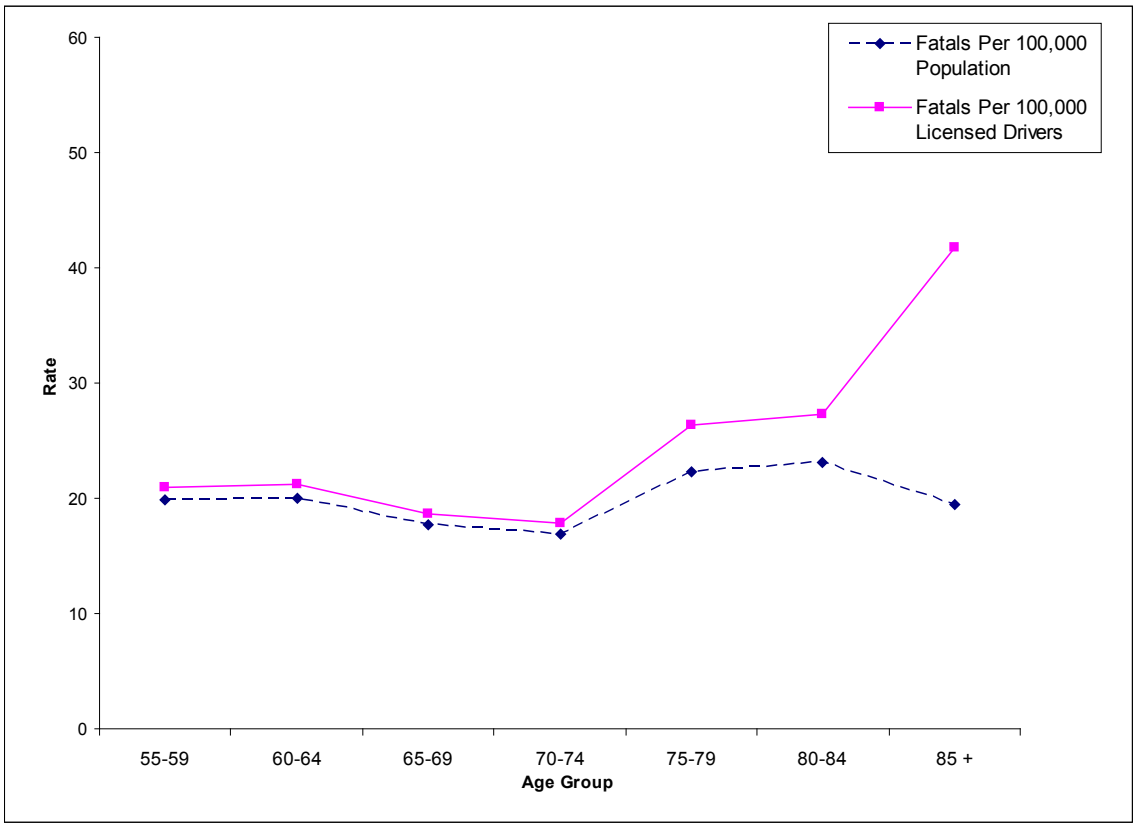


Figure 6. Iowa Driver Fatalities per 100,000 Licensed Drivers and 100,000 Population



7. KANSAS

Kansas was selected as a special emphasis State because of its in-person renewals with vision screenings and written tests for all drivers.

7.1 Licensing Policies and Activities Affecting Older Drivers

The Division of Motor Vehicles (DMV), which is administratively housed in the Kansas Department of Revenue, was responsible for driver licensing in Kansas. Of the 105 counties in the State, 104 offered some type of driver licensing service. County Treasurers served as Limited Service Stations and could complete all transactions except road tests, and CDL testing and licensing. The DMV managed Full Service Stations that were located throughout the State, particularly in the larger towns and cities.

Kansas required that drivers complete all license renewals in-person. The renewal cycle was 6 years for drivers under 65 and 4 years for drivers 65 or older. Drivers' vision was screened at every renewal, regardless of driver age. The DMV accepted a vision test from an eye care professional in lieu of the in-office vision screening.

All drivers completed a short written test at each license renewal. For a standard renewal, the paper-and-pencil test was open-book, and drivers could complete it before arriving at the service station. The test included questions about road signs and traffic laws. A pictorial version of the test was available if an individual could not read. The DMV administered a more in-depth closed-book version to drivers called in because of a medical or other referral. A driver who failed the written test could retake it three times and then was required to wait six months before trying again.

A Kansas license examiner could require an on-road test at any time during the renewal process if he or she suspected that a driver had a cognitive or physical limitation that could render the driver unsafe. Drivers with visual acuity of less than 20/60 were required to take road tests. Examiners did not renew licenses of drivers who refused to take the test. After taking and failing the road test four times, drivers were required to wait six months before trying again.

Kansas could administer local drive tests near a person's home in order to test the individual on the roads where he or she usually drove. Drivers who passed these local drives received a restricted license that limited the roadways and time of day they were allowed to drive. Drivers generally had only one chance to pass the local drive test. If a driver passed the test, the scheduling of the next test cycle was at the discretion of the examiner.

The Kansas DMV had an in-house medical review unit that processed a substantial number of medical referrals for drivers of all ages. This medical review unit recommended license restrictions or suspensions based on established criteria for specific conditions. Kansas maintained an MAB, and the medical review unit referred cases to the MAB that they could not resolve using the established protocols. The DMV, however, made final decisions on license restrictions, suspensions, or revocations.

Drivers signed a form permitting their doctor to release information to the DMV, and doctors reporting such information were immune from damages. The DMV accepted letters of concern from courts, police, family members, other driver license offices, or neighbors. These letters of concern were signed and available for review if the driver requested a copy.

7.2 Discussions with Licensing Staff

On July 20-23, 2009, researchers held discussions with licensing staff at four Kansas DMV offices. DMV staff members included certified driver license examiners, office clerks, and staff supervisors. The DMV selected offices to be representative of licensing offices across the State and included:

- Wichita - A large urban office;
- Kingman - A small, one-person, one day per week, office servicing a rural area;
- Manhattan - A midsize facility servicing a university town; and
- Seneca - A small, full-time office with two employees servicing a rural area.

Staff members noted the following pertaining to their job responsibilities and interactions with older drivers who came in for a license renewal:

- All staff members performed all in-office duties except for CDL road tests;
- As with routine processing, each staff member could conduct all aspects of referrals; and
- Managers tended to handle more difficult cases (e.g., those involving medical review).

Staff members indicated that the reduced renewal cycle probably increased safety, but most favored reducing the renewal cycle further after age 80. Staff said the vision screen was a good indicator of the need for medical review, and it prompted many older drivers to go to their eye care professional for a check-up. They indicated the referral written test (closed book) was a good screen, and the open-book test that everyone takes appeared to provide a reasonable review for drivers. If staff detected a problem before the vision or written screens, they could conduct a line drive before proceeding with any other screening activities.

Staff members indicated that they conducted local drives relatively often. Drivers who requested such tests understood that passing the test would lead to a restricted license. License examiners had broad discretion in generating restrictions based on local drives. Staff members noted that these tests and the resulting restrictions allowed older drivers to safely remain mobile for important activities. The local drives were more prevalent in rural areas, and most examiners believed that restricted older drivers generally complied with the restrictions.

Senior staff members reported attending a conference or two on identifying at-risk older drivers, but junior staff reported no formal training beyond advice from supervisors. Most training was on the job.

Staff indicated that older drivers generally thought the licensing process was fair but did not like it when a complaint was filed about them that required them to come in to the licensing office for evaluation. Most of the staff thought that requiring a drive test would be good for drivers around age 75 but that the costs of such test would be prohibitive.

Overall, the field office staff members appreciated and valued the medical reporting/review process and felt that the central office provided excellent support. Staff members thought that the medical review process in combination with all of the other licensing practices led to enough drivers being screened to have a statewide safety impact on older drivers.

7.3 Discussions with Older Drivers

On July 20-23, 2009, researchers held discussions with 44 older drivers (23 males, 21 females) who ranged in age from 52 to over 90 (most were over 80) at the four driver licensing offices. These drivers had just completed the driver license renewal process.

Most of the drivers indicated they drove very little, less than 20 miles per week, but a few drove more than 10,000 miles per year. Many mentioned they preferred not to drive at night, on freeways, in big cities, during rush hour, or in unfamiliar places. Most drove alone, but some drove with spouses.

Overall, the drivers were satisfied with the license process, especially when wait times were short, because staff gave priority to handicapped and older drivers. Some of the drivers said they were nervous about the vision screening, but not about the open-book written test. They said the written test served as a good refresher. Had it been closed-book, they would have been more concerned. Some drivers who had taken a local drive said that process made retaining a license particularly easy.

Some of the drivers did not realize that older drivers had a reduced renewal cycle, but those who knew about it thought it was fair. Many would support a further reduced cycle after age 80. There was some support for a mandatory road test, at around 80. However, older adults might find it difficult to travel to a city to take the test.

The only age-related issues that came up were degradation of vision and reflexes. Otherwise, the older drivers did not feel that they had any major limitations that would affect their driving safety. Many indicated that they visited an eye care professional before renewal to avoid the vision screening. Others studied the driving manual in advance, but most were not concerned about failing the license renewal process. Most reported not using any special strategies when driving, although a few mentioned using pillows to sit higher or a lumbar support. One participant mentioned getting a smaller car because it was easier to maneuver. Only one person had taken a driver training course to get an insurance discount.

Most of the drivers indicated that not being able to drive would have a negative impact on their lives and the lives of their families. Most did not want to be a burden on their families and said they would compensate somehow (e.g., take taxis) rather than depend on relatives. Many noted that their children watched their driving abilities and had suggested or would recommend restricting driving. Others said a doctor had restricted their driving at night. Drivers indicated that they would stop driving if:

- They were in a crash.
- They caused a crash.
- Had vision or other health deficits.
- Children indicated they were no longer safe drivers.

- They did not feel comfortable or safe.
- The license examiner suspended or revoked their license.

Knowledge of alternative transportation varied with many in the rural areas not knowing of or having access to alternative transportation. Many drivers said they would rely on family or friends, while others said they would take vans or taxis for older adults.

7.4 Crash and Fatality Rate Profile

Figure 7 shows the Kansas crash profile per 1,000 population and per 1,000 licensed drivers by 5-year age groups for calendar years 2003-2007. Crashes per 1,000 population showed a decline with increasing driver age. The decline leveled off from ages 70 to 79 before declining again for drivers over 80. The crash rate reached a low of 13.8 for those 85 and older.

Given that the number of drivers licensed was always less than the population estimates as shown in Figure 8, (reaching nearly 100% for 60 to 69-year-olds), the crashes per 1,000 licensed drivers was always greater than crashes per 1,000 population. Crashes per 1,000 licensed drivers declined until age 65 when crashes per 1,000 licensed drivers leveled off before dropping slightly for drivers 85 and older to a low of 24.2.

Kansas showed a drop in percentage of population licensed among those 85 and older (57.0% licensed), and the crashes per 1,000 licensed drivers declined for this age group, although not as much as the decline for crashes per 1,000 population.

Figure 7. Kansas Crashes per 1,000 Licensed Drivers and 1,000 Population

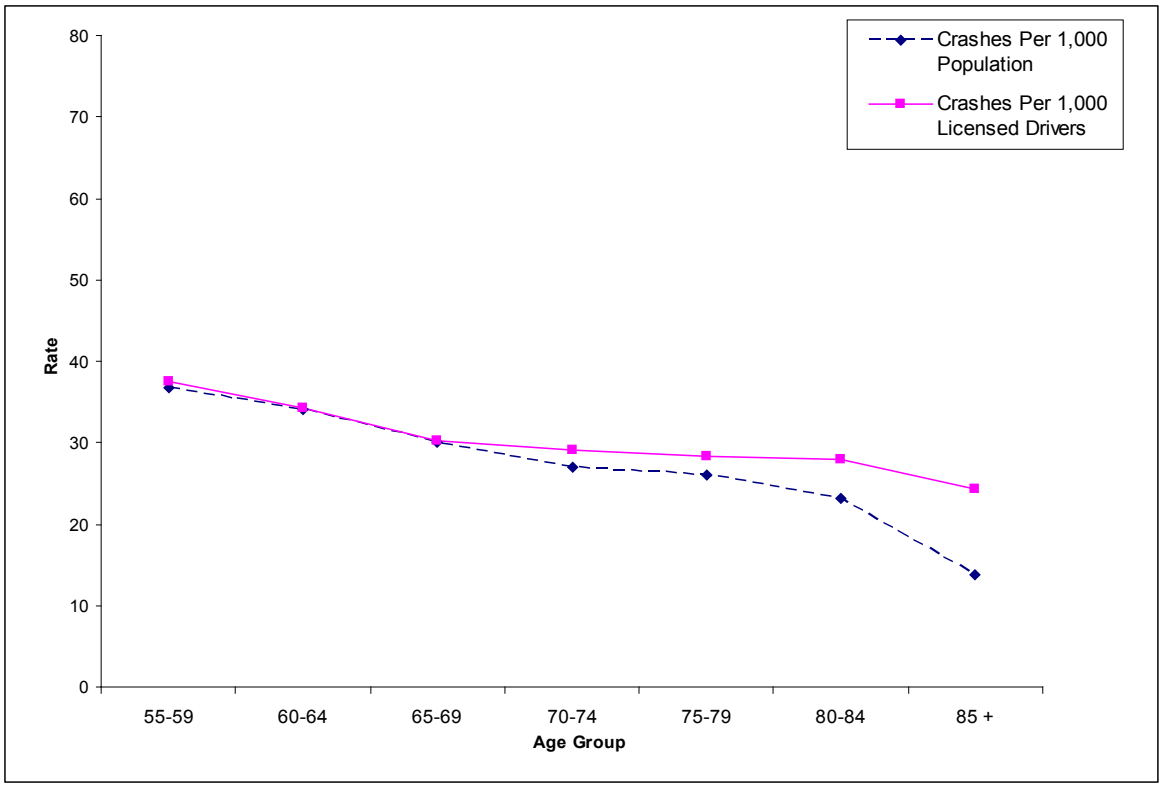


Figure 9 shows the driver fatality rates per 100,000 licensed drivers and per 100,000 population for the various age brackets in Kansas. The fatality rate per 100,000 population dropped to a low of 19.6 at age 70-74 and then increased for 75-89-year-olds before dropping again for the two oldest groups. The fatality rate per 100,000 licensed drivers showed a similar drop to age 70-74 where it bottomed out at 21.2, but then showed an increase thereafter, reaching a 29.2 fatalities per 100,000 licensed drivers for drivers 85 and older.

Figure 8. Percentage Licensed by Age Group in Kansas

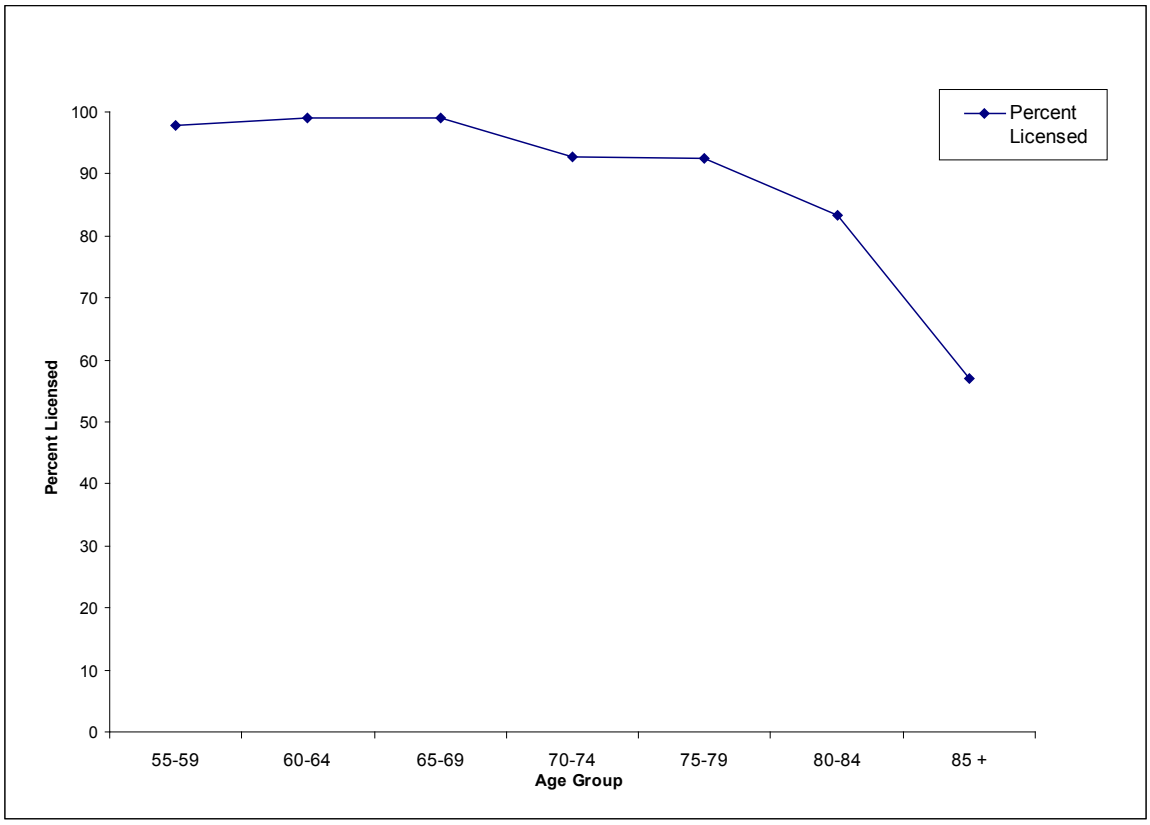
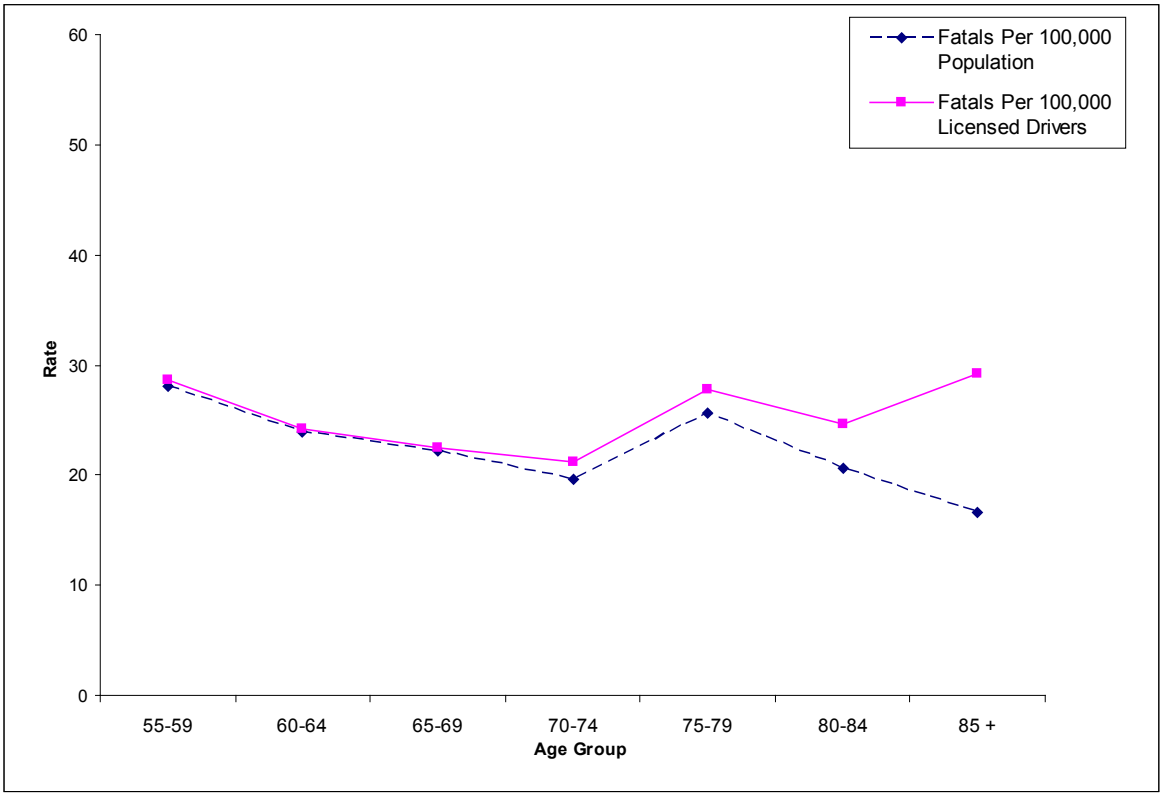


Figure 9. Kansas Driver Fatalities per 100,000 Licensed Drivers and 100,000 Population



8. NEW HAMPSHIRE

New Hampshire was selected as a special emphasis State primarily because of its road test requirement for renewals of drivers over age 75, and other licensing policies and activities that could affect the safety of older drivers.

8.1 Licensing Policies and Activities Affecting Older Drivers

The Division of Motor Vehicles (DMV) of the New Hampshire Department of Public Safety had responsibility for New Hampshire driver licensing. The DMV had 18 substations located throughout the State that could perform all driver licensing functions.

All drivers, regardless of age, were required to renew their license every five years. Until 2010, all renewals had to be in-person at a licensing office. However, drivers whose licenses expired beginning in February of 2010 were eligible to renew their license online every other renewal cycle. A driver renewing a license online had to have a photo on file with the DMV and could not have a suspended license. Drivers who were required to complete a licensing exam or road test could not renew online, which encompassed all drivers over 75 since they were required to complete a road test at renewal. Drivers renewing online had to verify their personal information and certify that their vision was adequate for driving. The online renewal produced a temporary paper license that drivers held along with the old license until the new license arrived in the mail.

Up until 2010, all drivers completed a vision screening at each renewal. A traditional eye chart screening was administered to drivers who failed or could not take the electronic vision screen. Drivers who did not pass this second eye screen were required to see an eye care professional for a more thorough examination. When appropriate, the eye care professional completed a form stating the individual had adequate vision to drive.

Drivers over 75 were required to take an on-road driving test at a driver licensing office at each renewal. This road test was the same as that younger drivers received at first-time licensing. The driver used his or her own vehicle, and the examiner sat in the passenger seat. No other passengers were allowed in the vehicle. The DMV defined the routes for the drive test for each testing station with the intent of exposing drivers to a variety of traffic situations, even if they did not normally drive in those situations. Examiners could use different routes to discourage drivers from practicing on common test routes, but there were no special test routes for older drivers.

Drivers who failed the on-road test could take the test two more times. They could request a different examiner or go to a different DMV office, but there was no guarantee that another examiner would be available for the test. A third test failure resulted in the suspension of the person's license. A person who failed three times could request a hearing with the DMV. The hearing examiner generally required that the driver take additional training before retaking the driving test. Drivers who failed again could request another hearing and possibly get another road test.

Police, family members or physicians who had concerns about a person's driving ability could refer drivers of any age to the DMV. A driver was allowed to know who made the referral to the DMV. The referrals were reviewed by the DMV (New Hampshire did not have a standing MAB) to decide whether the driver should be tested. If the DMV determined further investigation was warranted for medical or non-medical reasons, it issued the driver a letter explaining the reason he or she needed to come in for a test in order to maintain a valid license.

Anyone who received such a letter was required to pass a written test before taking the road test. The on-road test for a person who was referred due to a medical condition was expanded in order to give the examiner a better look at the person's driving skills and potential driving errors related to the medical conditions noted in the referral. The extended test applied to everyone, regardless of age.

8.2 Discussions with Licensing Staff

On April 15, 2009, researchers held discussions with New Hampshire driver license examiners to discuss the license renewal process for older drivers. All of the State's examiners were present at the DMV's headquarters in Concord, NH for training on that day. Twelve examiners from across the State participated in discussions before training and during breaks. Customer service staff who handled many of the administrative functions of licensing took part in brief discussions.

Pertaining to their job responsibilities and how they interacted with older drivers who came in for a license renewal, virtually all staff members noted that:

- Examiners in smaller offices performed all functions.
- Examiners in larger offices tried to work with an older driver from start to finish but could not always do so.
- Generally, there were no differences in procedures by driver age.
- Customer service staff did not have a major role in identifying potential problem drivers although they could make notes in a person's record.

Examiners indicated that most older drivers who came in for routine renewals passed the eye exam and immediately proceeded to the road test. Examiners agreed that the drive test for older drivers was an effective way to identify risky drivers and was likely related to increased safety for older drivers in the State given the numbers of drivers they screened and the fact that many drivers studied to prepare for the test.

Staff supported mandatory testing beginning at 75. Some of the examiners felt that a benefit might not show up in crash rates until drivers were older than 80 since so many people's renewal cycles did not require them to come in for the drive test until well after their 75th birthday. On the other hand, some examiners thought that crash rates might improve at age 75 since people might prepare for the drive test early, or might think they had to take the test when they turn 75, not upon their next renewal after age 75 as DMV regulations require. Most of the examiners asserted that they should retest drivers older than 75 at shorter intervals.

Examiners were adamant that the road tests were the same for younger and older drivers. Some examiners said that they may have paid more attention to the physical abilities of older

drivers compared to younger drivers, and, conversely, may have given more attention to the decision-making skills of younger drivers.

Staff felt that many older drivers who failed the test took the explanations for failure to heart and adjusted their behaviors for subsequent road tests and that some drivers completed training before or after the road test. Older drivers mentioned AARP's course most often, but some drivers reported being referred to driving schools that included on-road training. Examiners indicated that many, but not all, of the drivers who attended these programs showed marked improvement in subsequent tests.

A few of the examiners indicated they had conducted local drives in the past, but that these were only for special cases and were not part of normal activities. Some of the examiners thought that more local drives might be beneficial and would give older adults more freedom in remote areas of the State. Others felt that the older drivers should be tested in a variety of conditions just like everyone else since they would likely have to drive in those conditions at some point

The examiners indicated that they did not receive any training through the DMV that specifically addressed issues they could encounter with older drivers. They received on-the-job training from other examiners on how to interact with older drivers and the things to look for when they took older drivers out on the road. A few examiners reported that they explored issues related to older driver safety due to personal curiosity. Some had read AARP's materials or other information on older driver errors that can affect safety.

Examiners indicated that almost all of the drivers over 75 who came in to renew their license were aware that they must take a drive test, and that a small proportion of the drivers appeared to have taken training to prepare for the test. After failing the drive test, however, many were belligerent towards the examiners. One examiner estimated that as many as 70% of those who failed the test responded in a negative manner. Some of the examiners said that many of the drivers who failed appreciated the efforts of the examiners and understood why they failed, addressed the issues, and subsequently passed a re-test.

Overall, the examiners thought their procedures were good and would likely lead to reduced crash rates for older drivers.

8.3 Discussions with Older Drivers

On August 17-18, 2009, researchers held discussions with older drivers who had just completed the license renewal process at four New Hampshire licensing offices across the State. Participants included 26 males and 26 females, and ages ranged from 60 to over 75. Among the drivers in the discussions, 25 were over age 75 and had just completed on-road tests (23 passed, 2 failed). The other participants were visiting the licensing offices for other renewal-related purposes.

The DMV selected the following offices to be representative of licensing offices across the State:

- Concord - Large office with a high volume of drivers.
- Dover - Small office near the shore.
- Manchester - Large facility servicing many clients.
- Merrimack - Small inland office.

Some of the drivers did not drive at all while at least one person drove over 30,000 miles per year. Many indicated they did not drive at night, in heavy traffic (particularly around Boston), or in snow or ice. Most drove alone; if they had a passenger, it was usually their spouse.

All of the drivers were satisfied with the license renewal process and thought the different policies pertaining to older drivers were fair. The drivers agreed that the road test was fair since performance can decline with age. Almost everyone agreed that 75 was the correct age to start the mandatory road test. A small number of drivers over 75 admitted to being nervous about the road test. Of those under 75, about half knew that a road test would be required for renewal after age 75. Even when informed about the test requirement, drivers expressed little concern about the test.

Although most participants disliked the machine used to screen vision, they were not concerned about the vision screen. Some thought it would be better to screen vision more often. Most opposed a written test, however, since they felt it was not relevant to driving safety.

Most drivers were not worried about failing any portion of the license renewal, and some said they were better drivers than ever due to their experience. A few mentioned declines in reflexes, managing glare, and concentration. Only a few had taken a driver training program, and none had ever had anyone suggest that they should stop driving. If they did have to stop driving, most indicated it would be devastating. The primary causes that would lead them to stopping driving included:

- Being in a crash;
- A major health problem;
- Vision declines;
- Judgment deficits;
- A decline in reflexes; and
- A suggestion by a family member.

Most said they had limited transportation options if they ever had to stop driving. Many would rely on friends and family, but others said they had no other transportation.

8.4 Crash and Fatality Rate Profile

Figure 10 shows the New Hampshire crash profile per 1,000 population and per 1,000 licensed drivers by 5-year age groups for years 2004 - 2008. Crashes per 1,000 population showed a decline with driver age that leveled off from age 70 to 84 before declining again for drivers over 85. The crash rate reached a low of 16.1 for the 85-and older group.

As shown in Figure 11, the percentage of the population licensed in New Hampshire exceeded 100% for most age groups up to age 70,[2] which led to the rate of crashes per 1,000 licensed drivers being at or below the rate of crashes per 1,000 population. Crashes per 1,000 licensed drivers declined until the rate reached a bottom at the 70-to-74 age group. At 70, the percentage of population licensed dropped to 94.5% and continued to drop to 49.3% for the 85-and-older group. This drop in proportion of population licensed corresponded with an increase in crashes per 1,000 licensed drivers for all age groups above age 75. The rate peaked at 33.6 crashes per 1,000 licensed drivers 80 to 84.

The notable increase in crashes per 1,000 licensed drivers may indicate that the licensing system has had an impact on the older driver population by sharply reducing the percentage of older licensed drivers, thus reducing the denominator used to calculate the rate. Crashes per population continued to decline at the older ages even though the rate of crashes per 1,000 licensed drivers increased.

[2] As discussed earlier in this report, data on the number of licensed drivers in each State included in the study were obtained directly from the States. Population estimates were obtained from U. S. Census estimates based on projections from the 2000 Census. For some age groups in some States, the number of licensed drivers reported by the State licensing agency exceeded the population estimates from the Census.

Figure 10. New Hampshire Crashes per 1,000 Licensed Drivers and 1,000 Population

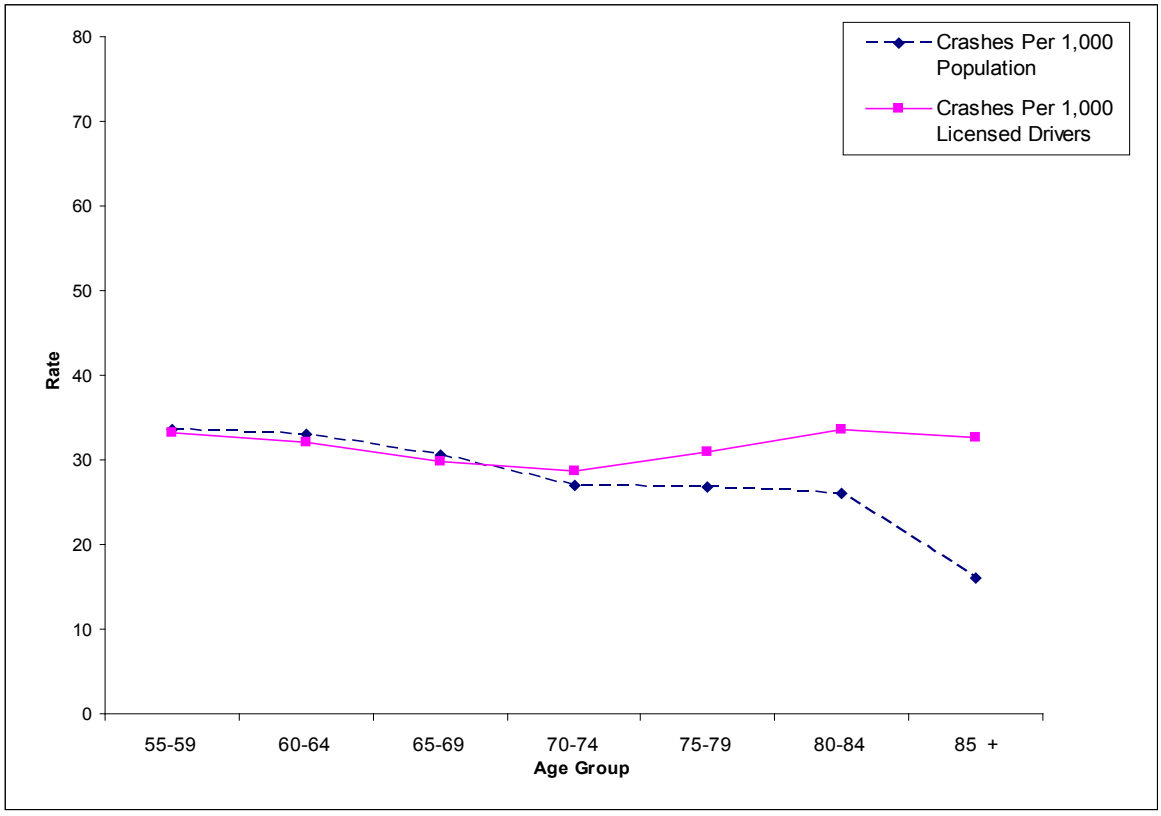


Figure 11. Percentage Licensed by Age Group in New Hampshire

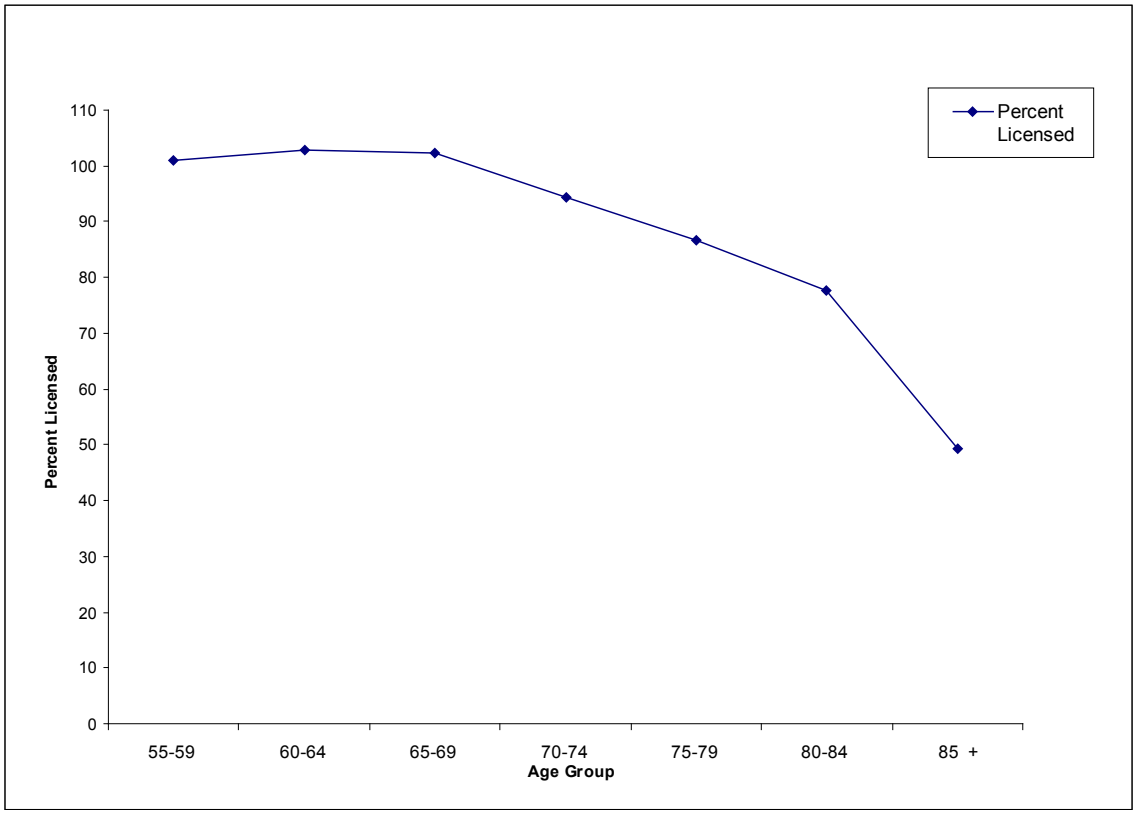
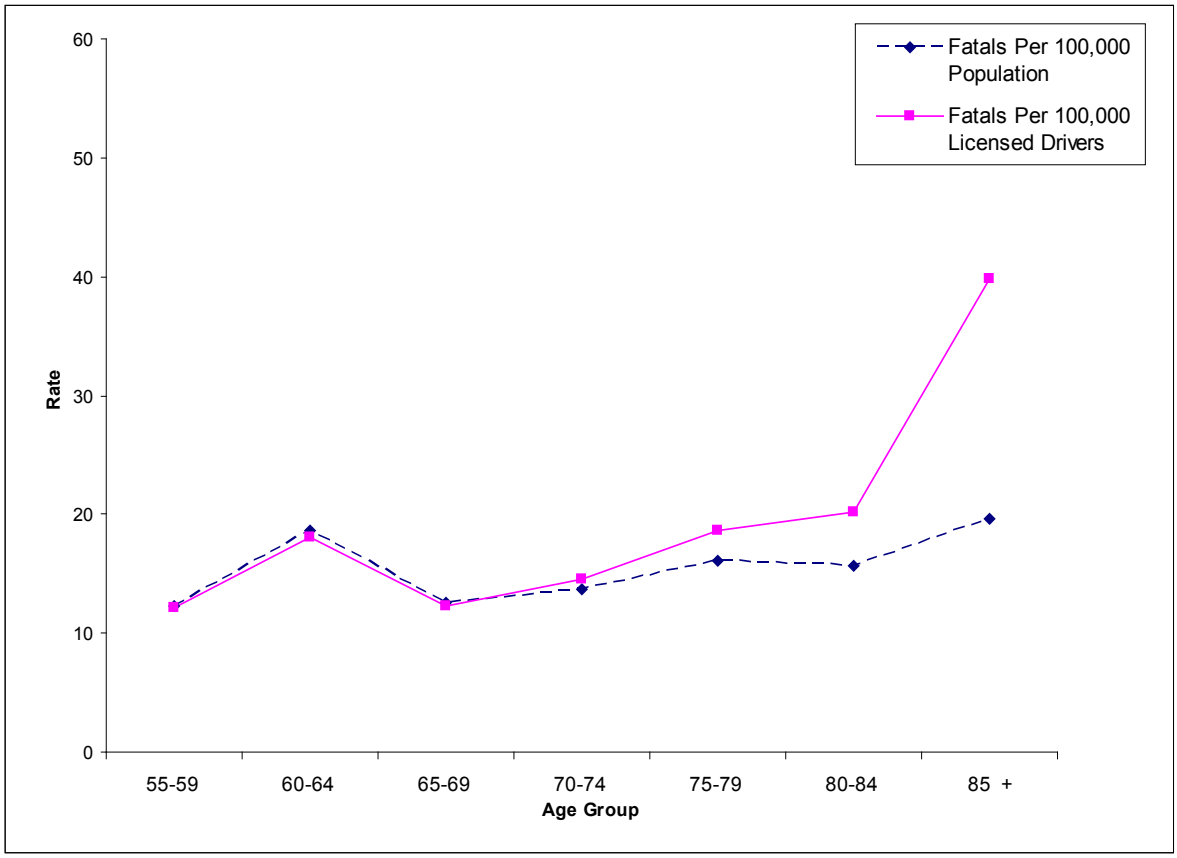


Figure 12 shows the fatality rates per 100,000 licensed drivers and per 100,000 population for the various age brackets in New Hampshire. The fatality rate per 100,000 population dropped to 12.5 at age 65-69 and then increased steadily thereafter to a high of 19.6 for those 85 and older. The fatality rate per 100,000 licensed drivers showed a similar drop to age 65-69 where it reached 12.3, but then showed increases thereafter, reaching a high of 39.8 fatalities per 100,000 licensed drivers among those 85 and older.

Figure 12. New Hampshire Fatals per 100,000 Licensed Drivers and 100,000 Population



9. COMPARISON STATES

Researchers chose Indiana, Minnesota, Missouri, Nebraska, Vermont, and Wisconsin, for comparison purposes due to their geographic proximity to the special emphasis States. The policies that could affect older drivers vary among these comparison States. Further, since the study did not include site visits in these States, some information may be missing regarding additional policies or activities that the States have in place specifically for older drivers. Table 3 below summarizes the key licensing policies considered applicable to older drivers in these States. Each State's subsection contains more detail regarding these policies.

Table 3. Licensing policies/activities in additional study States

State	Policies/Activities
Indiana	• In-person renewal required after 70 • Vision screening at every in-person renewal • Renewal cycle reduced to 3 years after 75; reduced to 2 years after 85 • Could administer local drive test at person's home for restricted license
Minnesota	• In-person renewal for all ages • Vision screening at every renewal • Immunity provided to reporting physicians
Missouri	• In-person renewal for all ages • Vision screening at every renewal • Renewal cycle reduced to 3 years at 70 • Immunity provided to reporting physicians
Nebraska	• In-person renewal for all ages • Vision screening at every renewal • License examiner can require road test at any time • Can administer local drive test at person's home for restricted license
Vermont	• Could renew license for 4 or 2 years • If last license photo was taken before January 5, 2004, in-person renewal required to get new photo ID
Wisconsin	• In-person renewal for all ages; could renew by mail if out-of-State • Vision screening at every renewal • Examiners could require drive test after failure of vision screen and 2 written tests • Could administer local drive test at person's home for restricted license • Immunity and legal protection available to reporting physicians

9.1 Indiana

The Indiana Bureau of Motor Vehicles (BMV) handled licensing of drivers in the State. For drivers younger than 74, a license was valid for six years. For drivers 75 to 84, the license was valid for three years, and for drivers 85 or older the license was valid for 2 years. Indiana allowed drivers under 70 to renew online.

The State required a vision screening at every renewal. A driver with six or more points on his or her license was required to take a written test to renew the license. Indiana did not provide immunity to physicians who reported drivers with medical conditions that could affect driving safety. The BMV accepted reports from many sources, but did not provide anonymity to the reporting individual. The BMV could request a special drive test with a person based on reporting. If a person failed the test, his or her license was suspended immediately. Drivers could take the test up to three times. The State could conduct local drives and restrict licenses. Indiana had a MAB that advised the BMV on medical issues for individual drivers.

9.1.1 Crash and Fatality Rate Profile

Figure 13 shows the Indiana crash profile per 1,000 population and per 1,000 licensed drivers by 5-year age groups for the years 2003 -2007. Crashes per 1,000 population declined with driver age to a low of 19.2 for the 85 and older group.

In Indiana, the percentage of population licensed exceeded 100% for the driver age groups between 50 and 69, which led to the crashes per 1,000 licensed drivers being lower than the crashes per 1,000 population (Figure 14). Crashes per 1,000 licensed declined until 70 where they leveled off before dropping slightly after 80. The rate reached a low of 30.6 for the 85 and older group.

Even though there was a drop in the percentage of population licensed for 85 and older (62.6% licensed), the crashes per 1,000 licensed drivers continued to decline for the age group, although not as sharply as crashes per 1,000 population.

Figure 15 shows Indiana fatality rates per 100,000 licensed drivers and per 100,000 population. The fatality rate per 100,000 population dropped with age to a low of 16.1 for those 85 and older. The fatality rate per 100,000 licensed drivers showed a similar drop to age 70-74 where it reached 17.7, but showed increased thereafter, reaching 25.7 fatalities per 100,000 licensed drivers for those 85 and older.

Figure 13. Indiana Crashes per 1,000 Licensed Drivers and 1,000 Population

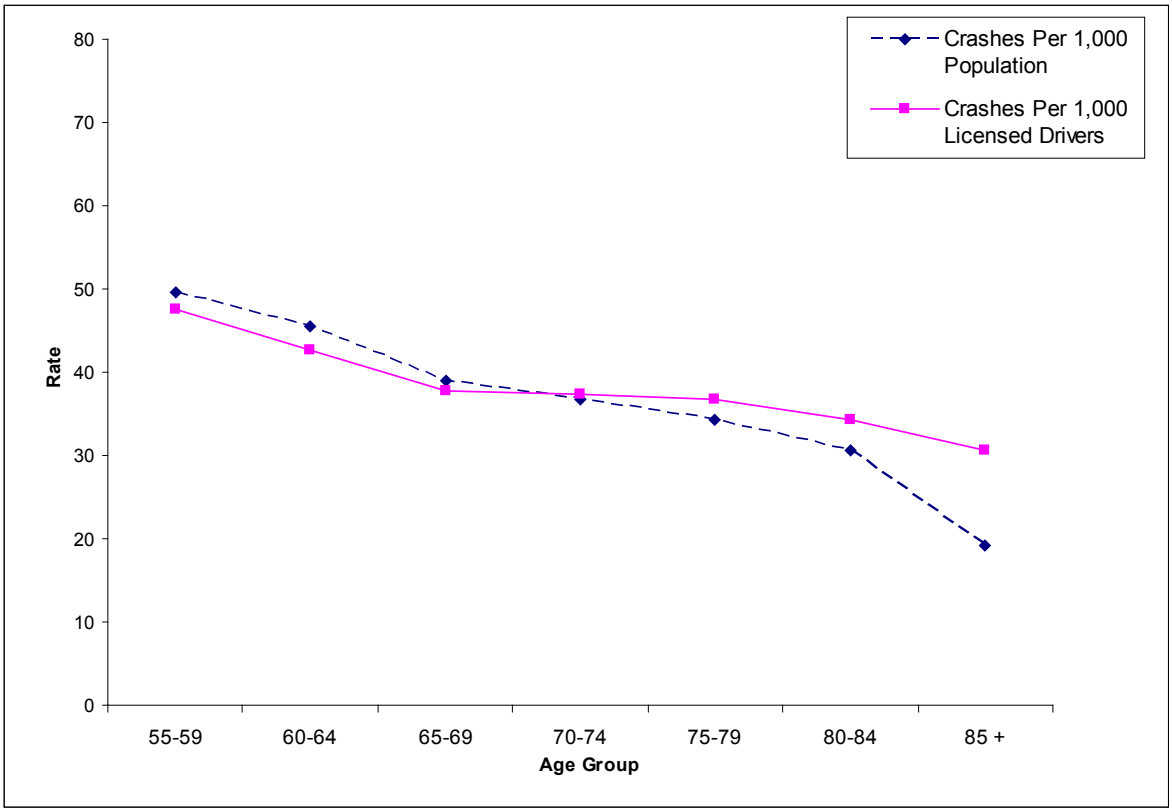


Figure 14. Percentage Licensed by Age Group in Indiana

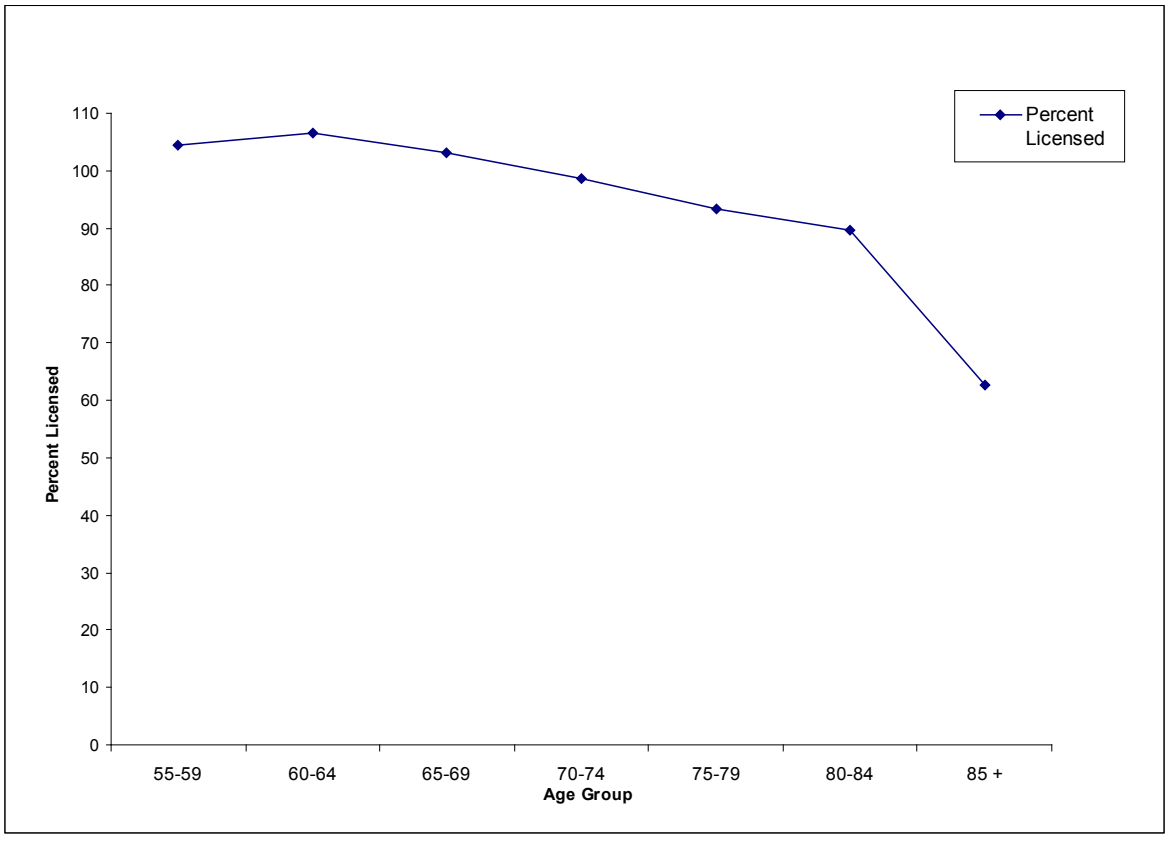
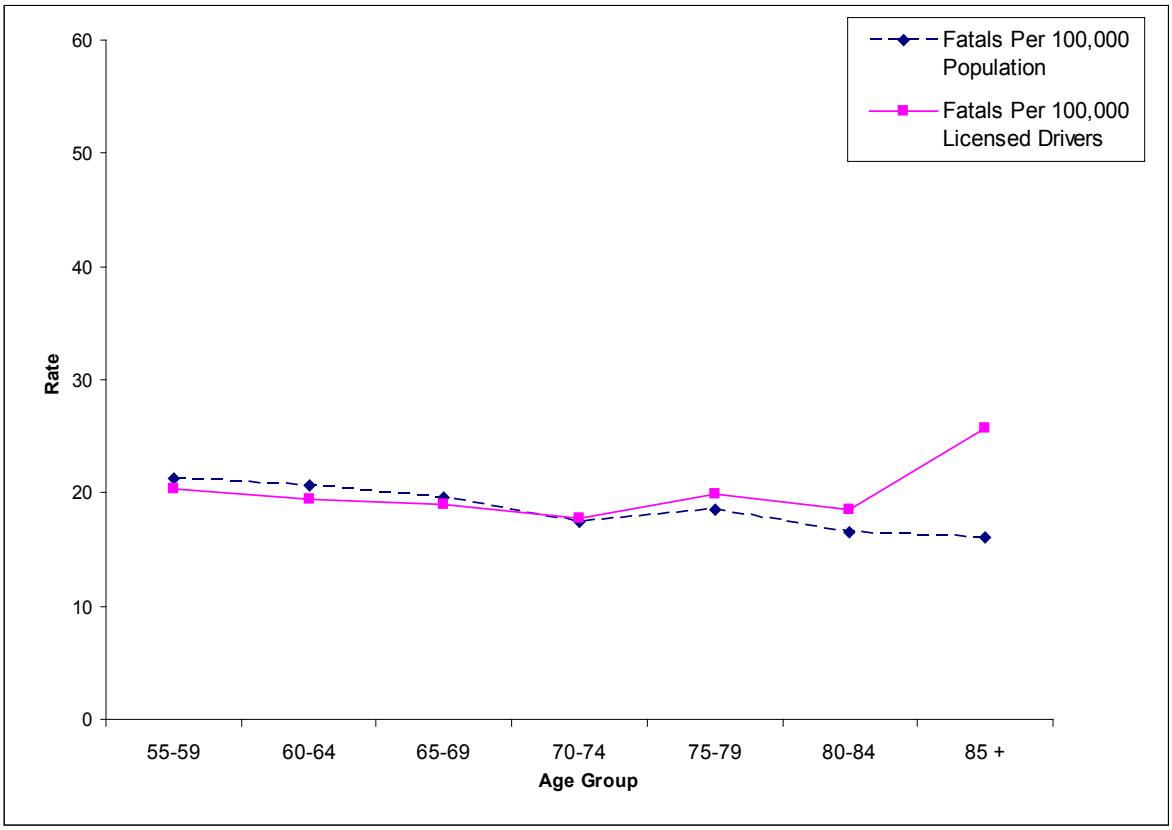


Figure 15. Indiana Fatals per 100,000 Licensed Drivers and 100,000 Population



9.2 Minnesota

The Driver and Vehicle Services Division of the Minnesota Department of Public Safety was responsible for driver licensing in the State. Minnesota prohibited driver re-examination based on age alone, and all driver licenses were valid for four years. License renewals had to be conducted in-person unless the individual resided out of State, in which case drivers could submit a renewal by mail. A vision screen or letter from a qualified eye care professional was required at each renewal.

The State required a written test if a person's license had been expired for more than one year and a road test if the license had been expired for more than five years. Minnesota provided physicians immunity for reporting individuals who had a medical condition that could affect driving safety. The State also accepted information from courts, other driver licensing authorities, police, and family members. The reporting was not anonymous, and courts could subpoena the reports. A Driver Evaluation Unit within the Department of Public Safety reviewed all referrals and could require re-examination. The referred driver was interviewed and completed the review process before re-testing. The MAB advised on individual cases, and licensing actions were based on the recommendation of the majority. The State had the authority to levy a variety of driving restrictions.

9.2.1 Crash and Fatality Rate Profile

Figure 16 shows the Minnesota crash profile per 1,000 population and per 1,000 licensed drivers by 5-year age groups for years 2002, and 2004-2007. Crashes per 1,000 population declined with driver age until it reached a low of 9.2 for those 85 and older.

Figure 17 shows that the number of drivers licensed was always less than the population estimates (reaching nearly 100% for 55 to 69-year-olds). As a result, crashes per 1,000 licensed drivers were always greater than crashes per 1,000 population. Crashes per 1,000 licensed drivers declined until age 65, then leveled off before dropping again to a low of 14.7 for those 85 and older .

Even with the drop in percentage of population licensed among the oldest age group (62.7% licensed), the crashes per 1,000 licensed drivers declined for the age group, although not as much as the decline for crashes per 1,000 population.

Figure 16. Minnesota Crashes per 1,000 Licensed Drivers and 1,000 Population

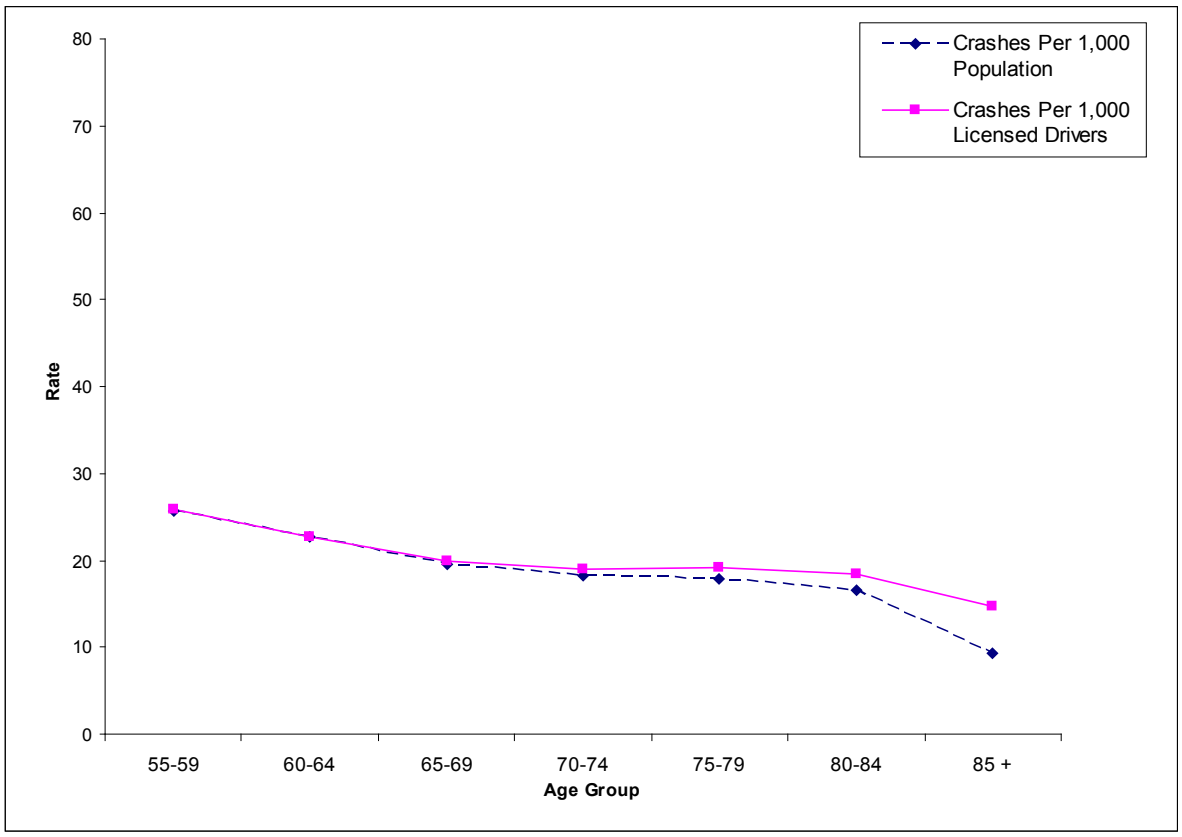


Figure 18 shows the fatality rates per 100,000 licensed drivers and per 100,000 population. The fatality rate per 100,000 population dropped to a low of 4.4 for 75- to 79-year-olds, then increased slightly for 80- to 85-year-olds before dropping again for drivers 85 and older. The fatality rate per 100,000 licensed drivers showed a similar drop to age 75-79 where it reached 4.7, but showed an increase thereafter, reaching 7.5 fatalities per 100,000 licensed drivers for 80- to 84-year-olds and 7.0 for 85 and older group.

Figure 17. Percentage Licensed by Age Group in Minnesota

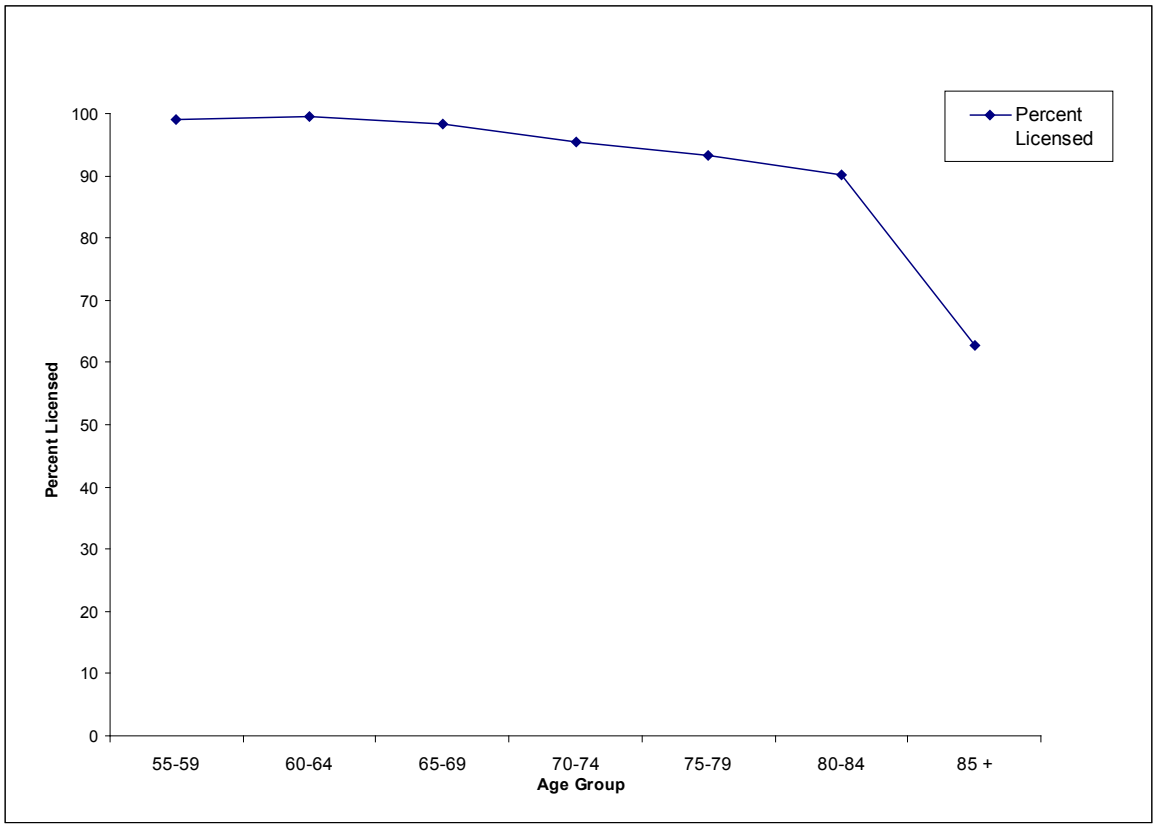
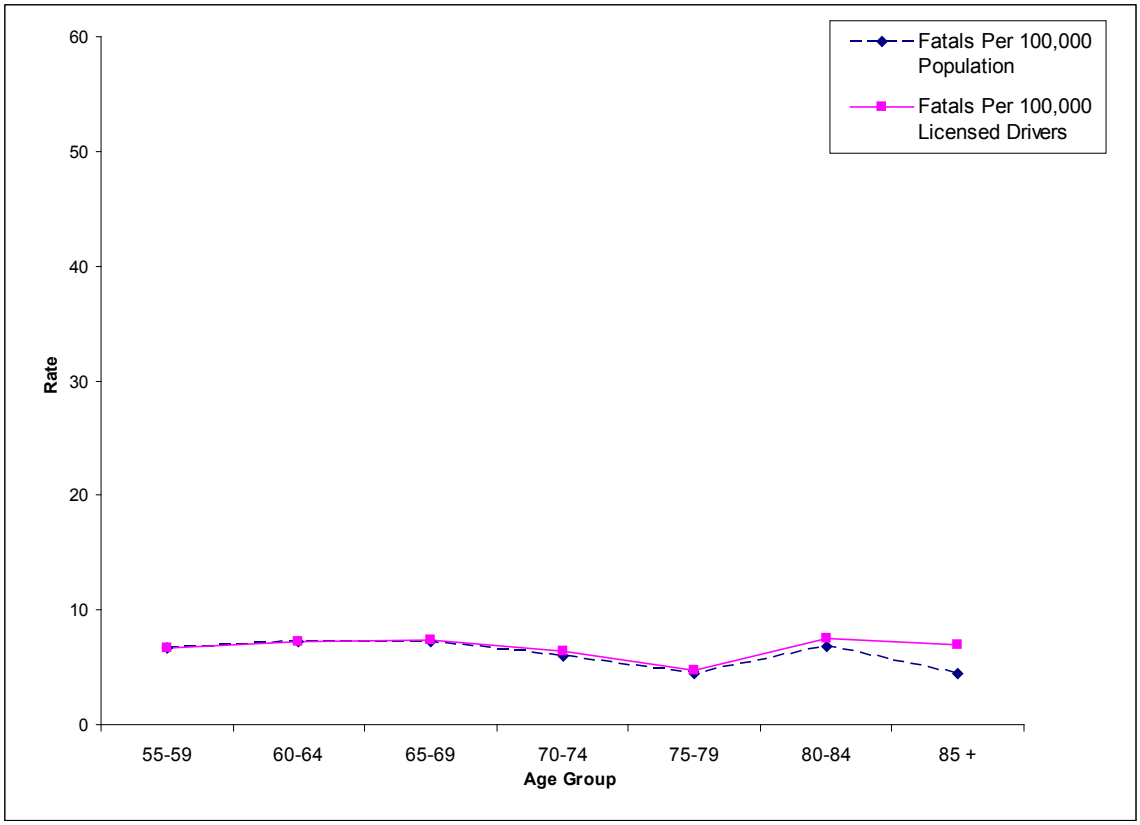


Figure 18. Minnesota Fatals per 100,000 Licensed Drivers and 100,000 Population



9.3 Missouri

The Missouri Department of Revenue housed the Division of Motor Vehicles and Driver Licensing. Missouri required in-person renewal for all licenses. Drivers 69 and younger were required to renew their licenses every six years while those 70 and older had to renew every three years. The State conducted a vision screening at every renewal and accepted an eye care professional's exam in lieu of the in-office vision screen. Missouri required a written test and/or road test if a person's license had been expired more than six months or if a person had been cited and was required to take the exam after undergoing the review process.

Physician reporting was not required, but the State provided immunity for those who did report. Missouri accepted information about unsafe drivers from a wide variety of individuals, and anonymity was available. The MAB could advise on individual referral cases, but a Division staff person generally processed referral cases. The State could impose a variety of restrictions based on findings from the review process.

9.3.1 Crash and Fatality Rate Profile

Figure 19 shows the Missouri crash profile per 1,000 population and per 1,000 licensed drivers by 5-year age groups for years 2003-2006. Crashes per 1,000 population declined with driver age. The decline leveled off for 70 to 79-year-olds before dropping again until it reached a low of 15.8 for the drivers 85 and older.

Given that the number of drivers licensed was always less than the population estimates (Figure 20), the crashes per 1,000 licensed drivers was always greater than crashes per 1,000 population. Crashes per 1,000 licensed drivers showed a decline until age 70 before increasing slightly to 36.9 for 80- to 84-year-olds. Another slight drop occurred for the oldest group, reaching a low of 33.3 crashes per 1,000 licensed drivers.

Despite the drop in percentage of population licensed for drivers 85 and older (only 47.5% licensed), the crashes per 1,000 licensed drivers declined slightly for that age group, although not as much as the decline for crashes per 1,000 population.

Figure 19. Missouri Crashes per 1,000 Licensed Drivers and 1,000 Population

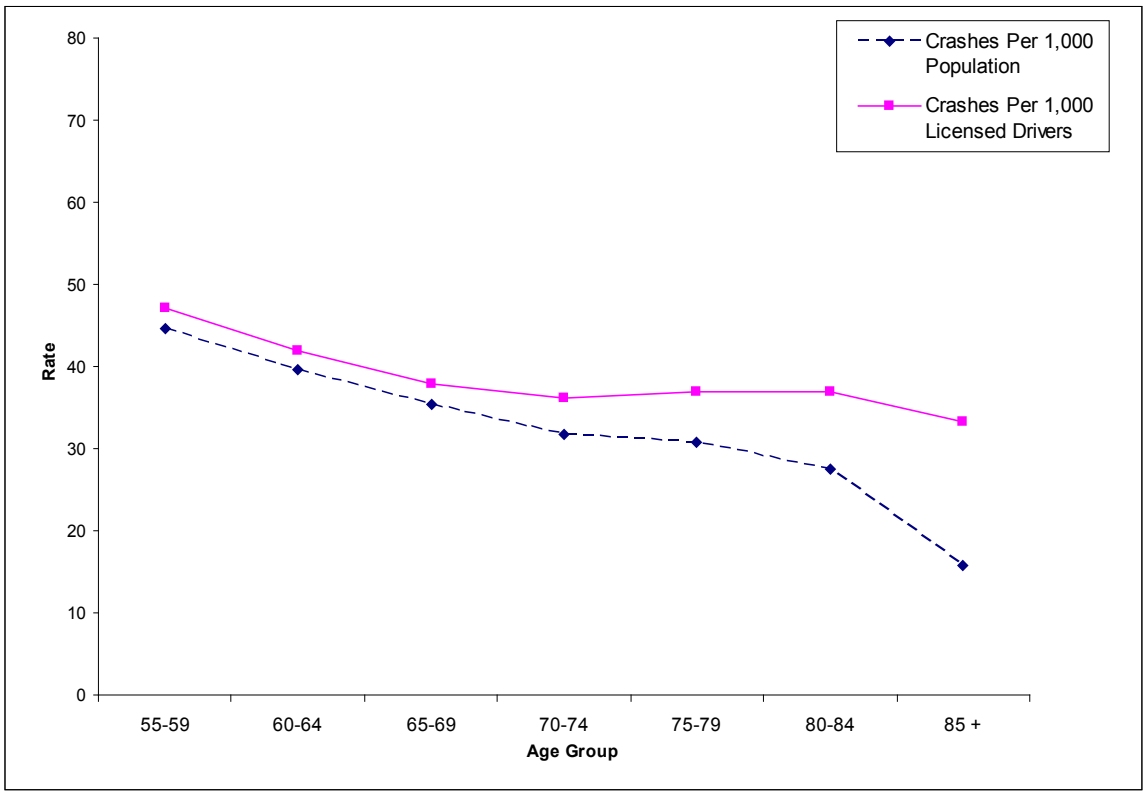


Figure 21 shows the fatality rates per 100,000 licensed drivers and per 100,000 population for the various age brackets in Missouri. The fatality rate per 100,000 population dropped to a low of 20.0 for those 85 and over, with an increase to 27.3 noted for 80- to 84-year-olds. The fatality rate per 100,000 licensed drivers declined until age 70-74 where it reached 23.8, but increased thereafter, reaching 42.2 for those 85 and older.

Figure 20. Percentage Licensed by Age Group in Missouri

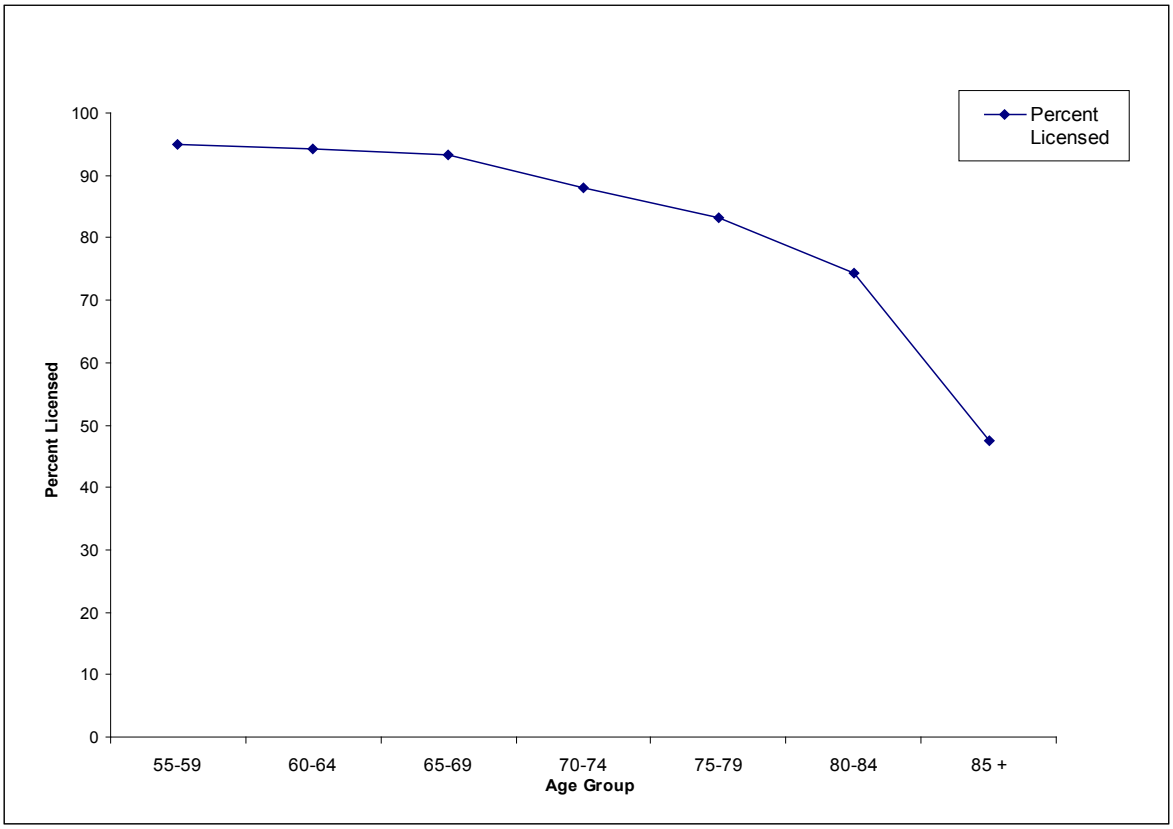
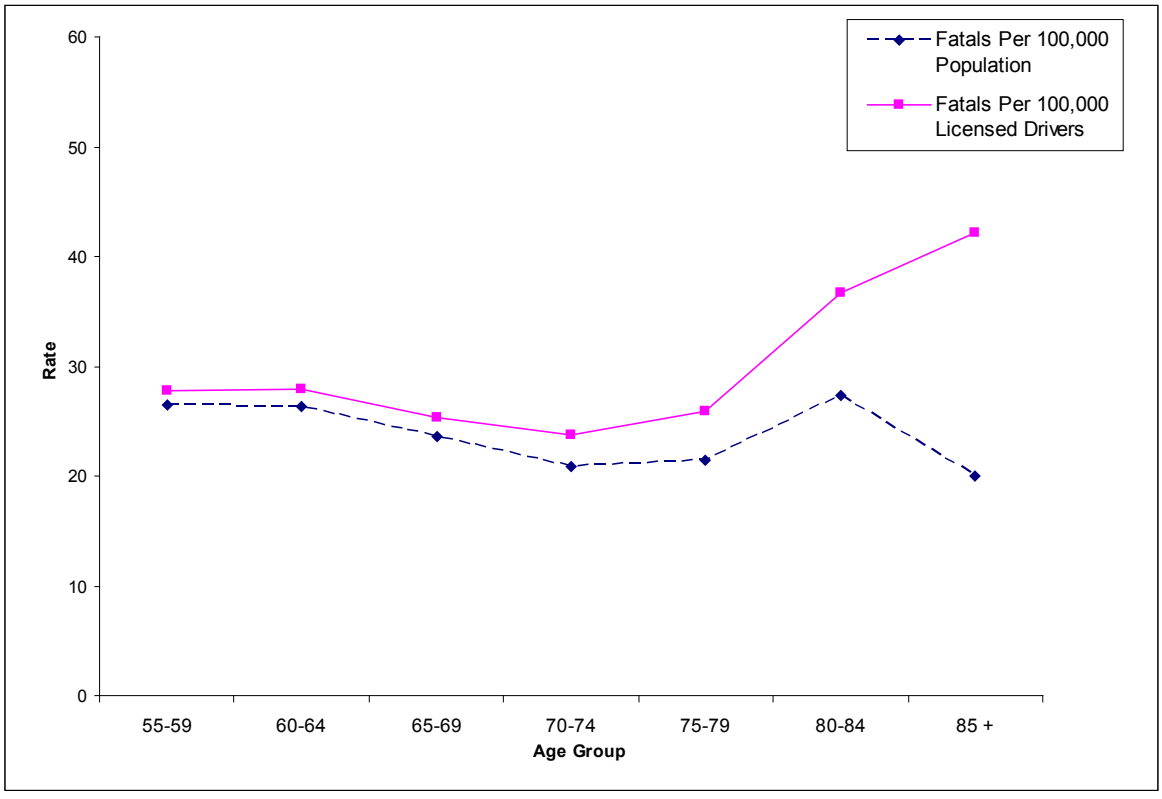


Figure 21. Missouri Fatals per 100,000 Licensed Drivers and 100,000 Population



9.4 Nebraska

The Nebraska Department of Motor Vehicles (DMV) managed all aspects of driver licensing in the State. Licenses were renewed every five years, regardless of driver age. The State could require drivers who used bioptic lenses to renew every one or two years depending on their physician's recommendation. Drivers renewed in person unless the driver was out of State at the time of renewal in which case the person could renew by mail. Starting in June of 2010, the State allowed online renewals for everyone under 65.

Nebraska required a vision screening upon every renewal. Examiners could require a written test and/or on-road test if a license had been expired for more than a year, or if the license was suspended, revoked, or canceled. The State allowed restricted licenses, but the on-road test for the license had to be completed at a licensing office. A license examiner could require a driver to take a "line drive" if he or she suspected the driver had a condition that affected driving safety.

Physicians were not required to report, and the State did not provide immunity for reporting physicians. The DMV accepted referrals from law enforcement officers and other concerned parties. This information remained confidential unless the person appealed the DMV's decision in court. The State did not have an active MAB, and the DMV had no review board. A person appealing the DMV's licensing decision had to go to court to reverse a decision.

9.4.1 Crash and Fatality Rate Profile

Figure 22 shows the Nebraska crash profile per 1,000 population and per 1,000 licensed drivers by 5-year age groups for years 2003-2007. Crashes per 1,000 showed a decline with driver age that continued until it reached a low of 18.0 for the 85 and older group.

In Nebraska, the percentage of population licensed exceeded 100% for the driver age groups between 55 and 64 (Figure 23) that led to the crashes per 1,000 licensed drivers being lower than the crashes per 1,000 population for those ages. Crashes per 1,000 licensed declined until age 70 where it leveled off before dropping slightly after age 85 where it reached a low of 30.1.

Although there was a drop in percentage of population licensed at 85 and older (59.65% licensed), the crashes per 1,000 licensed drivers declined for the age group, although the decline per 1,000 population was much sharper for this age group.

Figure 22. Nebraska Crashes per 1,000 Licensed Drivers and 1,000 Population

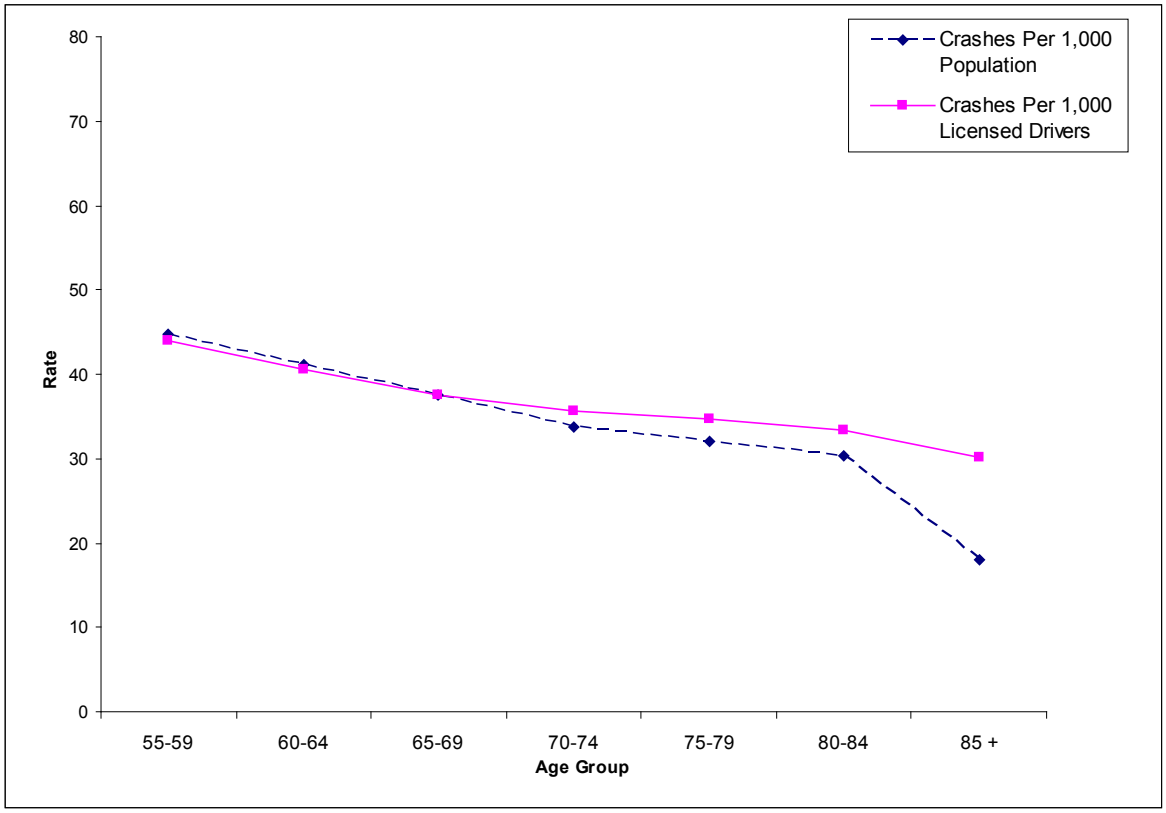


Figure 23. Percentage Licensed by Age Group in Nebraska

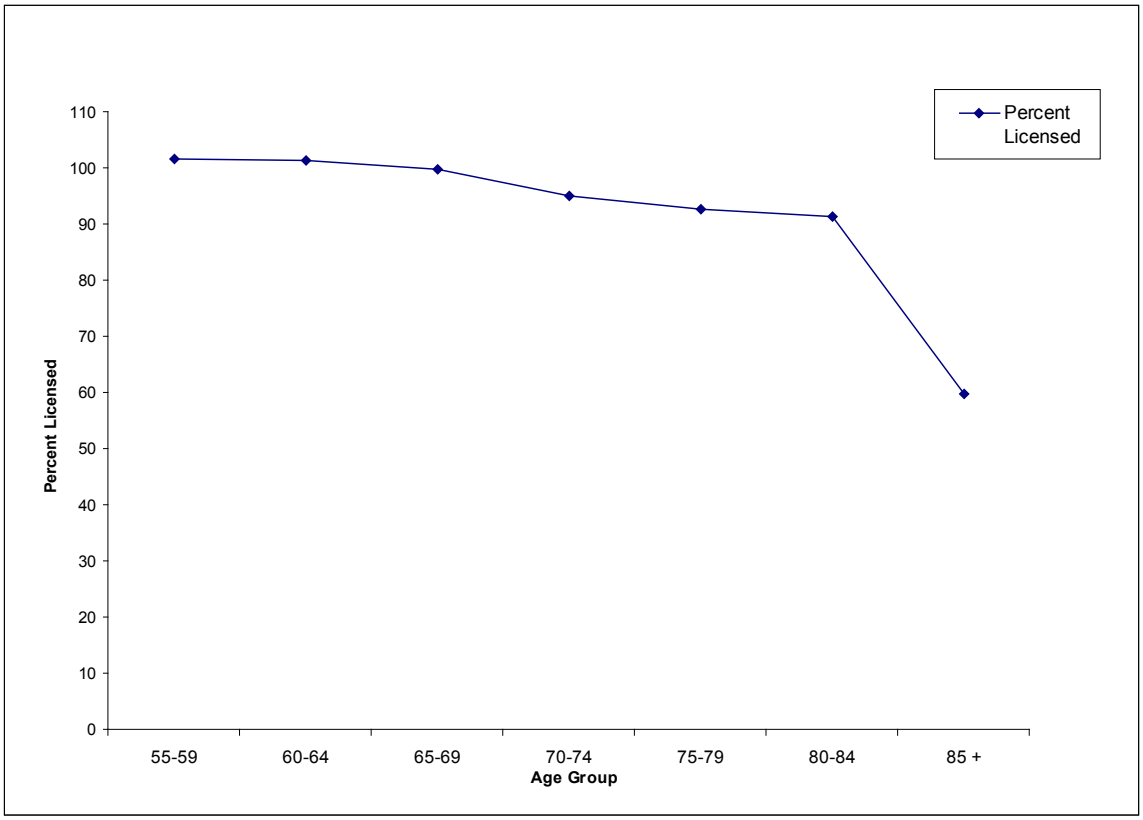
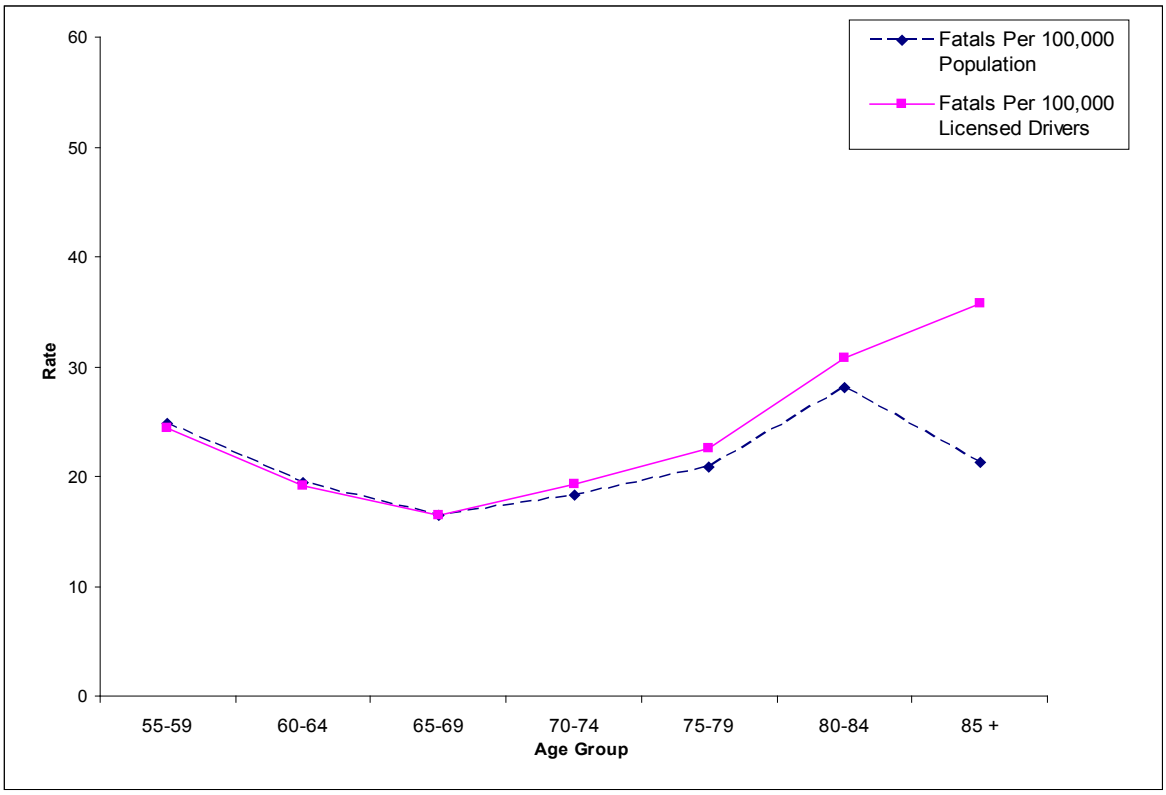


Figure 24 shows the fatality rates per 100,000 licensed drivers and per 100,000 population for the various age brackets in Nebraska. The fatality rate per 100,000 population dropped to a low of 16.4 for 65- to 69-year-olds, and then increased to 28.1 for 80- to 84-year-olds before dropping to 21.3 for the 85 and older group. The fatality rate per 100,000 licensed drivers showed a drop to age 65-69 where it reached 16.4 but then increased thereafter reaching 35.7 fatalities per 100,000 licensed drivers for 85 and older.

Figure 24. Nebraska Fatals per 100,000 Licensed Drivers and 100,000 Population



9.5 Vermont

The Vermont Department of Motor Vehicles (DMV) managed all aspects of driver licensing in the State. Vermont had no driver licensing policies aimed at older drivers. Drivers could choose a two or four year license and could renew in-person or via mail. Vermont required no vision, written, or on-road test for a standard renewal; drivers were only re-examined if the DMV received a referral. A physician could provide a referral to the DMV only with the permission of the patient, and the State did not provide physicians with immunity. The DMV considered complaints from anyone who provided a signed letter. The identity of the individual providing information was not released unless the driver named in the complaint requested a hearing. Vermont did not maintain an MAB, although it did have a Hearing Board to process appeals.

9.5.1 Crash and Fatality Rate Profile

Figure 25 shows the Vermont crash profile per 1,000 population and per 1,000 licensed drivers by 5-year age groups for years 2004-2008. Crashes per 1,000 population declined with driver age. The decline in crashes per 1,000 population leveled off from 65 to 80 and then dropped sharply for drivers over 85 when it reached a low of 17.3.

As shown in Figure 26, the available data for Vermont showed that the percentage of population licensed exceeded 100% for all driver age groups. This resulted in the crashes per 1,000 licensed drivers being lower than the crashes per 1,000 population. Crashes per 1,000 licensed declined until age 65 where rates leveled off before dropping precipitously after 85 where they reached a low of 14.3. Given that the percentage of population licensed exceeded 100% at all age groups, these data should be interpreted with extreme caution.

Figure 25. Vermont Crashes per 1,000 Licensed Drivers and 1,000 Population

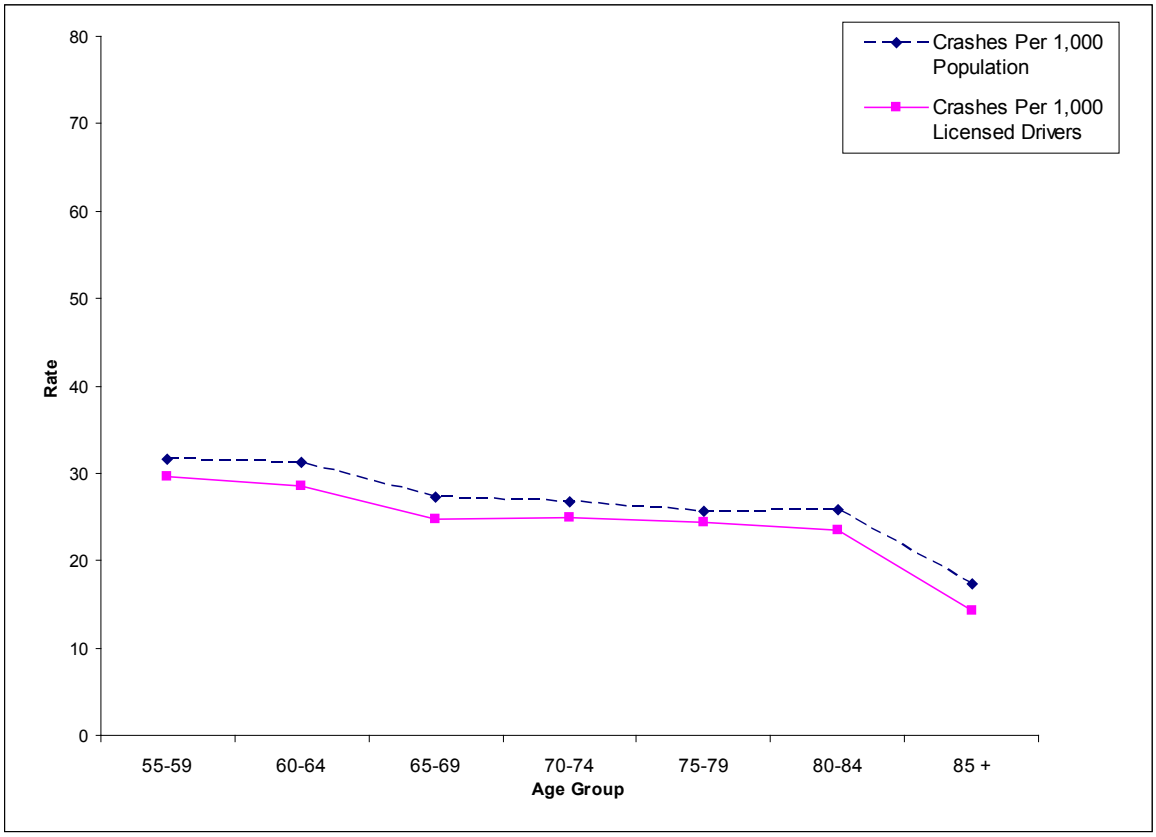


Figure 27 shows the fatality rates per 100,000 licensed drivers and per 100,000 population for the various age brackets in Vermont. The fatality rate per 100,000 population dropped to a low of 12.4 for 55- to 59-year-olds, and then increased to 22.2 for 70- to 74-year-olds before dropping to 18.0 for 80- to 84-year-olds and again rising to 20.2 for those 85 and older. The fatality rate per 100,000 licensed drivers showed a drop to age 55-59 where it reached 11.6, but then increased, reaching 20.6 fatalities per 100,000 licensed drivers for 70- to 74-year-olds before dropping again.

Figure 26. Percentage Licensed by Age Group in Vermont

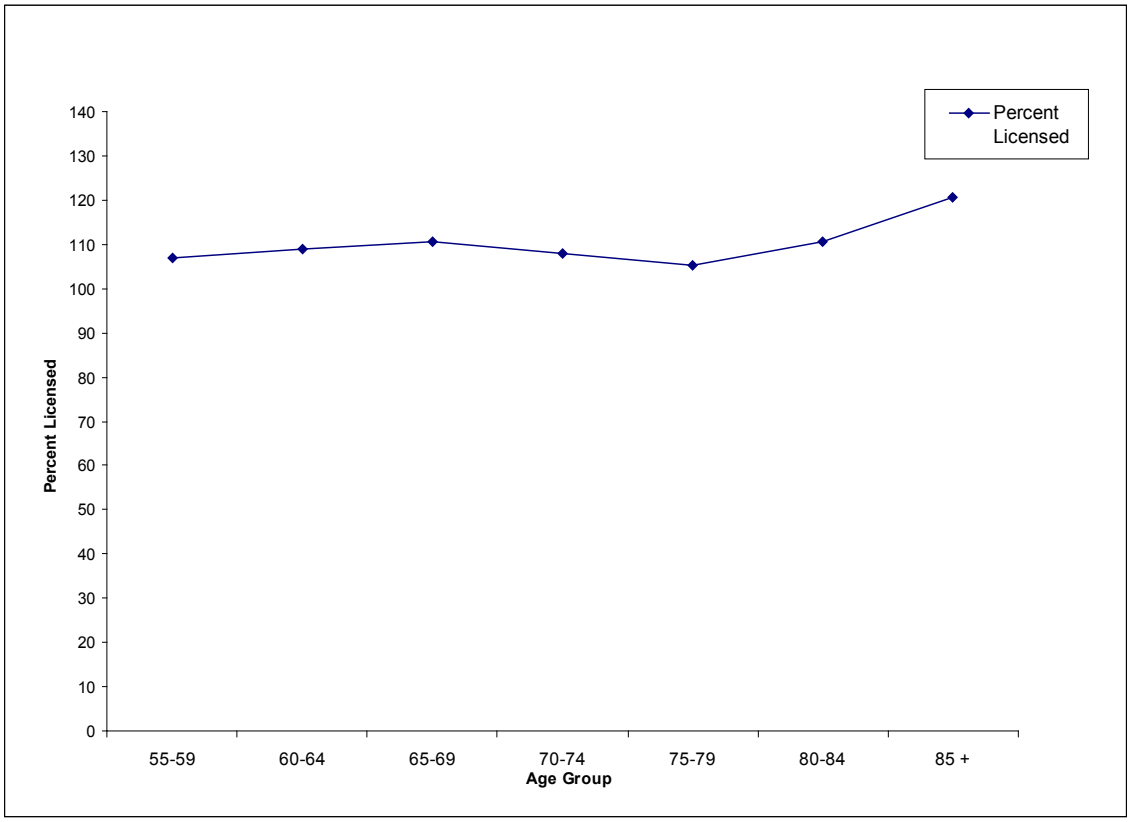
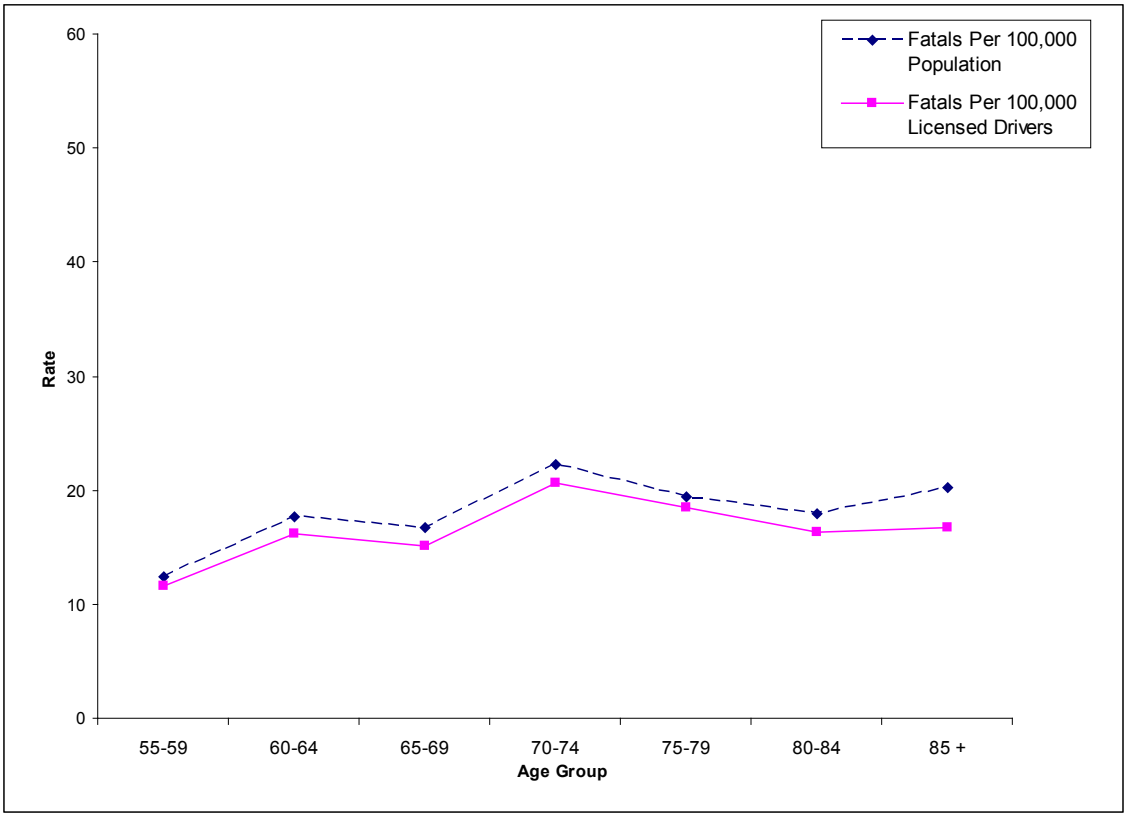


Figure 27. Vermont Fatals per 100,000 Licensed Drivers and 100,000 Population



9.6 Wisconsin

The Division of Motor Vehicles (DMV), housed in the Wisconsin Department of Transportation, handled driver licensing. Drivers renewed licenses every eight years. Renewals had to be completed in-person unless the individual was out of State. A vision screen was required at every renewal. An examiner, vision specialist, or physician could require a written test or on-road test. The State required an on-road test only after a person had failed the vision screen and two written tests. Drivers could receive a "limited area" test in which an examiner conducted the on-road test near a person's home. The DMV could impose a variety of restrictions on the driver's license based on the results of any drive test or on the recommendation of a physician.

Physicians were not required to report, but the State provided immunity to those who reported. The DMV considered information from a wide variety of other sources, but the provider name was not anonymous or confidential. The DMV had an internal medical review team and an active MAB. The MAB advised on individual cases and acted based on the recommendation of the majority.

9.6.1 Crash and Fatality Rate Profile

Figure 28 shows the Wisconsin crash profile per 1,000 population and per 1,000 licensed drivers by 5-year age groups for years 2003-2006. Crashes per 1,000 population declined with driver age. The decline leveled off for 65- to 74-year-olds before dropping again until it reached a low of 10.0 for the drivers 85 and older.

Given that the number of drivers licensed was always less than the population estimates in the available data (Figure 29), the crashes per 1,000 licensed drivers was always greater than crashes per 1,000 population. Crashes per 1,000 licensed drivers declined until 65 before increasing slightly until 85 and older, when it dropped to 22.6.

Even with the drop in percentage of population licensed at 85 and older (44.24% licensed), the crashes per 1,000 licensed drivers declined for that age group, although the decline was not as much as seen in the crashes per 1,000 population measure.

Figure 28. Wisconsin Crashes per 1,000 Licensed Drivers and 1,000 Population

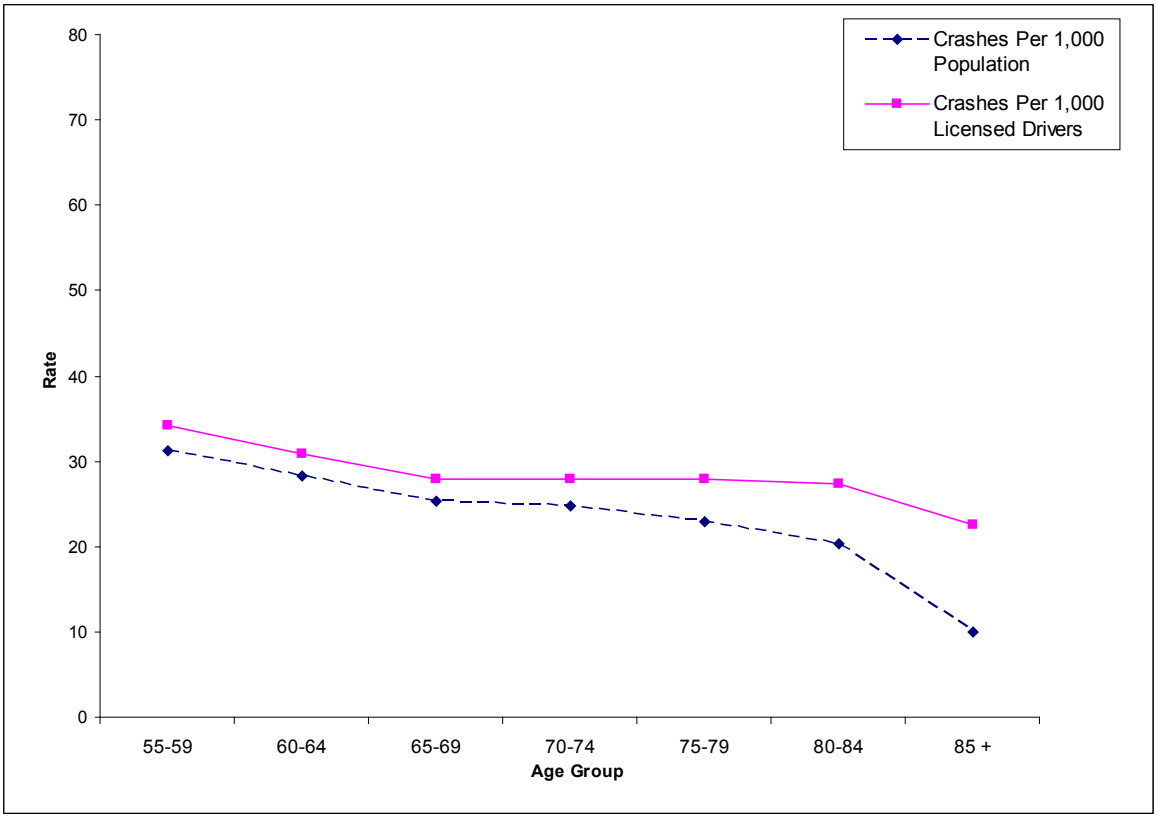


Figure 30 shows the fatality rates per 100,000 licensed drivers and per 100,000 population for the various age brackets in Wisconsin. The fatality rate per 100,000 population dropped to 15.6 for 70-74-year-olds, and then increased to 22.0 for 80-84-year-olds before dropping to 13.3 for those 85 and older. The fatality rate per 100,000 licensed drivers showed a drop to age 70 to 74, where it reached 17.6, but then increased, reaching 30.1 fatalities per 100,000 licensed drivers for those 85 and older.

Figure 29. Percentage Licensed by Age Group in Wisconsin

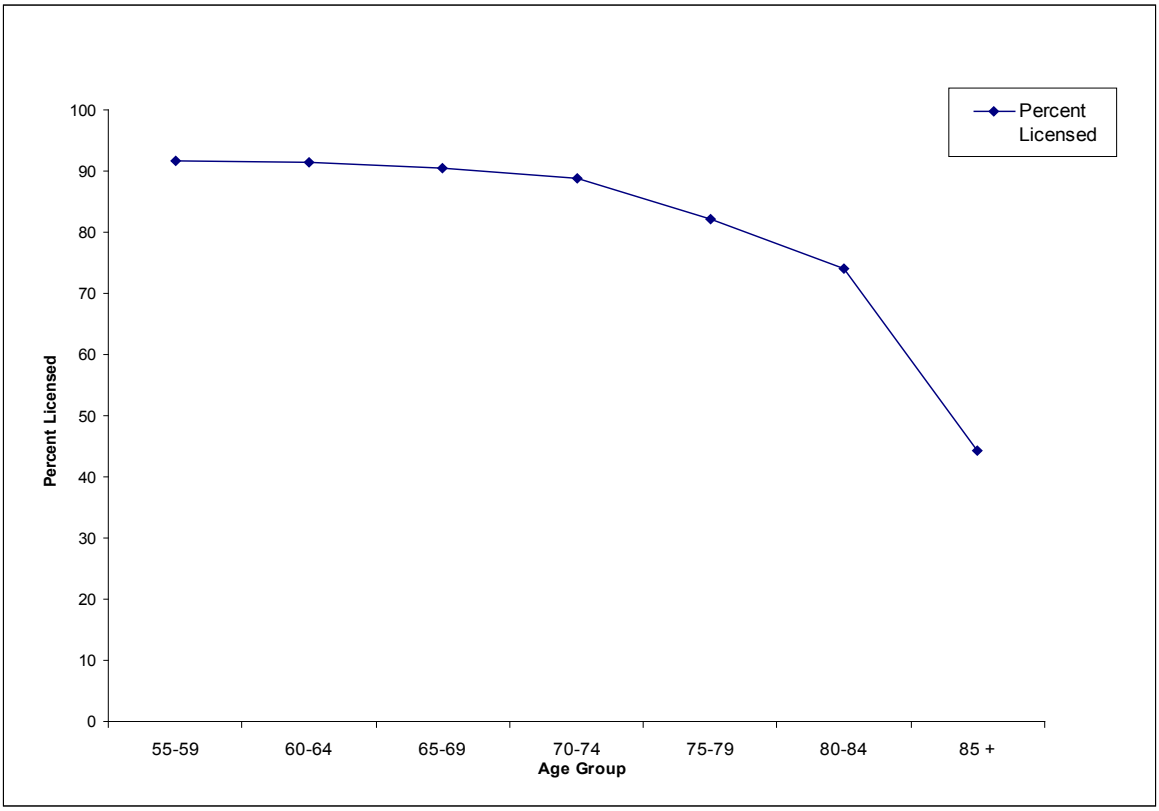
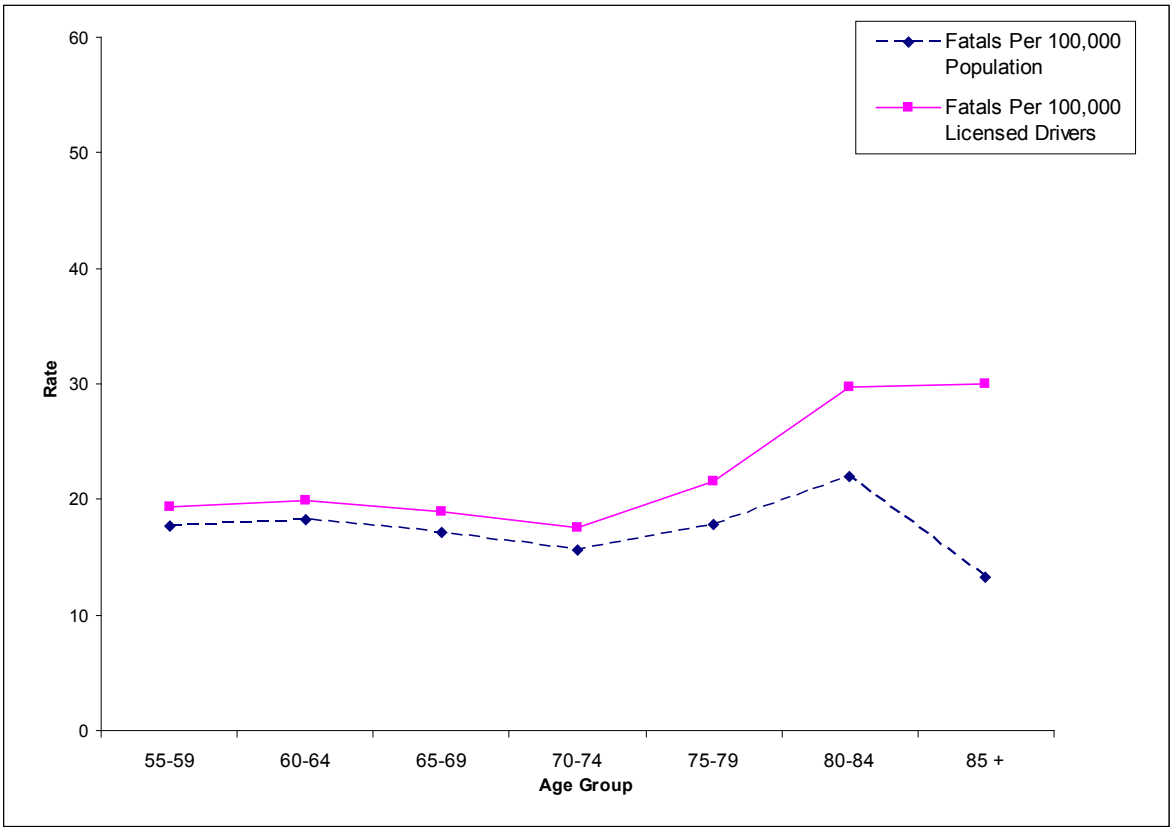


Figure 30. Wisconsin Fatals per 100,000 Licensed Drivers and 100,000 Population



10. COMPARISON OF CRASH AND FATALITY RATES ACROSS STATES

This section compares the emphasis States and comparison States for crashes per 1,000 licensed drivers and crashes per 1,000 population. A table and two figures are shown for each measure. The table presents the data for all of the studied States. The first figure displays the four emphasis States' crash rates, and the second figure contains the same measure for the six comparison States. The text highlights notable differences in crash rate curves.

Given the complexities and idiosyncrasies of the data, no formal inferential analyses were attempted to test the differences in crash rates between the emphasis and comparison States. It is important to keep the possible data anomalies in mind when examining the figures as they can greatly influence the results. Some of the major issues included:

- Questionable driver license counts for some of the States;
- Population counts based on estimates from the 2000 Census;
- Substantially different crash reporting requirements across States;
- The availability of different years of data for the various States; and
- Different sources of crash data (SDS or directly from State).

10.1 Crashes per 1,000 Licensed Drivers

Table 4 presents the data on crashes per licensed driver for the four emphasis and six comparison States and Figure 31 displays crashes per 1,000 licensed drivers for just the four emphasis States. The shape of the curves is the primary item of interest since any number of factors (e.g., crash reporting requirements, recordkeeping) could influence their heights and intercepts. The four emphasis States show essentially the same pattern of crashes per 1,000 drivers up to 70-74. Starting at age 75-79, Illinois, New Hampshire, and Iowa all showed increases in crashes per 1,000 licensed drivers while Kansas rates leveled off before dropping again for drivers 85 and older. New Hampshire and Illinois showed the most notable increases, with Illinois showing a marked increase for those 85 and older, and New Hampshire peaked at 80-84.

Of the six comparison States (see Figure 32), only Missouri showed an increase in crashes per 1,000 licensed drivers for those 75-79 with an additional slight increase at 80 before a slight drop for those 85 And older. All of the other comparison States showed a leveling off of crashes per 1,000 licensed drivers around age 65 to 69 with a drop in crash rates for those 85 and older.

Table 4. Crashes per 1,000 Licensed Drivers by State and 5-Year Age Groups

	Age Group													
State	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85 +
Illinois	118.4	97.1	88.2	80.5	74.9	68.1	61.8	56.7	50.6	44.7	41.5	41.0	42.1	51.6
New Hampshire	76.2	55.6	46.8	43.4	41.1	38.1	35.1	33.3	32.1	29.8	28.6	30.9	33.6	32.6
Iowa	72.3	53.1	47.4	43.5	39.9	35.9	33.7	31.4	29.1	25.8	24.0	25.0	23.6	24.5
Kansas	87.7	62.7	56.5	53.0	50.4	45.1	40.9	37.6	34.3	30.3	29.2	28.3	27.9	24.2
Indiana	109.3	79.6	75.2	68.7	64.9	57.3	51.9	47.6	42.7	37.8	37.3	36.8	34.2	30.6
Minnesota	64.2	47.4	41.4	37.5	34.5	30.5	28.1	25.9	22.8	19.9	19.0	19.1	18.4	14.7
Missouri	109.1	84.7	75.2	68.5	63.2	57.2	51.9	47.0	41.9	38.0	36.1	36.9	36.9	33.3
Nebraska	100.7	70.0	64.9	60.6	56.4	50.6	46.3	44.0	40.6	37.6	35.6	34.7	33.3	30.1
Vermont	74.9	47.4	38.6	37.2	36.4	34.2	32.0	29.6	28.6	24.7	24.9	24.4	23.4	14.3
Wisconsin	80.3	60.1	53.8	49.6	45.5	40.4	37.2	34.1	30.9	27.9	28.0	27.8	27.4	22.6

Figure 31. Emphasis States: Crashes per 1,000 licensed drivers

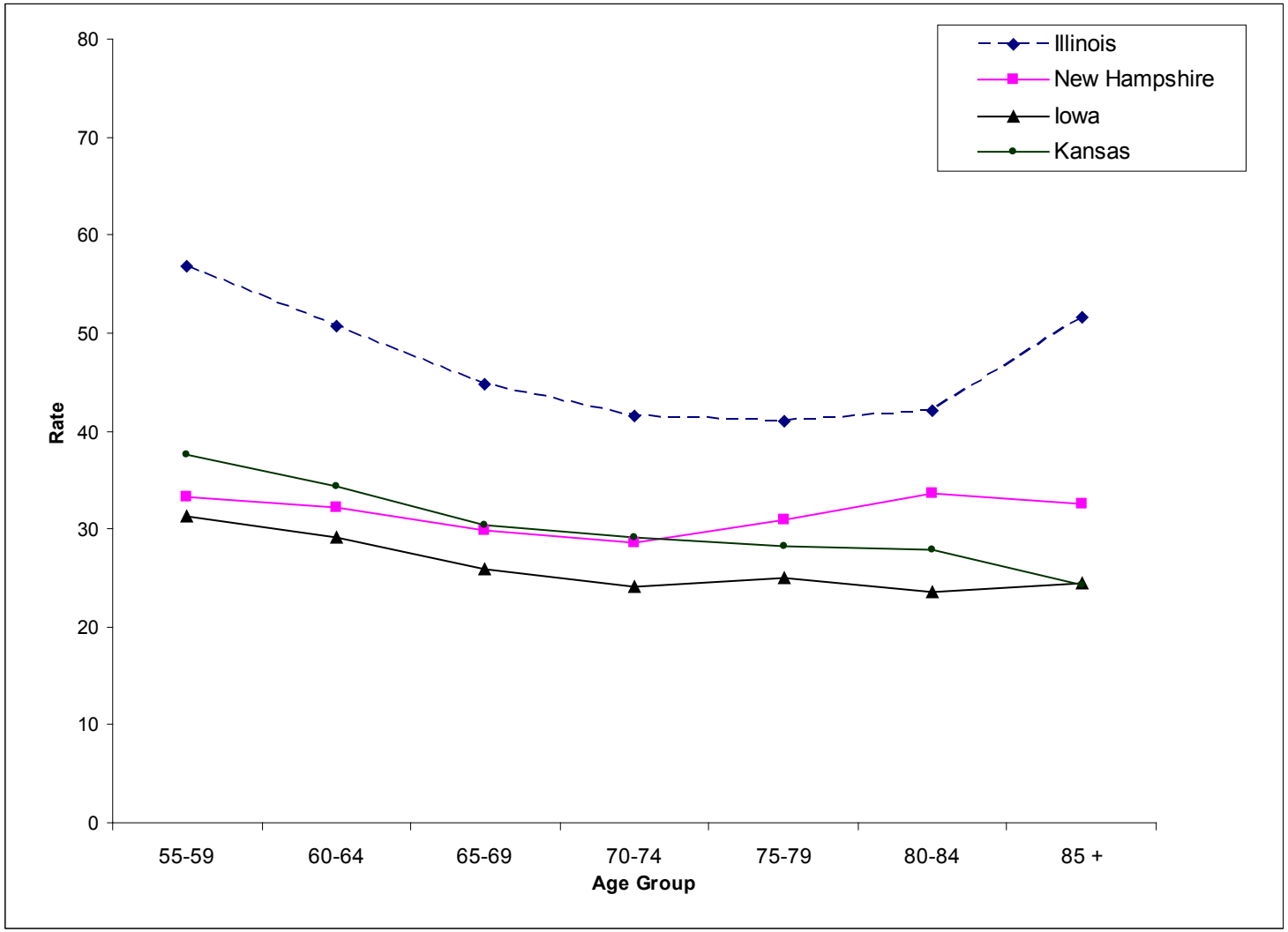
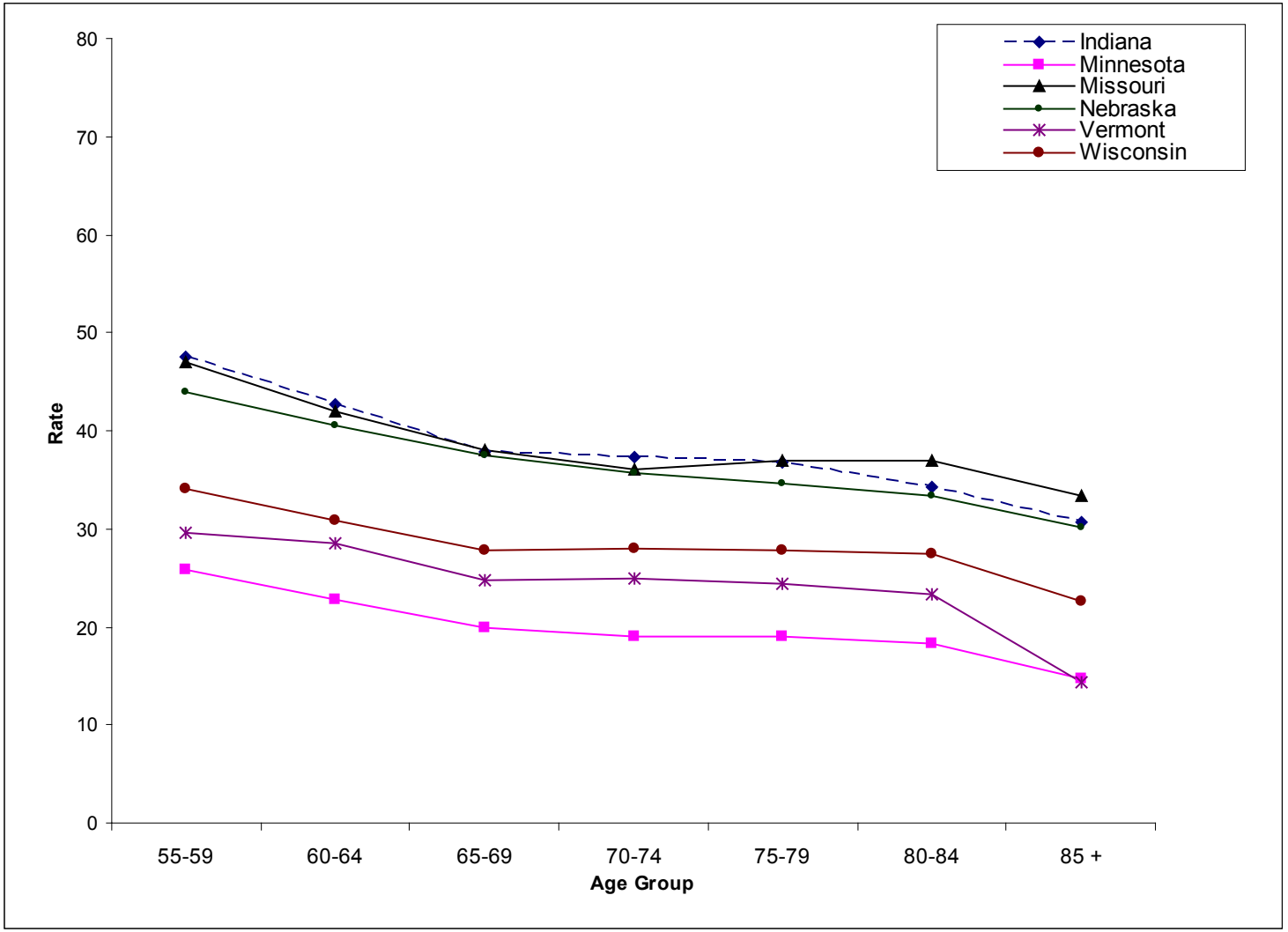


Figure 32. Comparison States: Crashes per 1,000 licensed drivers



10.2 Crashes per 1,000 Population

Table 5 presents the data on crashes per 1,000 population for the 10 States. Figure 33 displays the crashes per 1,000 population for the four emphasis States. While the heights/intercepts of the curves differed, the overall pattern of crash rates by age was generally similar across the four States with crashes declining with driver age. New Hampshire demonstrated a flattening of the curve for drivers 70 to 84 and a further drop for those 85 and older. The other three States showed consistent declines until 85 and older, when the slope accelerated.

Figure 34 shows essentially the same patterns for the comparison States. Most of the States showed consistent declines in crashes per 1,000 population until age 84 after which the decline accelerated. Two of the States, Vermont and Minnesota, showed patterns similar to New Hampshire where the curves flattened from 70 to 84 before dropping again.

Table 5. Crashes per 1,000 Population by State and 5-Year Age Groups

	Age Group													
State	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85 +
Illinois	99.7	86.9	75.5	71.6	66.8	61.6	57.2	52.9	47.3	39.8	35.6	32.0	28.0	16.6
New Hampshire	76.6	58.6	48.5	43.5	40.9	38.4	35.8	33.6	33.1	30.5	27.0	26.8	26.0	16.1
Iowa	58.7	48.0	42.9	39.8	36.5	33.5	31.4	29.6	27.5	24.5	22.8	21.1	20.0	11.5
Kansas	76.3	60.3	54.2	49.5	46.3	42.5	39.4	36.8	34.0	30.0	27.1	26.1	23.2	13.8
Indiana	101.3	78.7	72.2	66.8	61.4	56.3	53.0	49.7	45.4	39.0	36.7	34.4	30.7	19.2
Minnesota	59.3	47.0	39.1	35.4	32.3	29.4	27.4	25.7	22.7	19.5	18.2	17.8	16.6	9.2
Missouri	96.7	78.7	70.5	64.1	58.8	53.8	49.3	44.7	39.5	35.4	31.8	30.8	27.5	15.8
Nebraska	95.6	74.1	65.9	60.2	55.2	49.7	46.3	44.7	41.2	37.5	33.8	32.1	30.4	18.0
Vermont	74.2	60.0	49.7	43.1	39.3	36.5	34.2	31.7	31.2	27.4	26.8	25.7	25.8	17.3
Wisconsin	66.9	54.4	51.5	46.8	42.6	37.5	34.6	31.2	28.2	25.2	24.8	22.9	20.3	10.0

Figure 33. Emphasis States: Crashes per 1,000 population

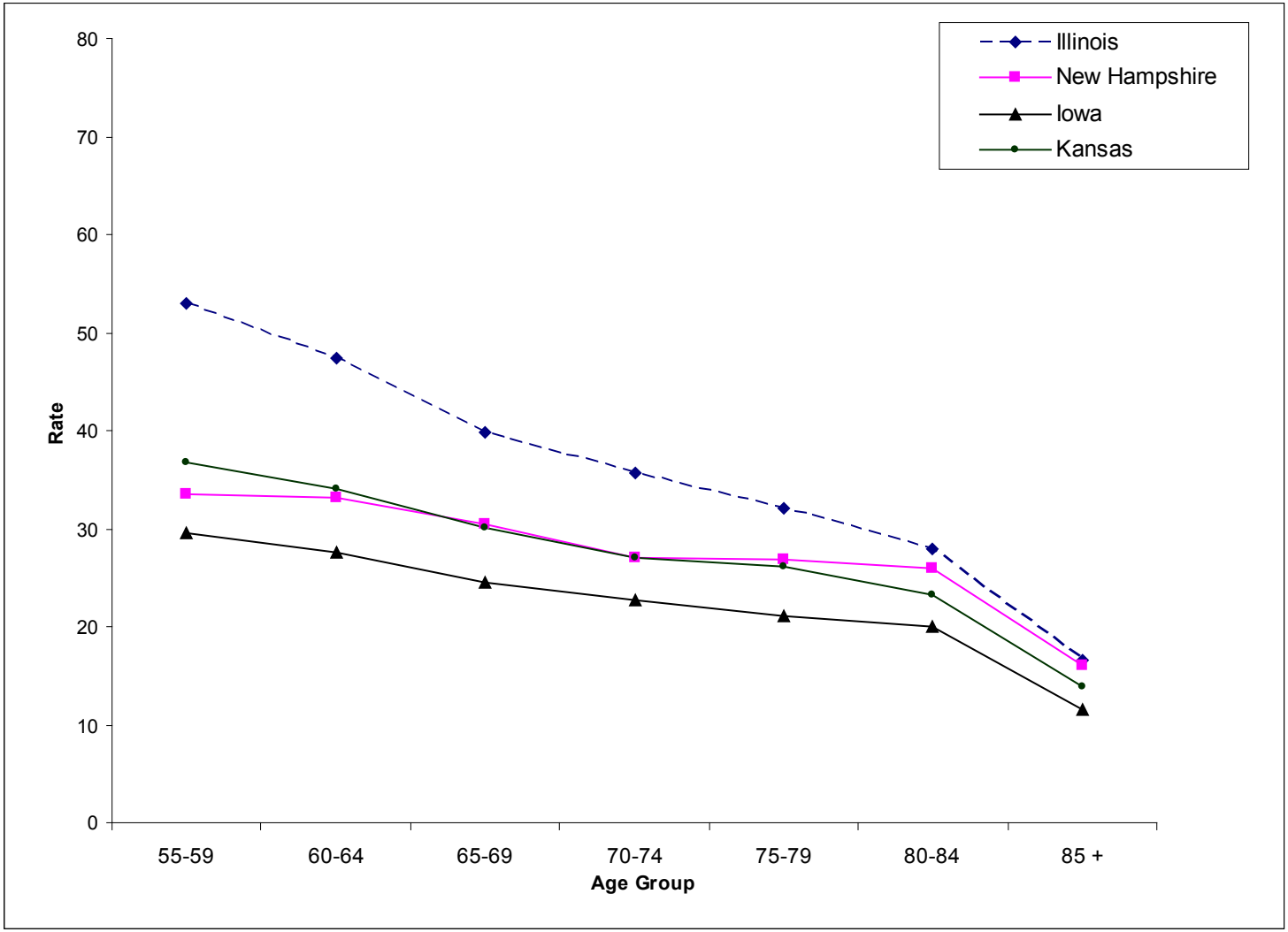
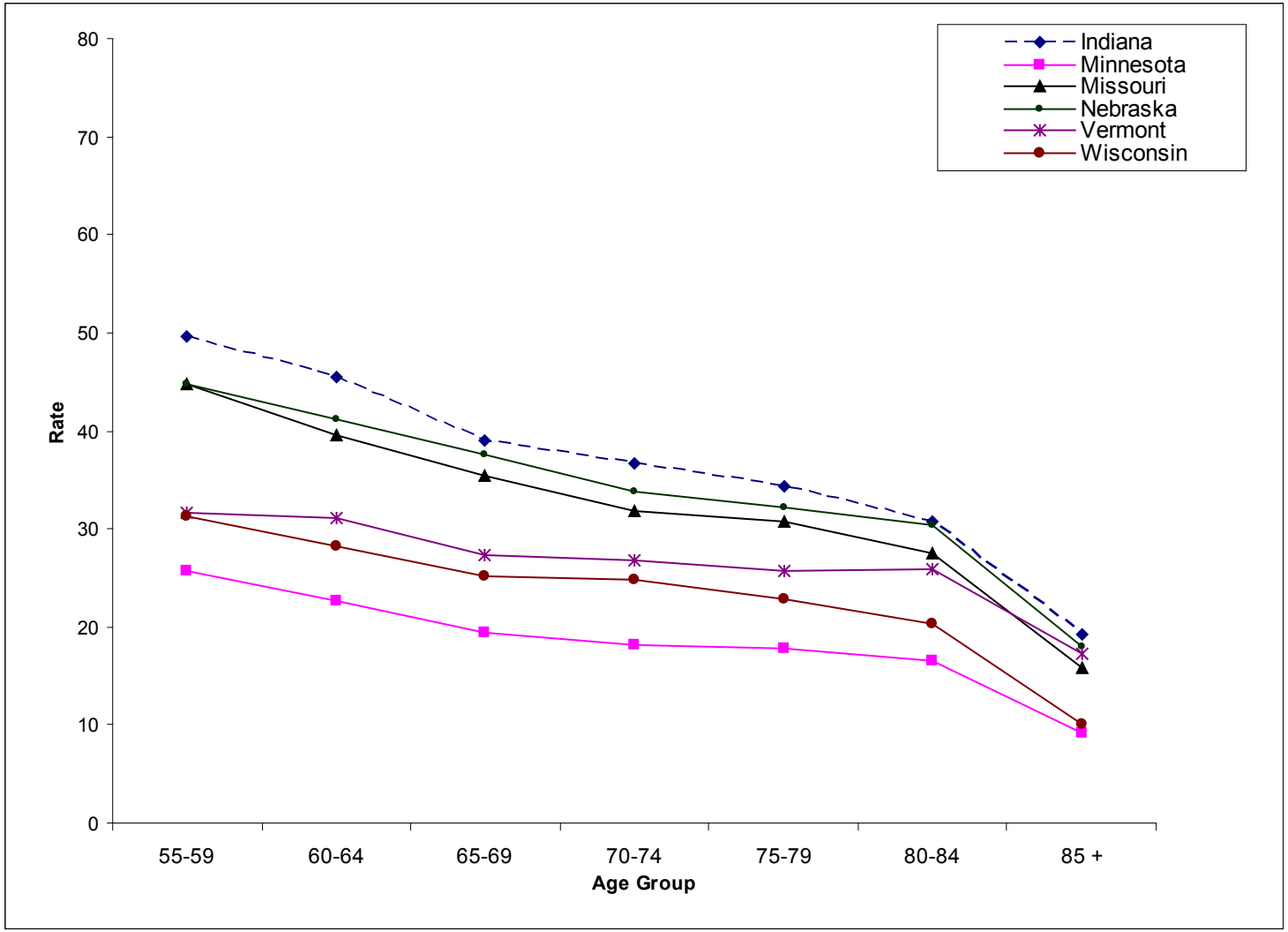


Figure 34. Comparison States: Crashes per 1,000 population



10.3 Driver Fatalities per 100,000 Licensed Drivers

Table 6 presents the data for fatalities per 100,000 licensed drivers. Figure 35 shows the driver fatalities per 100,000 licensed drivers for each of the age groups in the four emphasis States. Illinois, New Hampshire, and Iowa showed virtually the same pattern of fatally injured drivers with the curves reaching their lowest points around age 65-69 or 70-74 and increasing thereafter, especially for the oldest drivers. Kansas showed a similar pattern, although the increase was not as pronounced after 65-69.

Figure 36 displays the driver fatalities per 100,000 licensed drivers for each of the comparison States. Missouri, Nebraska, and Wisconsin followed a U-shaped curve similar to that seen for Illinois, New Hampshire and Iowa, although the spike at 85 and beyond was not as pronounced for the three comparison States. Indiana, Minnesota, and Vermont did not show as marked an increase after 65-69 as the other States, although Indiana showed a spike for the oldest drivers.

Table 6. Driver Fatalities per 100,000 Licensed Drivers by State and 5-Year Age Groups

	Age Group													
State	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85 +
Illinois	34.7	24.7	20.8	19.9	19.8	18.5	15.3	15.2	14.3	14.0	16.0	16.7	21.3	38.8
New Hampshire	29.1	20.5	15.9	21.5	16.9	16.4	16.6	12.2	18.0	12.3	14.6	18.6	20.2	39.8
Iowa	40.1	26.9	28.4	27.1	24.9	24.6	24.5	21.0	21.2	18.7	17.9	26.3	27.3	41.8
Kansas	44.4	32.0	27.6	26.5	31.8	28.6	27.4	28.7	24.2	22.5	21.2	27.8	24.7	29.2
Indiana	40.6	28.5	29.7	25.7	27.2	24.8	23.0	20.4	19.4	19.0	17.7	19.9	18.5	25.7
Minnesota	11.3	8.3	6.9	6.2	6.6	8.1	7.5	6.7	7.3	7.4	6.3	4.7	7.5	7.0
Missouri	60.7	41.5	37.8	36.2	36.5	32.7	28.4	27.8	27.9	25.3	23.8	25.8	36.7	42.2
Nebraska	40.3	22.3	21.8	25.4	24.4	21.0	26.1	24.4	19.1	16.4	19.3	22.5	30.8	35.7
Vermont	27.1	21.8	20.2	15.5	17.1	15.5	13.2	11.6	16.2	15.1	20.6	18.5	16.3	16.7
Wisconsin	45.8	33.9	27.1	26.3	21.6	23.7	19.8	19.3	19.9	18.9	17.6	21.6	29.8	30.1

Figure 35. Emphasis States: Driver Fatalities per 100,000 Licensed Drivers

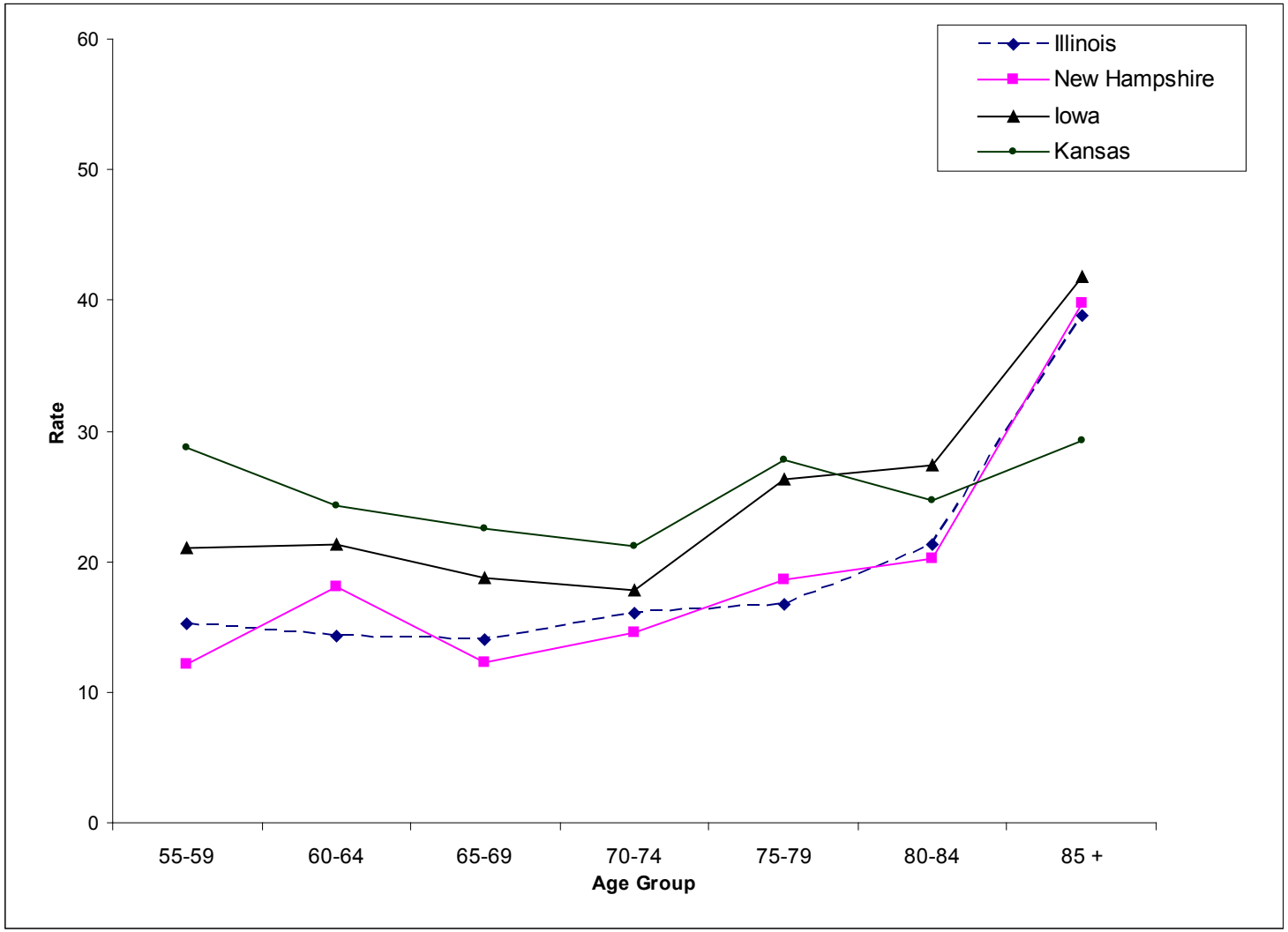
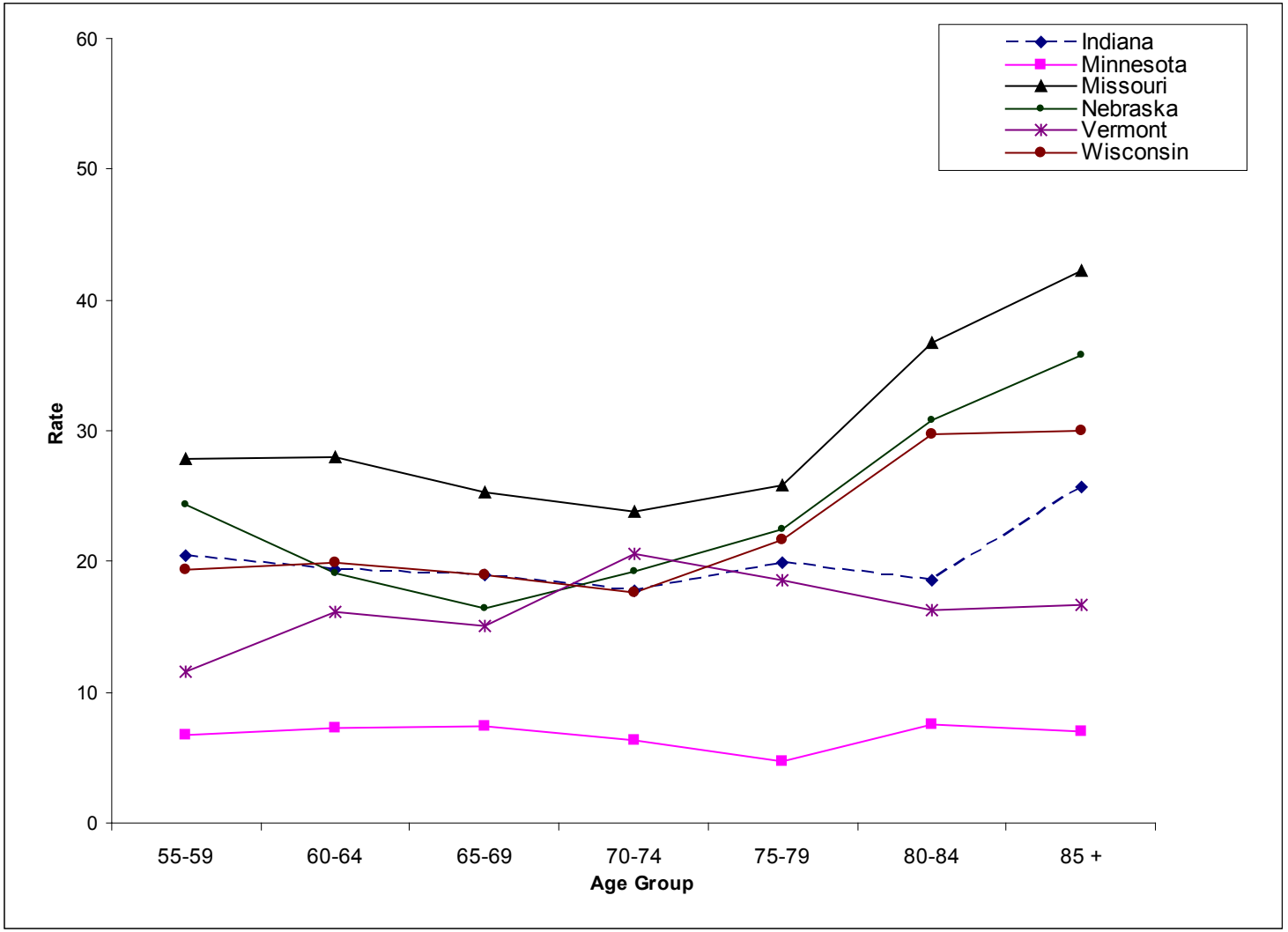


Figure 36. Comparison States: Driver Fatalities per 100,000 Licensed Drivers



10.4 Driver Fatalities per 100,000 Population

The final measure examined addressed fatalities per 100,000 population in each State (Table 7). Figure 37 shows the driver fatalities per 100,000 population for the four emphasis States. Iowa and Kansas showed similar patterns, reaching low points at 70-74 before rising at 75-79 and then declining for drivers 85 and older. New Hampshire reached a low point at 65-69 and then showed a steady increase with advancing age. Illinois reached a low point at 65-69 and remained relatively flat from that point on.

Figure 38 displays the driver fatalities per 100,000 population for the six comparison States. Missouri, Nebraska, and Wisconsin showed similar patterns of fatalities with spikes at 80-84. Vermont showed a spike at 70-74, and Indiana and Minnesota showed slight declines in fatalities per 100,000 population after 65-69.

Table 7. Driver Fatalities per 100,000 Population by State and 5-Year Age Groups

	Age Group													
State	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85 +
Illinois	29.2	22.1	17.8	17.7	17.7	16.8	14.2	14.2	13.4	12.5	13.7	13.0	14.2	12.5
New Hampshire	29.3	21.6	16.4	21.6	16.8	16.5	16.9	12.3	18.6	12.5	13.8	16.1	15.7	19.6
Iowa	32.6	24.3	25.7	24.8	22.7	22.9	22.9	19.8	20.1	17.7	16.9	22.3	23.1	19.5
Kansas	38.7	30.8	26.5	24.7	29.2	26.9	26.4	28.1	24.0	22.3	19.6	25.7	20.6	16.7
Indiana	37.6	28.1	28.5	25.0	25.7	24.4	23.5	21.3	20.7	19.6	17.4	18.5	16.6	16.1
Minnesota	10.5	8.2	6.6	5.8	6.2	7.8	7.3	6.6	7.2	7.2	6.1	4.4	6.8	4.4
Missouri	53.7	38.6	35.5	33.8	33.9	30.8	27.0	26.4	26.3	23.6	20.9	21.5	27.3	20.0
Nebraska	38.3	23.6	22.1	25.2	23.9	20.6	26.1	24.8	19.4	16.4	18.3	20.8	28.1	21.3
Vermont	26.8	27.6	26.1	17.9	18.4	16.6	14.1	12.4	17.6	16.7	22.2	19.5	18.0	20.2
Wisconsin	38.2	30.7	25.9	24.8	20.2	22.0	18.5	17.7	18.2	17.1	15.6	17.8	22.0	13.3

Figure 37. Emphasis States: Driver Fatalities per 100,000 Population

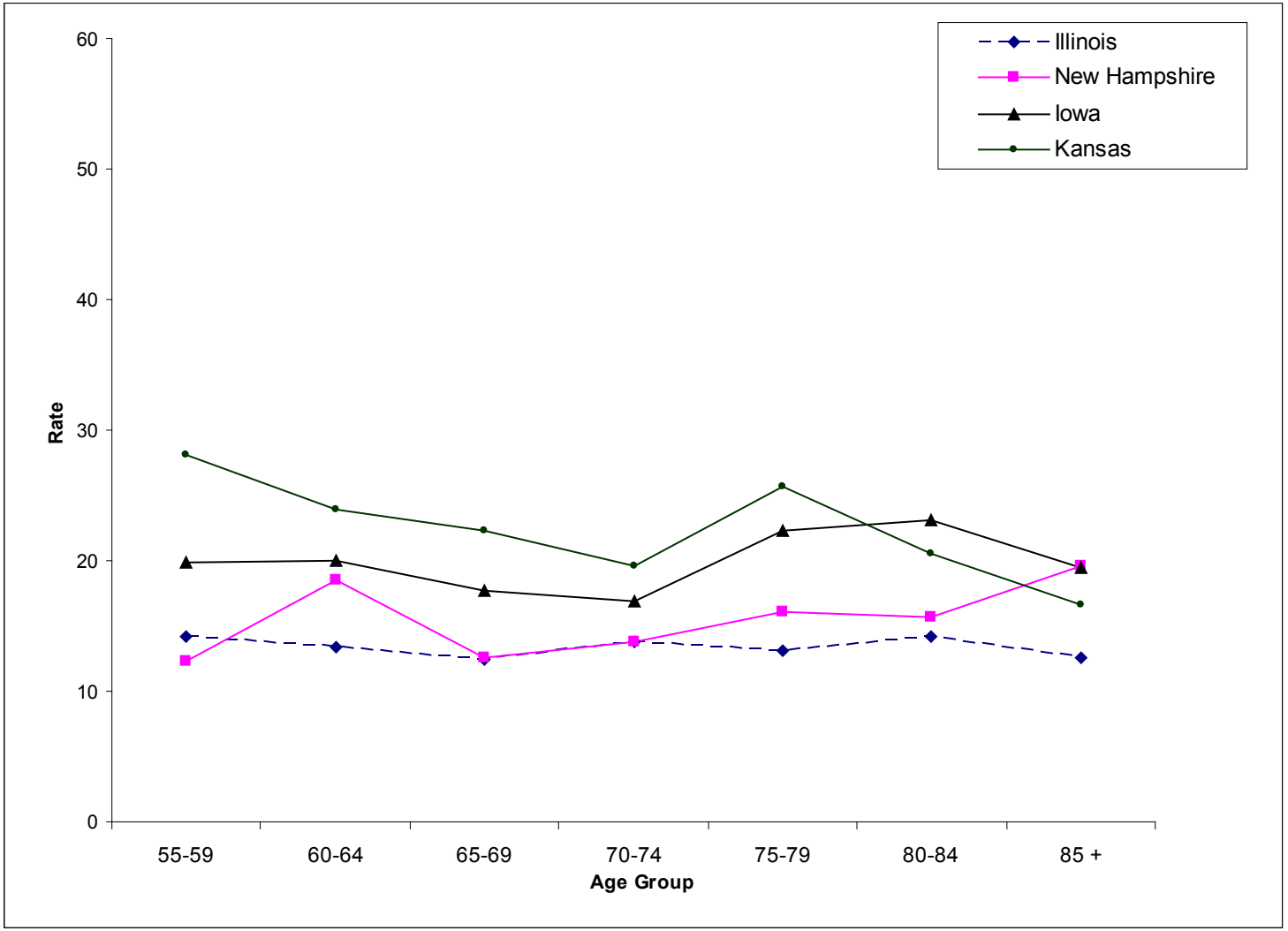
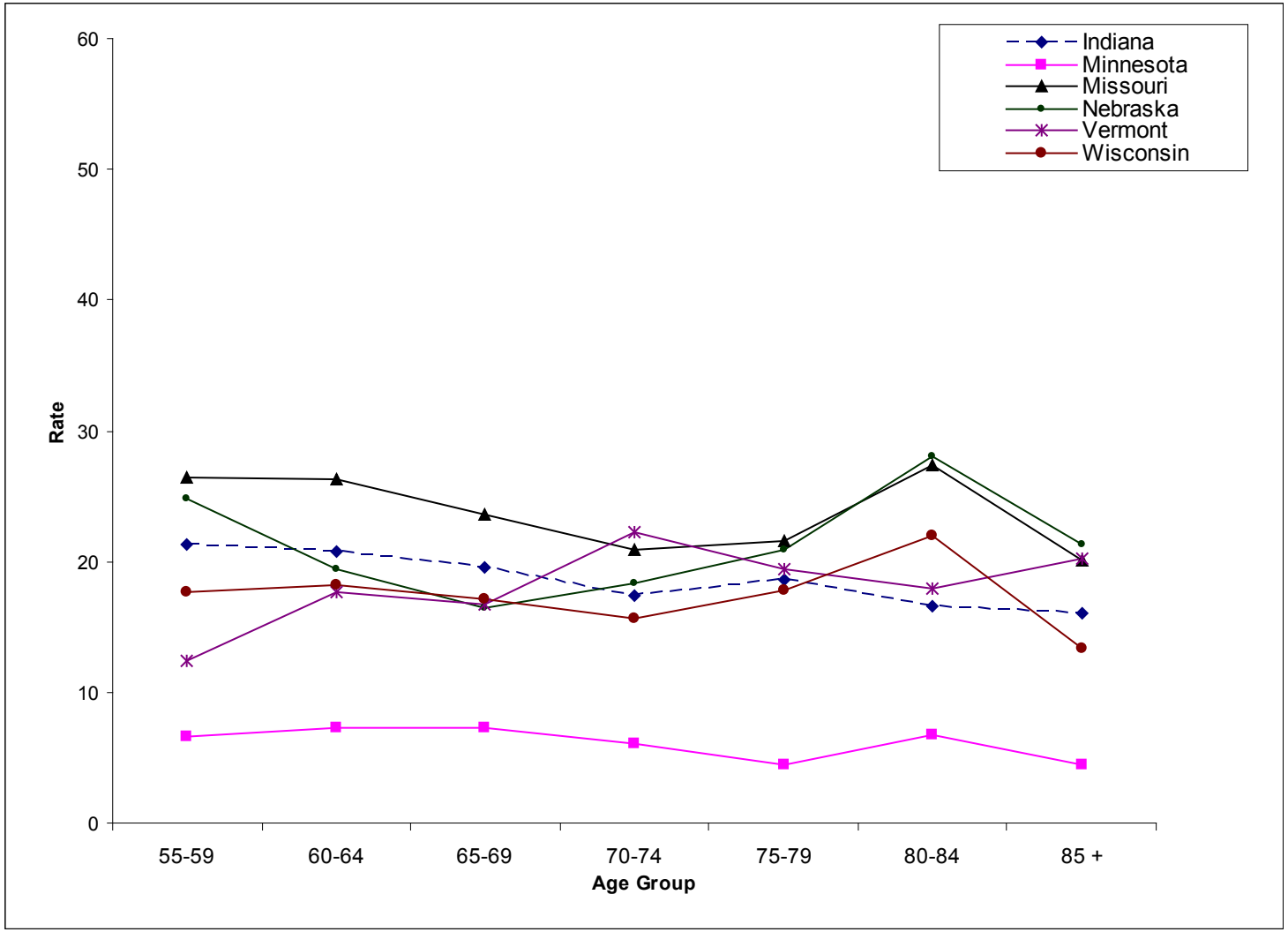


Figure 38. Comparison States: Driver Fatalities per 100,000 Population



11. DISCUSSION

This study first catalogued the licensing practices of the States as they pertain to older drivers and examined the literature relating to older drivers, licensing, and safety. The research team then selected four special emphasis States and six comparison States for an evaluation of the effects of specific older driver licensing practices on crashes. Each special emphasis State became a case study composed of both subjective data on the licensing process and objective data based on crash, licensing, and census records. This section discusses the pattern of results.

11.1 The Licensing Process

The examination of the licensing practices in the various States as they pertain to older drivers did not uncover remarkable differences. Varying renewal periods and the existence of a requirement to appear at a licensing office are some basic discriminating factors. Based on the literature and the pattern of State practices, the requirement for a road test on every renewal over age 75 (only Illinois and New Hampshire) was of particular interest as a potential safety intervention.

The study only collected in-depth process data for the four special emphasis States. Even though the renewal practices for these States varied somewhat as shown earlier in Table 2, the examinations showed more similarities than differences. In all cases, the licensing department managers and staffs showed concern for the needs of the older driver and a good understanding of issues related to older driver safety. In all four emphasis States, licensing personnel expressed strong beliefs that the processes they had in place were implemented as intended and were successful in promoting older driver safety.

Several parts of the licensing processes in the special emphasis States warrant additional comments. First, while the licensing staffs considered vision screening valuable, there was widespread dissatisfaction with the available vision testing equipment, especially the applicability of the equipment to the older driver. Many drivers, particularly older drivers, had difficulty using the vision testing equipment. Problems included the need to apply force with the forehead in order to activate the machine and an inability to see the targets because of head position. The research and development community could significantly aid the licensing process by developing a vision testing apparatus that is easier for older adults to use.

A second important part of the process relates to the requirement for a personal appearance by the renewing driver. All of the licensing staff involved in the study's discussions appeared to believe sincerely to the opportunity to interact directly with an older driver (or, with any driver with a potential performance problem) had a significant effect on safety. During the observations in licensing offices, the project staff observed several instances of drivers of all ages being required to take line drives or undergo additional screening. This added scrutiny should provide valuable assistance to the staff in deciding which drivers should complete more intensive testing or be denied renewal privileges altogether.

License agency staffs, particularly those in smaller offices, considered shorter renewal intervals a safety benefit. In general, license personnel noted that older drives' capabilities can diminish rapidly, so interacting with them more often should promote safety. In the smaller offices, staff members noted remembering individual drivers and being able to track their functional changes.

The concept of line or local drive tests also resonated with licensing staffs. They liked the idea of permitting an older adult to drive in a restricted driving area that allowed them to carry out their important daily functions and remain independent. However, some expressed concern about the continued viability of line or local drives in an era of severe cost-cutting. License staff recognized that they had little or no data on the extent to which older drivers complied with driving restrictions.

Overall, the data collected in this study led to the conclusion that the implementation of licensing practices in the special emphasis States followed the intent of State rules and regulations. Staff members maintained that their systems were fair, reasonable, and that they supported safety. It must be noted however, that as the study progressed, evidence began to emerge that some of the practices the licensing staffs considered important to safety would be discontinued. For example, some States began permitting more online renewals.

11.2 Reactions of Older Drivers

Contrary to what some might expect, the discussions with older drivers in the special emphasis States indicated that they believed the licensing systems treated them fairly and that the special licensing procedures applicable to them were effective. Overall, older drivers understood that the aging process had the potential to compromise their driving ability and safety. They appeared willing to be screened and, in general, confident that their abilities had not eroded to the point of creating a safety hazard. Many of the older drivers emphasized that their years of driving experience compensated for any degradation in faculties such as reaction time or range of motion.

Two of the emphasis States, Illinois and New Hampshire, required road tests for all older driver renewals and two, Iowa and Kansas, did not. This provided an opportunity to explore the effects of adding an age-triggered road test requirement. Again, the older driver reaction was uniformly positive and non-defensive. While most Iowa and Kansas older drivers in the study felt that they did not require a road test since they considered themselves good drivers, they generally accepted the concept and did not consider it unfair.

11.3 Crash Data Analyses

An objective of this study was to document any clear-cut differences in the licensing approaches among the special emphasis States, and between them and the comparison States, which would have supported a rigorous, multivariate analysis. In fact, the differences in the licensing processes between the emphasis and comparison States were not sufficient to yield reliable differences in the crash data results. All 10 States employed a multiple-intervention approach, and many of the potentially effective licensing policies and activities of interest were present in both the emphasis and comparison States. This supported the decision to treat each State as a separate case study.

The nature and quality of the available crash and licensure data also prevented the use of rigorous inferential statistical tests. Available crash data did not cover the same years in each State and came from two different sources (the NHTSA SDS and the States themselves). The definition of a reportable crash varied across the States thereby precluding direct comparisons of the magnitude of crash rates. No data were available on driving exposure by age from which to form a true, risk-related crash rate. The use of crashes per population and crashes per licensed driver as surrogates was reasonable, but both denominator variables suffered from data uncertainties. Population estimates by age derived from U. S. Census data likely contain some errors or "noise" that may differ by State, time, and/or age category. License data, although available for all 10 States, was typically based on an informal year-end tally kept as a printout by the licensing agencies. The fact that the data show many instances of more than 100% of the population holding a license casts significant doubt on the accuracy of the available data and its ability to support strong inferential conclusions.

Notwithstanding the data issues, several noteworthy patterns emerged in the crash data that relate directly to the research objectives of this study. The first is the general downward trend in crashes per population with increasing age. The evidence of this trend in all of the States suggests that older driver safety is being well managed by the combination of societal interventions and older driver self-limitation.

A second pattern of note is the sharp reduction in the percentage of licensed drivers as age increases beyond 65. The reduction in licensed older drivers likely arises from a combination of self-limitation, licensing agency actions, and the fact that today's oldest population may have a higher proportion of people who were never licensed. Whatever the reasons, the lower proportion of licensed drivers in the older population must be considered when interpreting crash results.[3]

Perhaps the most striking results pattern is the differential shape of the crashes per licensed driver curves for Illinois and New Hampshire when compared to all of the other States. This suggests an influence of the mandatory road test. It is curious but not necessarily counter-intuitive that both States displayed an increase in crashes per licensed driver at the oldest ages while still showing a decrease in crashes per population consistent with the other States. This finding was consistent with the results presented by Langford et al. (2004) for Australia where the States with the most stringent licensing requirements for older drivers showed increased crashes per licensed driver, but not an increased rate of crashes per population. Perhaps the road tests in Illinois and New Hampshire resulted in an increased withdrawal of licenses, but did not remove the drivers most at risk for a crash. Alternatively, passing the test may embolden older drivers and convince them to drive more thereby increasing their exposure to crashes. More likely, however, is that the systems in these two States led to the surrender, expiration, or withdrawal of licenses for those older people who had already stopped driving or greatly self-limited their driving. This would reduce the overall licensed population for the age group, but not greatly affect the number of crashes since these people already had exposure levels near zero.

[3] The research team considered the possibility that the reduced proportion of licensed drivers in the older population resulted in increased unlicensed driving. An analysis of the license status of fatally injured drivers in the 10 States from FARS did not show a relationship between the percentage unlicensed by age and the percentage of unlicensed driving among those drivers killed.

11.4 Implications for Future Research

The foregoing results raise some interesting additional research questions. In particular:

- What explanations exist for the pattern of crashes per licensed driver in Illinois and New Hampshire? Do data exist to confirm or reject these explanations?

- Restricting older adults' driving privileges appears to be a widely employed safety intervention. How extensive is this practice, and do older drivers comply with these restrictions?

- Can licensing agencies implement vision-testing systems better matched to older adults' needs?

- To what extent do older drivers self-restrict their driving exposure? What motivates an older adults to surrender his or her driver's license? How do older drivers make the decision to self-limit, what strategies do they employ to maintain their mobility? Can a licensing agency effectively influence an older driver to self-limit based on the license renewal practices it adopts?

- To what extent will ongoing changes in licensing practices due to budget pressures (e.g., more online renewal) affect older drivers' safety? Will older drivers continue to renew in person if permitted to renew by mail or online?

There should be reasonable scientific and operational interest in each of these and, likely, several other research questions highlighted by the foregoing results. However, nothing found in the current investigation implies the need for an immediate response to counter a safety issue.

12. REFERENCES

Adler, G., Rottunda, S., & Dysken, M. (2005). The older driver with dementia: An updated literature review. *Journal of Safety Research, 36,* 399-407.

Andersen, G. J., Cisneros, J., Saidpour, A., & Atchley, P. (2000). Age-related differences in collision detection during deceleration. *Psychology and Aging, 15,* 241-252.

Assailly, J. P., Bonin-Guillaume, S., Mohr, A., Parola, A., Grandjean, R., & Frances, Y. M. (2006). Healthy elderly drivers are more likely to commit errors or lapses than violations - Survey of 904 volunteers. *Presse Medicale, 35,* 941-947.

Avolio, B. J., Kroeck, K. G., & Panek, P. E. (1985). Individual differences in information-processing ability as a predictor of motor vehicle accidents. *Human Factors*, 27, 577-587.

Ball, K. (1997). Attentional problems and older drivers. *Alzheimer Disease and Associated Disorders, 11,* 42-47.

Ball, K., & Owsley, C. (1991). Identifying correlates of accident involvement for the older driver. *Human Factors, 33,* 583-595.

Ball, K., Owsley, C., Sloane, M. E., Roenker, D. L., & Bruni, J. R. (1993). Visual attention problems as a predictor of vehicle crashes in older drivers. *Investigative Ophthalmology & Visual Science, 34,* 3110-3123.

Bayam, E., Liebowitz, J., & Agresti, W. (2005). Older drivers and accidents: A meta analysis and data mining application on traffic accident data. *Expert Systems with Applications, 29,* 598-629.

Bolstad, C. A., & Hess, T. M. (2000). Situation awareness and aging. In M.R.Endile & D. J. Garland (Eds.), *Situation Awareness Analysis & Measurement* (pp. 277-302). Mahway, NJ: Lawerence Erlbaum Associates.

Bowers, A., Peli, E., Elgin, J., McGwin, G., & Owsley, C. (2005). On-road driving with moderate visual field loss. *Optometry and Vision Science, 82,* 657-667.

Brouwer, W. H., Waterink, W., Vanwolffelaar, P. C., & Rothengatter, T. (1991). Divided Attention in Experienced Young and Older Drivers - Lane Tracking and Visual Analysis in A Dynamic Driving Simulator. *Human Factors, 33,* 573-582.

Bryer, T. (2000). Characteristics of motor vehicle crashes related to aging. In K. W. Schaie & M. Pietrucha (Eds.), *Mobility and Transportation in the Elderly,* 157-206. New York, NY: Springer Publishing Company, Inc.

Bulstrode, S. J. (1987). Car mirrors for drivers with restricted neck mobility. *International Disability Studies*, 9, 180-181.

Campagne, A., Pebayle, T., & Muzet, A. (2004). Correlation between driving errors and vigilance level: influence of the driver's age. *Physiology & Behavior, 80,* 515-524.

Cerella, J. (1990). Aging and information-processing rate. In J. E.Birren & K. W. Schaie (Eds.), *Handbook of Psychology and Aging. 3rd edition* (pp. 202-221). San Diego, CA: Academic Press.

Cerrelli, E. C. (1998, January). Crash Data and Rates for Age-Sex Groups of Drivers, 1996. (Unnumbered Report). Washington, DC: National Highway Traffic Safety Administration. Retrieved Jan 12, 2007, from www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/RNotes/1998/AgeSex96.pdf [non-working link]. Available at www-nrd.nhtsa.dot.gov/Pubs/98.010.PDF

Chandraratna, S., & Stamatiadis, N. (2003). Problem driving maneuvers of elderly drivers. *Human Performance, Simulation, User Information Systems, and Older Person Safety and Mobility,* 89-95.

Chipman, M. L., Payne, J., & McDonough, P. (1998). To drive or not to drive: The influence of social factors on the decisions of elderly drivers. *Accident Analysis and Prevention, 30,* 299-304.

Clay, O. J., Wadley, V. G., Edwards, J. D., Roth, D. L., Roenker, D. L., & Ball, K. (2005). Cumulative meta-analysis of the relationship between useful field of view and driving performance in older adults: Current and future implications. *Optometry and Vision Science, 82,* 724-731.

Cook, L. J., Knight, S., Olson, L. M., Nechodom, P. J., & Dean, J. M. (2000). Motor vehicle crash characteristics and medical outcomes among older drivers in Utah, 1992-1995. *Annals of Emergency Medicine, 35,* 585-591.

Cooper, P. J. (1990). Elderly drivers' views of self and driving in relation to the evidence of accident data. *Journal of Safety Research, 21,* 103-113.

Cranney, A. B., Harrison, A., Ruhland, L., Vaidyanath, C., Graham, I., Man-Son-Hing, M., et al. (2005). Driving problems in patients with rheumatoid arthritis. *Journal of Rheumatology, 32,* 2337-2342.

Crook, T. H., West, R. L., & Larabee, G. J. (1993). The driving reaction-time test: assessing age declines in dual-task performance. *Developmental Neuropsychology,* 9, 31-39.

Curcio, C. A., Millican, C. L., Allen, K. A., & Kalina, R. E. (1993). Aging and the human photoreceptor mosaic: Evidence for selective vulnerability of rods in central vision. *Investigative Ophthalmology and Visual Science*, 43, 3278-3296.

DeCarlo, D. K., Scilley, K., Wells, J., & Owsley, C. (2003). Driving habits and health-related quality of life in patients with age-related maculopathy. *Optometry and Vision Science, 80,* 207-213.

De Raedt, R., & Ponjaert-Kristoffersen, I. (2001). Predicting at-fault car accidents of older drivers. *Accident Analysis and Prevention, 33,* 809-819.

Di Stefano, M., & Macdonald, W. (2003). Assessment of older drivers: Relationships among on-road errors, medical conditions and test outcome. *Journal of Safety Research, 34,* 415-429.

Eby, D. W., Trombley, D. A., Molnar, L. J., & Shope, J. T. (1998). *The Assessment of Older Drivers' Capabilities: A Review of the Literature* (Report No. UMTRI 98-24). The University of Michigan, Transportation Research Institute.

Emsbach, M., & Friedel, B. (1999). Traffic accidents of senior citizen car drivers. *Zeitschrift fur Gerontologie und Geriatrie, 32,* 318-325.

Evans, L. (1991). *Traffic Safety and the Driver*. New York: Van Nostrand Reinhold.

Freund, B., Colgrove, L. A., Burke, B. L., & McLeod, R. (2005). Self-rated driving performance among elderly drivers referred. for driving evaluation. *Accident Analysis and Prevention, 37,* 613-618.

Gamboz, N., Russo, R., & Fox, E. (2000). Target selection difficulty, negative priming, and Aging. *Psychology and Aging, 15,* 542-550.

Grabowski, D. C., Campbell, C. M., & Morrisey, M. A. (2004). Elderly licensure laws and motor vehicle fatalities. *Journal of the American Medical Association (JAMA), 291,* 2840-2846.

Hakamies-Blomqvist, L. (1994). Compensation in older drivers as reflected in their fatal accidents. *Accident Analysis and Prevention, 26:* 107-112.

Hakamies-Blomqvist, L. (1996). Research on older drivers: A review. *IATSS Research, 20,* 91-101.

Holland, C. A. (1993). Self-Bias in Older Drivers Judgments of Accident Likelihood. *Accident Analysis and Prevention, 25,* 431-441.

Hoyer, W. J., & Verhaeghen, P. (2006). Memory Aging. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the Psychology of Aging, 2nd Edition*. New York: Van Nostrand Reinhold.

Hultsch, D. F., Hertzog, C., Small, B. J., & Dixon, R. A. (1999). Use it or lose it: Engaged lifestyle as a buffer of cognitive decline in aging? *Psychology and Aging, 14,* 245-263.

Isler, R. B., Parsonson, B. S., & Hansson, G. J. (1997). Age related effects of restricted head movements on the useful field of view of drivers. *Accident Analysis and Prevention, 29,* 793-801.

Janke, M. K., & Eberhard, J. W. (1998). Assessing medically impaired older drivers in a licensing agency setting. *Accident Analysis and Prevention, 30,* 347-361.

Janke, M. K. (2001). Assessing older drivers - Two studies. *Journal of Safety Research, 32,* 43-74.

Justiss, M. D., Mann, W. C., Stav, W., & Velozo, C. (2006). Development of a behind-the-wheel performance assessment for older adults. *Topics in Geriatric Rehabilitation, 22,* 121-128.

Klavora, P., & Heslegrave, R. J. (2002). Senior drivers: An overview of problems and intervention strategies. *Journal of Aging and Physical Activity, 10,* 322-335.

Kostyniuk, L. P., & Shope, J. T. (2003). Driving and alternatives: Older drivers in Michigan. *Journal of Safety Research, 34,* 407-414.

Kramer, A. F., Hahn, S., Irwin, D. E., & Theeuwes, J. (1999). Attentional capture and aging: Implications for visual search performance and oculomotor control. *Psychology and Aging, 14,* 135-154.

Kroemer, K. H. E., & Grandjean, E. (1997). *Fitting the Task to the Human, 5th Edition,* Philadelphia; London: Taylor & Francis, Inc.

Langford, J., Fitzharris, M., Newstead, S., & Koppel, S. (2004). Some consequences of different older driver licensing procedures in Australia. *Accident Analysis and Prevention, 36,* 993-1001.

Lawton, M. P., Moss, M. S., Winter, L., & Hoffman, C. (2002). Motivation in later life: Personal projects and well-being. *Psychology and Aging, 17,* 539-547.

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.

Malfetti, J. W. (1985). *Needs and Problems of Older Drivers: Survey Results and Recommendations*. Falls Church, VA: AAA Foundation for Traffic Safety.

Marottoli, R. A., deLeon, C. F. M., Glass, T. A., Williams, C. S., Cooney, L. M., & Berkman, L. F. (2000). Consequences of driving cessation: decreased out-of-home activity levels. *Journal of Gerontology: Social Sciences, 55(6),* S334–S340.

Marottoli, R. A., deLeon, C. F. M., Glass, T. A., Williams, C. S., Cooney, L. M., Berkman, L. F., & Tinetti, M. E. (1997). Driving cessation and increased depressive symptoms: Prospective evidence from the New Haven EPESE, *Journal of the American Geriatrics Society, 45 (2)*, 202-206.

Marottoli, R. A., & Richardson, E. D. (1998). Confidence in, and self-rating of, driving ability among older drivers. *Accident Analysis and Prevention, 30,* 331-336.

Marottoli, R. A., Richardson, E. D., Stowe, M. H., Miller, E. G., Brass, L. M., Cooney, L. M. et al. (1998). Development of a test battery to identify older drivers at risk for self-reported adverse driving events. *Journal of the American Geriatrics Society, 46,* 562-568.

Maylor, E. A., & Lavie, N. (1998). The influence of perceptual load on age differences in selective attention. *Psychology and Aging, 13,* 563-573.

MacDougall, H. G., & Moore, S. T. (2005). Functional assessment of head-eye coordination during vehicle operation. *Optometry and Vision Science, 82,* 706-715.

McGill, S. M., Yingling, V. R., & Peach, J. P. (1999). Three-dimensional kinematics and trunk muscle myoelectric activity in the elderly spine - a database compared to young people. *Clinical Biomechanics, 14,* 389-395.

McGwin, G., Xie., A., Mays, A., Joiner, W., DeCarlo, D., Hall, T., & Owsley, C. (2005). Visual field defects and the risk of motor vehicle collisions among patients with glaucoma, *Investigative Ophthalmology & Visual Science, 46(12),* 4437-4441.

McPherson, K., Michael, J., Ostrow, A., & Shaffron P. (1988*). Physical Fitness and the Aging Driver. Phase I*. Washington, DC: AAA Foundation for Traffic Safety.

McPherson, K., Ostrow, A., Shaffron, P., & Yeater, R. (1989). *Physical Fitness and the Aging Driver. Phase II*. Washington, DC: AAA Foundation for Traffic Safety.

Mihal, W.L., & Barrett, G.V. (1976). Individual differences in perceptual information processing and their relation to automobile accident involvement. *Journal of Applied Psychology*, 6, 229-233.

Nieuwenhuis, S., Ridderinkhof, K. R., de Jong, R., Kok, A., & van der Molen, M. W. (2000). Inhibitory inefficiency and failures of intention activation: Age-related decline in the control of saccadic eye movements. *Psychology and Aging, 15,* 635-647.

NIH Senior Health (2007). National Institute of Health Online Resource, Glaucoma, Retrieved Jan 20, 2007, from http://nihseniorhealth.gov/glaucoma/toc.html.

Owsley, C., Ball, K., Sloane, M. E., Roenker, D. L., & Bruni, J. R. (1991). Visual / cognitive correlates of vehicle accidents in older drivers. *Psychology and Aging, 6,* 403-415.

Owsley, C., Stalvey, B., Wells, J., & Sloane, M. E. (1999). Older drivers and cataract: Driving habits and crash risk. *Journal of Genrontology: Medical Sciences, 54A,* M203-M211.

Parasuraman, R. (1991). Attention and driving performance in Alzheimer's dementia. Proceedings of the Conference, *Strategic Highway Research Program and Traffic Safety on Two Continents*, Gothenburg, Sweden, Sept. 18-20, 1991 .

Parasuraman, R., & Nestor, P. G. (1991). Attention and Driving Skills in Aging and Alzheimer's-Disease. *Human Factors, 33,* 539-557.

Patient Education Institute (2007). Patient Education Institute Online Resource, Macular Degeneration, Retrieved Jan 20, 2007, from www.nlm.nih.gov/medlineplus/ tutorials/maculardegeneration/htm/index.htm

Perryman, K. M., & Fitten, L. J. (1996). Effects of normal aging on the performance of motor-vehicle operational skills. *Journal of Geriatric Psychiatry and Neurology, 9,* 136-141.

Proctor, R. W., & van Zandt, T. (1994). *Human Factors in Simple and Complex Systems,* Boston: Allyn and Bacon, Inc.

Pradhan, A. K., Hammel, K. R., DeRamus, R., Pollatsek, A., Noyce, D. A., & Fisher, D. L. (2005). Using eye movements to evaluate effects of driver age on risk perception in a driving simulator. *Human Factors, 47,* 840-852.

Ragland, D. R., Satariano, W. A., & MacLeod, K. E. (2004). Reasons given by older people for limitation or avoidance of driving. *Gerontologist, 44(2),* 237-244.

Ranney, T.A., & Pulling, N.H. (1989). Relation of individual differences in information-processing ability to driving performance. *Proceedings of the Human Factors Society, 33rd Annual Meeting,* Denver, Colorado, October 16-20, 1989. Santa Monica, CA: Human Factors Society.

Rosman, D. (2001). The Western Australian Road Injury Database (1987-1996): Ten years of linked police, hospital and death records of road crashes and injuries. *Accident Analysis and Prevention, 33,* 81-88.

Rudman, D. L., 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 on Aging, 25,* 65-76.

Ryan, G. A., Legge, M., & Rosman, D. (1998). Age related changes in driver's crash risk and crash type. *Accident Analysis and Prevention, 30,* 379-387.

Salthouse, T. A. (1985). Speed of behavior and its implications for cognition. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the Psychology of Aging, 2nd Edition*. New York: Van Nostrand Reinhold.

Schieber, F. (2006). Vision and aging. In Birren, J. E., Schaie, K. W. (Eds.), *Handbook of the Psychology of Aging,* 129-161. Amsterdam: Academic Press.

Shipp, M. D. (1998). Potential human and economic cost-savings attributable to-vision testing policies for driver license renewal. *Optometry and Vision Science, 75,* 103-118.

Sit, R. A., & Fisk, A. D. (1999). Age-related performance in a multiple-task environment. *Human Factors, 41,* 26-34.

Staplin, L. (1995). Simulator and field measures of driver age differences in left-turn gap judgments. *Transportation Research Record, 1485,* 49-55.

Staplin, L., Lococo, K., & Sim, J. (1993). *Traffic Maneuver Problems of Older Drivers*. Publication No. FHWA-RD-92-092, Federal Highway Administration, Washington, DC.

Strayer, D. L., & Drews, F. A. (2004). Profiles in driver distraction: Effects of cell phone conversations on younger and older drivers. *Human Factors, 46,* 640-649.

Stutts, J., Martell, C., & Staplin. L. (2009). Identifying Behaviors and Situations Associated with Increased Crash Risk for Older Drivers. (Report No. DOT HS 811 093). Washington, DC: National Highway Traffic Safety Administration. . Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811093.pdf

Talbot, A., Bruce, I., Cunningham, C., Coen, R. F., Lawlor, B. A., Coakley, D. et al. (2005). Driving cessation in patients attending a memory clinic. *Age and Ageing, 34,* 363-368.

White, S., & O'Neill, D. (2000). Health and relicencing policies for older drivers in the European Union. *Gerontology, 46,*146-152.

West, R. L., Crook, T. H., & Barron, K. L. (1992). Everyday memory performance across the life-span: Effects of age and noncognitive individual differences. *Psychology and Aging*, 7, 72-82.

Wood, J. M. (2002). Age and visual impairment decrease driving performance as measured on a closed-road circuit. *Human Factors, 44(3),* 482-495.

Yamashita, K., Iijima, K., & Kobayashi, S. (1999). Relationship among activities of daily living, apathy, and subjective well being in elderly people living alone in a rural town. *Gerontology, 45,* 279-282.

Yassuda, M. S., Wilson, J. J., & von Mering, O. (1997). Driving cessation: The perspective of senior drivers. *Educational Gerontology, 23,* 525-538.

Yee, D. (1985). A survey of the traffic safety needs and problems of drivers age 55 and over. In J.W. Malfetti (Ed.), *Needs and Problems of Older Drivers: Survey Results and Recommendations*. Falls Church, VA: AAA Foundation for Traffic Safety.

Appendix

Crash and Licensure Rate Figures Showing All Ages

This Appendix contains the figures presented in the text expanded to show all ages of licensed drivers. Figures in the Appendix carry the same numbers as those in the text but preceded by the letter "A." Thus, for example, Figure A-1 presents the same information for all ages of drivers that can be found in Figure 1 for drivers 55 and older.

Figure A-1. Illinois Crashes per 1,000 Licensed Drivers and 1,000 Population

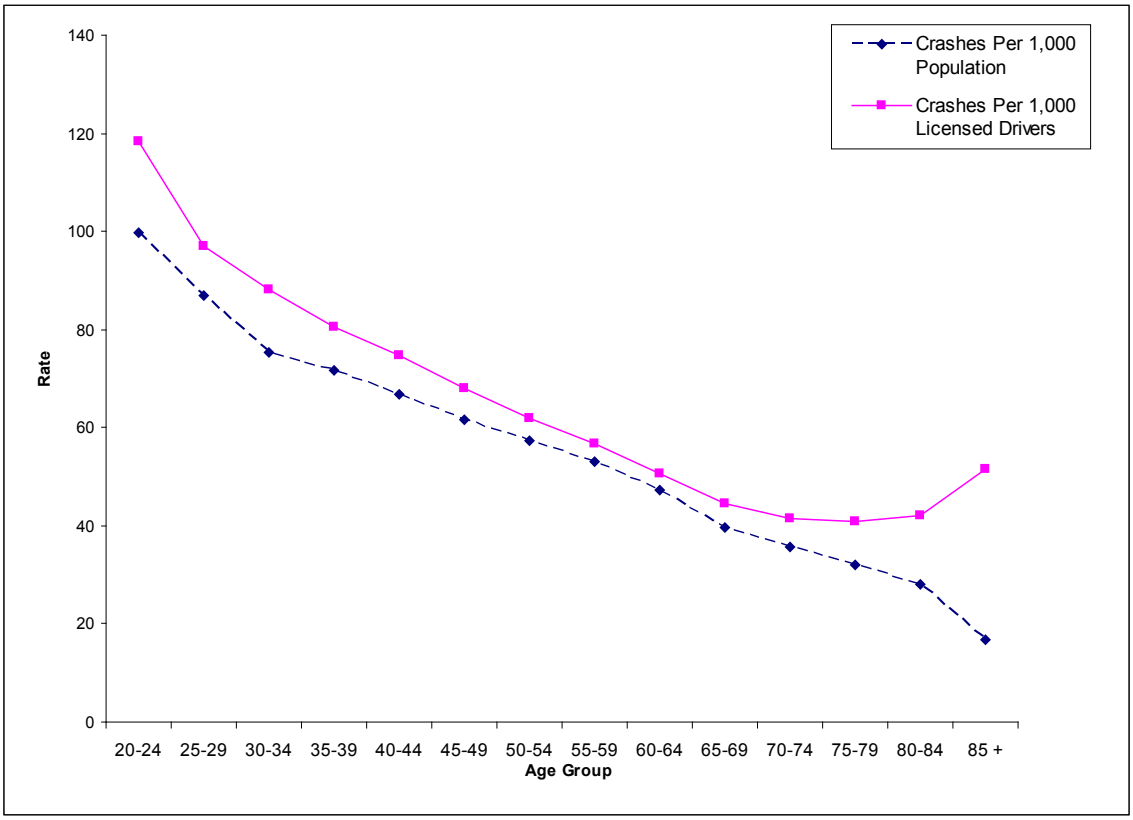


Figure A-2. Percentage Licensed by Age Group in Illinois

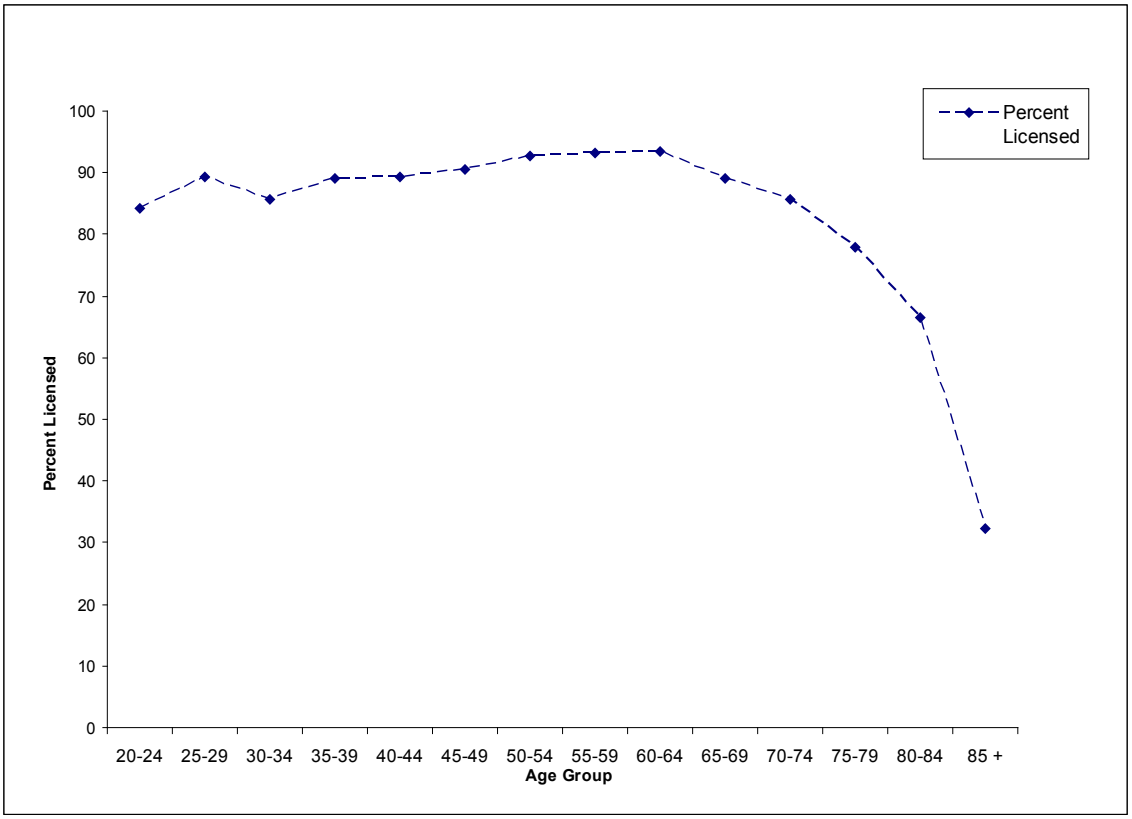


Figure A-3. Illinois Driver Fatalities per 100,000 Licensed Drivers and 100,000 Population

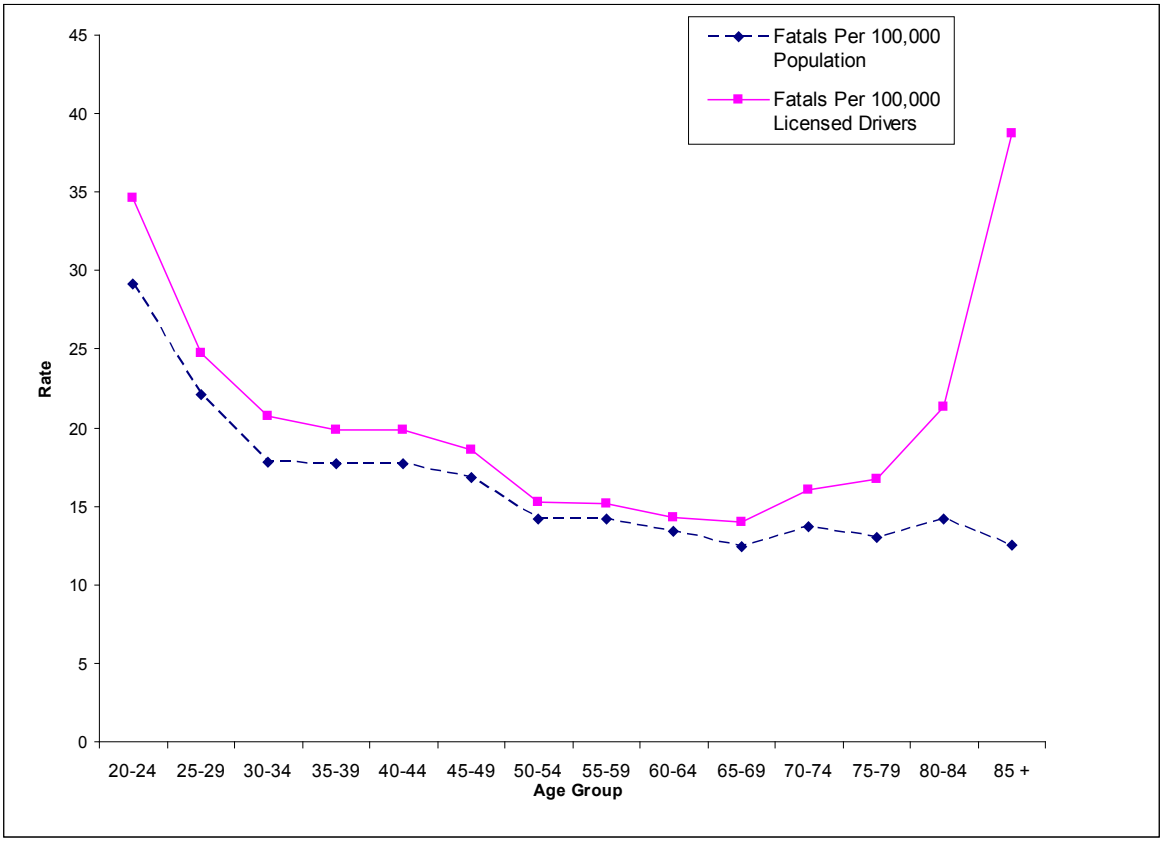


Figure A-4. Iowa Crashes per 1,000 Licensed Drivers and 1,000 Population

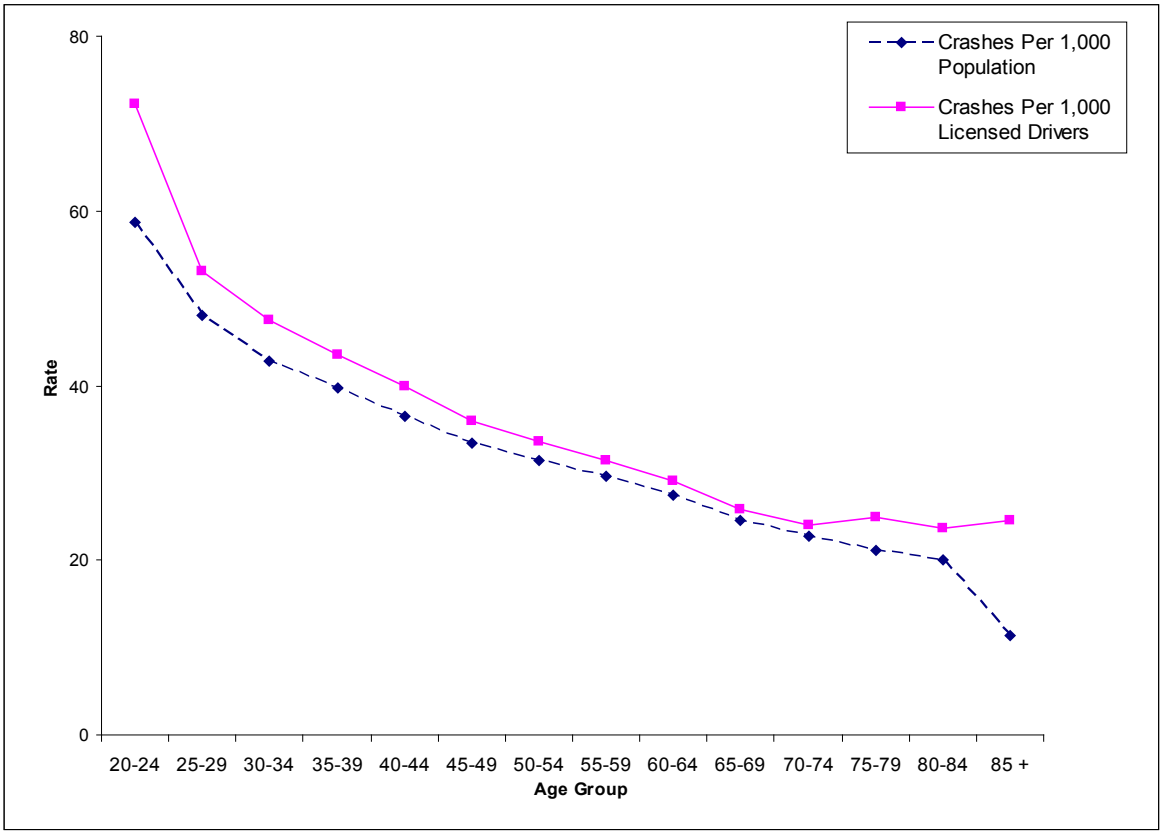


Figure A-5. Percentage Licensed by Age Group in Iowa

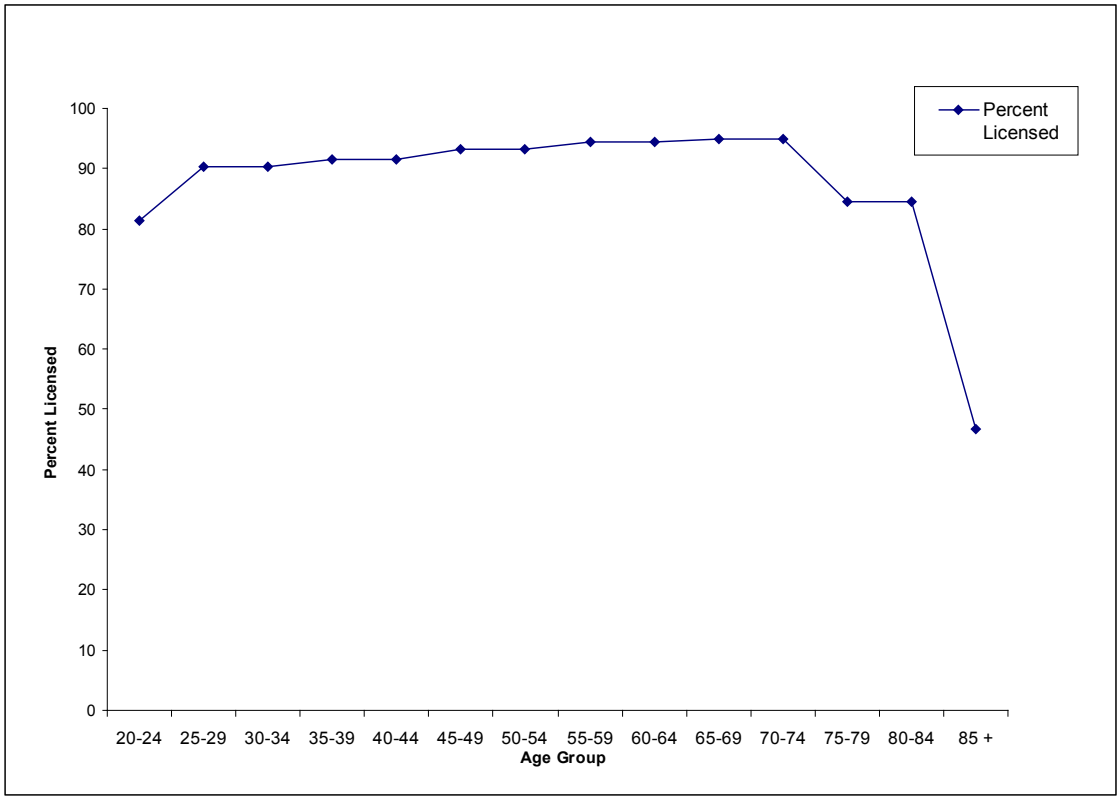


Figure A-6. Iowa Driver Fatalities per 100,000 Licensed Drivers and 100,000 Population

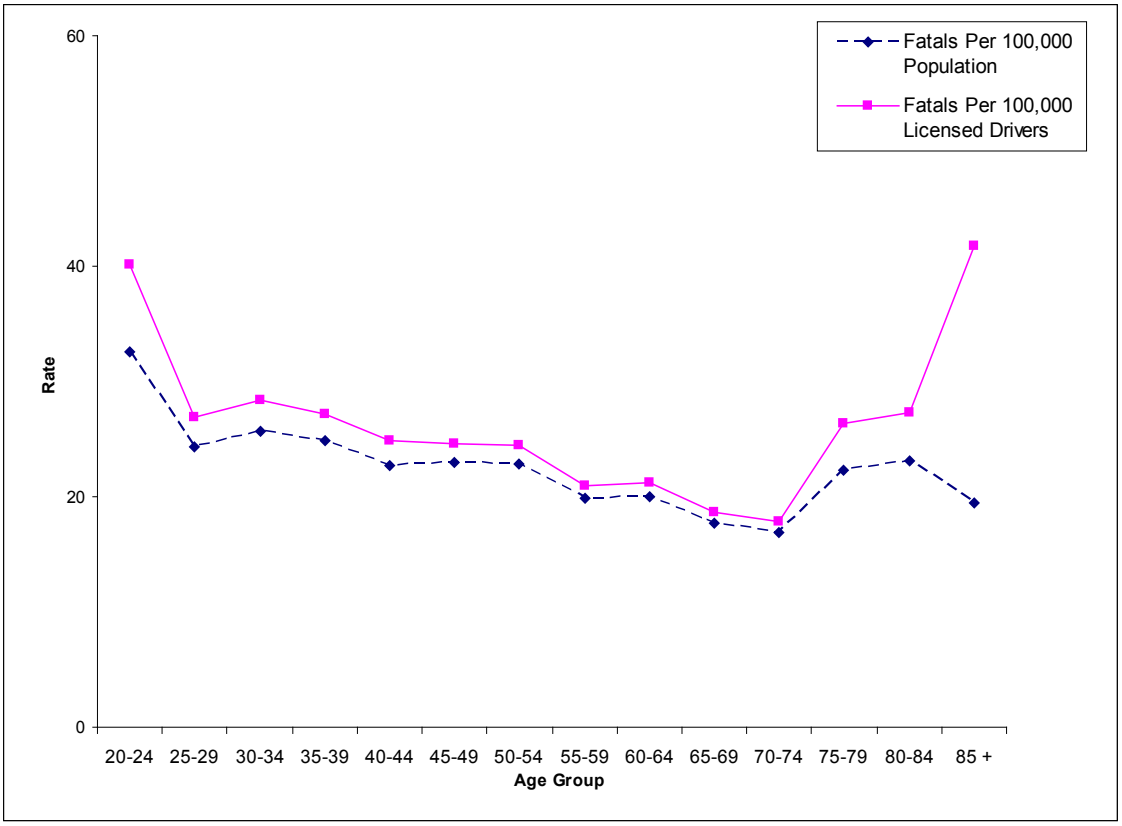


Figure A-7. Kansas Crashes per 1,000 Licensed Drivers and 1,000 Population

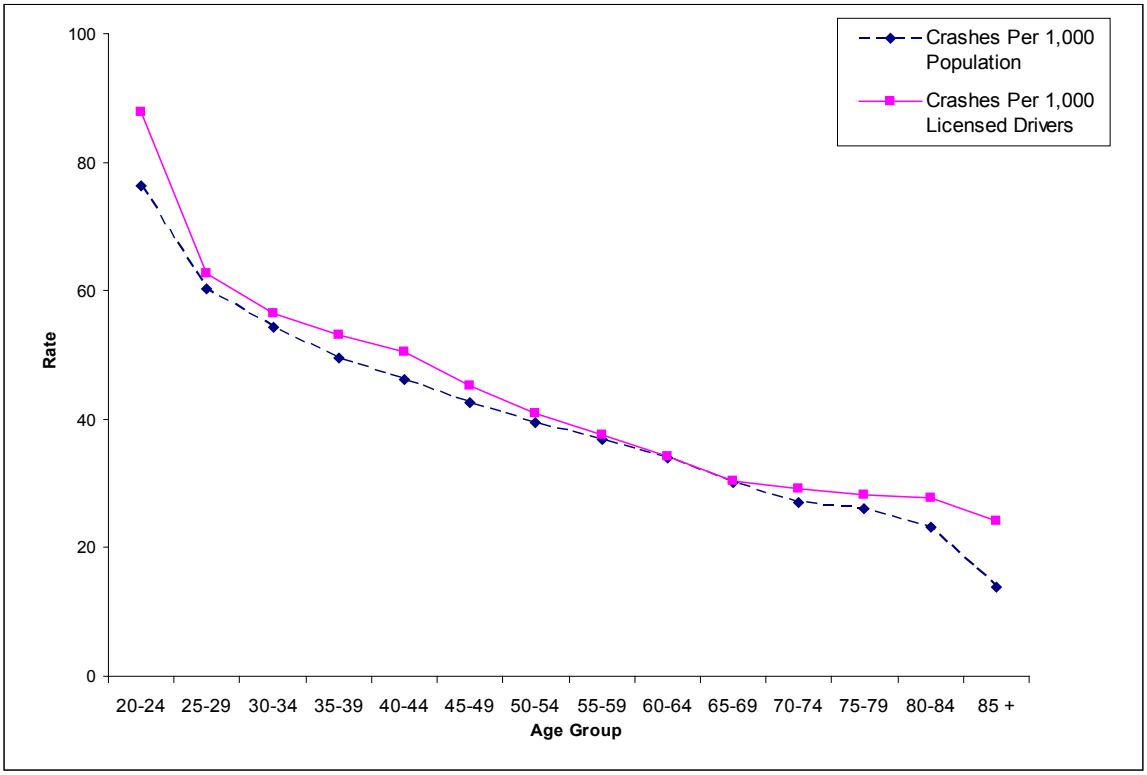


Figure A-8. Percentage Licensed by Age Group in Kansas

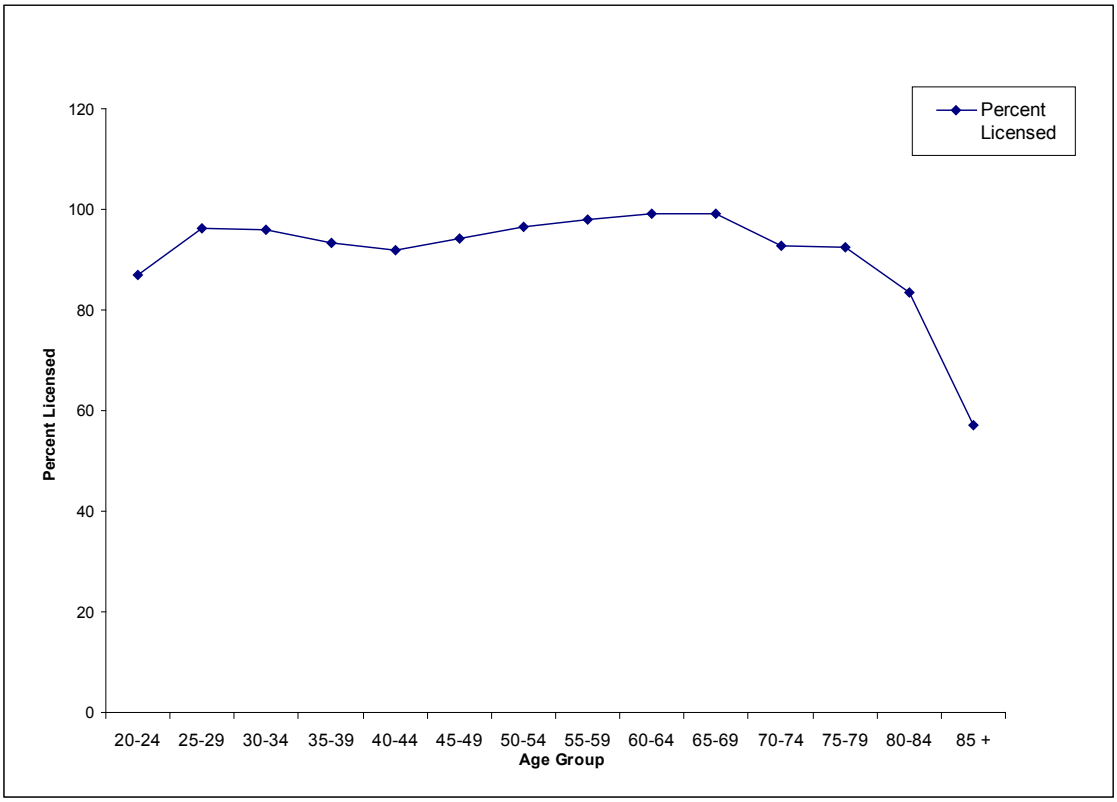


Figure A-9. Kansas Driver Fatalities per 100,000 Licensed Drivers and 100,000 Population

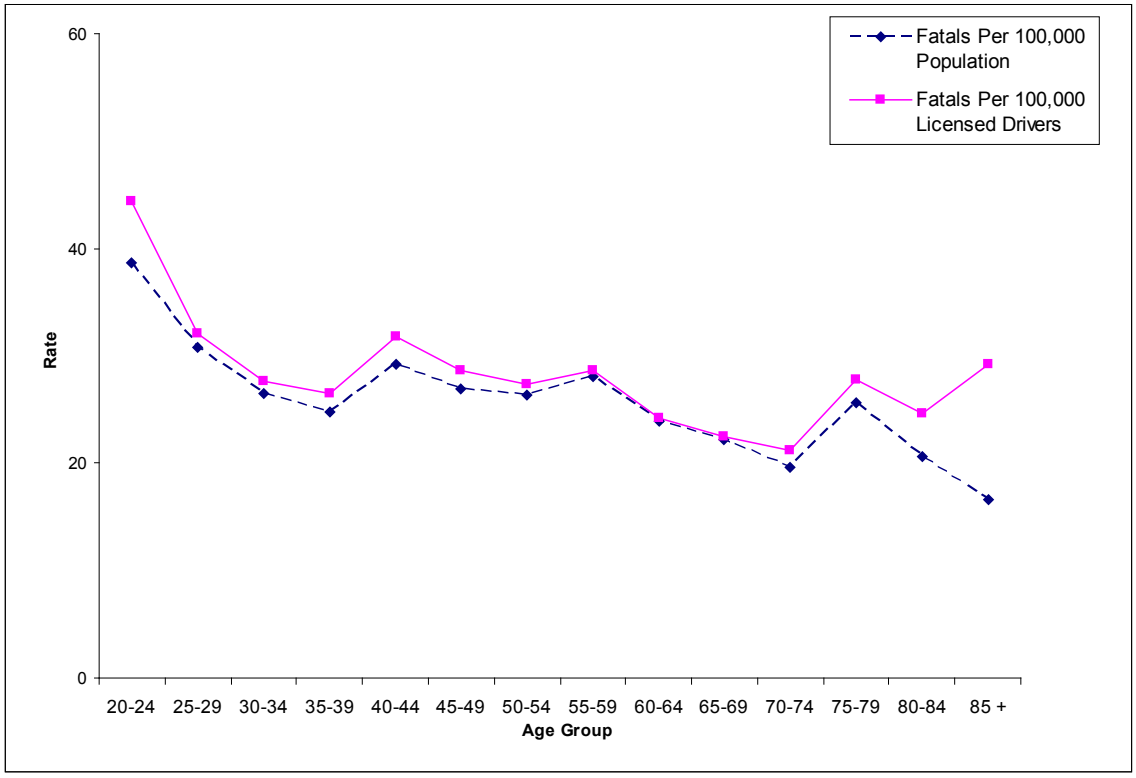


Figure A-10. New Hampshire Crashes per 1,000 Licensed Drivers and 1,000 Population

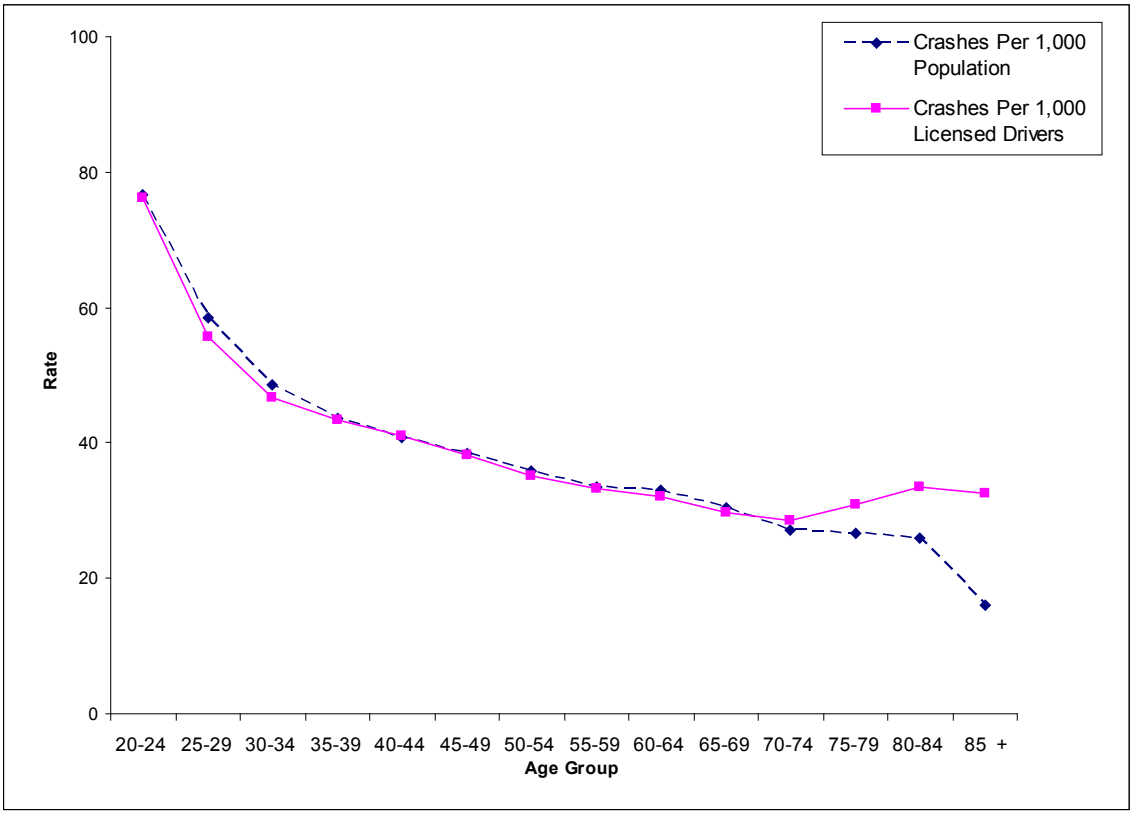


Figure A-11. Percentage Licensed by Age Group in New Hampshire

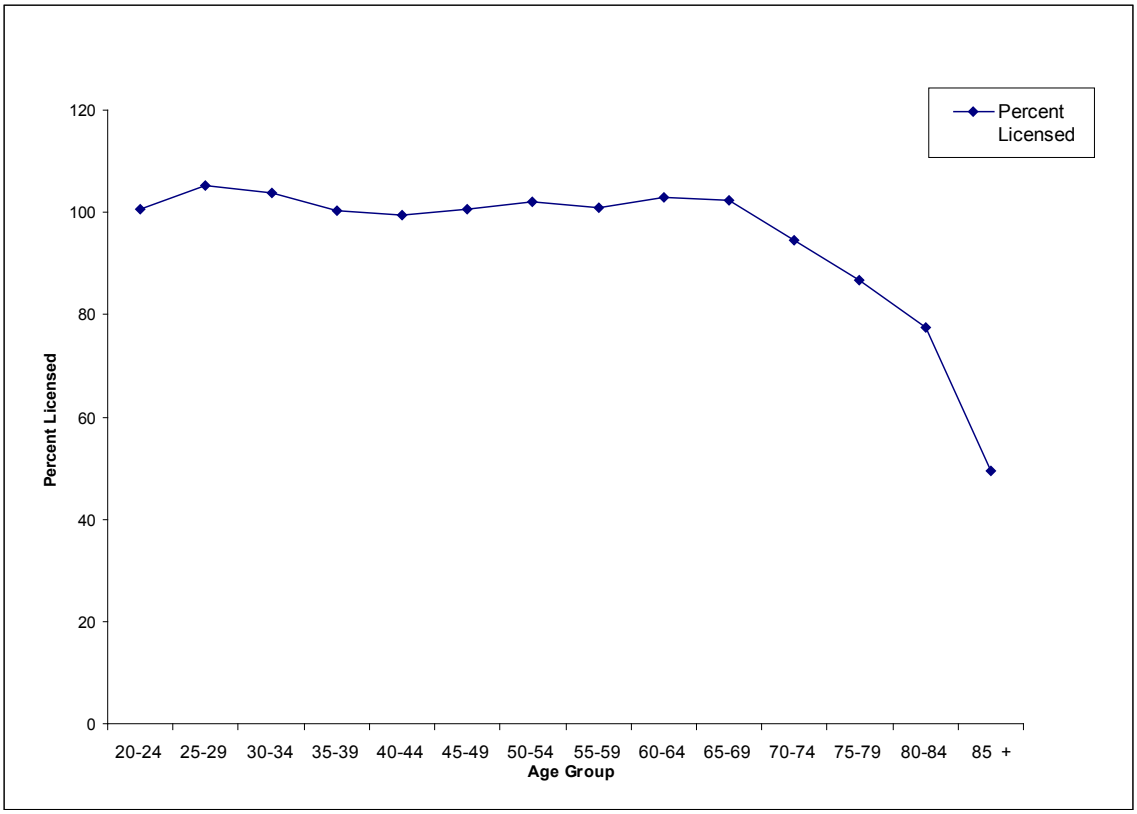


Figure A-12. New Hampshire Fatals per 100,000 Licensed Drivers and 100,000 Population

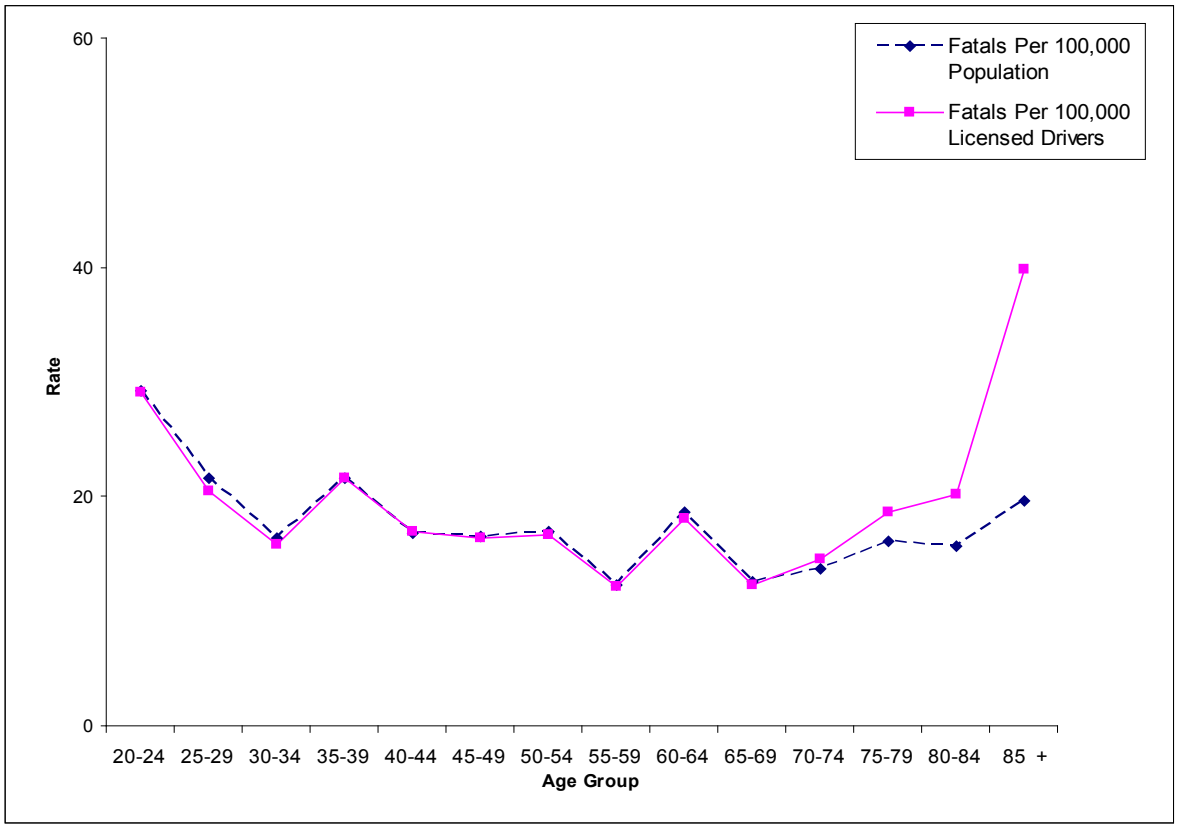


Figure A-13. Indiana Crashes per 1,000 Licensed Drivers and 1,000 Population

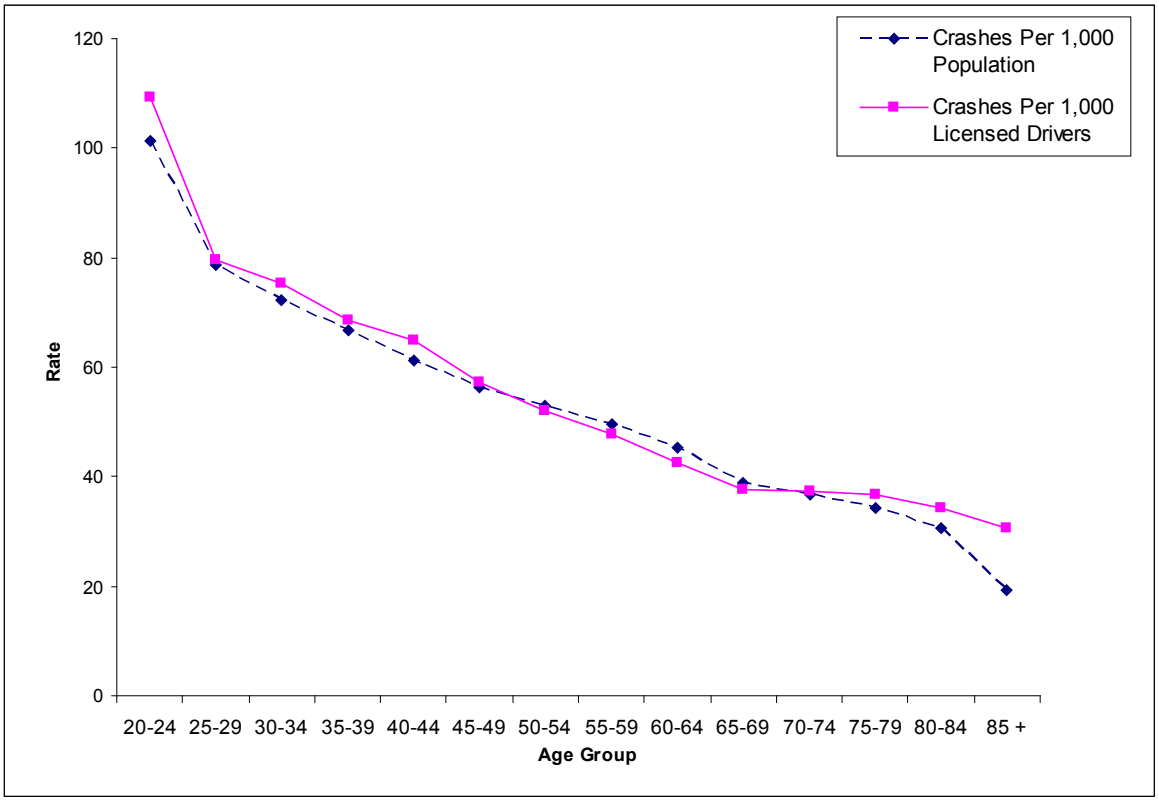


Figure A-14. Percentage Licensed by Age Group in Indiana

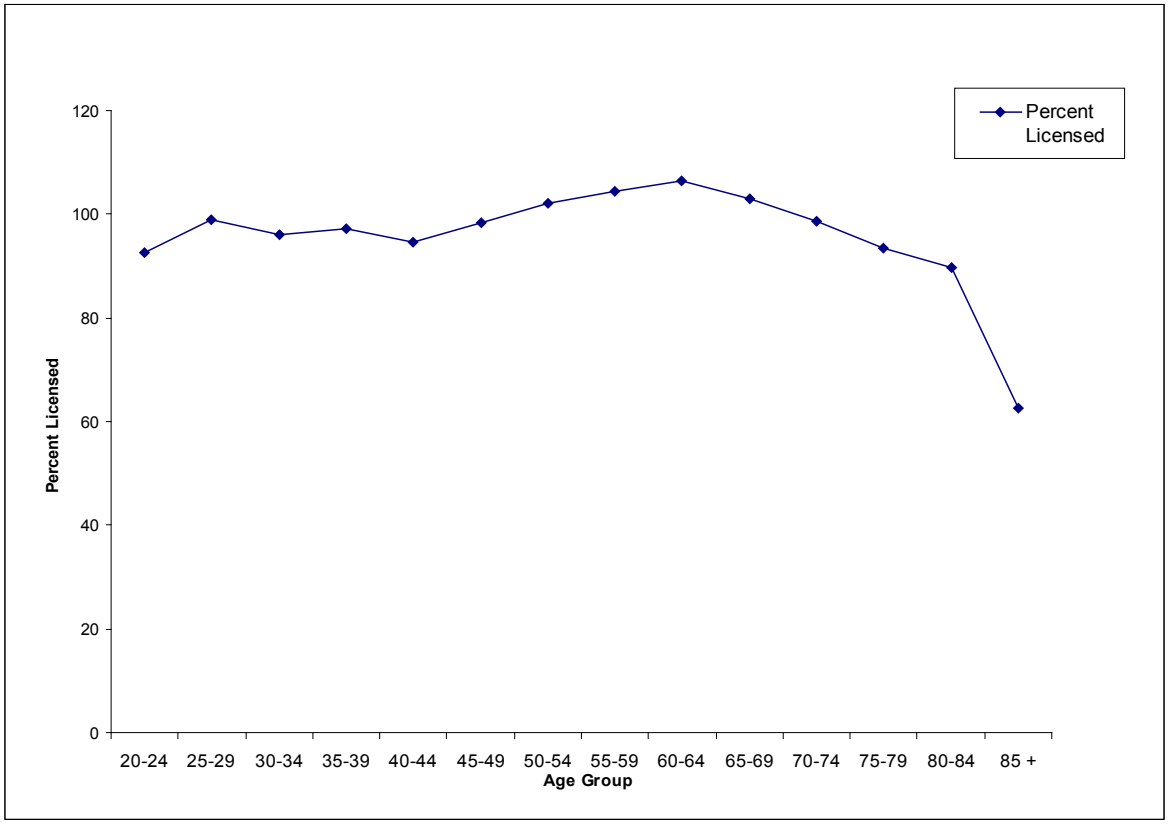


Figure A-15. Indiana Fatals per 100,000 Licensed Drivers and 100,000 Population

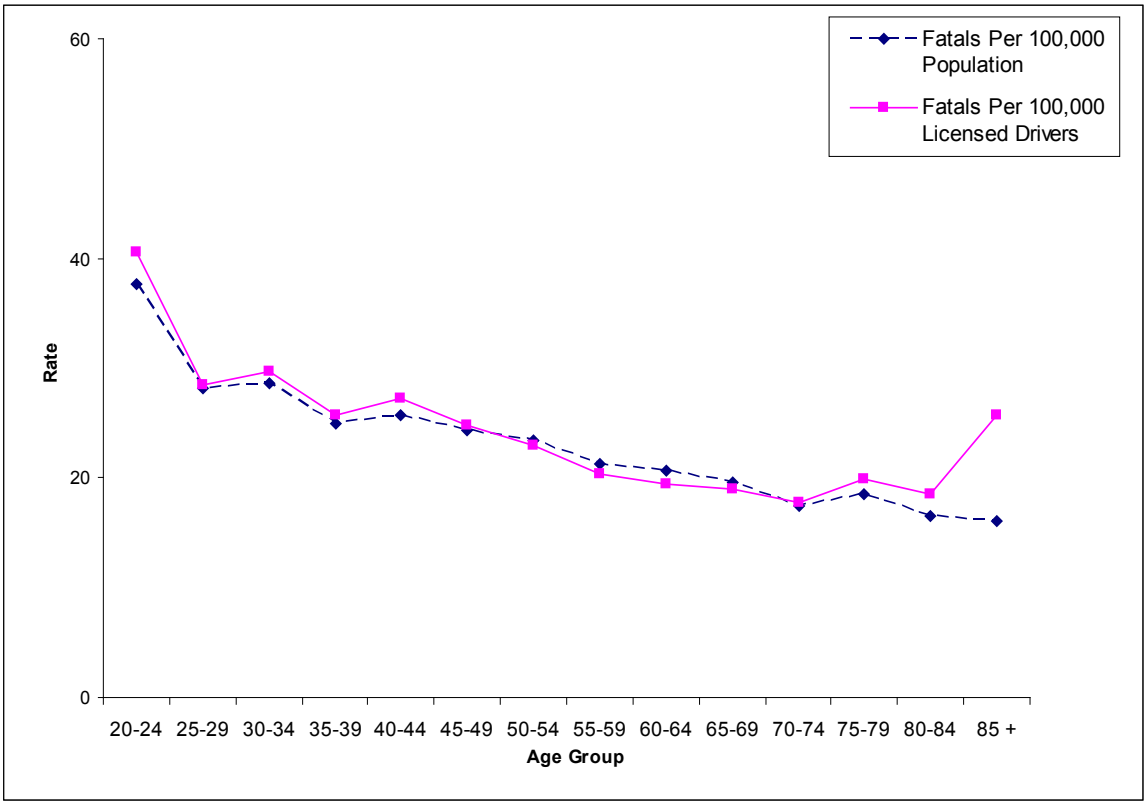


Figure A-16. Minnesota Crashes per 1,000 Licensed Drivers and 1,000 Population

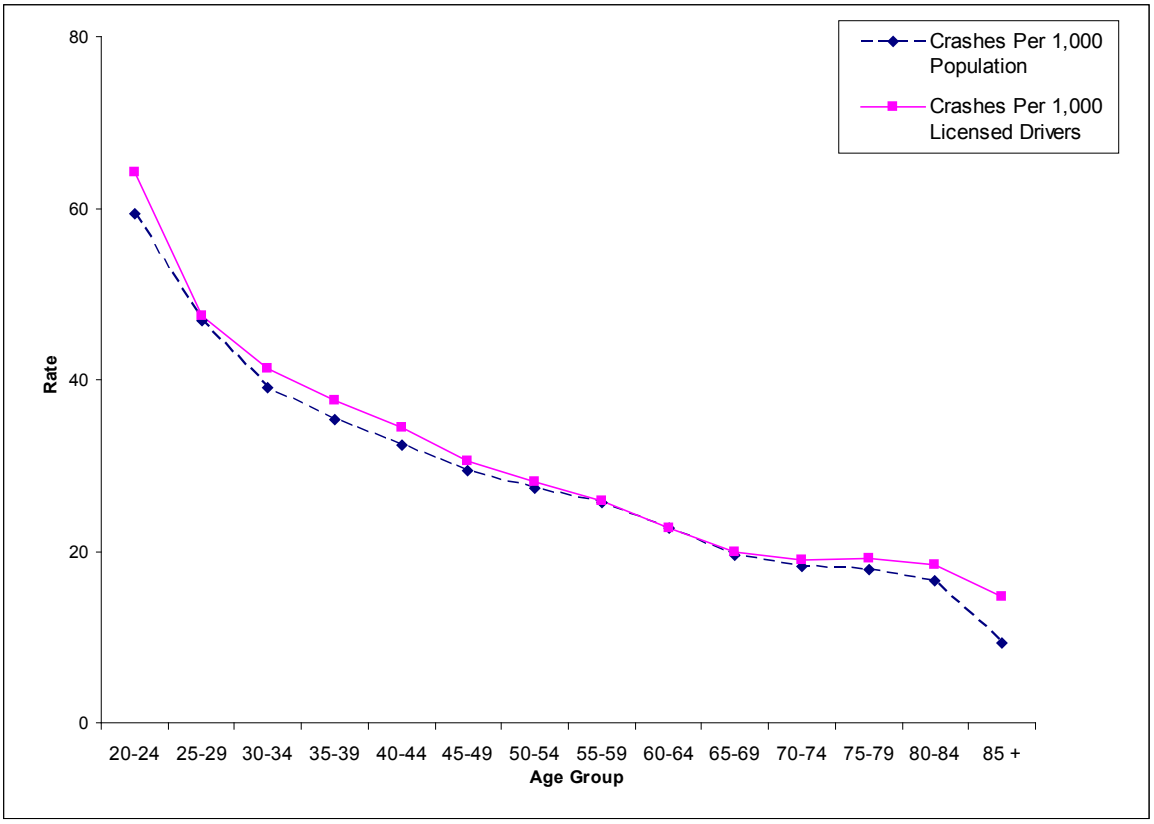


Figure A-17. Percentage Licensed by Age Group in Minnesota

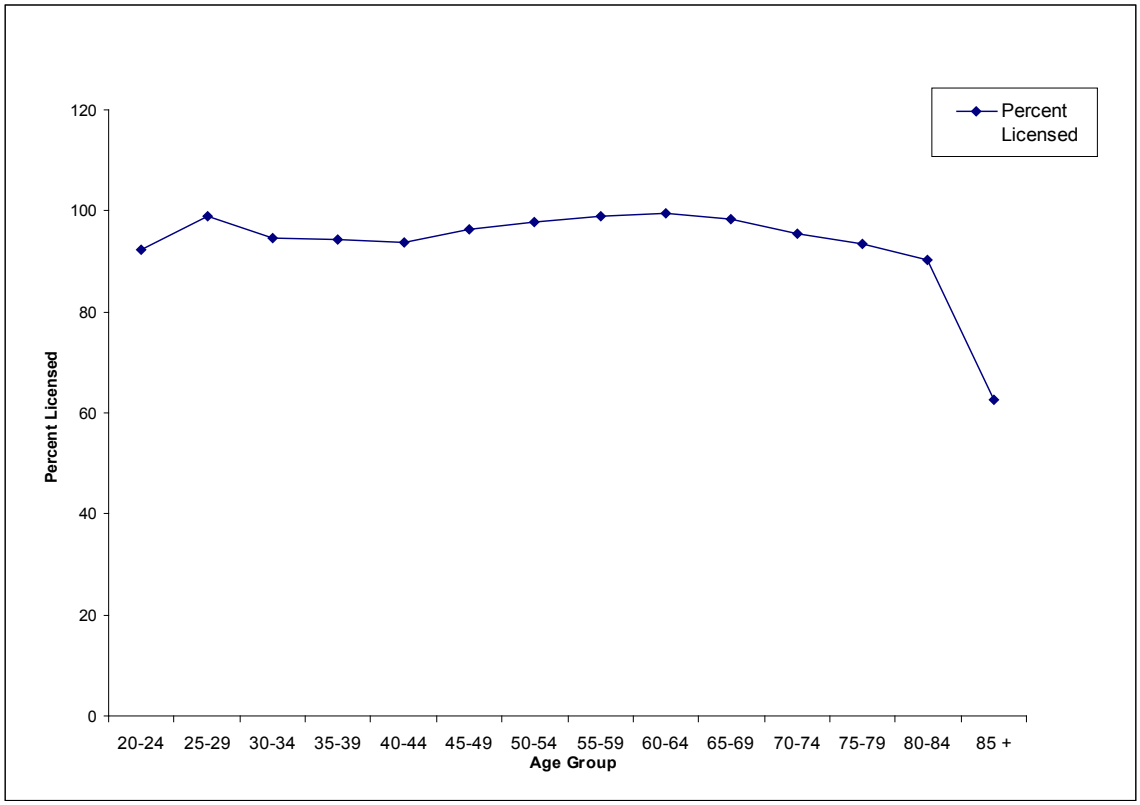


Figure A-18. Minnesota Fatals per 100,000 Licensed Drivers and 100,000 Population

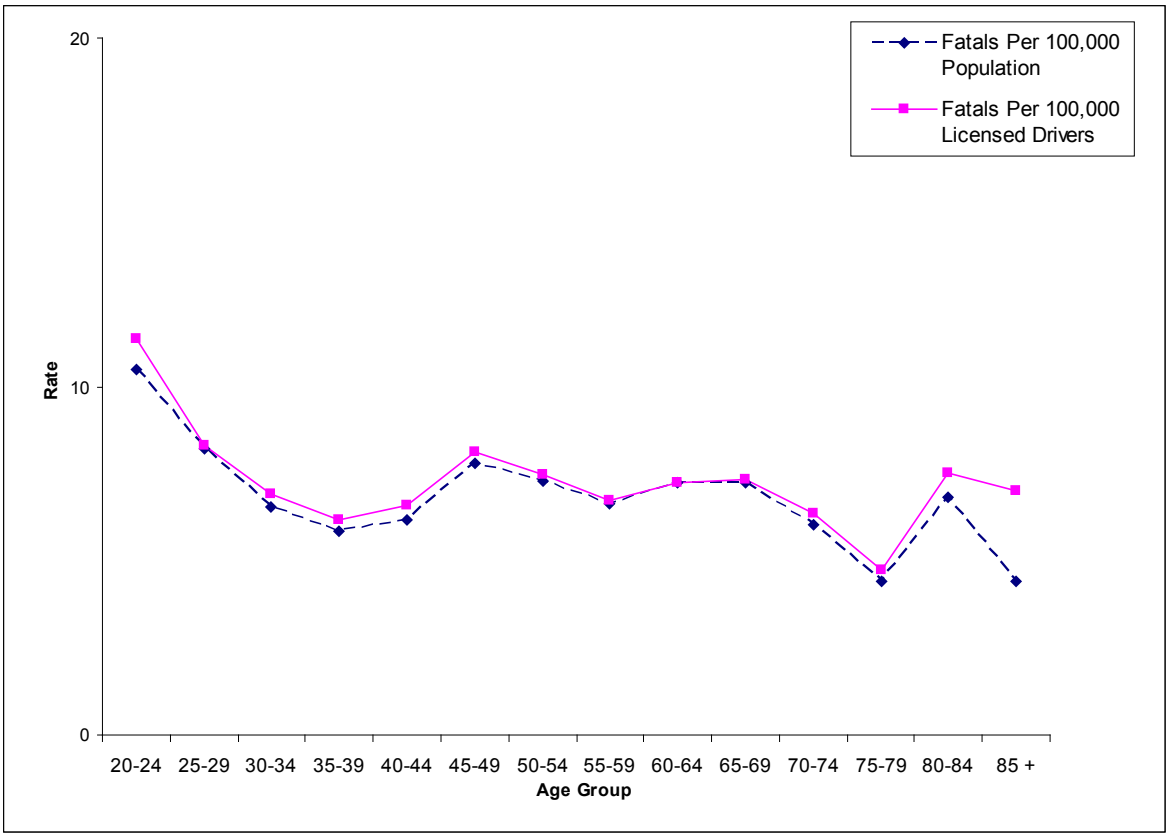


Figure A-19. Missouri Crashes per 1,000 Licensed Drivers and 1,000 Population

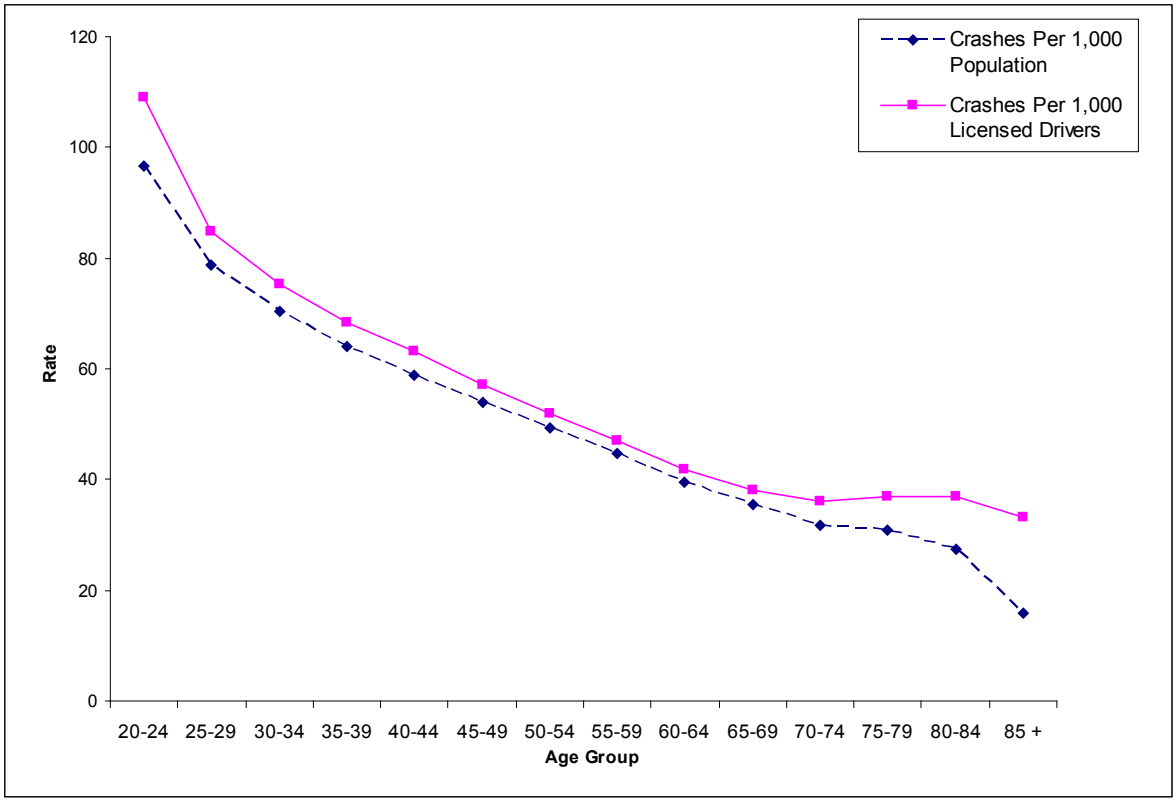


Figure A-20. Percentage Licensed by Age Group in Missouri

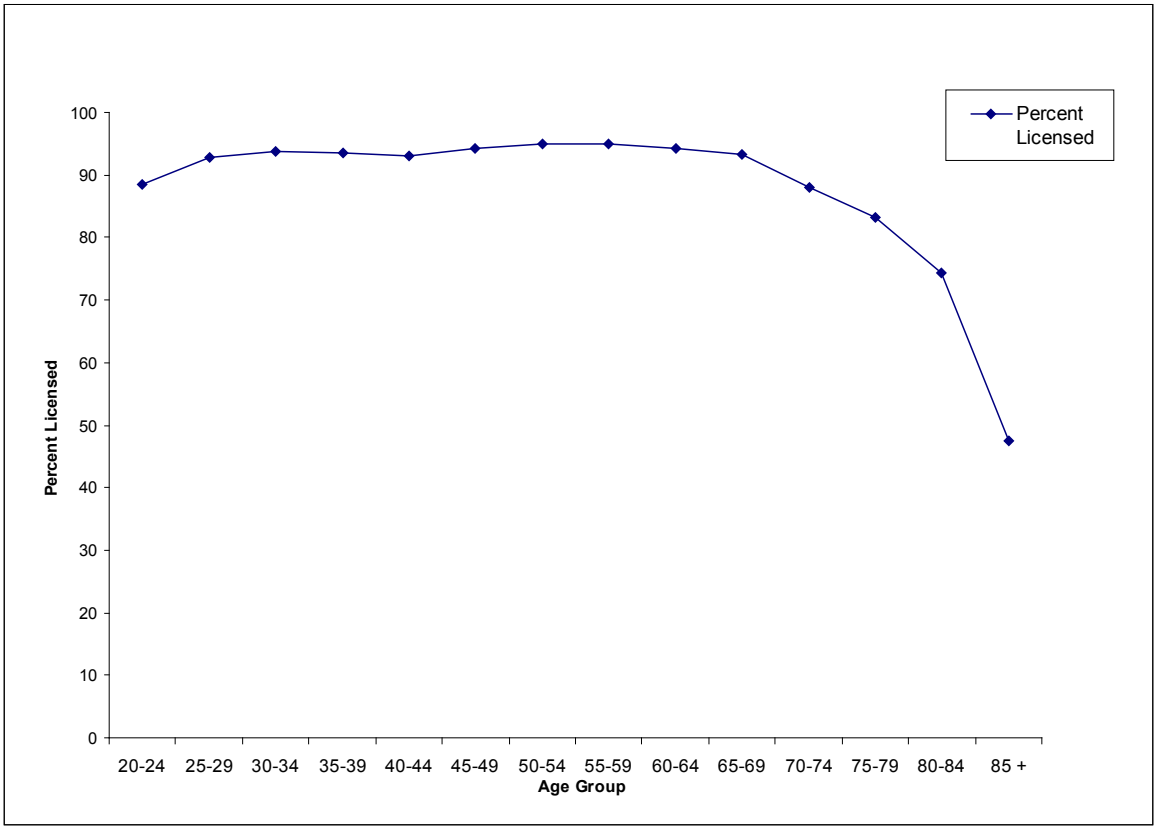


Figure A-21. Missouri Fatals per 100,000 Licensed Drivers and 100,000 Population

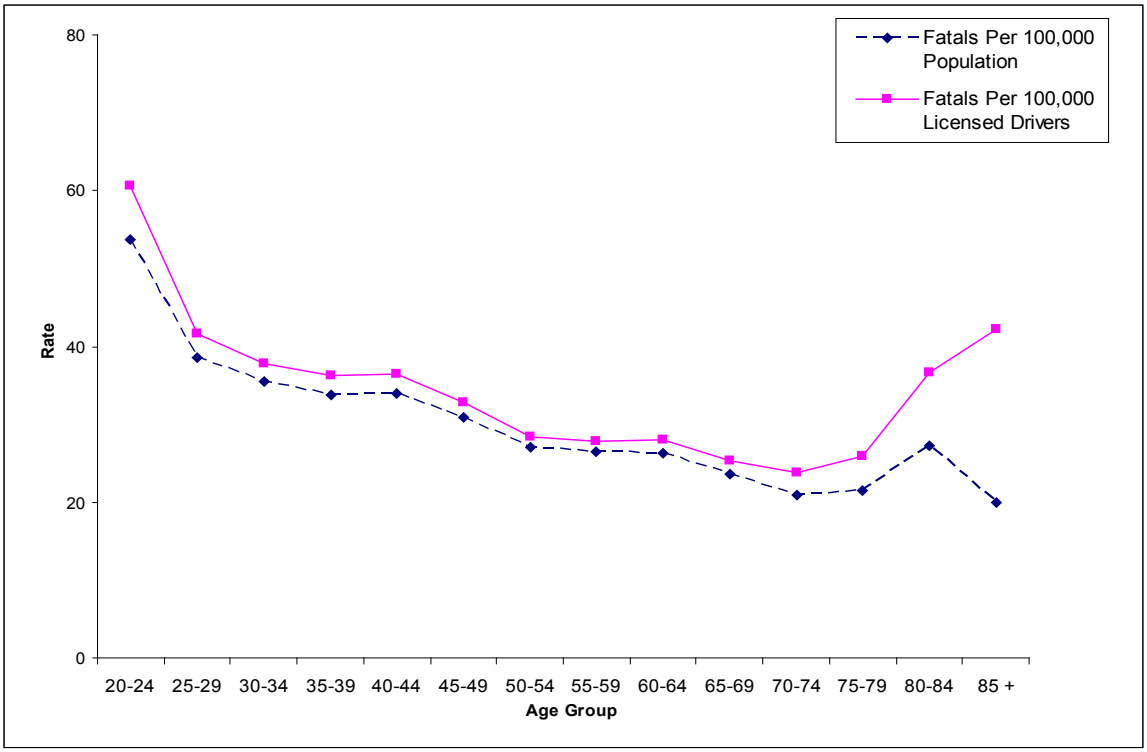


Figure A-22. Nebraska Crashes per 1,000 Licensed Drivers and 1,000 Population

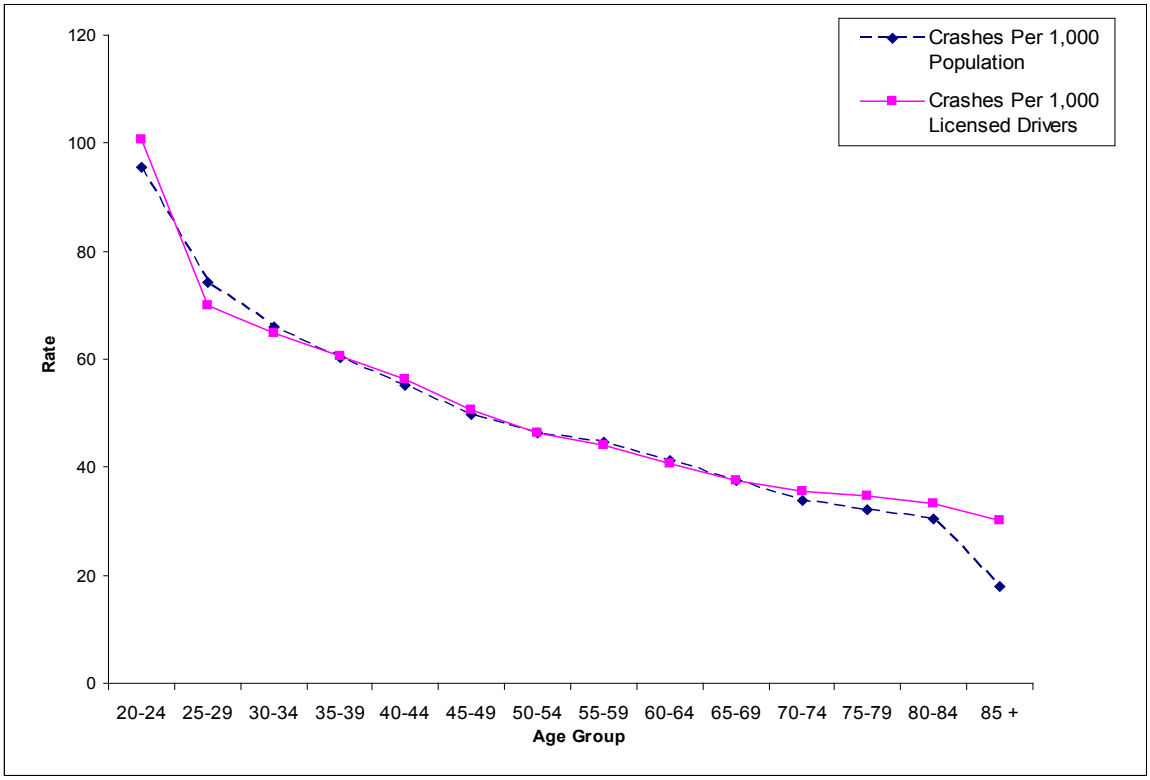


Figure A-23. Percentage Licensed by Age Group in Nebraska

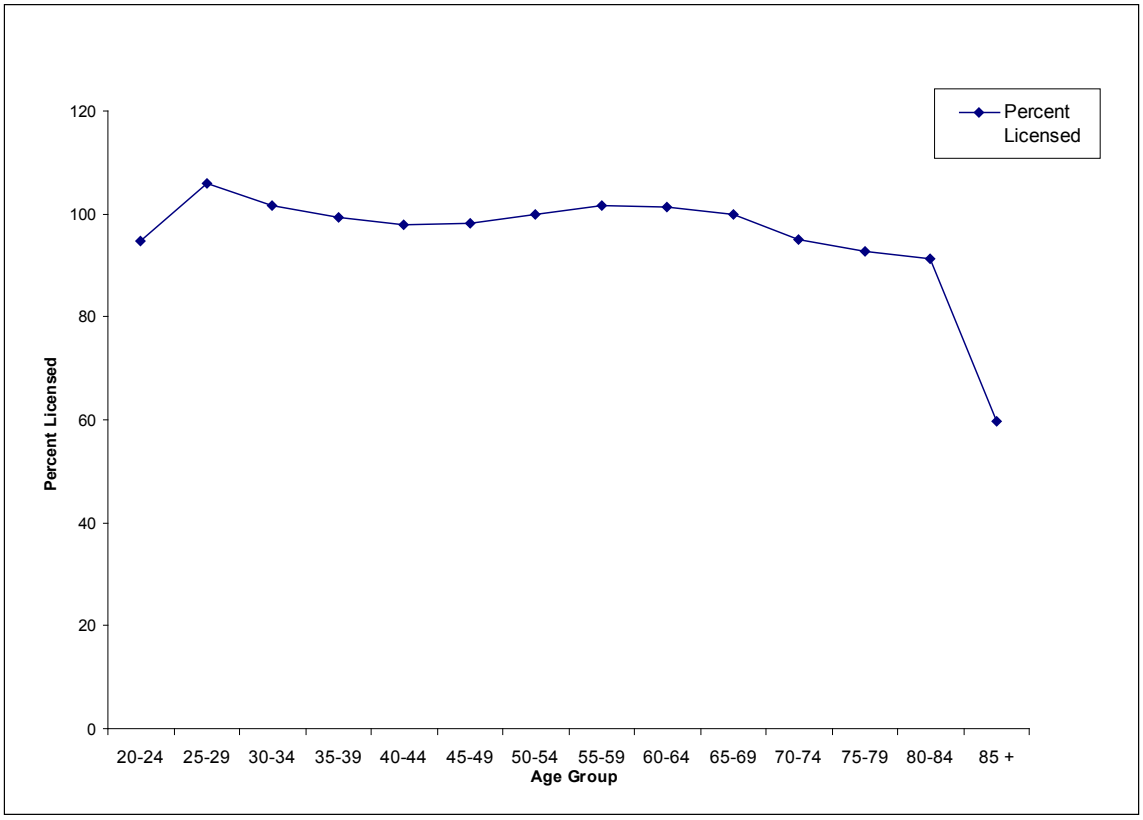


Figure A-24. Nebraska Fatals per 100,000 Licensed Drivers and 100,000 Population

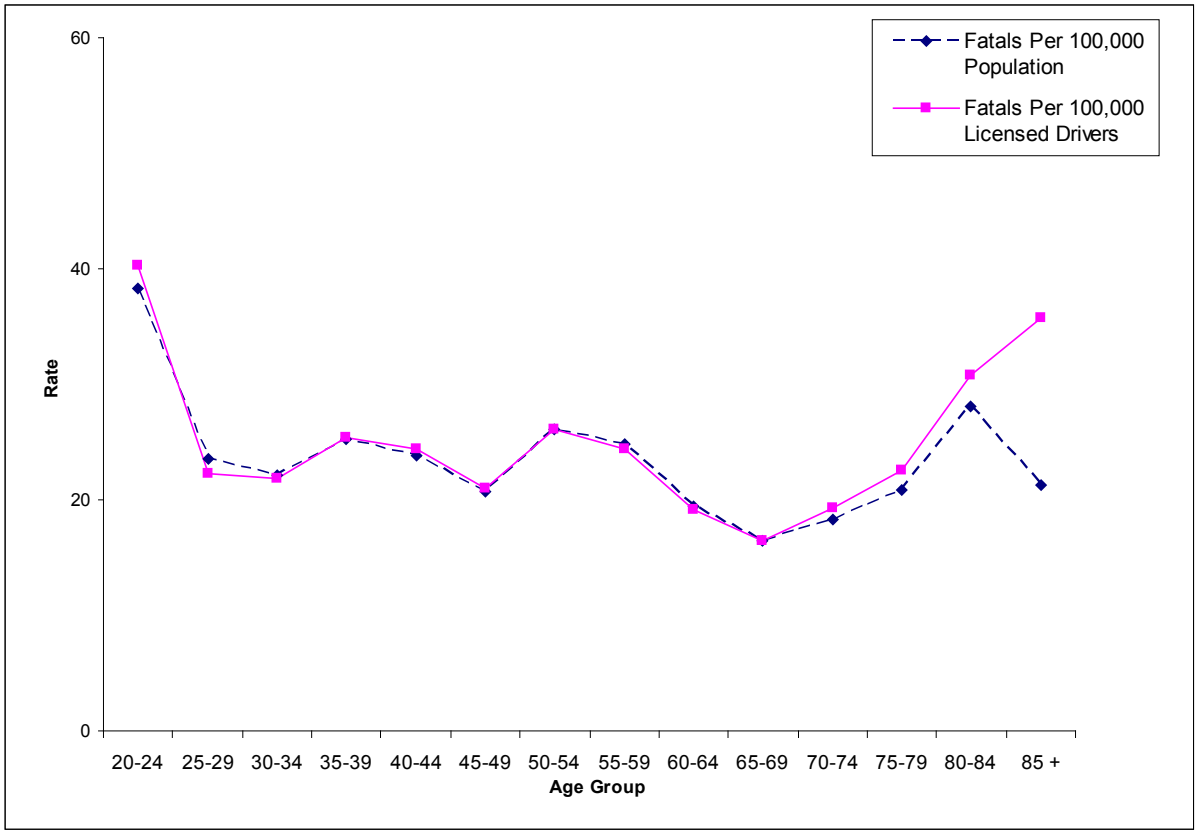


Figure A-25. Vermont Crashes per 1,000 Licensed Drivers and 1,000 Population

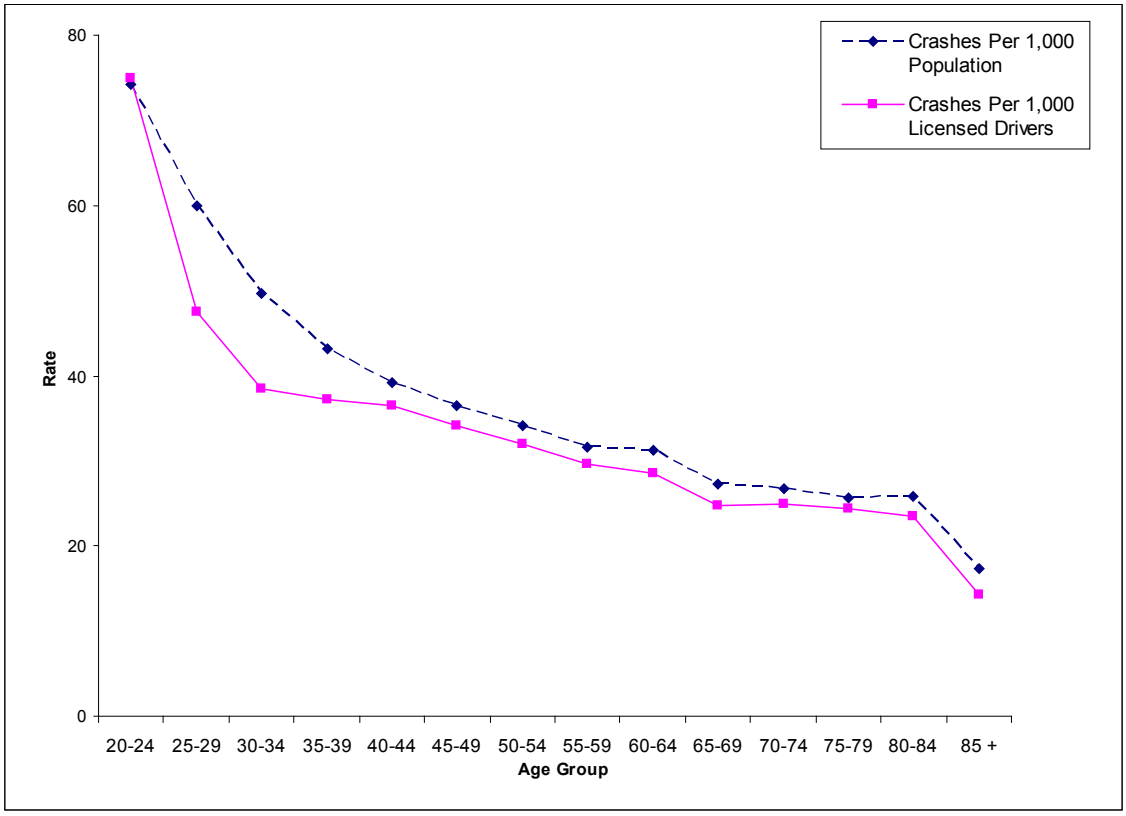


Figure A-26. Percentage Licensed by Age Group in Vermont

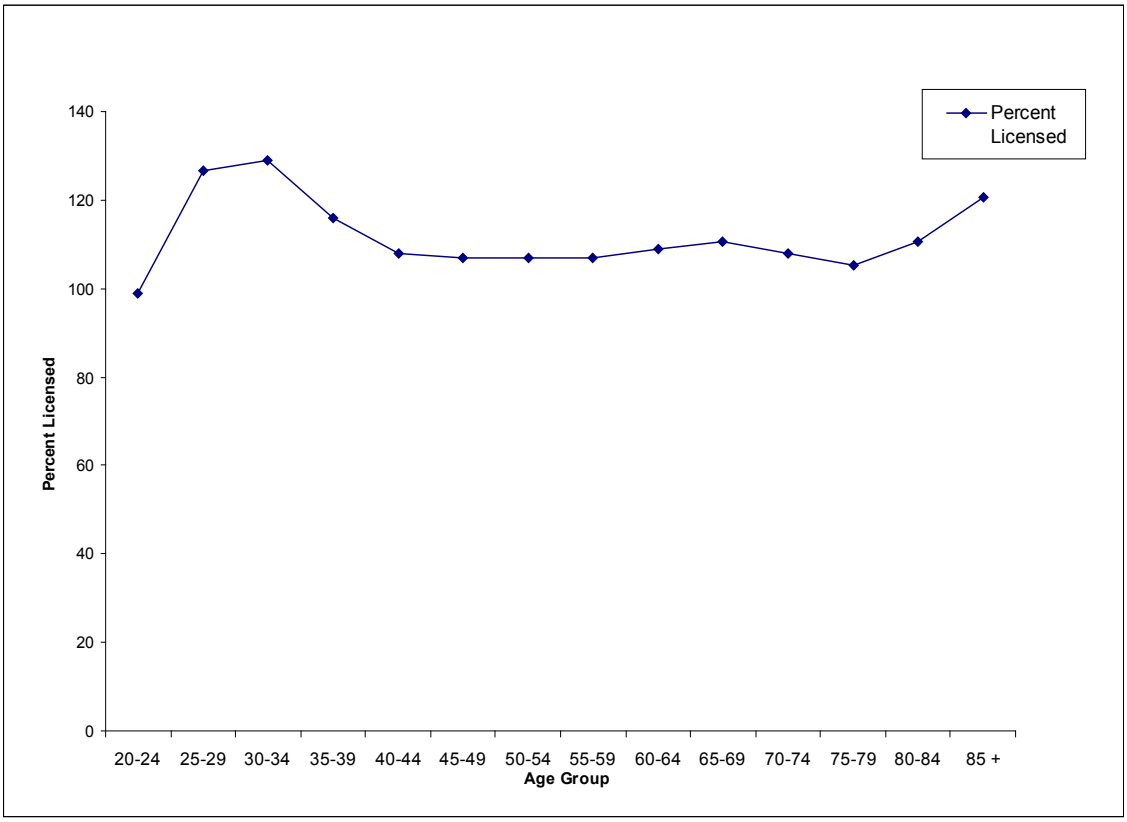


Figure A-27. Vermont Fatals per 100,000 Licensed Drivers and 100,000 Population

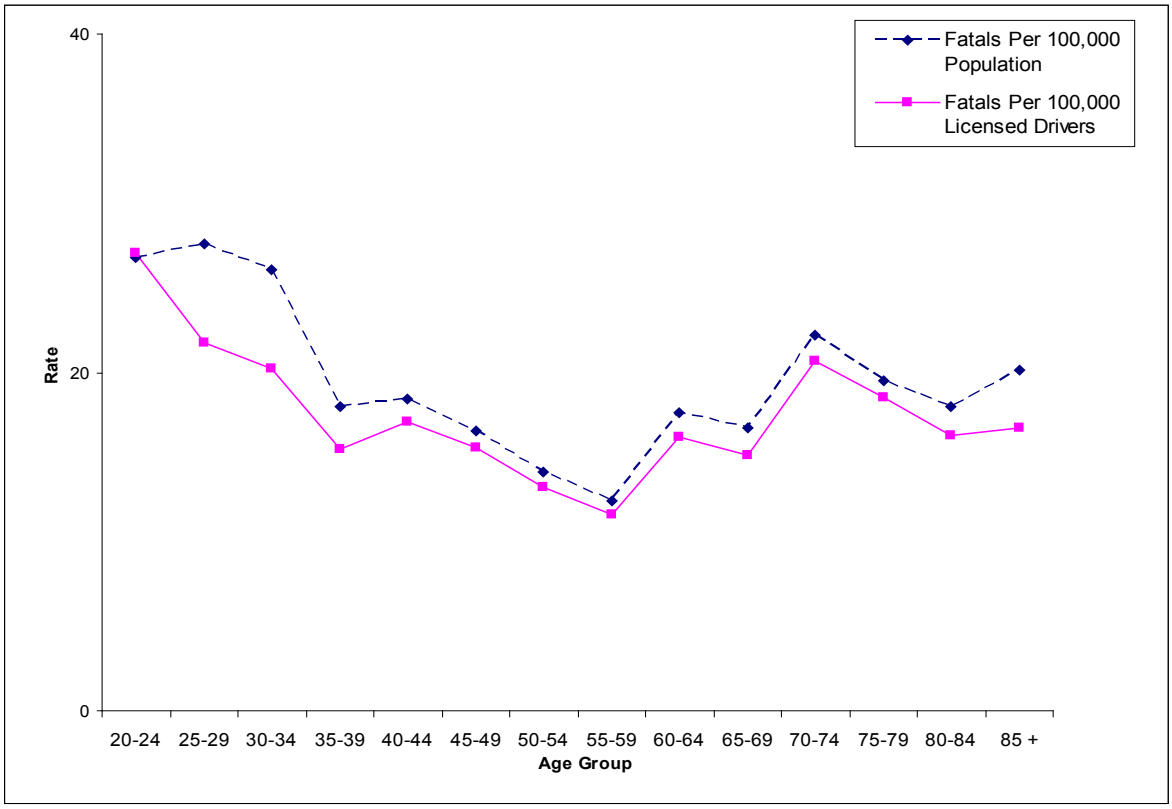


Figure A-28. Wisconsin Crashes per 1,000 Licensed Drivers and 1,000 Population

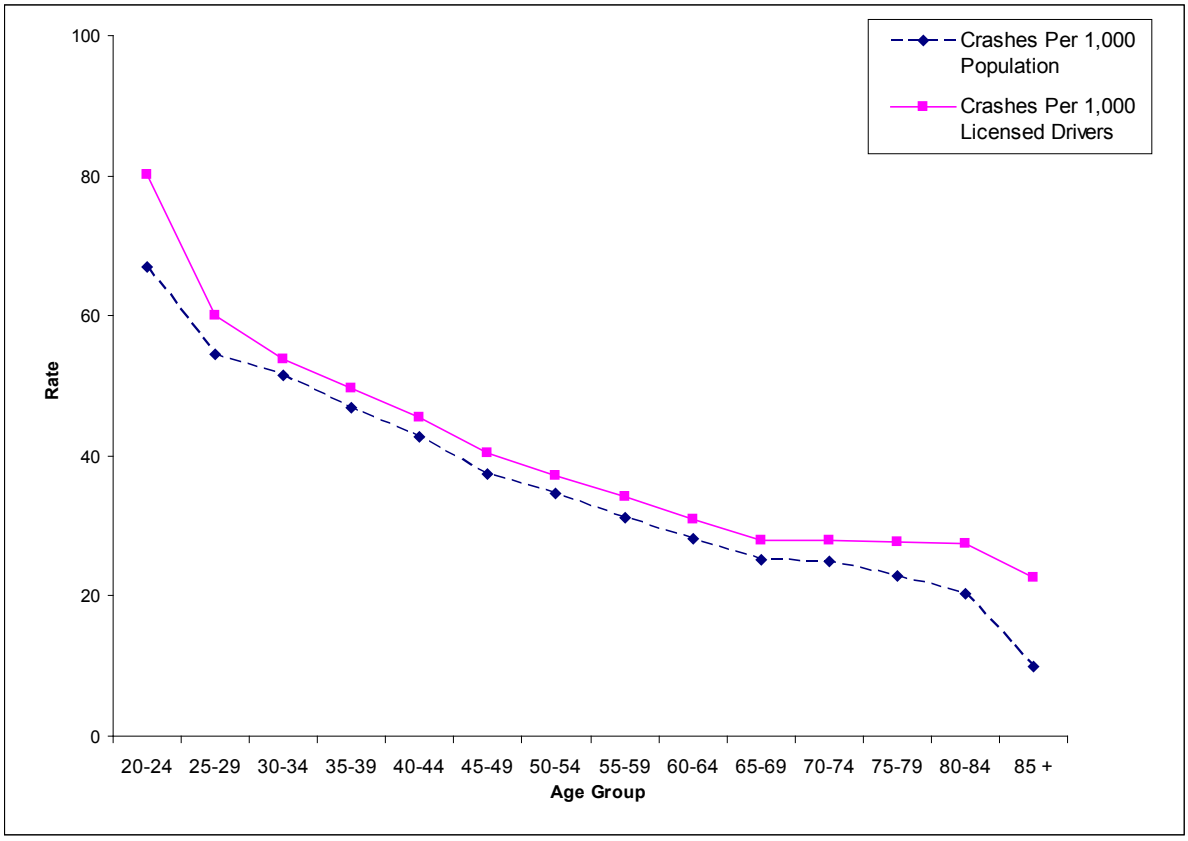


Figure A-29. Percentage Licensed by Age Group in Wisconsin

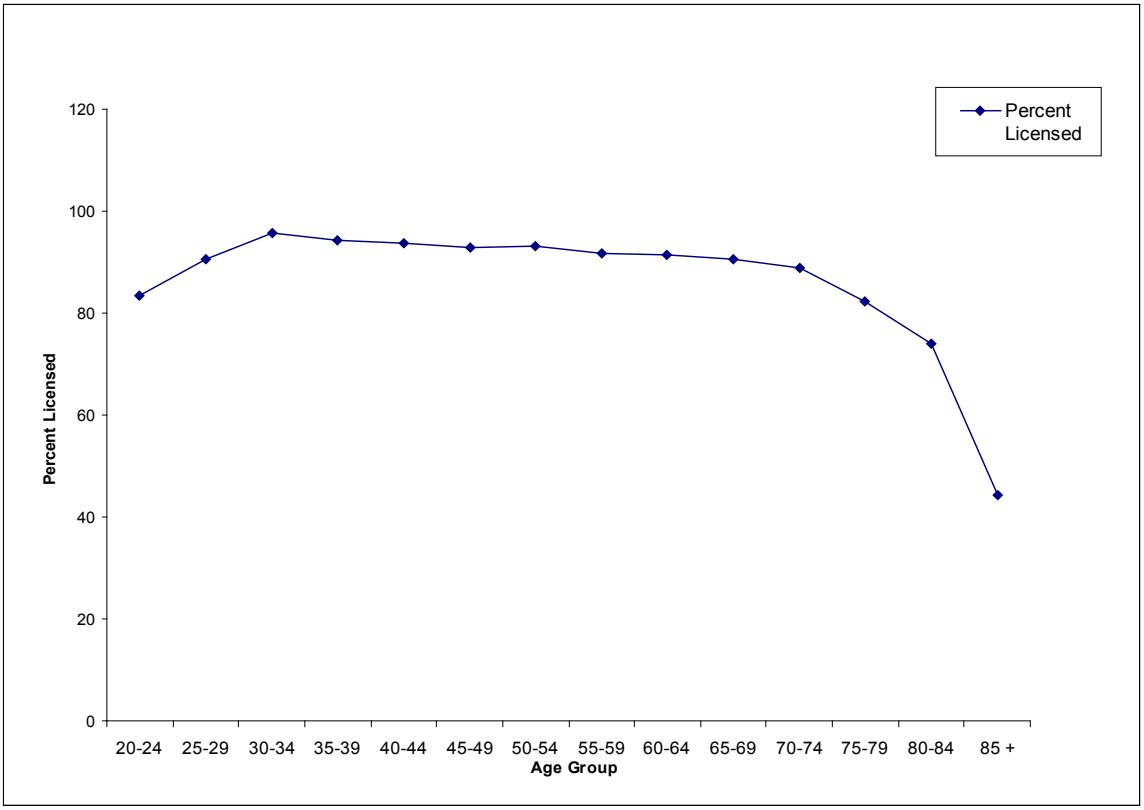


Figure A-30. Wisconsin Fatals per 100,000 Licensed Drivers and 100,000 Population

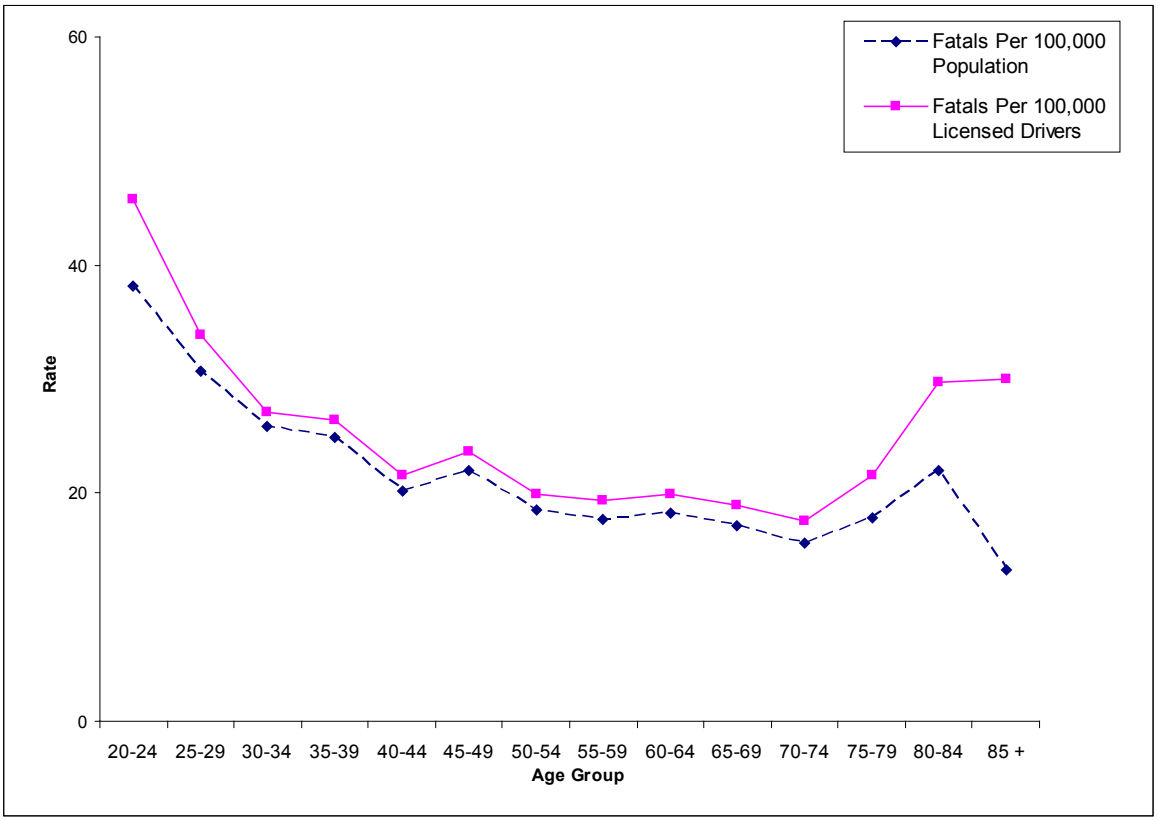


Figure A-31. Emphasis States: Crashes per 1,000 licensed drivers

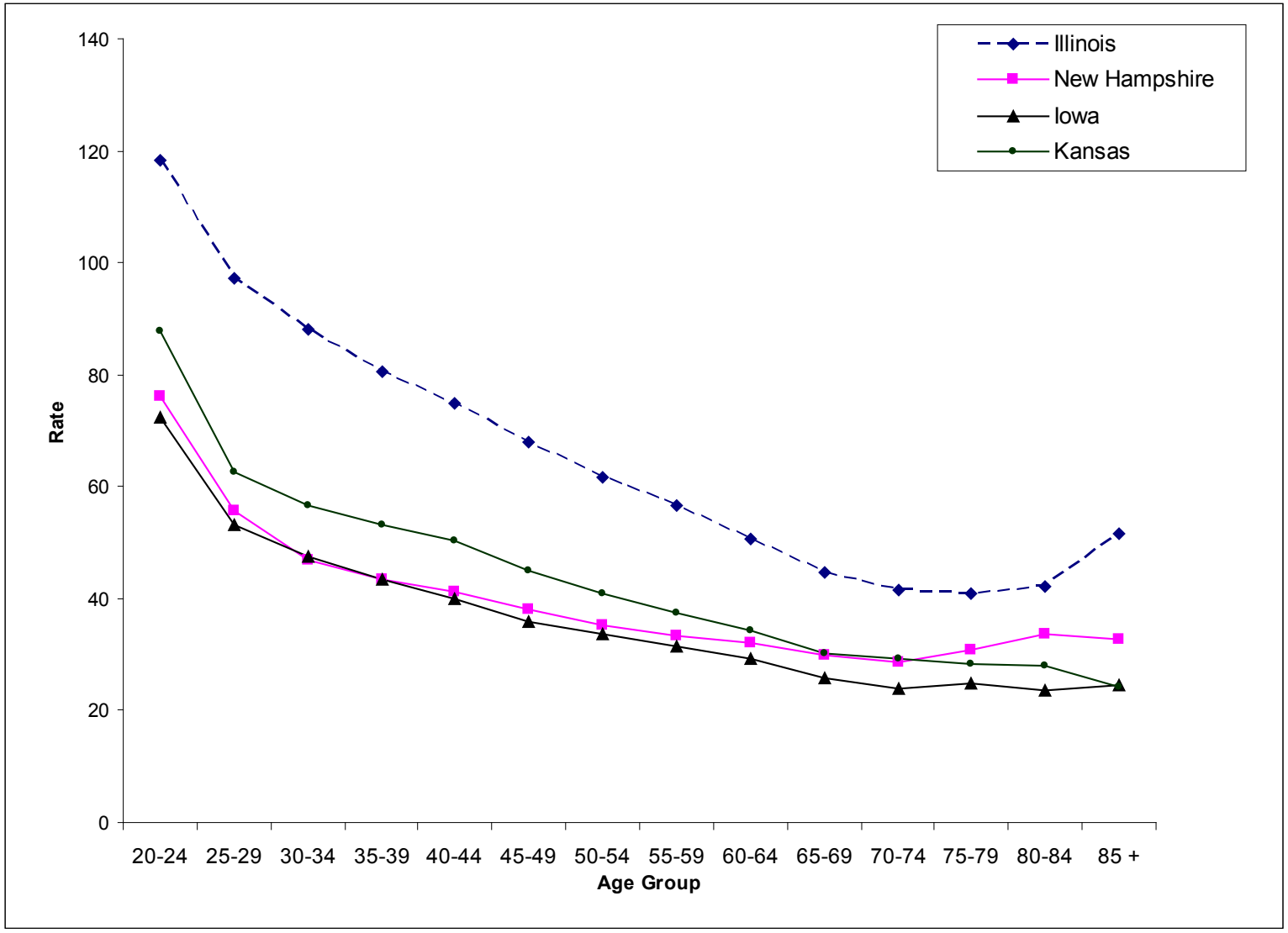


Figure A-32. Comparison States: Crashes per 1,000 licensed drivers

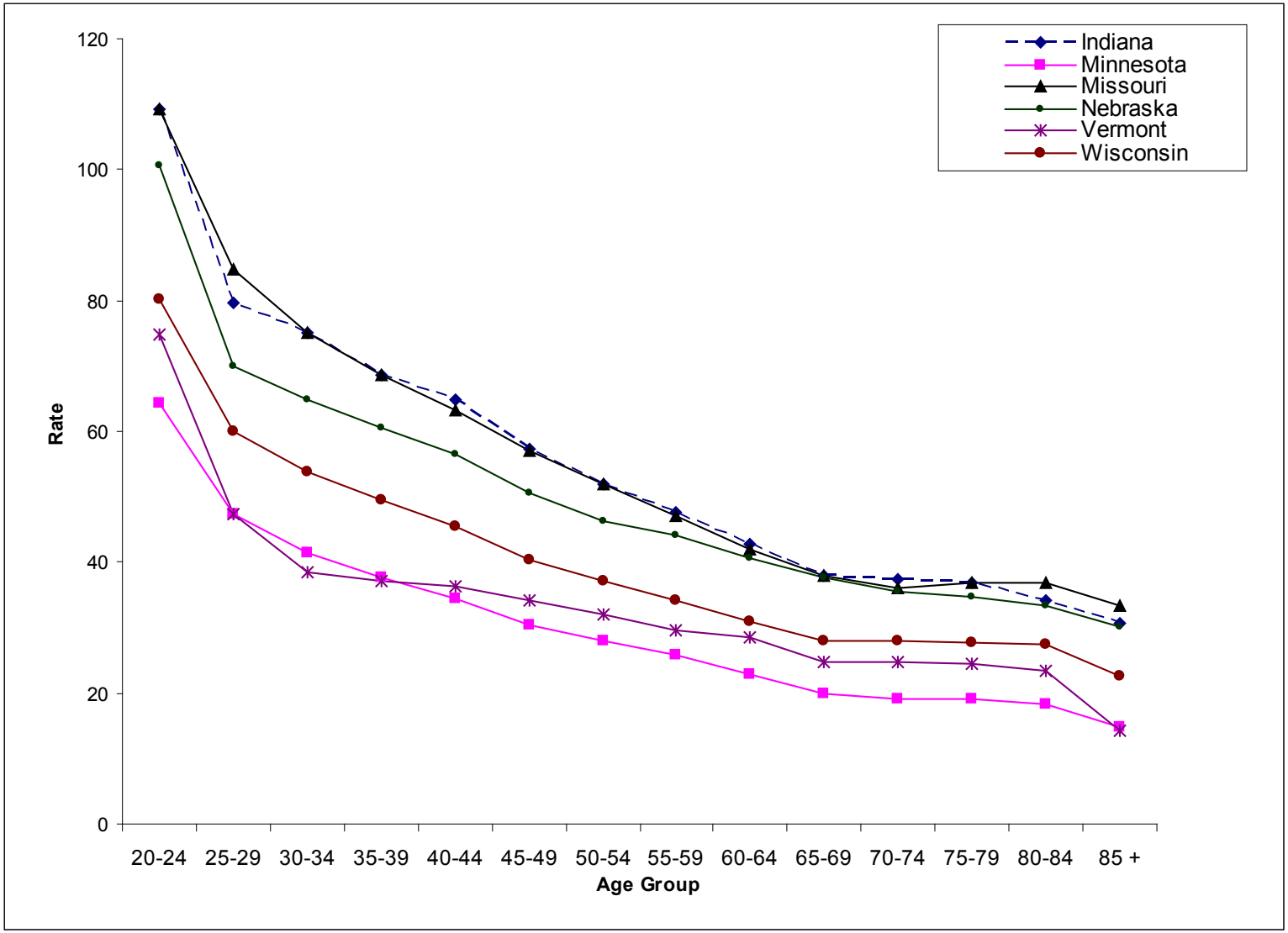


Figure A-33. Emphasis States: Crashes per 1,000 population

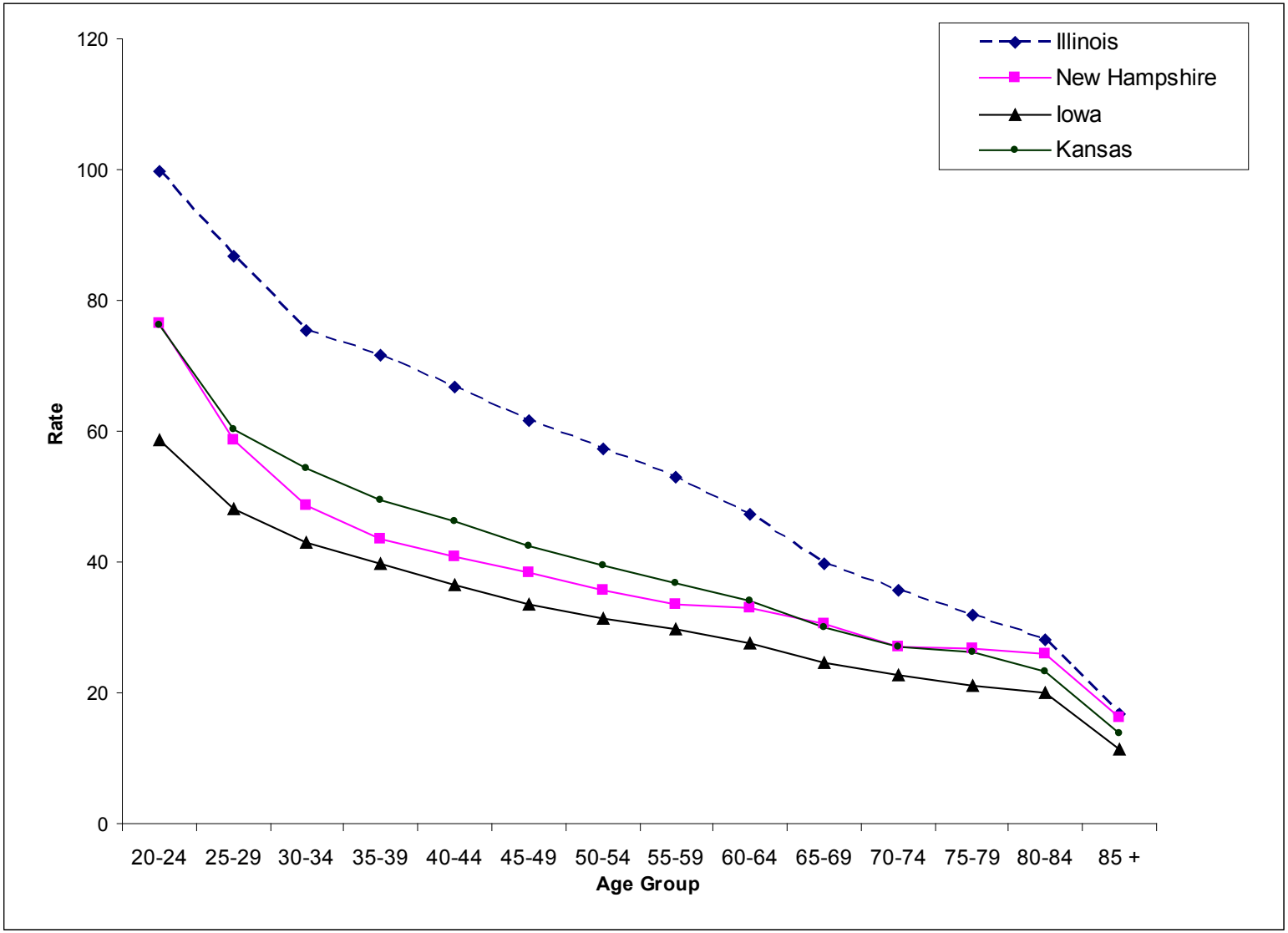


Figure A-34. Comparison States: Crashes per 1,000 population

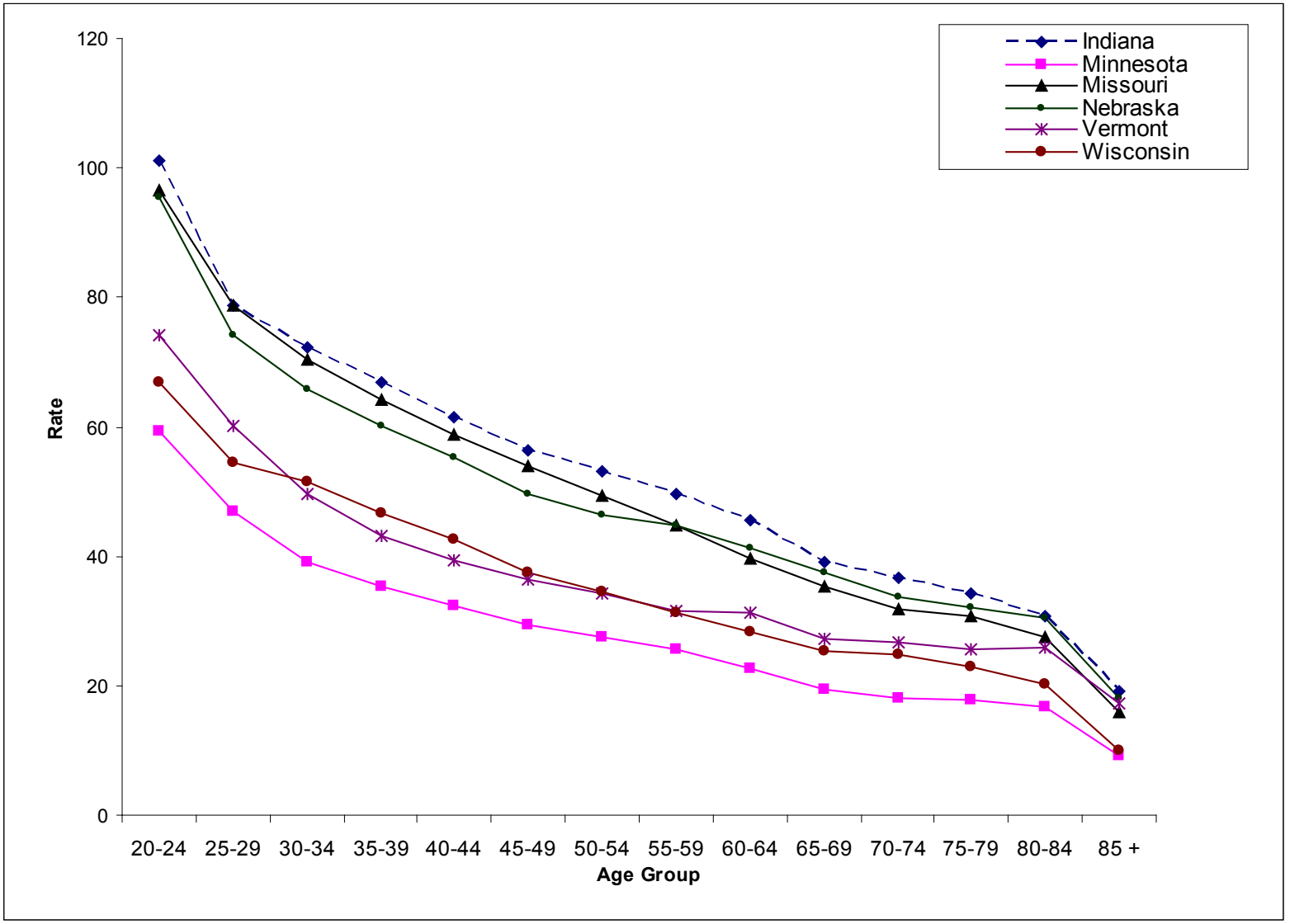


Figure A-35. Emphasis States: Driver Fatalities per 100,000 Licensed Drivers

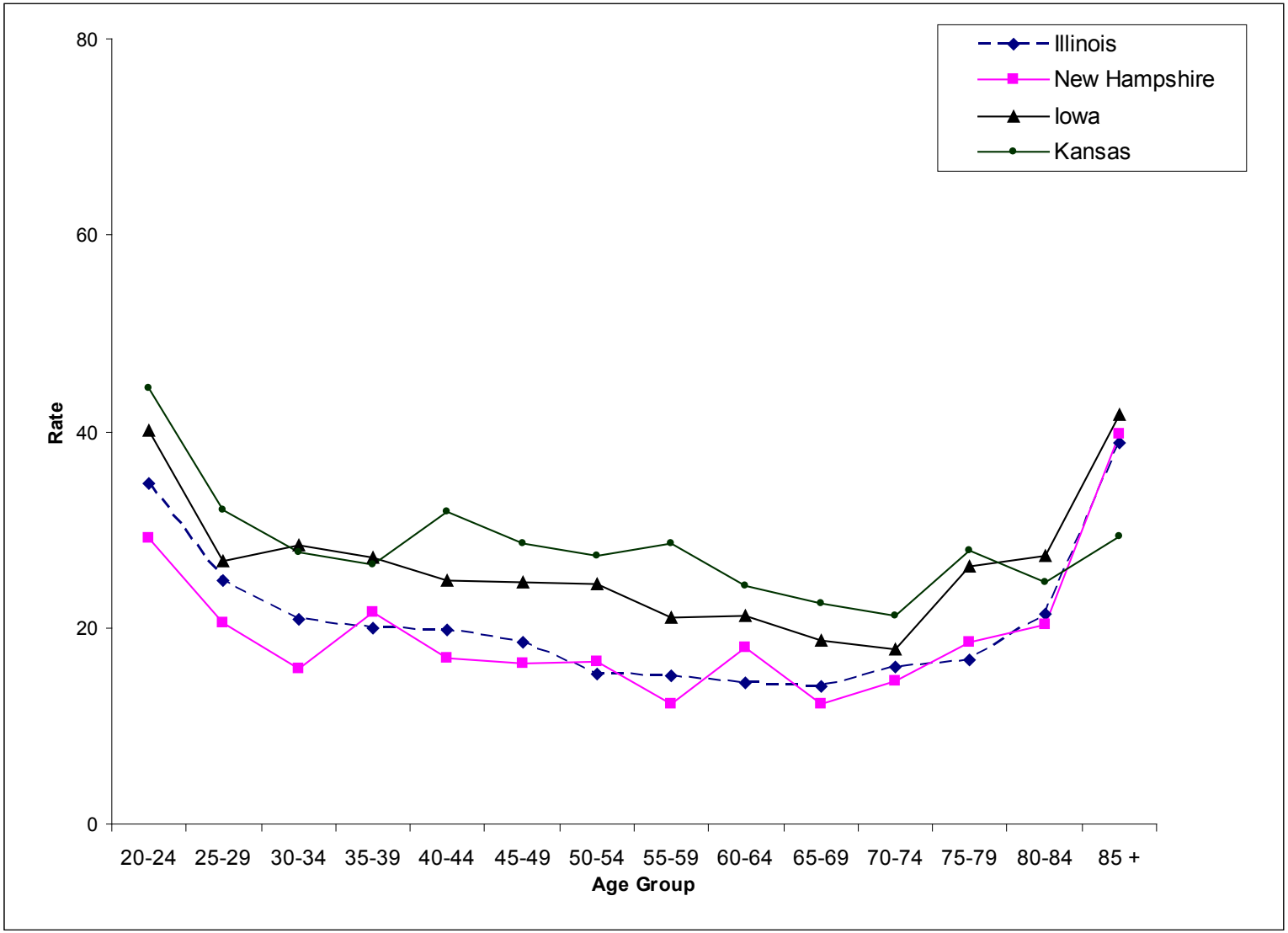


Figure A-36. Comparison States: Driver Fatalities per 100,000 Licensed Drivers

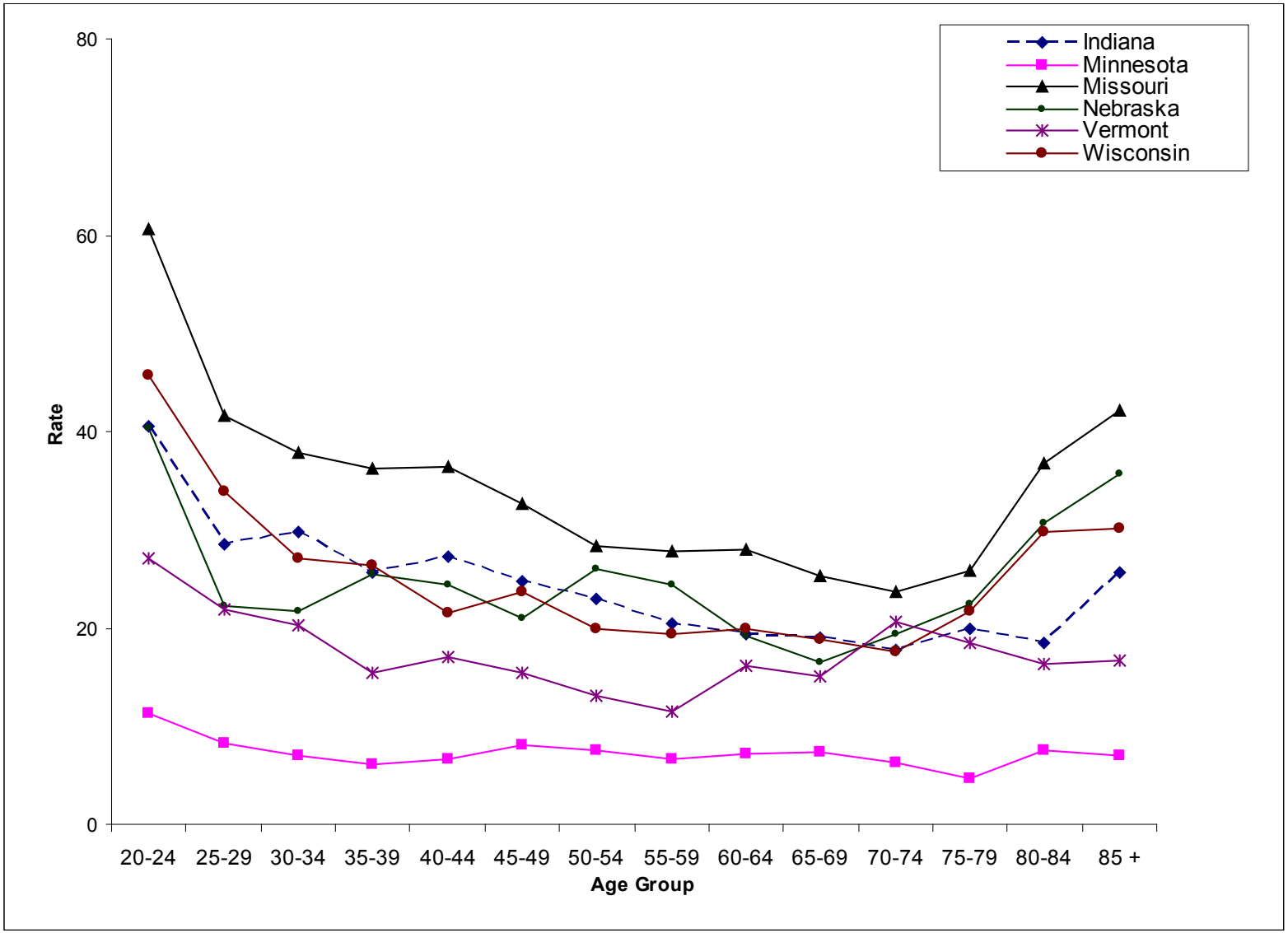


Figure A-37. Emphasis States: Driver Fatalities per 100,000 Population

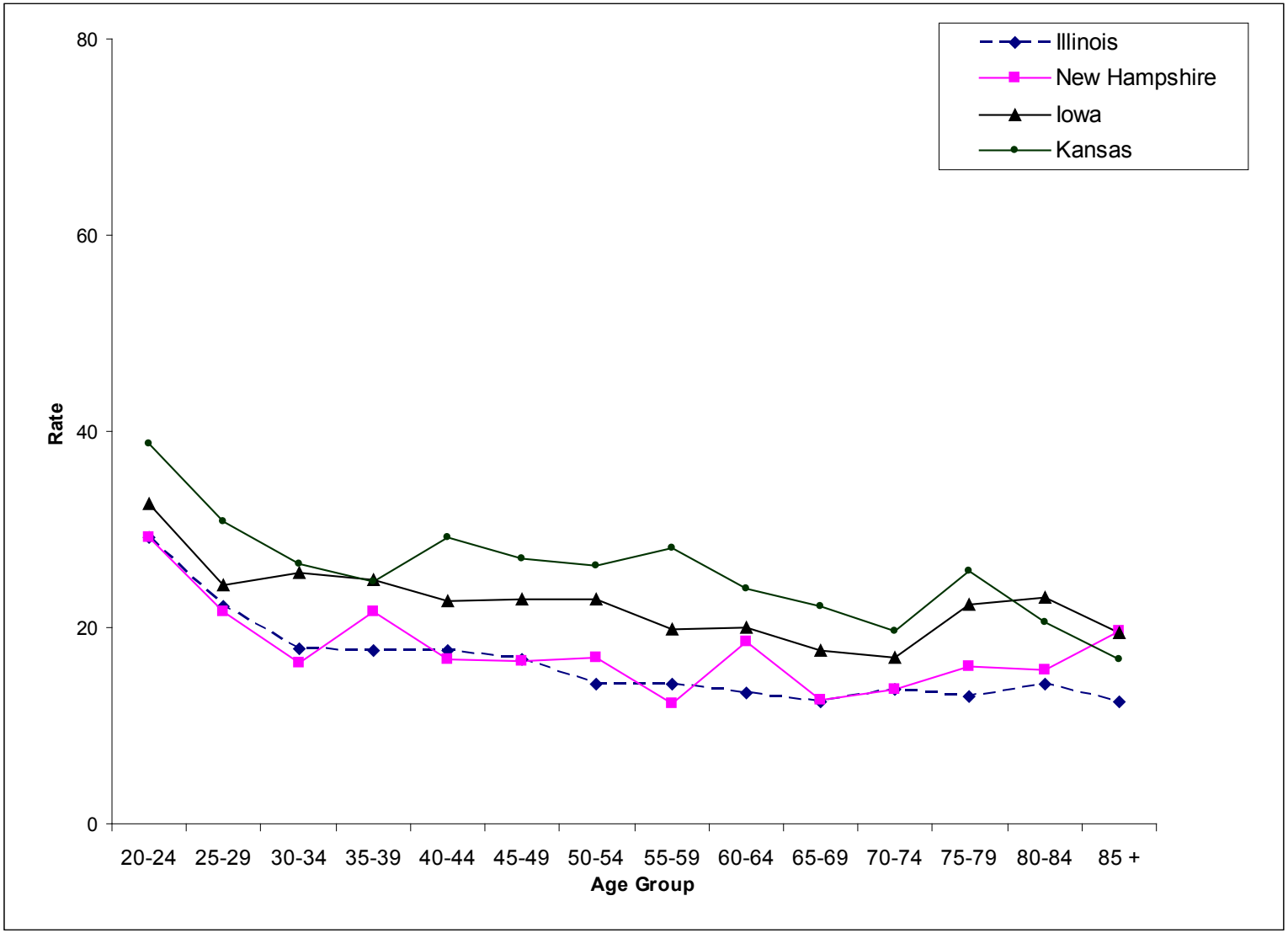
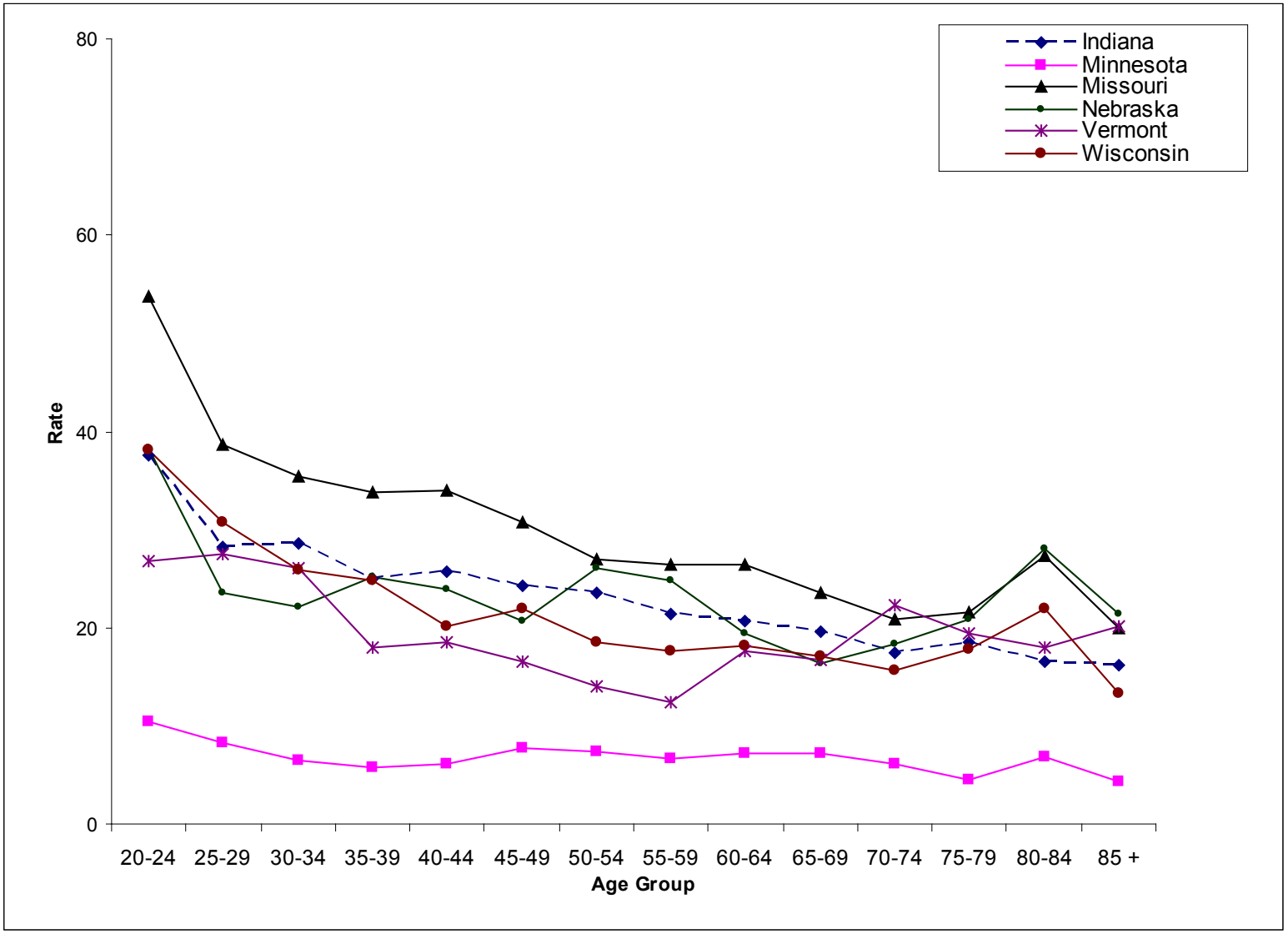


Figure A-38. Comparison States: Driver Fatalities per 100,000 Population



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