The Effect of State Regulations on Motor Vehicle Fatalities for Younger and Older Drivers: A Review and Analysis

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Motor vehicle fatalities in the United States have declined dramatically during the past two decades due to a number of factors, including technological improvements in vehicles and roadways, the increased use of seat belts, and a decrease in alcohol-impaired driving. This recent trend has been part of a gradual decline over the past 80 years, which led the Centers for Disease Control and Prevention (CDC) to identify motor vehicle safety as one of the 10 great public health achievements of the 20th century (CDC 1999). Despite the positive steps made in this area, the motor vehicle death rate—and the death rate for younger and older drivers, in particular—continues to be an area of concern for policymakers (see figure 1).

Anyone who has purchased automobile insurance for a driver under 25 years of age knows that drivers in that age group are substantially overrepresented in motor vehicle crashes. In fact, motor-vehicle-related injury is the leading cause of death for people aged 1 to 24 in the United States (CDC 1997). The auto fatality rate for 16- to 20-year-old drivers is more than two to three times the rate for middle-aged drivers (U.S. Department of Transportation 2000). Furthermore, a high number of deaths occurs among teenage passengers of motor vehicles: In 1993,

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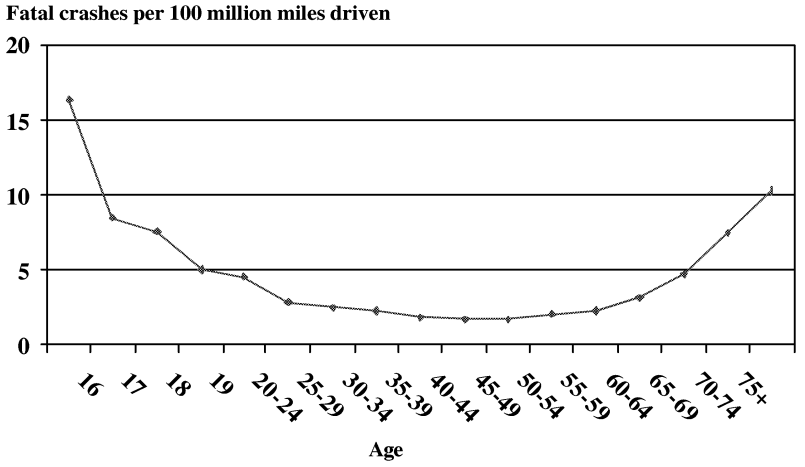

FIG. 1. Fatal crash involvement by age, 1995–1996. *Source:* National Highway Traffic Safety Administration (1998).

two-thirds of the deaths of passengers aged 13 to 19 occurred when other teenagers were driving (Williams and Wells 1995).

Although the popular press often portrays slow-driving elderly people as menaces on the road, safety problems posed by older drivers are less obvious and often differ from the popular perception. Elderly individuals represent the most rapidly growing segment of the driving population in the United States, both in the total number of drivers on the road and in the number of miles driven annually per driver. It is estimated that by the year 2024, one out of four drivers will be over the age of 65. Older drivers have higher crash rates per vehicle-mile traveled than all other age groups, except males aged 16 to 24, and these rates rise steadily after age 70. For every 100,000 miles driven, crash rates for older drivers are double those of middle-aged drivers. Because they are frailer than younger persons, two-car crashes are more likely to be fatal or cause serious injury for older drivers. Although the auto fatality rates per 100,000 population have fallen over the past 25 years for both young drivers (aged 16–20) and the driving population as a whole, the rate for older drivers (aged 75+) has increased 21 percent over this period (see figure 2).

Compared both with the rest of the population and with each other, the problems posed by these two age groups stem from different origins and are manifested in different ways. This paper first reviews the unique

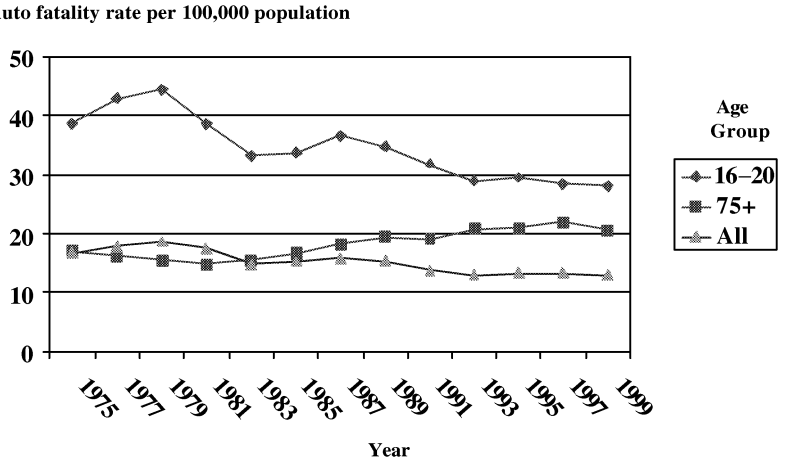

FIG. 2. Auto fatality rates, 1975–1999. *Source:* U.S. Department of Transportation (2000).

motor vehicle safety issues facing younger and older drivers. It then considers and reviews previous research involving six classes of state laws that may decrease motor vehicle fatalities in these populations.

Motor Vehicle Fatalities

The Case of Young Drivers

Several features distinguish automobile crashes in younger drivers: lack of skills, elevated risk taking, peer pressure, nighttime driving, and high rates of alcohol-impaired driving.

Early efforts to reduce young driver auto fatalities focused on education and skill building. Early National Highway Traffic Safety Administration (NHTSA) studies identified behaviors necessary to operate a passenger car, and assessed how critical each behavior was to driving (U.S. Department of Transportation 1993). This information was used to develop two model curricula for high school driver education, which were subsidized by grants from the federal Department of Transportation. Although high school driver education has been a fixture in many states since the 1970s, these education and training programs have demonstrated only limited success in reducing the unsafe driving

behaviors of young drivers (Vernick, Li, Ogatis, et al. 1999). The best evidence regarding driver education is based on a randomized controlled trial conducted in DeKalb County, Georgia, from 1978 to 1981, which found that driver education had no effect on motor-vehicle-related crashes or violations (Lund, Williams, and Zador 1986). The reasons why driver-education courses seem to have had only limited success as a crash reduction program are unclear (U.S. Department of Transportation 1993).

Young-driver safety stems from more than a lack of knowledge or skills. To quote an NHTSA Report to Congress (U.S. Department of Transportation 1993), "the apparent disregard for one's own personal safety appears to be a defining element of youth." The CDC's Youth Risk Behavior Surveillance System indicates that teenagers who do not wear their seat belts or who drive after drinking also tend to take other risks, such as smoking, drinking, using drugs, and fighting (Dee and Evans 2001). Three risky behaviors are associated with motor vehicle crashes among teenage drivers: driving 20 miles per hour over the speed limit, passing a car in a no-passing zone, and taking risks while driving in traffic because it makes driving "more fun" (CDC 1994). These behaviors are most common in male teenage drivers. Effective methods to restrain impulsive, risky behaviors have traditionally concentrated on law enforcement, license restriction or denial, or other aversive controls. The effect of these approaches is, of course, limited by the resources communities devote to them.

Peer pressure also plays an important role in motor vehicle crashes involving younger drivers. In a recent study of fatal crashes involving 16- and 17-year-old drivers, crashes were more likely to be fatal when the driver was in the presence of male (rather than female) passengers and passengers in their teens and twenties (Chan, Baker, Braver, et al. 2000). A survey of 192 high school drivers reported that dangerous driving behaviors (driving after drinking alcohol or using drugs, speeding, swerving, crossing the center line, purposely skidding, and running a red light) were strongly associated with the presence of peers (Doherty, Andrey, and MacGregor 1998). A similar, and perhaps related, finding is that teen traffic fatalities are concentrated during the nighttime. One-fifth of teen car-occupant fatalities happen on a Friday or Saturday night, compared to roughly one-sixth for all adults. Between the hours of 10 p.m. and midnight, 16- and 17-year-old driver death rates are nearly three times greater per trip (2.6 times greater when driving alone and

2.9 times greater when driving with a passenger) than during the hours from 6 a.m. to 10 p.m. (Chan, Baker, Braver, et al. 2000).

A significant portion of motor vehicle crashes involving teenage and young adult drivers relate to the use of alcohol. In 1994, the CDC reported that alcohol was involved (blood alcohol concentration $\geq$0.01 grams/deciliter) in 13.9 percent of all fatal crashes involving individuals aged 15 to 17, 27.1 percent for those aged 18 to 20, and 37.3 percent for those aged 21 to 24 (CDC 1995). For comparative purposes, alcohol was involved in 23.9 percent of all fatal crashes involving individuals aged 25 and older. As we note below, increases in the minimum drinking age, enactment of illegal blood-alcohol concentration laws, administrative license suspensions, and increased public health awareness have resulted in a decline in the proportion of alcohol-related motor vehicle fatalities for all age groups over the past two decades. Nevertheless, the high proportion of alcohol-related deaths involving young drivers highlights a need for additional research targeted specifically at young drivers.

The Case of Older Drivers

Older drivers face a contrasting set of risk factors for increased motor vehicle crashes and fatalities. Researchers have highlighted three primary areas of concern: deterioration in vision, a decline in cognition, and a loss of psychomotor skills.

Vision is inarguably a fundamental component of safe motor vehicle operation. Because visual-function problems and eye disease are more common in the elderly population, visual disorders are thought to be a major cause of driving problems for elderly individuals. Visual acuity is the most common visual-screening test used by state licensing agencies for the determination of driving fitness. Interestingly however, there is remarkable agreement among studies that visual acuity is only weakly associated with crash involvement and unsafe driving performance in elderly drivers. This finding has led some to question whether the current practice of visual-acuity screening at driver-licensing sites is effective in identifying those whose visual impairments elevate crash risk (Owsley and McGwin 1999). Although these acuity tests may still have an indirect positive effect, in that examiners may discover other problems at the time of the test, there is stronger evidence of the critical role of peripheral vision for safe driving. Ball and colleagues (1988) developed the "useful

field of view" test that assesses the visual field over which one can use rapidly presented information. Unlike conventional measures of visual field, which assess visual sensory sensitivity, the useful-field-of-view test relies on higher-order processing skills, such as selective and divided attention and rapid visual processing speed. Reduction in the useful field of view in older drivers has been shown to be associated with increased crash involvement (e.g., Owsley 1994). Visual attention skills and visual processing speed also show promise as ways to identify high-risk older drivers (Owsley and McGwin 1999). Other aspects of visual sensory impairment (disorders affecting contrast sensitivity, motion perception, eye movements, and binocular vision) have high face validity to the driving task but have not been sufficiently examined to permit firm conclusions about their roles in crashes.

Cognitive impairment, particularly when caused by a dementing illness, has been linked to higher motor vehicle crash rates in elderly individuals (Retchin and Anapolle 1993). Cognitive impairment rises with age and has its highest prevalence in later years. Cognitive functions related to driving include memory and attention, systematic scanning of the environment, other visual-spatial skills, verbal and other information processing, decision making, and problem solving (Colsher and Wallace 1993). Furthermore, these functions must be carried out in a dynamic fashion in response to both themselves and the environment. Alzheimer's disease is by far the most common cause for serious cognitive impairment in older individuals, with a prevalence estimated to be as high as 11.6 percent for those aged 65 and older and 47.8 percent for those over age 85 (Odenheimer 1993). It is not known what proportion of individuals with dementia drive, or what specific difficulties they encounter, but research suggests that it is common for demented persons to drive and that they are at substantially increased risk for crashes (Odenheimer 1993). Other research in the rehabilitation literature has focused on the relationship between cognitive deficits due to stroke and head injuries and impaired driving skills (DeMaria 1993).

Psychomotor slowing occurs routinely with age and may significantly affect the driving of elderly individuals (Retchin and Anapolle 1993). The reasons for this slowing are presently unclear but are probably a combination of peripheral and central processes. Psychomotor strength, too, appears to deteriorate with age and is also important for driving. Strength may be an important requisite even with power-assisted motor vehicle control devices, such as power brakes or steering.

Trunk stability, endurance, and coordination, all of which are affected by psychomotor weakness, are essential for holding and manipulating the steering wheel and brake pedal. Researchers have found a positive relationship between various diseases—such as arthritis (Roberts and Roberts 1993) and seizure disorders, diabetes mellitus, and cerebrovascular disease (Hansotia 1993)—and the crash involvement of elderly drivers. Additionally, the age-related decline in psychomotor function—including vision, attention, information processing, and psychomotor coordination—may increase the effects of medications on the central nervous system (Ray, Thapa, and Shorr 1993).

The prevalence of alcoholism is lower in elderly individuals relative to middle-aged persons, but vulnerability to harm is greater in elderly individuals due to both pharmacokinetic factors and increased tissue sensitivity (West, Maxwell, Noble, et al. 1984). Alcohol and aging have been found to be additive in their harmful effects (West et al. 1984). There has been limited work examining the role of alcohol in motor vehicle crashes among elderly drivers. Higgins and colleagues (1996) found that 14 percent of elderly drivers (and 21 percent of male elderly drivers) who were admitted to an urban Level 1 trauma center after a motor vehicle crash had a positive blood alcohol screen. Although more work in this area is needed, this result suggests alcohol use may play an important role in motor vehicle crashes among elderly drivers, particularly men.

It is important to note that many studies examining elderly drivers have failed to account for driving exposure—how much, where, and under what circumstances someone drives—in examining the role of visual, cognitive, and psychomotor impairment in driving. In conjunction with other life changes, such as retirement, drivers with these impairments often reduce their time on the road and avoid night driving and other challenging driving situations (such as rush hours).

State Regulation and Motor Vehicle Deaths among Older and Younger Drivers

Given the safety issues faced by older and younger drivers, states have introduced a number of regulatory initiatives to directly or indirectly promote safe driving practices. This section reviews the six primary classes of regulations and policies states employ to deter unsafe driving and also briefly discusses previous research examining their effect on

motor vehicle fatalities. Certain state-level policies (e.g., graduated licensing of teenage drivers and relicensing of elderly drivers) are directed specifically at either younger or older drivers. However, the other four policies (alcohol taxes, alcohol-control measures, speed limits, and seatbelt laws) potentially affect both age groups—and all other drivers, for that matter. We concentrate on these four policies because they are the four most prominent state-level regulations directed at lowering motor vehicle fatalities and, despite the important differences in motor vehicle fatalities across older and younger drivers, they are potentially and differentially important for each of these high-risk groups.

Graduated Driver-Licensing (GDL) Systems for Teenage Drivers

A state's driver-licensing system is the primary method of integrating new drivers safely into the highway network and limiting the driving of those who may pose safety problems. Traditionally, most states have employed a single-stage licensing system where individuals turning 16 or 17 years old can obtain full driving privileges. As mentioned above, there is no convincing evidence that high school driver-education courses reduce motor vehicle crash involvement for young drivers, at either the individual or community level (Vernick et al. 1999).

In an effort to better train young novice drivers, 32 states have recently enacted graduated driver-licensing (GDL) systems. These programs are very new to the United States, with only two states enacting GDL systems prior to 1997. GDL programs attempt to address a number of the risk factors for motor vehicle crashes in young drivers. GDL systems have three levels of licensure, designed to introduce teenage drivers, in stages, to the cognitively complex tasks of operating a motor vehicle. Under GDL systems, new teenage drivers must remain in each of the first two stages for a set minimum period of time. The first stage is a supervised learner's period. In the second stage, the driver is granted an intermediate license after passing a road test, in which unsupervised driving in high-risk situations is limited. The third stage grants the driver a license with full privileges, only after completion of the first two stages.

Only eight (of the 32) state GDL systems meet the Insurance Institute for Highway Safety's (IIHS) recommendation that learner's permits be available no sooner than age 16. Only seven state GDL systems meet the IIHS recommendation of waiting to grant full licensure until age 18,

with the other 25 granting licenses prior to age 18. In all states with GDL systems, the first stage requires supervision at all times by an experienced older driver. The third stage, by contrast, has few restrictions, if any. However, there is substantial variation in state requirements for the second stage. Key elements of the intermediate stage may include limits on late-night unsupervised driving and transporting teenage passengers at night. All GDL programs allow unsupervised driving during the day and early evening. However, eight state GDL programs allow teenage drivers to drive as late as 1 a.m. (see figure 3). Another second-stage restriction is a limit on the number of passengers riding with the novice driver. The IIHS recommends no more than one teenage passenger in the vehicle during this intermediate stage; only 13 states currently meet this standard.

GDL systems are relatively new in the United States. However, international studies have suggested that they decrease fatal motor vehicle crashes among new drivers (e.g., Langeley, Wagenaar, and Begg 1996). Within the United States, there have been studies of either a general curfew or a nighttime driving restriction for teens. In a review of four such studies, Foss and Evenson (1999) found substantial reductions in crashes during restricted hours, with 23 to 25 percent lower crash injury and fatality rates for curfews beginning before midnight in three of the studies. A potential limitation of these studies is the assumption that the effects of these curfew laws can be identified by comparing teenagers who reside in states with different laws. If these laws are correlated with

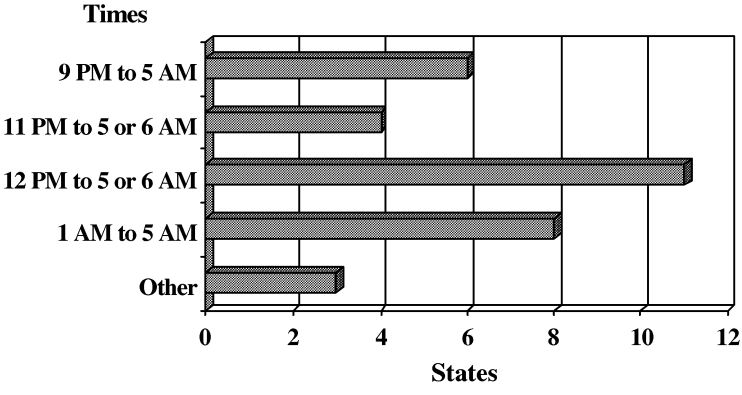

FIG. 3. Prohibited Driving Hours in Graduated Licensing Programs. *Source:* Insurance Institute for Highway Safety (2000).

unobserved attributes that also influence fatalities, such as public sentiment, the cross-state variation in the policies may not provide a valid "natural experiment."

In one of the few U.S. studies directly examining a "full" GDL system to date, Ulmer and colleagues (2000) compared data from Florida, which instituted a GDL program in 1996, with similar data from Alabama, a state that borders Florida but did not have a GDL system in place. Using 1995–1997 data, there was a 9 percent total reduction in crashes for 15- to 17-year-olds in Florida, but no such reduction in Alabama. Interestingly, the decrease in Florida crashes was greatest for 15-year-olds (19 percent) and lowest for 18-year-olds (0 percent). This result raises serious doubts about the overall efficacy of age-specific regulations such as a GDL system (Dee and Evans 2001). Driving is an activity where experiential learning is likely to be important. If "learning by doing" is essential, this raises the possibility that from a lifetime perspective, the efficacy of GDL systems may be minimal. More specifically, GDL systems, which keep younger teenage drivers away from potentially risky situations, may simply shift the attendant mortality risks to the age at which they are exposed to those situations. Although no direct empirical evidence exists to support this conjecture, any study evaluating the effectiveness of a GDL system in lowering motor vehicle fatalities should consider both the fatality rate of new drivers (16- and 17-year-olds) and that of recently trained drivers (18- to 20-year-olds). As we acquire more experience with GDL systems across states, we will be able to construct intrastate comparisons using multiple years of data across a range of age groups.

Driver's-license-renewal Policies for Older Drivers

State driver's-license-renewal requirements for elderly drivers are public policies that can have a direct effect on traffic safety. Currently, states employ a number of different renewal procedures for older drivers. These procedures may include accelerated cycles that mandate shorter renewal intervals for drivers older than a specified age, typically 65 or 70. Currently, 12 states have such accelerated renewal procedures (see figure 4). Additionally, states may require that elderly persons renew their licenses in person, rather than electronically or by mail where remote renewal is

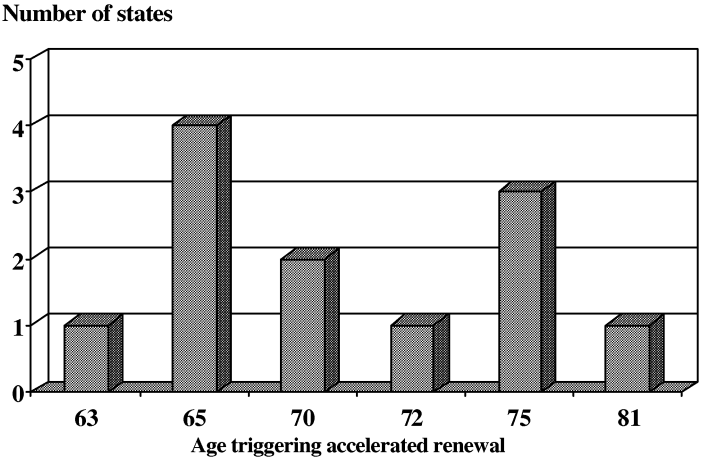

FIG. 4. Accelerated renewal for seniors. *Source:* Insurance Institute for Highway Safety (2000).

permitted, and require tests that are not routinely required of younger drivers such as vision and road tests. These special renewal procedures for older drivers apply in addition to the license-renewal procedures that exist in all states for dealing with licensed drivers of any age who no longer meet the standards for licensure because of physical or mental infirmities.

In addition to special renewal procedures for elderly drivers, a person's continued fitness to drive may be questioned because of his or her appearance or demeanor at the renewal, because of a history of crashes or violations, or because of reports by physicians, police, and others. The licensing agency may require these renewal applicants to undergo physical or mental examinations or retake the standard licensing tests (i.e., vision, written, and road). States typically rely on medical review boards, composed of health care professionals, to advise on licensing standards and on individual cases in which a person's ability to drive safely is in doubt. After reviewing an applicant's fitness to drive, the licensing agency may allow the person to retain the license; may refuse to renew the license; or may suspend, revoke, or restrict the license. Typical restrictions prohibit nighttime driving, require the vehicle to have additional mirrors, or restrict driving to specified places or a limited radius from the driver's home. Because skill deprivation may be rapid for some older individuals (e.g., following a heart attack or stroke), driving problems

may be detected more promptly with frequent testing. Where the renewal cycle is not shorter for older drivers, licensing agencies still have the authority to shorten the renewal cycle for individual license holders if their condition warrants.

A few studies have examined the effect of driver's-license-renewal policies on traffic fatalities among the elderly. Nelson and colleagues (1992) found lower fatal-crash involvement among older drivers in selected states that mandated vision tests at license renewal. Similarly, Levy and colleagues (1995) found that state-mandated tests of visual acuity, adjusted for license-renewal period, were associated with lower fatal-crash risk for older drivers, but that knowledge tests, when added to vision tests and applied only to older drivers, provided a nonsignificant reduction in fatal-crash risk. Although both of these studies indicate some safety gains with more comprehensive licensure policies for elderly drivers, the plausibility of these results—and their implications for public policy—depend critically on the quality of their research design. An important feature of both of these studies is the assumption that the policy responsiveness of elderly-driver licensure laws can be effectively identified by comparing elderly individuals who reside in states with different laws. In a study that made use of intrastate (rather than cross-state) variation, Kelsey and colleagues (1985) found little effect of increased testing for elderly (aged 70+) drivers. The authors constructed a randomized study of older clean-record drivers in California and found that crash rates were similar across a renewal-by-mail group and a control group, which underwent annual written and vision renewal tests, over four years of follow-up. Although the authors did not report the numbers who applied and were denied licenses across the two groups, drivers (of all ages) in the renewal-by-mail group had more valid licenses but fewer vision restrictions and limited term licenses at follow-up at both 18 and 36 months. Further research is clearly necessary to examine the effect of renewal policies on motor vehicle fatalities for older drivers.

Mandatory Seat-belt-use Laws

Laws that reduce harm from risky behaviors or declining skills may be especially important for young and old drivers. Early estimates indicated that proper use of automobile seat belts reduced the risk of serious injury or death in traffic crashes by 30 to 50 percent (Wagenaar and Wiviott 1986). In a recent study, Levitt and Porter (1999) argued that these

estimates may be biased downward because systematic crash data are collected only when a fatality occurs. Because seat-belt and air-bag use influences survival rates, which in turn determine whether a crash is included in the sample, these data suffer from sample selection. By limiting their study sample to crashes in which someone in a different vehicle dies, the authors provide estimates suggesting that the actual risk reduction associated with seat belts is 60 percent. Regardless, it was in part due to a growing awareness of these dramatic lifesaving benefits that states began enacting mandatory seat-belt-use laws in the mid-1980s. Currently, every state (except New Hampshire) and the District of Columbia have mandatory seat-belt-use laws. In most states, the laws cover front-seat occupants only, although belt-use laws in 13 states cover rear occupants. In only 18 states are belt-use laws standard, or primary, meaning that police may stop vehicles solely for belt-law violations. Police authority to enforce belt laws in other jurisdictions is limited to secondary enforcement. This means officers must have some other reason to stop a vehicle before citing an occupant for failing to wear a seat belt. The maximum fine for a first offense ranges from $5 to $75 across states (see figure 5). In 17 states, a "safety-belt defense" is allowed in civil-court cases whereby the damages collected by someone in a crash may be reduced for failure to use a belt. The reduction is permitted only for injuries caused by nonuse of belts and, in some states, may not exceed a fixed percentage of the damages.

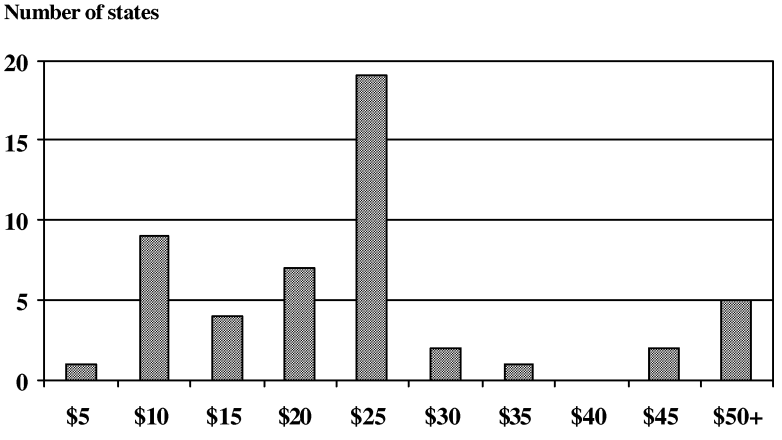

FIG. 5. Maximum fine for failure to use front seat belt. *Source:* Insurance Institute for Highway Safety (2000).

Mandatory seat-belt-use laws have been shown to increase the use of seat belts. Early studies, which compared pre- and postlaw belt use in various states, found that belt use rose 34 to 38 percentage points after a primary law went into effect (Wagenaar and Wiviott 1986; Evans and Graham 1991). More recent evidence (Dee 1998) has shown that this earlier literature may have overestimated the law's effect by confounding the advent of the law with other independent, time-varying determinants of belt use. During the period in which states were adopting seat-belt laws, there was also wide dissemination of information regarding the lifesaving benefits of seat belts. Thus, these early estimates of the effect of seat-belt laws may be biased upward because they do not distinguish the timing of the laws from the overall trend toward increased use nationally. By conditioning on the unobserved time-varying determinants of belt use, Dee (1998) found that seat-belt use rose by 26.2 percentage points in primary-enforcement states and by 17.2 in secondary-enforcement states.

Despite the lifesaving benefits and increased use of seat belts, several factors suggest that the gains from these mandatory belt-use laws may be sharply attenuated. First, there may be an issue of selection bias whereby safer drivers are those most likely to respond to these laws. If so, one would see a smaller response in belt use among those most likely to be in motor vehicle crashes. Dee (1998) presented evidence in support of this argument. He found that belt use has been significantly lower among males, drinkers of alcohol, and young drivers. Furthermore, there is the possibility of risk-compensating behavior. Peltzman (1975) demonstrated that the potential gains from safety policies—such as mandatory seat-belt-use laws—will be reduced if drivers subsequently increased their risk-taking behaviors behind the wheel. However, several papers have tested Peltzman's risk-compensation hypothesis and have found that such behavior has not attenuated the benefits of seat-belt-use laws (Evans and Graham 1991; Dee 1998).

There has been only limited work examining the effect of mandatory belt-use laws on teenage-driver fatalities. A study by Dee and Evans (2001) found that a seat-belt law with primary enforcement significantly reduced passenger-vehicle fatalities among 16- to 17-year-olds by nearly 8 percent and among 18- to 19-year-olds by almost 10 percent. In general, these results were shown to be smaller in those states that only had secondary enforcement for their seat-belt laws and substantially larger among female teens.

We are not aware of published work examining the effect of these laws on elderly-driver fatalities. Because older drivers suffer more serious injuries in crashes than do younger drivers, seat-belt use may be differentially beneficial to older drivers. Furthermore, we are not aware of work that considers the effects of mandatory seat-belt-use laws on traffic fatalities with the recent growth in the use of safety air bags within motor vehicles.

Although a great deal of research has examined seat-belt laws and driver fatalities, there is surprisingly little recent work examining the effect of other vehicle laws on younger- and older-driver safety. A majority of states have experimented with mandatory safety inspections for motor vehicles. In reviewing the early literature in this area, Thompson (1985) argued that the best available econometric evidence suggested that while vehicle inspection programs can reduce crash rates, they have not been effective as implemented. Furthermore, inspection programs have been criticized for their high cost (e.g., Thompson 1985) and the susceptibility of inspectors to consumer "influence" (e.g., Hubbard 1998). This area warrants further research, given the lack of more recent rigorous econometric studies.

Maximum-speed-limit Laws

Vehicle speed is a particular risk factor for inexperienced drivers, drivers attracted to risky behaviors, and drivers with declining skills. In response to the OPEC oil embargo, a National Maximum Speed Limit (NMSL) of 55 miles per hour (mph) was established in the early 1970s. Over the last two decades, there have been two primary changes in these laws. The first occurred in 1987, when the NMSL was relaxed and most states (38 states in 1987 alone) raised the speed limit from 55 to 65 mph on portions of their rural interstate highways. The second shift occurred in 1995 when Congress repealed the NMSL and 44 states once again raised their speed limits. Today, Hawaii is the only state with a 55 mph speed limit on rural interstates. Many states now have 70 mph speed limits, with a few as high as 75 mph (see figure 6).

Several studies have investigated whether increased maximum speed limits have affected the number of motor vehicles crashes and fatalities. Using 1976–1988 data from the Fatality Analysis Reporting System (FARS), Garber and Graham (1990) estimated that an increase in the speed limit to 65 mph resulted in 15 percent more fatalities on rural

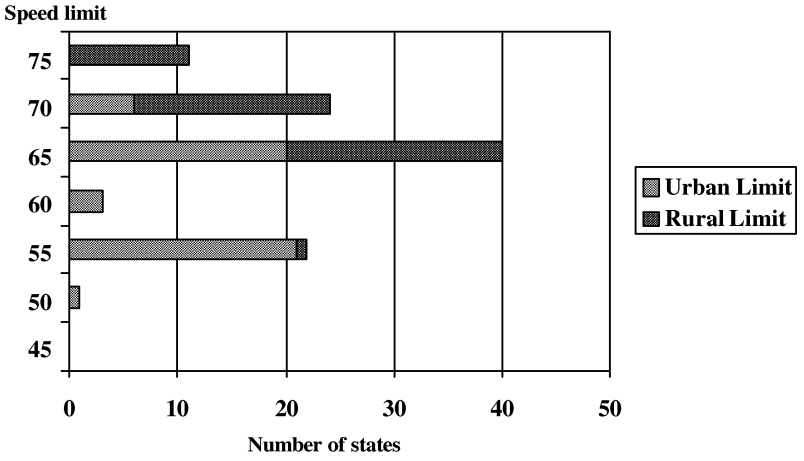

FIG. 6. Maximum interstate speed limits. *Source:* Insurance Institute for Highway Safety.

interstates and 5 percent more on rural noninterstates. A similar study conservatively estimated fatalities on rural interstates to be 15 percent higher than they would have been if the states had retained the 55 mph limit (Baum, Lund, and Wells 1989). Using more recent data that examined the 1995 repeal of the NMSL, fatalities on interstates increased 15 percent in the 24 states that raised speed limits (Farmer, Retting, and Lund 1999). After accounting for changes in vehicle-miles of travel, fatality rates were 17 percent higher following the speed-limit increases. In an analysis specific to young-driver fatalities, however, Dee and Evans (2001) did not find a statistically significant effect of the initial move to 65 mph speed limits.

Significantly, maximum-speed-limit laws may increase not just the average speed but also the variance of speed among drivers. Lave (1985) and Forester and colleagues (1984) were among the first to argue that variation in driving speeds (i.e., many fast drivers, many slow drivers) also causes fatalities by creating more vehicle overtakings and thus more opportunities for collision. The important role of speed variation is confirmed across a number of studies utilizing a range of model specifications (Fowles and Loeb 1989; Levy and Asch 1989; Snyder 1989; Zlatoper 1991). A limitation of several of the maximum-speed-limit studies cited above is that they do not incorporate speed variance into the analysis.

Another criticism of many of the maximum-speed-limit studies is that they examine only the direct effects of these speed-limit changes. There may be systemwide or statewide effects that these studies miss. For example, the new speed-limit laws may allow highway patrols to shift their resources from speed enforcement on the interstates to other safety activities and other highways. Similarly, the chance to drive faster on the interstates may attract drivers away from other, more dangerous roads, again generating systemwide consequences. One study that attempted to control for these systemwide effects found that fatality rates actually declined by 3.4 to 5.1 percent with the increase in speed limits from 55 to 65 mph (Lave and Elias 1994).

Although there has been limited work examining the effect of speed-limit laws on younger drivers, we are not aware of any published work examining the effect of these laws on elderly-driver fatalities.

Alcohol-control Laws

Alcohol is involved in a significant portion of motor vehicle fatalities and is subject to age-related regulation. During the past two decades, federal and state legislators have undertaken a number of efforts to decrease alcohol-related traffic fatalities by passing strict regulations aimed at reducing alcohol-involved driving. For example, the Federal Alcohol Traffic Safety Act of 1983 provided incentives for states to enact stringent drunk-driving laws, and the Uniform Drinking Act of 1984 included provisions for withholding a portion of federal highway funds from states failing to raise their minimum legal drinking age (MLDA) to 21. By 1988, every state had mandated a MLDA of 21, and all states (except Massachusetts) and the District of Columbia currently have "per se" laws deeming it a crime to drive with a blood-alcohol concentration (BAC) at or above a prescribed level. Drivers convicted of alcohol-impaired driving face the suspension or revocation of their driver's license in the majority of states. Additionally, 41 states and the District of Columbia have administrative license suspension, in which licenses are taken before conviction if the driver's BAC exceeds a specified level or if the driver refuses to take a chemical test. These administrative license suspensions, which can range up to a year in length, are immediate and independent of criminal procedures (see figure 7).

A range of other alcohol-control measures are currently in use by various states, including the authorization of police to administer roadside

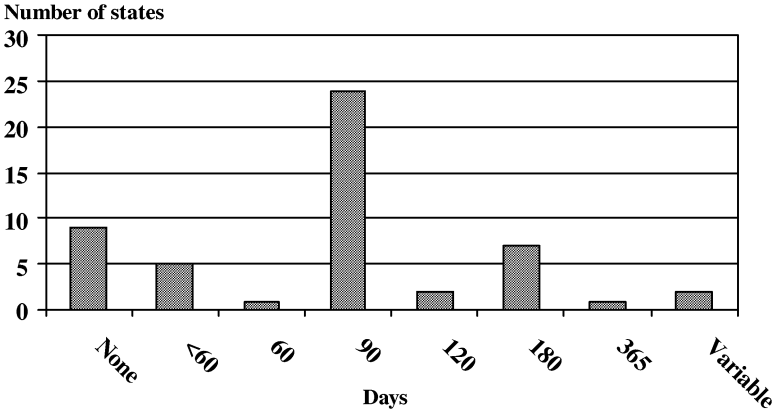

FIG. 7. Length of administrative license suspension, DWI/DUI first offense. *Source:* Insurance Institute for Highway Safety (2000).

breath tests for alcohol, mandated minimum jail sentences or community service for driving under the influence (DUI), authorization of lawsuits against alcohol servers (dramshop laws), required license sanctions for drivers who refuse to submit to alcohol testing (implied-consent laws), ignition interlocks that analyze a previously convicted driver's breath and disable the ignition if the driver has been drinking, vehicle forfeiture for multiple offenders, and the prohibition of open containers of alcohol in passenger sections of motor vehicles. In the 1990s, several states enacted a BAC level of 0.08 percent (the previous standard was 0.10 percent in most states), increased use of administrative per se laws, and mandatory fines for the first DUI conviction. In 2000, Congress enacted legislation making a BAC level of 0.08 percent the national standard. Additionally, all states have now adopted "zero tolerance" laws that make it illegal for underage drivers to have any positive BAC. There are also a variety of efforts under way to target illegal purchases of alcohol by minors, including "responsible hospitality" programs, "sting" operations, and mandatory loss of one's driver's license.

There is a large literature examining the effect of alcohol-related laws on motor vehicle fatalities. Before we review these studies, it is important to point out several criticisms that apply to many of the early studies in this area. First, some of the studies relied on cross-state comparisons of alcohol policies and motor vehicle fatalities, which may produce biased estimates due to unobserved characteristics that are correlated with

cross-state variations in alcohol policies. A second source of potential bias is the failure of some studies to analyze all the relevant alcohol policies. For example, some of the early studies investigate the effect of MLDA laws without controlling for liquor prices or any other DUI legislation. Finally, traffic fatalities fluctuate with economic conditions, but many early studies did not adequately control for the macroeconomy.

Given these methodological issues, evidence from the early literature in this area should be interpreted with some caution. More rigorous studies of teenage motor vehicle fatalities have provided clear evidence with respect to certain alcohol-control policies but are inconclusive in regard to others. The majority of studies find a strong inverse relationship between legal drinking ages and motor vehicle fatalities (e.g., Cook and Tauchen 1984; Evans, Neville and Graham 1991; Chaloupka, Saffer, and Grossman 1993; Ruhm 1996; Dee 1999). Similarly, most available evidence suggests that administrative per se laws and dramshop laws reduce teenage motor vehicle fatalities (Chaloupka, Saffer, and Grossman 1993; Kenkel 1993; Ruhm 1996). One study also found mandatory jail sentences for a DUI conviction to have a deterrent effect in (Kenkel 1993), but other studies have not found such an effect (Chaloupka, Saffer, and Grossman 1993; Evans, Neville, and Graham 1991). Preliminary breath-test legislation (e.g., Kenkel 1993), sobriety checkpoints (e.g., Kenkel 1993), and anti-plea-bargaining statutes (e.g., Chaloupka, Saffer, and Grossman 1993) were found to reduce predicted teenage traffic deaths in one or more studies. Other studies, however, failed to control for these policies or did not find any impact on traffic deaths. We are not aware of published work examining the specific effect of these alcohol-control policies on elderly-driver fatalities. Given people's reduced tolerance for alcohol with advancing age, and the aging of the baby-boom generation, such studies take on much greater importance.

Alcohol Taxes

In contrast to the number of alcohol-control laws passed in the last two decades, there has been a decline in real alcohol taxes over the last half-century. At higher prices, individuals—and especially younger individuals—have been shown to consume lower amounts of alcohol (Cook and Moore 2000). Typically, alcohol taxes are unit taxes, defined in terms of volume rather than the value of the product, and legislated increases have not kept up with inflation. For example, the federal tax

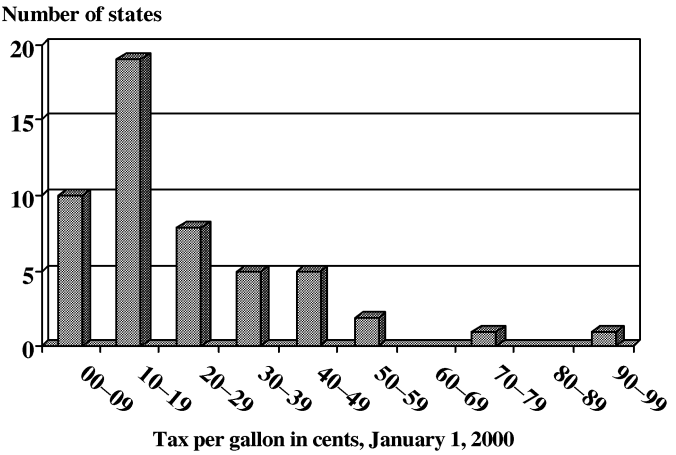

FIG. 8. State beer excise tax rates. *Source:* Federation of Tax Administrators (2000).

on distilled spirits in 1998 was about four times lower than it was in 1951, after accounting for inflation (Cook and Moore 2000). Additionally, there is substantial variation across states in alcohol taxes. State excise-tax rates per gallon of beer range from 2 cents in Wyoming to 92 cents in Hawaii (see figure 8). Researchers have used this interstate variation to examine the effect of alcohol taxes on the number of motor vehicle fatalities.

Alcohol taxes influence traffic fatalities—if at all—through their effect on drinking. A series of steps must occur in order to link alcohol taxes with lower motor vehicle fatalities (Cook and Moore 2000). First, increased excise taxes on alcoholic beverages must reduce their consumption. Second, a reduction in average consumption of alcohol must reduce the prevalence of impairment. Next, a reduction in the prevalence of alcoholic impairment must reduce the prevalence of driving while impaired. And finally, a reduced prevalence of driving while impaired must reduce the motor vehicle fatality rate. If any of these steps breaks the link, there will be no effect of alcohol excise taxes on motor vehicle fatalities.

Rather than estimating each of these four structural relationships (which would be subject to large errors in measurement), researchers have concentrated on estimating a "reduced form" model, which examines the effect of alcohol taxes directly on traffic fatalities using state-year panel data. Several studies have examined the total fatality rate (e.g, Chaloupka, Saffer, and Grossman 1993; Ruhm 1996; Benson, Rasmussen, and Mast

1999), while others have isolated the motor vehicle death rate for teenage drivers (e.g, Saffer and Grossman 1987; Ruhm 1996; Dee 1999). We are not aware of any work examining the effect of alcohol taxes on elderly-driver fatalities. The early studies of teenage drivers (e.g., Ruhm 1996; Saffer and Grossman 1987) concluded that fatalities declined when beer taxes were increased. The magnitudes of the results from these studies were quite large. Saffer and Grossman (1987) and Ruhm (1996) found that the elasticity of the motor vehicle fatality rate with respect to the real beer tax was –0.17 among 18- to 20-year-olds. In other words, a 10 percent increase in beer tax was estimated to decrease motor vehicle fatalities in this age group by 1.7 percent.

Several more recent studies have not found support for this link between excise taxes and motor vehicle fatalities (e.g., Dee 1999; Benson, Rasmussen, and Mast 1999; Mast, Benson, and Rasmussen 1999). These studies have argued that the findings from the earlier literature are implausibly large because beer taxes account for a relatively small portion of the overall price of alcohol (roughly 10 percent), and heavy drinkers are the least responsive to prices. Part of the problem with the early literature is that some of the studies relied on cross-state comparisons that may have been biased. Additionally, those studies that relied on intrastate comparisons may not be reliable because states have seldom changed their taxes. The implausibility of the traditionally estimated tax elasticity of youth traffic fatalities was illustrated by Dee (1999), using a counterfactual analysis that compared models of nighttime fatalities to those that occur in the daytime. The author was able to replicate the result from the earlier literature using daytime traffic fatalities even though a substantially smaller proportion of fatal crashes that occur during the daytime involve any alcohol. Thus, we are left with inconclusive evidence as to the true effect of alcohol taxes on motor vehicle fatalities.

Implications for Policymakers and Researchers

Lessons for Policymakers

Understanding the relationship between state laws and the safety of elderly and teenage drivers is fundamentally important to policymakers because, outside of direct enforcement, such policies are the primary means of improving safety on our roadways for these two high-risk groups.

Although technological improvements in vehicles and roadways, the increased use of seat belts, and a decrease in alcohol-impaired driving have contributed to an overall decrease in traffic fatalities over the last eight decades, the death rates for younger and older drivers—and the death rate for occupants of other vehicles in crashes caused by these drivers—continue to be elevated areas of concern for policymakers. The death rate for elderly drivers is likely to be of increasing concern in the next two decades as the baby-boom population ages. This review suggests several important lessons for state policymakers:

- The research on graduated driver-licensing (GDL) systems and youth motor vehicle fatalities indicates that certain risk factors are important toward explaining fatal crashes among teenage drivers. The presence of other teenagers in the vehicle and nighttime driving are both significant predictors of crashes within this age group. However, there is some doubt about (1) whether GDL systems simply shift motor vehicle fatalities up the age continuum and (2) whether variation in the design of these GDL systems affect the impact.
- The evidence on re-licensure laws for elderly drivers has been inconclusive as to the overall effect of these programs on motor vehicle fatalities. There is remarkable agreement among studies that visual acuity is only weakly associated with crash involvement. As such, the current practice of visual-acuity screening by state licensing agencies should not be viewed as an effective means of identifying high-risk older drivers. Policymakers will want to consider alternative tests that measure such aspects as peripheral vision, contrast sensitivity, motion perception, and visual processing speed. Given the rapidly growing number of older drivers, policies for assisting older drivers—and limiting their driving when appropriate—is a growing priority.
- Primary seat-belt enforcement laws, whereby police can stop vehicles based solely on belt-law violations, have been shown to be effective at lowering motor vehicle fatalities in younger drivers. Currently, only 18 states have primary enforcement of seat-belt laws in place. There is no evidence of the effect of differential monetary penalties on motor vehicle fatalities.
- A number of recent studies have found that higher maximum speed limits are associated with higher fatality rates. However, the

effect of these policies on younger and older driver fatalities is unclear.

- There is strong evidence across studies that increasing the minimum legal drinking age has decreased fatalities among younger drivers. However, whether these policies simply shift the fatality risk up the age distribution to drivers in their early 20s is unclear. Minimum-blood-alcohol concentration and dramshop laws have also been shown to be effective in this regard. The evidence for other DUI policies has been inconclusive.
- Beer taxes have had an inconclusive effect on traffic fatalities. Although some studies have found that increased beer taxes reduce auto fatalities, the limited intrastate variation over time in these taxes raises a question of the plausibility of these results.

It is also important to recognize that these laws and regulations impose costs on both the states and the individual drivers. Consider, for example, the case of license-renewal policies for elderly drivers. When licenses are denied, older individuals face the burden of restricted mobility, which may prohibit the performance of routine daily activities, opportunities for social interaction, and employment. This burden, as well as the societal costs of older-driver licensing policies (e.g., vision and road tests), should be weighed against any potential benefits of improved motor vehicle safety in determining the overall value of these policies (Miller and Levy 2000).

Directions for Future Research

We suggest three primary areas for future research. The first area involves a further examination of those policies where previous research has found inconclusive effects on motor vehicle fatalities. In particular, license-renewal tests for elderly individuals, maximum-speed-limit laws, and certain DUI policies (i.e., preliminary breath-test legislation, sobriety checkpoints, anti-plea-bargaining statutes, and changes in tort liability laws) did not have conclusive effects on motor vehicle fatalities across studies. GDL systems belong in this class, as well, given their recent enactment and varying form. Finally, researchers will need to identify some intrastate variation in beer taxes in future research to determine whether these taxes influence traffic fatalities.

The second area for future research involves addressing particular methodological issues from the existing literature. A number of studies analyze the effect on motor vehicle fatalities of a single policy in isolation of other state-level policies. Such studies may suffer from one or more types of omitted-variable bias. For example, attributing a decrease in motor vehicle fatalities to the implementation of primary seat-belt laws without also controlling for the maximum-speed-limit laws, DUI laws, and other policies may lead to erroneous conclusions. There currently is not a comprehensive study that examines all of these policies in a common framework.

As a similar methodological critique, the overall efficacy of each of these policies in reducing motor vehicle fatalities needs to be addressed. Many studies limit their specifications in analyzing the effect of a given policy on fatalities. A policy may have a certain effect in a limited specification of the model, but this effect may actually be the direct opposite in a more general specification. For example, GDL systems may decrease fatalities in 16- and 17-year-old drivers but, because of the shift in experiential learning, these policies may increase fatalities in 18- to 20-year-old drivers. Although no research with GDL systems has yet tested this hypothesis, an increase in the minimum legal drinking age has been shown to decrease alcohol-related deaths among 18- to 20-year-old drivers, but to increase deaths among 21- to 23-year-old drivers, presumably due to experiential learning (Males 1986; Asch and Levy 1990). As another example, policies that raise the maximum speed limit may increase highway fatalities but, because more drivers would then avoid more dangerous rural roads and highway patrols can shift their resources, overall fatality rates for the state may actually decline. These examples illustrate the need for researchers to think broadly about the positive and negative effects of these policies.

As a final methodological issue, interstate differences in motor vehicle fatalities are likely to be influenced by differences in difficult-to-measure characteristics such as road conditions, driving patterns, and social attitudes toward drinking (e.g., grassroots activities such as Mothers Against Drunk Driving). Many previous studies have ignored this heterogeneity across states, resulting in biased estimates when the unobserved factors are correlated with cross-state variations in these state-level policies. For example, if states with poor weather (and thus, more fatal crashes) also had the least-stringent alcohol-control policies, the studies would systematically overestimate the effect of the alcohol-control policies on the

fatal-crash rate. Future analyses will need to provide more fully specified models and better study designs to reduce bias in policy estimates.

A third priority for further research would address the general lack of work assessing the effectiveness of motor vehicle laws on elderly-driver fatalities. Given the aging of the U.S. population and the increase in older-driver fatalities per 100,000 population over the past 25 years, we need to focus greater attention on the elderly driver and what can be done to ensure their safety on the roads.

Conclusion

This paper has reviewed the unique risk factors associated with younger and older drivers and the effect of the six primary state-level policies toward lowering motor vehicle fatalities. These studies provide important lessons for policymakers and future directions for researchers. The downward trend in motor vehicle fatalities over the past 80 years has been truly remarkable. However, despite this overall trend, elevated rates of motor vehicle fatalities among teenage and elderly drivers continue to be an important area of concern for policymakers. Although further technological advances and increased public awareness are important toward addressing this issue, well-targeted public policies can also help to combat elderly and teenage motor vehicle fatalities.

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