Teens have the highest crash rate of any group in the United States.

Evaluation of New Jersey's Graduated Driver Licensing Program

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Abstract

Introduction: New Jersey has a licensing system that is unique in the United States. The licensing age is 17, compared with 16 in most states. New Jersey's graduated driver licensing (GDL) system, introduced in 2001, includes provisions for novices of all ages. Maryland is the only other state where GDL features apply to drivers older than 18. Moreover, New Jersey's system is one of the most comprehensive in the nation. Before 2001, a learner permit was available at age 16 and an unrestricted license at age 17. Beginning in 2001, the learner permit had to be held for at least six months, and the initial license included night and passenger restrictions for at least one year. Prior studies have shown that postponing licensure until age 17 provides a safety benefit. However, there has never been a comprehensive study of the combined effects of New Jersey's higher licensing age and strong GDL.

Methods: Driver crash rates per population for ages potentially affected by GDL were compared, pre- and post-GDL implementation, with those of an older age group (ages 25–59) that would not have been affected by GDL, using data on police-reported crashes of all severities from the New Jersey Department of Transportation and data on fatal crashes from the National Highway Traffic Safety Administration.

Results: After GDL implementation, there were statistically significant reductions in the crash rates of 17-year-olds, based on all crashes (16%), injury-only crashes (14%), and fatal crashes (25%), relative to those of drivers ages 25–59. The crash rates of 18-year-olds decreased significantly on the basis of all crashes (10%) and injury-only crashes (10%), relative to those of drivers ages 25–59. The fatal crash rate of 18-year-olds dropped by 4 percent. There was a statistically significant reduction in fatal crashes of 16-year-old drivers; however, this is unlikely to have been attributable to GDL.

Under GDL, all 17-year-old drivers and many 18-year-old drivers in New Jersey are subject to restrictions on driving at night and driving with more than one passenger. Significant reductions in nighttime crashes (of all severity levels) of drivers ages 17 and 18 were observed, as were significant yet smaller reductions in their daytime crash rates. Due to data limitations, crashes involving young drivers with passengers could only be analyzed using data on fatal crashes; reductions in fatal crashes of 17- and 18-year-olds carrying more than one passenger were sizable (23% and 24%, respectively) but were not statistically significant.

Discussion: New Jersey's combination of licensing policies for young drivers is a model for the nation. The licensing age of 17 eliminates most crashes at age 16. With respect

to population-based fatal crash involvement rates of 17-year-olds (relative to ages 25–59), New Jersey's national ranking dropped from 45th prior to having implemented GDL to 21st currently; for 16- and 17-year-olds combined, New Jersey ranks second behind the District of Columbia. To the extent that the relative inexperience of 17-year-old New Jersey drivers negatively impacts their crash rate compared with 17-year-olds licensed at 16, this effect appears to be largely blunted by the strong GDL system. New Jersey's GDL system also reduces crashes at age 18, an age group untouched by other states' GDL systems. Provisions introduced to strengthen the night and passenger restrictions, effective in 2010, will likely extend the substantial safety gains that have been achieved thus far.

Introduction

A primary function of licensing systems is to ensure that people allowed to drive on public roads are knowledgeable about traffic laws and can drive competently, demonstrating at least a minimally acceptable level of proficiency. However, licensing systems are not uniform across U.S. states or internationally. Great variation exists in the minimum ages at which driving is allowed, in education and training requirements, and in tests that must be passed to obtain a license.

Licensing Policies in the United States

Relative to the rest of the world, the United States historically has allowed early licensing with minimal requirements and easy tests. That situation prevailed for most of the 20th century, prior to the graduated driver licensing (GDL) movement that began in 1996. With 51 separate jurisdictions setting licensing rules, however, there was variation within this framework. A review of policies just prior to GDL illustrates the considerable differences that existed (Williams et al., 1996). Licensing ages as of 1995 ranged from 14 to 17. Whereas most jurisdictions offered regular (unrestricted) licenses at age 16, one state (South Dakota) licensed at age 14; six licensed at age 15 (South Carolina New Mexico, Hawaii, Montana, Louisiana, Idaho); one at 16 years, one month (Indiana); one at 16 year, 6 months (Massachusetts); and one at 17 (New Jersey).

In addition to differences in licensing ages, the ease of license acquisition varied across states. In 1995, prior to GDL, a learner's permit was a prerequisite for a license in only 30 states (Williams et al., 1996). In 19 jurisdictions, teens who had reached the minimum licensing age could obtain a license without ever having had a permit, although they would have needed a permit to drive legally prior to licensure. In some states not requiring a permit, the necessity of having one was waived for teens who had reached the minimum licensing age or were in a driver education program. Of the 30 states that required a permit, only 11 included a provision that it be held for a minimum period of time (hereafter referred to as *holding period*) before applying for a license. In seven states the required holding period was 30 days or less. One state specified 60 days; three required 90. Driver education was necessary for obtaining a license prior to age 18 in 26 states, but was optional in the others. Eight states imposed night driving restrictions for a period of time after initial licensure. In all other states, full driving privileges were available upon licensure. There was some limited variation in driving tests; in general, they were not difficult.

These licensing systems did little to address the primary risk factors that so strikingly elevate the crash risk of young novice drivers: youthful age and driving inexperience.

The Emergence of Graduated Driver Licensing

Despite laws allowing easy access to full licensure, undoubtedly many parents tried to make sure their sons and daughters were well practiced before taking the driving test, and attempted to keep them out of higher risk driving situations while they were gaining experience. In the early 1970s, a type of licensing system that would require everyone to take this path began to be discussed. This approach—graduated driver licensing—phases in full driving privileges over time, protecting novices while they are learning by limiting their exposure to specific risks. In practice, a GDL system consists of an extended learner period for supervised practice driving, augmented in many cases by a requirement that parents certify that a certain minimum number of hours of supervised driving have been completed, and restrictions on high-risk driving during the initial months of licensure. Typically, the restrictions pertain to late night driving and driving with young passengers, both of which are known high-risk activities for young novice drivers (Williams, 2003; Williams, Ferguson, & McCartt, 2007).

It makes sense to put novice drivers through this type of apprenticeship, in contrast to prevailing licensing systems that, as Waller (2003) noted, "violate everything we know about learning." This is particularly so because mistakes on the road can have serious consequences, involving injuries to both novices and others. Despite the logic of GDL, it took more than two decades to become popular. Many of the licensing provisions in place in the 1970s had existed without change since the beginning of the 20th century, when the U.S. was a more agrarian society with a limited vehicle population (Mayhew, Fields, & Simpson, 2000). The rationale for these licensing provisions was unclear, and their relevance in a more modern environment can be questioned, but there was little interest in changing the status quo. This was the case even though night restrictions, a central feature of GDL, were in place in a few states. The legislative history of night driving restrictions in states like Pennsylvania and New York is lost, and the circumstances of their introduction unknown, but their existence allowed study of their effects. A series of studies found that they were associated with significant crash reductions, were popular with parents, and accepted or at least tolerated by teens themselves (Williams & Preusser, 1997).

Despite this record, night restrictions and GDL in general were not popular in the 1970s, 1980s, and early 1990s. The National Highway Traffic Safety Administration (NHTSA) devised a model GDL system in the 1970s and offered states financial incentives to adopt it (Croke & Wilson, 1977). The model included parent-supervised driving practice, a program of license testing and certification geared to young beginners, a nighttime driving restriction, and a youth-oriented driver improvement program. Only California and Maryland elected to adopt versions of this system, which resulted in modest crash reductions (Hagge & Marsh, 1988; McKnight, Hyle, & Albricht, 1983).

The Modern Graduated Driver Licensing Movement

It was not until Florida introduced a GDL program in 1996 that the modern graduated driver licensing era began. Once started, GDL became a strong public health movement, as in a little over a decade all 51 jurisdictions in the United States adopted at least one of its central features (i.e., an extended learner phase as stage one, and nighttime and/or passenger restrictions as stage two). Many states have amended their original legislation one or more times, in most cases strengthening the requirements. As of September 1, 2009, 48 jurisdictions had both an extended learner period and night and/or passenger restrictions. Table 1 provides a comparison of key licensing provisions in place in 1995 and in 2009, illustrating the major changes that have taken place.

As in the case of pre-GDL licensing systems, there is great variation in the comprehensiveness of state GDL systems; some are still lacking key provisions. In others, they are present but weak, for example, night restrictions that do not begin until 1 a.m. In the rating system used by the Insurance Institute for Highway Safety (IIHS), 35 states are currently rated as “good,” 10 are “fair,” and 6 “marginal” (IIHS, 2009).

Table 1. Number of states with various licensing requirements, 1995 vs. 2009 (as of 9/1/2009).

Requirement	1995	2009
Learner period 6+ months	0	47
30+ practice hours certified	0	39
Night restriction	8	49
Passenger restriction	0	43

Evaluations of state GDL systems have found very positive effects. This is not unexpected, since GDL is a research-based policy, taking into account factors that increase or decrease crash risk among young beginners. The learner stage is known to provide a low-crash-risk environment (Gregerson, Nyberg, & Berg, 2003; Lam, 2003; Mayhew, Simpson, & Pak, 2003), and extending this period provides more time to practice and gain driving experience.

The extent to which increased practice driving in the learner period results in safer driving and fewer crashes has not been established. What has been established is that extended learner periods reduce crashes by delaying licensing beyond the age at which new drivers obtained their licenses in pre-GDL periods (Williams, 2007). The amount of delay depends on the minimum age at which a learner permit can be obtained, which varies from 14 to 16 in the United States, and the length of the required holding period. If, for example, the permit age is 16, and the permit must be held for a minimum of six months, this combination of policies *de facto* increases the licensing age to 16 years, 6 months. Thirteen states have GDL systems that delay licensing in this way. In another

16 states, the time between permit age and licensing age is equal to the required learner permit holding period, which also fosters delay in licensure. Even in states where the minimum holding period is much less than the time between permit age and licensing age, delay has been reported (Shope & Molnar, 2004). Night restrictions were known in pre-GDL times to reduce crashes, and that finding has been confirmed in modern GDL systems (Foss, Feaganes, & Rodgman, 2001; Shope & Molnar, 2004; Ulmer et al., 2000). Passenger restrictions in GDL systems independently reduce crashes (Chaudhary, Williams, & Nissen, 2007; Williams, 2007), and the presence of night and passenger restrictions results in teens having more time to mature and gain experience before being allowed full driving privileges.

Shope (2007) reviewed 27 GDL evaluations conducted since 2002, and the reported crash reductions, primarily pertaining to 16-year-olds, ranged from 20 to 40 percent. These evaluations included a broad geographic range of states, all rated good or fair in the IIHS's grading system. National studies have also found positive effects, the most positive outcomes occurring in states with the strongest systems (Chen, Baker, & Li, 2006; Baker, Chen, & Li, 2007). In the 2007 study, based on injury crashes in 35 states and fatal crashes in 43 states, states with the most comprehensive requirements in the learner stage and restricted license stage had fatal crash rates for 16-year-old drivers that were 38 percent lower and injury crash rates 40 percent lower than in other states. Another national study found that GDL systems with higher IIHS ratings were associated with greater reductions in fatal crash involvements of teen drivers; and nighttime driving restrictions beginning earlier and passenger restrictions allowing fewer passengers were found to be more effective than less restrictive requirements or no requirements (McCartt et al., 2009).

On a national basis, data from NHTSA and the U.S. Census Bureau indicate that there has been a 29 percent reduction in fatal crash involvements per capita for 16-year-olds between 1996 and 2007, and an 18 percent decrease for 17-year-olds, compared with much smaller reductions for older drivers, likely attributable in large part to the growing number of states with increasingly comprehensive GDL systems.

Graduated driver licensing is also very popular among parents (Williams, Nelson, & Leaf, 2002; Williams, Ferguson, Leaf, & Preusser, 1996). Under the lax state requirements that existed prior to graduated driver licensing, parents were on their own in terms of instituting and enforcing GDL-type rules. When states mandate a phased-in approach controlling exposure to risk, parents are empowered.

Graduated Driver Licensing in Other Countries

The United States is not the only country to have multi-phased licensing systems. New Zealand was actually the first country to introduce the type of graduated driver licensing conceived in North America, the distinguishing feature being an intermediate phase of licensure with significant restrictions on when and under what conditions novices can drive. In the 1970s and 1980s, when GDL was being rejected in the United States, New Zealand demonstrated that such a system could effectively reduce crashes and achieve wide popular acceptance (Begg & Stephenson, 2003). In Canada, North American-style graduated driver licensing began to be introduced in 1994 and now exists in every province and territory. Graduated driver licensing systems in Canada and New Zealand apply to novices of all ages. This is logical since graduated driver licensing is designed to deal with driving inexperience, beginners of all ages have elevated crash risk, and some novices are older. In contrast, U.S. GDL systems typically apply only to novices younger than age 18. In most U.S. states (New Jersey and Maryland excepted), new drivers 18 years or older are exempt from the GDL system, and if those in the GDL system turn 18 while still under driving restrictions, they automatically graduate to full-privilege driving.

Some European countries have systems with provisional stages (Organisation for Economic Co-operation and Development, 2006). Taking driver education and passing a driving test allows entry into this phase, and to advance to full driving privileges another round of training must be completed. Some Australian states have multi-phased systems. These typically have not included significant restrictions on driving during the intermediate phase, although in some cases there have been limitations on driving high powered vehicles or exceeding certain speeds. The effect of such restrictions is unknown (Ferguson, 2003). That situation is changing as some Australian states are now adopting their own versions of night and passenger restrictions (Senserrick, 2007). In countries around the world with differing licensing ages and requirements, it has been found that there is greatly magnified crash risk in the first few months immediately following licensure (Drummond, 2000; Laberge-Nadeau, 1998; Sagberg, 1998; Gregerson et al., 2000). This is when night and passenger restrictions, which have shown the ability to moderate risk, come into play. This has helped to make North American-style GDL attractive to other countries.

Some Australian states have quite elaborate graduated systems. For example, in New South Wales, a learner license is available at age 16. After a one-year period and a minimum of 120 hours of supervised driving, passing an on-road test allows entry to an initial provisional license stage (P1). During this period, a red *P-plate* must be affixed to the front and the rear of the vehicle, indicating to other road users and law enforcement officers that the operator of the vehicle is a novice driver, and the driver is not permitted

to exceed 90 km/hr even if the speed limit is higher. There are restrictions on mobile phone use, and only one passenger under age 21 can be transported between 11 p.m. and 5 a.m. After one year, advancement to a second provisional phase (P2) is allowed upon passage of a computer based hazard perception test. During this phase, a green P2 plate must be displayed, the driver is limited to maximum speed of 100 km/hr, and the nighttime passenger restriction is dropped. After two years, and passing an exit test assessing knowledge and hazard perception, a full license can be gained.

New Jersey's Licensing System

The excessively high crash rate of young novice drivers is a serious public health problem in every motorized country in the world. Thus, adopting successful policies from other countries, as Australia is doing, is a sensible way to proceed. The one U.S. state that blends licensing policies that are more popular in other countries is New Jersey. Around the world, licensing ages of 17 or 18 are the norm, but New Jersey is unique in the United States in having a licensing age of 17.

Why New Jersey adopted a licensing age of 17 is not known. Historical records note the minimum licensing ages in various states, but not the rationale for choosing one age in preference to another. Whatever the case, this policy has given New Jersey a safety advantage compared with states that license earlier. In New Jersey, learner permits are available at age 16. Crashes of 16-year-olds in New Jersey can involve learner drivers, 16-year-old New Jersey residents driving illegally, or 16-year-olds from other states driving in New Jersey. However, the overall crash rate of 16-year-olds in New Jersey is very low compared to the crash rates of 16-year-olds in neighboring states. A possible concern is the extent to which 17-year-olds in New Jersey might face an inexperience penalty, that is, that they might have higher crash rates than they would have had if they had been licensed at a younger age and accumulated more driving experience prior to age 17. Studies comparing the crash rates of young drivers New Jersey and in neighboring states licensing at age 16 have indicated that there may be a modest inexperience penalty at age 17 in New Jersey, but that the combined crash rate for 16- and 17-year-olds is far lower in New Jersey than in neighboring states (Williams, Karpf, & Zador, 1983; Ferguson et al., 1996).

In one such study, based on 1975–1980 data, the fatal crash involvement rate of New Jersey 16-year-old drivers was 4 per 100,000, compared with 26 for neighboring Connecticut, a 16-year-old licensing state. At age 17, per capita fatal crash involvement rates were somewhat higher in New Jersey than in Connecticut (46 vs. 40), although at age 18 they were slightly lower in New Jersey than in Connecticut. Assuming that the difference at age 17 is an inexperience offset, combining ages 16 and 17 resulted in a per capita rate substantially lower in New Jersey than in Connecticut (25 vs. 33). It was

estimated that Connecticut could realize a 66 percent reduction in fatal crash involvements of 16- and 17-year-old drivers by raising the licensing age to 17, assuming that Connecticut would have New Jersey's lower rate for 16-year-olds and higher rate for 17-year-olds. Other analyses found that New Jersey and Connecticut had similar rates of deaths in all other motor vehicle categories, primarily passengers, bicyclists, and pedestrians, suggesting that there was no substitution effect (Williams, Karpf, & Zador, 1983).

A second study of New Jersey's licensing law, based on 1988–1990 injury crashes of teens compared to adult drivers in the same state, substantiated the earlier findings. The per capita fatal and injury crash rate for 16-year-old drivers was 87 percent lower than that of drivers ages 25–59, whereas 16-year-olds in Connecticut had crash rates 56 percent higher than adults ages 25–59, and in Delaware, 73 percent higher. The rate for 17-year-olds was highest in New Jersey, but for ages 16 and 17 combined, the overall rate in New Jersey (34 percent higher than that of drivers ages 25–59) was still much lower than in Connecticut (82 percent higher than that of drivers ages 25–59) and Delaware (83% higher). There were negligible differences among crash rates for 18- to 20-year-olds in the three states (Ferguson et al., 1996).

Prior to 2001, a learner permit could be obtained in New Jersey at age 16, and an unrestricted license was available at age 17. On January 1, 2001 a graduated driver licensing system went into effect, featuring an extended learner permit, both nighttime and passenger restrictions, and a minimum age of 18 years for a full license. Notably, New Jersey is one of only two states to apply GDL to novices older than age 18. All novices in New Jersey are subject to GDL, although the learner period is shorter and night and passenger restrictions are waived for novice drivers age 21 and over. For novices ages 16 to 20, both the learner and the restricted stages have nighttime driving restrictions and passenger limits. For novices of all ages, the learner and restricted stages include a ban on cell phones and other electronic devices (effective 2/1/02), and a requirement that all occupants wear seatbelts. The specific GDL requirements in effect in New Jersey during the study period are listed in Table 2.

Presently, New Jersey is one of the 35 jurisdictions whose GDL system is rated as "good" in the IIHS's rating scheme. A "good" rating can be obtained by achieving a point count of at least 6 (out of 10) using the IIHS's scoring system, which is based on the jurisdiction's minimum age for a learner permit, duration of the learner period, requirement for supervised practice driving certification, and the strength and duration of night and passenger restrictions, as described in IIHS (2009). Two jurisdictions—Rhode Island and the District of Columbia—rank ahead of New Jersey, with 9 points each. New Jersey is tied for third with 13 other states having 8 points. Nineteen of the states with

GDL systems rated as “good” have 6 or 7 points, and the remaining 16 states have GDL systems rated as “fair” or “marginal.” Thus New Jersey is in the top tier in terms of GDL strength.

With its higher licensing age, strong GDL system, and the application of GDL to novices of all ages, New Jersey combines best practices from several countries. The studies assessing the effects of New Jersey’s higher licensing age were conducted many years ago, and have not been updated. There has never been a comprehensive study of New Jersey’s graduated driver licensing system and the combined effect of a higher licensing age and a strong GDL that applies to novices beyond age 18 (Williams, 2009). The present study was undertaken to assess the effects of this package of policies.

Table 2. New Jersey GDL requirements for 16- to 20-year-olds in effect during study period*

Special Permit/Examination Permit (Learner Stage)**
Minimum age 16 (with driver education)
Supervised driving with adult age 21 and older
No driving midnight–5 a.m. (11 p.m.–5 a.m. if age 16)
Passengers only from household plus one additional person
No cell phones, hand held video games, other electronics
Driver and all passengers must use seat belts
Practice for at least six months
Provisional (Restricted) License
Minimum age 17
Unsupervised driving allowed except midnight–5 a.m.***
Passengers only from household plus one additional person
No cell phones, hand held video games, other electronics
Driver and all passengers must use seat belts
Practice for at least one year
Basic (Unrestricted) Driver’s License
Minimum age of 18

*If the novice is age 21 or older, the minimum learner period is 3 instead of 6 months, and there are no passenger or hour restrictions. All other provisions apply.

**A special learner permit, requiring driver education, is available at age 16. An examination permit, not requiring driver education, may be obtained at age 17. Other requirements are the same except that the night restriction begins at 11 p.m. for special permit holders, and at midnight for those with examination permits.

***Exemption certificates for employment or religious reasons are available.

Source: State of New Jersey Motor Vehicle Commission

Methods

The basic study design involved comparing the crash rates of various age groups before and after the implementation of GDL in New Jersey, which occurred on January 1, 2001. To control for population growth, population-based crash rates were computed, using crash data (discussed below) and mid-year population estimates from the U.S. Census Bureau. To control for general trends in crashes in New Jersey, crash rates for age groups potentially affected by graduated driver licensing were compared with rates for an older age group (25–59) that would not have been affected by GDL. This is a standard research design that has been used in other studies of the effects of GDL (e.g., Foss, Feaganes, & Rodgman, 2001; Shope & Molnar, 2004). It was not possible to include neighboring states in the comparisons, as has been done in some other studies (e.g., Ulmer et al., 2000), because all candidate states themselves enacted and in some cases amended GDL legislation during the study period.

Crash involvements per population is the most appropriate outcome measure to capture both the effects of the GDL restrictions and any changes in the timing of license acquisition due to GDL. Crash rates per licensed driver could supplement the information based on per capita rates. However, licensure data were not available from New Jersey prior to 2006, and licensure data from the Federal Highway Administration have been found to be unreliable, especially for the youngest drivers (IIHS, 2007).

Two data sets were examined, the National NHTSA's Fatality Analysis Reporting System (FARS), which provides detailed information on fatal crashes on public roads in the U.S., and New Jersey data on all police reported crashes, available online from the New Jersey Department of Transportation since 1997. In New Jersey, crashes are reportable if they involve injury or vehicle damage in excess of $500, a requirement that has existed since 1994. Parallel analyses were conducted using all police-reported crashes, injury crashes, and fatal crashes.

Analyses of FARS data were straightforward. Comparisons were made based on all drivers of passenger vehicles in fatal crashes, drivers in crashes during restricted hours (midnight–4:59 a.m.) and unrestricted hours; and drivers with more than one passenger (restricted) and drivers with none or only one. Comparisons were made based on six pre-GDL years (1995–2000) and six post-GDL years (2002–2007). In the year in which the new GDL requirements initially took effect, some drivers in the applicable age groups would have been subject to the new licensing requirements while others would not have been. Thus, data for 2001 were not included, a customary procedure in GDL evaluations.

Analyses based on all police-reported crashes were not as straightforward. New Jersey officials advised that data quality prior to 2001 was questionable. Since those years constitute the pre-GDL period, this is obviously an issue. During these years, crash forms were not initially coded into a database, and subsequently, several years of crash forms were coded rapidly and added, which was suspected to have resulted in some coding errors. Data from 1997 were excluded as the file layout was different than for 1998–2000 and there was no translation guide. Inspection of the 1998–2000 data revealed the presence of many duplicates. The first instance of each duplicate case was kept and subsequent instances discarded. In some cases, the driver age coded in the database did not match the age calculated from the driver's date of birth and the crash date. Analyses used the calculated age instead of the age provided.

Data from the year 2006 was also identified as problematic. New Jersey officials explained that a new crash reporting form was introduced in this year, but many police departments had continued submitting reports using the old form. These were returned, and the police departments were asked to use the new forms, but the result was that the total number of reports was lower than expected.

Because of these issues, in analyses of all police-reported crashes and of injury crashes, the pre-GDL period was 1998–2000, and the post-GDL period was 2002–2005, again excluding 2001, the transition year.

The main effects of New Jersey's graduated driver licensing program would be expected at age 17. Even before the implementation of GDL, 16-year-olds in New Jersey were not eligible for licenses that allowed any unsupervised driving. Both before and after graduated driver licensing, learner permits were available upon reaching age 16 and permit holders were subject to a nighttime restriction (Williams et al., 1996). The only changes that GDL introduced for 16-year-olds were that the night driving restriction began at 11 p.m. instead of midnight, permit holders under GDL were subject to special seat belt requirements and restrictions on the use of cell phones and other electronic devices, and there was a ban on carrying more than one non-household passenger. Given that all legal driving by 16-year-olds in New Jersey would have to have been supervised by an adult both before and after GDL implementation, it is not expected that GDL implementation would significantly impact the crash rates of 16-year-olds in the present study. Effects at age 18 are possible, since the rules are applicable to all novices irrespective of age, and any driver who did not obtain his or her initial (restricted) license immediately upon reaching age 17 would still be subject to night and passenger restrictions upon reaching age 18 (i.e., for one full year after receiving the restricted license). Unfortunately, due to data limitations, it is not possible to determine

how many 18-year-olds in New Jersey have learner permits, how many have restricted licenses, and how many have unrestricted licenses. At ages 19 and 20, novices are also subject to the full set of GDL rules, but their numbers are likely to be negligible.

Driver crash rates per population were computed for ages 16, 17, 18, 19, 20–24, and 25–59. For drivers in fatal crashes the rates were computed per 100,000 population; for drivers in all police reported crashes, the computations were done per 1,000 population. Rate ratios were then derived by dividing the crash rate for each target age group by the crash rate of the reference group (drivers ages 25–59). *Z*-tests were used to evaluate the statistical significance of differences in rate ratios between the before and after periods (Ferguson et al., 1996; Ulmer et al., 2000).

Using 25- to 59-year-olds as a reference group deals with a potential problem in comparing pre- and post-GDL police-reported data, in that there was an average of about 66,000 more drivers in crashes per year in the post- than in the pre- period. About one-third of this is accounted for by missing or implausible values for birth dates in the pre-GDL period, and it is suspected that some crashes were missing altogether from the database. Assuming that such crashes are evenly distributed across all age groups, the analysis techniques used provide a valid test of the effects of GDL on teen crash rates.

Similar logic could have been applied in regard to the 2006 data. However, it is possible that the differential reporting across police agencies may have led to a bias in the proportion of crashes of drivers of different age categories that were missing from the database.

The same techniques were used to assess the effects of night and passenger restrictions. However, assessment of the passenger restriction could only be conducted using FARS data, because the data on non-fatal crashes did not include information on passengers who were not injured. This greatly reduced the statistical power to detect the effectiveness of passenger restrictions, as less than one of every hundred police-reported crashes in New Jersey is fatal.

Results

All Police-Reported Crashes

Tables 3 and 4 display data for all police-reported crashes and for injury-only crashes in New Jersey, from the data obtained from the New Jersey Department of Transportation.

Table 3. Pre- and post-GDL crashes, rates per 1,000 population, and rate ratios: All police-reported crashes

Driver Age	N	Rate	Rate Ratio†	N	Rate	Rate Ratio†	Change in Rate Ratio (Percent)
	Pre-GDL (1998–2000)			Post-GDL (2002–2005)			
16	1,676	5.23	0.11	3,044	6.50	0.11	0
17	43,911	138.69	2.86	63,192	138.57	2.39	-16**
18	36,964	122.45	2.52	58,072	131.86	2.27	-10**
25–59	595,742	48.55	1.00	996,352	58.00	1.00	–

† Rate ratio = crash rate of drivers of age in first column divided by crash rate of drivers ages 25–59.
***p* < .01

Table 4. Pre- and post-GDL crashes, rates per 1,000 population, and rate ratios: Injury crashes

Driver Age	N	Rate	Rate Ratio†	N	Rate	Rate Ratio†	Change in Rate Ratio (Percent)
	Pre-GDL (1998–2000)			Post-GDL (2002–2005)			
16	502	1.57	0.11	729	1.56	0.10	-6
17	13,322	42.08	2.86	17,354	38.05	2.45	-14**
18	11,779	39.02	2.65	16,351	37.13	2.39	-10**
25–59	180,593	14.72	1.00	266,805	15.53	1.00	–

† Rate ratio = crash rate of drivers of age in first column divided by crash rate of drivers ages 25–59.
***p* < .01

These data provided consistent results. For both all police-reported crashes and injury crashes, there were statistically significant reductions for 17-year-olds and 18-year-olds, with the stronger effect at age 17. Note that because of the smaller sample sizes in the pre-GDL data (due to apparent missing data), as well as the possibility that trends unrelated to GDL also influenced crash rates in New Jersey over the study period, the changes in the crash rates of teenage drivers should only be interpreted in relation to the change in the crash rate of the reference group. This is accomplished by comparing the pre- and post-GDL rate ratios. Changes in the population-based rates alone are not a good indication of the effects of GDL.

There was no evidence of any effect of GDL at age 16. As noted previously, drivers in New Jersey were not eligible to drive without adult supervision until age 17 even before GDL implementation, thus the GDL provisions introduced in 2001 were not expected to impact the crash rates of 16-year-olds significantly. At ages 19 and 20–24, there were small changes in population-based rates relative to ages 25–59. There was a 2 percent reduction in all police-reported crashes for both age groups, and a 1 percent reduction in injury crashes at age 19. There was no change in the injury crash rate of drivers ages 20–24 in relation to the reference group.

Table 5 displays data pertaining to crashes during hours restricted under GDL (midnight–4:59 a.m.) and unrestricted hours (5 a.m.–11:59 p.m.) separately. For ages 18 and 19, there were statistically significant reductions in crashes during both restricted and unrestricted hours in the post-GDL period. The decrease in crashes during restricted hours was greater than during unrestricted hours for both 17-year-olds (z = 10.18, $p < .01$) and 18-year-olds (z = 4.88, $p < .01$).

Table 5. Pre- and post-GDL crashes, rates per 1,000 population, and rate ratios: All police-reported crashes, restricted and unrestricted hours.

Driver Age	N	Rate	Rate Ratio†	N	Rate	Rate Ratio†	Change in Rate Ratio (Percent)
Restricted Hours (midnight–4:59 a.m.)							
	Pre-GDL (1998–2000)			Post-GDL (2002–2005)			
16	59	0.18	0.11	103	0.22	0.11	0
17	1,856	5.86	3.45	1,880	4.12	2.05	-40**
18	2,316	7.67	4.51	3,330	7.56	3.76	-17**
25–59	20,870	1.70	1.00	34,488	2.01	1.00	–
Unrestricted Hours (5 a.m.–11:59 p.m.)							
	Pre-GDL (1998–2000)			Post-GDL (2002–2005)			
16	1,606	5.01	0.11	2,918	6.23	0.11	0
17	41,737	131.82	2.84	61,007	133.77	2.41	-15**
18	34,368	113.82	2.45	54,458	123.65	2.22	-9**
25–59	569,429	46.41	1.00	955,523	55.62	1.00	–

† Rate ratio = crash rate of drivers of age in first column divided by crash rate of drivers ages 25–59.
**$p < .01$

Fatal Crashes

Table 6 displays data on fatal crashes in New Jersey, from NHTSA's FARS database.

Table 6. Pre- and post-GDL crashes, rates per 100,000 population, and rate ratios: Fatal crashes

Driver Age	N	Rate	Rate Ratio[†]	N	Rate	Rate Ratio[†]	Change in Rate Ratio (Percent)
	Pre-GDL (1995–2000)			Post-GDL (2002–2007)			
16	22	3.48	0.28	13	1.81	0.16	-43
17	176	28.41	2.27	136	19.38	1.71	-25**
18	183	30.91	2.47	180	26.75	2.36	-4
25–59	3,015	12.51	1.00	2,917	11.32	1.00	–

[†] Rate ratio = crash rate of drivers of age in first column divided by crash rate of drivers ages 25–59.
**$p < .01$

Table 6 shows a somewhat different pattern of results than the data based on police-reported crashes. The population-based fatal crash involvement rate of 17-year-olds decreased by 32 percent, however, the fatal crash involvement rate of the reference group of drivers ages 25–59 decreased by 10 percent; the fatal crash rate ratio for 17-year-olds decreased by 25 percent in the post-GDL period. There was a 4 percent reduction in fatal crash involvement rate of 18-year-olds relative to ages 25–59, although their population based rate decreased by 13 percent.

At age 16, there was a large reduction in driver fatal crash involvements, which was not statistically significant due to the small number of cases. At age 19, there was a 10 percent increase in fatal crash involvements (not statistically significant) relative to ages 25–59, and at ages 20–24, there was a statistically significant 14 percent increase. The reasons for these changes are unknown.

Tables 7 and 8 provide data on fatal crash involvements separately for night (restricted) and day periods, and for travel with two or more passengers (restricted) compared to none or one.

Table 7. Pre- and post-GDL crashes, rates per 100,000 population, and rate ratios: Fatal crashes, restricted and unrestricted hours.

Driver Age	N	Rate	Rate Ratio†	N	Rate	Rate Ratio†	Change in Rate Ratio (Percent)
Restricted Hours (midnight–4:59 a.m.)							
	Pre-GDL (1995–2000)			Post-GDL (2002–2007)			
16	11	1.73	0.95	2	0.28	0.16	-84**
17	24	3.87	2.13	15	2.14	1.20	-44**
18	43	7.26	3.99	35	5.20	2.91	-27
25–59	439	1.82	1.00	461	1.79	1.00	–
Unrestricted Hours (5 a.m.–11:59 p.m.)							
	Pre-GDL (1995–2000)			Post-GDL (2002–2007)			
16	11	1.74	0.16	11	1.53	0.16	0
17	152	24.54	2.30	121	17.24	1.80	-21*
18	140	23.65	2.21	145	21.55	2.25	+2
25–59	2,576	10.69	1.00	2,456	9.57	1.00	–

† Rate ratio = crash rate of drivers of age in first column divided by crash rate of drivers ages 25–59.
*p < .05, **p < .01

Table 8. Pre- and post-GDL crashes, rates per 100,000 population, and rate ratios: Fatal crashes, more than one passenger (restricted) and none or one.

Driver Age	N	Rate	Rate Ratio†	N	Rate	Rate Ratio†	Change in Rate Ratio (Percent)
More than One Passenger (Restricted)							
	Pre-GDL (1995–2000)			Post-GDL (2002–2007)			
16	9	1.42	0.88	7	0.98	0.62	-30
17	49	7.91	4.91	42	5.98	3.78	-23
18	45	7.60	4.73	38	5.65	3.58	-24
25–59	387	1.61	1.00	406	1.58	1.00	–
No Passengers or One Passenger (Not Restricted)							
	Pre-GDL (1995–2000)			Post-GDL (2002–2007)			
16	13	2.05	0.19	6	0.83	0.09	-53
17	127	20.50	1.88	94	13.39	1.37	-27*
18	138	23.31	2.14	142	21.10	2.17	+1
25–59	2,628	10.90	1.00	2,511	9.74	1.00	–

† Rate ratio = crash rate of drivers of age in first column divided by crash rate of drivers ages 25–59.
*p < .05

Table 7 indicates that for 17-year-olds, fatal crashes during restricted hours declined by 44 percent relative to ages 25–59, and by 21 percent during the day. Both of these differences were statistically significant, with the decrease during restricted hours greater than during unrestricted hours (z = 1.65, p < .05). Sixteen-year-olds also had a

statistically significant decrease in nighttime fatal crash involvements. Relative to the fatal crash rate of drivers ages 25–59, the fatal crash rate of 18-year-olds decreased by 27 percent during restricted hours (not statistically significant), and increased by 2 percent during the day. The change during restricted hours was not significantly greater than during unrestricted hours, due to the small number of cases involved.

Table 8 indicates only one statistically significant change, a 27 percent reduction in fatal crash involvements of 17-year-olds with no passengers or only one passenger, relative to the corresponding rate for ages 25–59. There was a 23 percent reduction in the fatal crash involvement rate of 17-year-olds with two or more passengers relative to ages 25–59, but that was not statistically significant. The fatal crash involvement rate of 18-year-olds with two or more passengers decreased by 24 percent relative to ages 25–59, which was not statistically significant, and increased by 1 percent when fewer than two passengers were present.

Comparison with Other States

A major concern in prior studies of New Jersey's licensing law has been the extent to which the safety gains at age 16 might be offset by a higher crash rate at age 17. This could occur because of the relative driving inexperience of New Jersey 17-year-olds compared with 17-year-olds in states licensing at age 16. Comparisons of states are now more complicated because all states introduced versions of GDL between 1996 and 2007. However, in the 1995–2000 pre-GDL period, New Jersey ranked 45th out of all 51 jurisdictions in its population based fatal crash involvement rate of 17-year-olds (referenced against 25- to 59-year-olds). In recent years (2004–2007), following the introduction of GDL, the ranking of New Jersey's fatal crash involvement rate of 17-year-olds improved to 21st. Five of the states ranked ahead of New Jersey license at age 15 or 15 ½ and have a different pattern of teen crashes than states licensing at age 16. In the other 15 states in the top 20, some or all 17-year-olds are subject to GDL restrictions.

Notably, crash rates for 17-year-olds, relative to ages 25–59, were higher in New Jersey than in neighboring Connecticut in the late 1970s (Williams, et al., 1983), the late 1980s (Ferguson et al., 1996), and in the pre-New Jersey GDL period 1995–2000 (2.27 vs. 1.86). However, since New Jersey instituted GDL, the fatal crash rate of New Jersey's 17-year-olds (relative to ages 25–59) has been lower than Connecticut's (1.60 vs. 1.86 in 2004–2007). New Jersey's combined fatal crash involvement rate of 16- and 17-year-olds is second only to the District of Columbia, an urban area that is tied with Rhode Island for the highest IIHS rating for the strength of its GDL program.

Discussion

The results are based on two data sets, using different pre- and post-GDL periods. Both sets of data have weaknesses: issues of completeness and quality in the New Jersey police report crash information, and limited statistical power in the case of FARS. Having two different data sets can be an advantage if both produce similar results. Certainly that was the case for 17-year-olds, the group most likely to be affected by New Jersey's GDL system. Substantial reductions were observed in all police-reported crashes, injury-only crashes, and fatal crashes of 17-year-olds in New Jersey subsequent to GDL implementation. For 18-year-olds, there was also solid evidence of positive effects based on data encompassing all crashes, injury-only crashes, and fatal crashes. Although there was not a significant reduction overall in fatal crash involvements of 18-year-olds, the reductions were concentrated in the restricted hour period and when carrying two or more passengers. This makes sense, since many 18-year-olds would be subject to these restrictions due to new drivers not being eligible for a provisional license until their 17th birthday, as well as their being required to hold their provisional license for a full year before they are eligible to obtain an unrestricted license.

The police reported crash data provided no evidence of an effect for 16-year-olds, but the fatal crash data did. This was not anticipated, since the only major new requirements for 16-year-olds were a ban on driving from 11 p.m. to midnight and a cell phone restriction, and all 16-year-olds in New Jersey were required to have an adult supervisor in the vehicle at all times, even prior to GDL implementation. No fatal crashes occurred between 11 p.m. and midnight in pre- or post-GDL periods, and cell phone use is not coded in FARS. There were only 22 16-year-olds in fatal crashes in the six pre-GDL years and 13 in the post-GDL years. Inspection of the data indicated that some 16-year-olds in fatal crashes had unknown license status or were misclassified as having a valid license. The most common crash (17 pre-GDL and 3 post-GDL) occurred during late night/early morning hours, usually involving a 16-year-old driver without a learner permit and with only other teens in the vehicle. How GDL would affect such crashes is not apparent.

Although the supervised driving period is known to be relatively safe, in the pre-GDL period, there were five 16-year-olds with learner permits involved in fatal crashes, compared with one post-GDL. In all but one of these cases, there was a passenger present old enough to be a supervisor, and the driver was belted. How GDL would reduce these types of 16-year-old driver crashes is also unclear, unless New Jersey teens were getting their permits later at age 16 than they were prior to GDL. This is a possibility if restrictions on the license available at age 17 make licensing less attractive

to teenagers. However, in that case there should also have been reductions in police reported crashes in general at age 16, and there were not.

On balance, it seems unlikely that the reduction in fatal crashes of 16-year-olds is due to GDL. However, if it is, it adds to the overall benefits.

The other odd result was the increase in fatal crash involvements at ages 19 and 20–24 relative to ages 25–59. These changes occurred only in the fatal crash data; there were small decreases at ages 19 and 20–24 in the rates of all police-reported crashes. Furthermore, there were not large increases in their actual crash involvement rates (the population-based fatal crash involvement rate of 19-year-olds increased by 3 percent, and the fatal crash involvement rate of 20- to 24-year-olds decreased by 1 percent), but the fatal crash involvement rate of the reference group ages 25–59 decreased by 10 percent. If there were negative after-effects of GDL among 19-year-olds, they would not show up until those who went through the GDL system reached this age, and there is no evidence of such an effect in the year-to-year fatal crash data. The fact that not only 19-year-olds but also 20- to 24-year-olds showed similar effects also precludes their association with GDL.

There is good evidence from this study that the nighttime restriction has been an effective GDL component in New Jersey. On the other hand, the contribution of the passenger restriction is uncertain. The data on police reported crashes were inadequate for examining the passenger restriction. The passenger restriction appears to have been associated with a 23–24 percent reduction in the rate of fatal crashes of 17- and 18-year-old drivers carrying more than one passenger. However, given the limited statistical power associated with analyzing small numbers of fatal crashes, this result was not statistically significant and should be interpreted with caution. Also, it is notable that there was a serious limitation in addressing the effects of the passenger restriction in that holders of restricted licenses are still allowed to transport family members, but the relationship of the driver and passengers cannot be determined from available data.

New Jersey’s combination of policies for licensing new drivers makes it a national leader in dealing with the young driver problem. The licensing age of 17 eliminates most crashes at age 16. The GDL system, one of the nation’s strongest, effectively reduces crashes, especially at age 17. New Jersey’s national ranking with respect to fatal crash involvement rates of 17-year-olds has improved dramatically since before GDL, and is now lower than in neighboring Connecticut, reversing a long-standing trend. If later licensing in New Jersey results in a safety penalty at age 17 due to 17-year-olds in New Jersey being less experienced than 17-year-olds in states licensing at age 16, it appears that this effect is largely blunted by the GDL program. In addition, because of

New Jersey's higher licensing age, many 18-year-olds are subject to GDL rules, leading to crash reductions in an age group not addressed by other states' GDL systems. Eighteen-year-olds in New Jersey who are under GDL rules include those who are just beginning the licensing process. Applying GDL to all novices is sound policy because novices of all ages have elevated crash risk (Mayhew & Simpson, 1990). Moreover, it has been suggested that some teens may wait until age 18 to begin the licensing process thus avoiding GDL rules (Masten & Hagge, 2003), but there is no incentive to do so in New Jersey.

Despite a successful young driver program in New Jersey, many teens are still involved in serious crashes. This recognition prompted the New Jersey legislature to establish a Teen Driver Study Commission in 2007. The commission's report, issued in 2008, listed 47 recommendations for policies aimed at further reducing the young driver problem (New Jersey Teen Driver Study Commission, 2008). A bill was subsequently passed limiting passengers to just one regardless of family affiliation, and reducing the start time for the night restriction from midnight to 11 p.m. These revised policies go into effect in 2010 and should improve the positive impact of the graduated program.

Another bill that has been considered would lengthen learner holding periods from six months to one year and require a minimum number of practice hours. These policies would delay licensing further in New Jersey, thus adding to GDL benefits. The practice hours requirement would also add one point to New Jersey's score based on the IIHS GDL rating scale, bringing it into a tie with the District of Columbia and Rhode Island as the nation's strongest GDL program.

Other states such as Connecticut and Illinois have appointed study commissions to consider ways to better protect young people and/or have amended their original GDL legislation, recognizing that upgrades were needed. Even though the majority of states have GDL systems rated by the Insurance Institute for Highway Safety as "good," all state systems, including New Jersey's, can be improved. It is clear, however, that for states considering how to modify their licensing systems to minimize crashes and injuries involving young people, New Jersey stands as a model.

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