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A National Evaluation of the Nighttime and Passenger Restriction Components of Graduated Driver Licensing

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Abstract

Introduction—The high crash rate of youthful novice drivers has been recognized for half a century. Over the last decade, graduated driver licensing (GDL) systems, which extend the period of supervised driving and limit the novice's exposure to higher-risk conditions (such as nighttime driving) has effectively reduced crash involvements of novice drivers.

Method—This study used data from the Fatality Analysis Reporting System (FARS) and the implementation dates of GDL laws in a state-by-year panel study to evaluate the effectiveness of two key elements of GDL laws: nighttime restrictions and passenger limitations.

Results—Nighttime restrictions were found to reduce 16- and 17-year-old driver involvements in nighttime fatal crashes by an estimated 10% and 16- and 17-year-old drinking drivers in nighttime fatal crashes by 13%. Passenger restrictions were found to reduce 16- and 17-year-old driver involvements in fatal crashes with teen passengers by an estimated 9%.

Conclusions—These results confirm the effectiveness of these provisions in GDL systems.

Impact on Public Health—The results of this study indicate that nighttime restrictions and passenger limitations are very important components of any GDL law.

Keywords

Graduated Driver Licensing (GDL); novice drivers; night restrictions; passenger limitations; fatal crash involvements; effectiveness

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IMPACT ON INDUSTRY

The results of this study indicate that nighttime restrictions and passenger limitations are very important components of any GDL law. States that do not have these components should strongly consider adopting them.

1. INTRODUCTION

The high crash rate of youthful novice drivers has been recognized for several decades in the United States. Young drivers start with very little knowledge or understanding of the complexities of driving a motor vehicle. Many young drivers act impulsively, use poor judgment, and participate in high-risk behaviors (Beirness, Mayhew, Simpson, & Desmond, 2004). Teens often drive at night with other teens in the car, which substantially increases their risk of a crash (Chen, Baker, Braver, & Li, 2000). When these factors are combined with inadequate driving skills, excessive speeds, drinking and driving, distractions from teenaged passengers, and a low rate of safety belt use, crash injury rates accelerate rapidly (Masten, 2004; Masten & Chapman, 2004; Mayhew, Simpson, & Pak, 2003).

Because of these factors, motor-vehicle crashes are the leading cause of death for young people aged 15 to 20 in the United States, accounting for more than one-third of their deaths (Subramanian, 2005). Young people aged 15 to 20 make up 8 to 9% of the U.S. population but account for only about 6 to 7% of the licensed drivers. However, these young drivers are involved in 13 to 14% of the fatal traffic crashes each year (National Center for Health Statistics [NCHS], 2010). Sixteen-year-old drivers have crash rates that are three times greater than 17-year-olds, five times greater than 18-year-olds, and even twice those of drivers aged 85 (McCartt, Shabanova, & Leaf, 2003). Research has indicated that at least four factors play a prominent role in crashes involving teenagers: inexperience, immaturity, risk taking, and greater exposure to risk (Masten, 2004; Senserrick & Haworth, 2004, available from Monash University).

1.1 Novice Driver Risk

There is ample evidence that young novice drivers present an elevated crash risk (McCartt et al., 2003; Mayhew et al., 2003; Subramanian, 2005). The risk of being in a crash is at a lifetime high during the first 2 years of driving (McCartt et al., 2003; Sagberg, 1998). Williams (1999) found that the crash involvement rate for 16-year-olds was four times that of drivers in their twenties. This high rate of crash involvement appears to be both a function of inexperience and risk taking, particularly by male teenagers. The risk of injury is increased by the failure to fasten safety belts (Womack, Trout, & Davies, 1997), nighttime driving (Williams & Preusser, 1997), and distractions created by teen passengers (Farrow, 1987). The threat extends to passengers who ride with novice drivers. These passengers are also less likely to buckle up and, thus, share the same risk of injury associated with driver errors and subsequent crashes.

1.2 Graduated Driver Licensing Systems

Over the last decade, the more effective alternative to high school driver education of extending the period of supervised driving and limiting the novice's exposure to higher-risk conditions, such as nighttime driving, has effectively reduced crash involvements (Williams & Ferguson, 2002). Research around the world has shown that the first few months of licensure for young novice drivers entail the highest crash risk (Mayhew et al., 2003; McCartt et al., 2003; Sagberg, 1998). This high crash rate of novice drivers suggests that restricting driving in situations known to be risky during this initial licensure period is one option for dealing with this vulnerability. To address this issue, many states have recently adopted graduated driver licensing (GDL) systems requiring that progression to full license privileges occur in three stages. In this system, the novice driver receives additional supervision in the first stage and is prohibited from the higher-risk conditions associated with nighttime driving and driving with teen passengers in the second stage (National Highway Traffic Safety Administration [NHTSA], 2008). The rationale for GDL is to extend the period of supervised driving, thus permitting beginners to acquire their initial on-

the-road driving experience under lower-risk conditions; in contrast, the historic licensing systems in most states generally allowed a quick and easy path to full driving privileges at a young age, resulting in extremely high crash rates for beginning drivers.

GDL systems in the United States vary widely, but typically there is a required supervised learning stage of 6 months or more (learner's permit), followed by an intermediate (or provisional license) stage of at least several months with restrictions on high-risk driving before a driver "graduates" to full license privileges. NHTSA—along with the Insurance Institute for Highway Safety (IIHS), the National Safety Council (NSC), and the National Transportation Safety Board (NTSB)—established such a three-staged national model for GDL to introduce driving privileges gradually to beginning drivers (NHTSA, 2008). Under these systems, novice drivers are required to demonstrate responsible driving behavior (no traffic citations or arrests) in each stage before advancing to the next stage. After novice drivers have graduated from supervised driving to independent driving, most GDL systems restrict late night driving and carrying young passengers among other provisions until the novice driver is fully licensed.

Examples of components and restrictions of each stage, suggested by the data and research, are depicted in Table 1 (NHTSA, 2006):

According to the U.S. Government Accountability Office (GAO, 2010) and updated by IIHS (2011), all 50 states and the District of Columbia (DC) currently have three-staged GDL systems. The IIHS has rated the various GDL systems in the states (IIHS, 2010). Only 16 states were rated as having "good" GDL systems in 2004, but currently, 35 states are rated as "good" GDL systems (IIHS, 2010). Chen, Baker, and Li (2006) found the "good" systems to be most effective, and they noted the gaps and weaknesses of existing legislation that needed to be addressed.

Despite such a general concept and specific guidelines, GDL systems in the United States vary widely, with different states enacting different components aimed to strengthen the GDL program. Evaluations of individual state programs in the United States and Canada have clearly shown the benefits of adopting GDL systems (Foss, Feaganes, & Roggman, 2001; Foss & Goodwin, 2003; Mayhew, Simpson, Des Groseilliers, & Williams, 2001; Shope & Molnar, 2004; Shope, Molnar, Elliott, & Waller, 2001; Ulmer, Preusser, Williams, Ferguson, & Farmer, 2000). Earlier independent studies have shown that nighttime restrictions for teenage drivers are generally effective in reducing crashes (Williams & Preusser, 1997), as are teen passenger restrictions (Chen, et al., 2000; Preusser, Ferguson, & Williams, 1998)—two key components in GDL systems.

Dee, Grabowski, and Morrisey (2005) found a 5.6% reduction in traffic fatalities for 15- to 17-year old drivers associated with the adoption of GDL laws in the first national study of GDL effects. Chen et al. (2006), in the second national evaluation of GDL programs, calculated an incidence rate ratio (IRR) for fatal crashes involving 16-year-old drivers in relation to GDL programs. They found that the presence of GDL programs in the states was associated with an 11% lower fatal crash involvement rate for 16-year-old drivers. The comparison groups were drivers aged 20 to 24 and 25 to 29. They found reductions of 16 to 21% in the 16-year-old IRR associated with the GDL programs that had five or more of the seven key components to GDL laws. The seven components were: (a) minimum age for a learner's permit, (b) mandatory waiting period before applying for an intermediate license, (c) minimum hours of supervised driving, (d) minimum age for an intermediate license, (e) nighttime restriction, (f) passenger limitation, and (g) minimum age for full licensing. McCartt and colleagues (2009) from IIHS conducted another national study of GDL systems in the states using methods similar to Chen et al. (2006). They found, compared to GDL

systems that IIHS had rated as “poor,” the states with GDL laws rated as “good” had a 30% lower fatal crash rate among 15- to 17-year-old drivers, and the states with GDL systems rated as “fair” had an 11% lower fatal crash rate among 15- to 17-year-old drivers (also see McCartt, Teoh, Fields, Braitman, & Hellinga, 2010). In a recent meta-analysis of GDL programs in North America, Vanlaar et al. (2009) found that GDL programs had a significant effect on 16-year-old drivers, but not on 17-, 18- or 19-year-old drivers. Passenger restrictions in the intermediate phase of licensing were also significantly associated with reductions in 16-year-old driver fatality rates.

1.3 Nighttime and Teen Passenger Restrictions

One of the two key components of GDL during the intermediate stage is the nighttime restriction that requires the presence of an adult while the teen is driving after certain hours. This nighttime restriction is designed to reduce the risk of late-night driving and drinking-and-driving by beginning drivers. Most underage drinking occurs at night, so this restriction on driving is designed to at least prevent the underage drinker from driving. It also may reduce underage drinking itself because the beginning driver is not allowed to drive to the location where the underage drinking is occurring during nighttime hours (at least not without an adult driver aged 21 or older in the vehicle). Williams (2005) reported that 38 states have some form of night restriction for beginning drivers but that 23 of those states do not start the restriction until midnight or 1 a.m. This may account for the results reported by Williams, Ferguson, and Wells (2005) who examined fatal crashes involving 16-year-olds in the United States from 1993 to 2003. Williams and his colleagues found that the proportion of fatal crashes that occurred between midnight and 5 a.m. has remained at 11% for these novice drivers. This does not mean that the nighttime restrictions did not work, but there does not appear to be a differential effect of these laws on nighttime fatal crashes. In states with night restrictions, 10% of the fatal crash involvements of 16-year-olds were late at night (midnight–5 a.m.) in both 1993 and 2003. In states without night restrictions, 12% of fatal crash involvements were late at night in 1993, and 9% in 2003, a nonsignificant difference. Other research on individual state GDL systems has shown an effect of nighttime restrictions on all crashes (rather than just fatal crashes) involving beginning drivers (Williams & Preusser, 1997; McKnight & Peck, 2002; Mayhew, et al., 2003).

In this study, we take a more detailed approach that compares the existence of a nighttime restriction within each state over time with the number of fatal nighttime crash involvements of 16- and 17-year-old drivers.

The presence of teen passengers also increases the crash risk of novice drivers (see Figure 1, which was taken from a report by Williams & Ferguson, 2002). Several studies (Farrow, 1987; Doherty, Andrey, & MacGregor, 1998; Preusser et al., 1998; Aldridge, Himmler, & Aultman-Hall, 1999; Chen et al., 2000) have documented the increased risk posed by young passengers distracting the novice driver or encouraging risky behavior. As a result, the inclusion in GDL laws of a restriction against transporting passengers aged 20 and younger during the early period of solo driving was recommended by NHTSA and IIHS and comprises the second key component to GDL systems. Begg and Stephenson (2003) found a 9% reduction in crashes involving teenage passengers following the enactment in New Zealand of a restriction on teenage passengers. Smith, Pierce, and Upledger (2001) found a 23% reduction in injuries per licensed driver following the addition of a teen passenger prohibition in the California GDL law. Thus, there is some limited indication of the effectiveness of the passenger restriction component of GDL laws. By using multiple states and a longer span of time, we expect to clarify the potential benefit of this provision of GDL laws.

Given this as background, this study had the following aims:

a. *Does the GDL nighttime restriction reduce fatal nighttime crashes of 16- and 17-year-old drivers?* This should provide an indication of what additional benefit states with GDL laws that do not include effective nighttime restrictions can achieve by adding such provisions to their legislations (see Table 2 for states that have a GDL law with a night restriction as of 2008).

b. *Does the passenger limitation reduce fatal crash involvements of 16- and 17-year-old drivers riding with teen passengers?* This should indicate what additional benefits states with GDL laws without an effective teen passenger limitation provision might achieve if such a provision were to be added to their laws.

2. METHODS

2.1 Data Sources

2.1.1 Fatal Crashes—Most prior GDL studies generally have been limited to a single state where the state crash files can provide a relatively large number of cases of 16- and 17-year-old driver involvements in crashes of all severities. Attempting to collect and analyze the state crash files from the 48 states that had GDL laws in 2008 was beyond the scope of effort provided in this study. Therefore, we used NHTSA's Fatality Analysis Reporting System (FARS) as our primary outcome database. The FARS is a census of all fatal crashes (defined as a death of a participant within 30 days of the crash event) on U.S. public roadways and reported to the police. FARS contains data in more than 100 categories from several state data sources (including state crash report records, driver records, death certificates, vehicle registration files, highway inventories, and other sources). Alcohol involvement is documented through blood alcohol concentration (BAC) test results collected by police, coroners, or medical examiners. When such data are not available, the BACs of drivers, pedestrians, and cyclists are statistically imputed using crash characteristics (such as the investigating police officer's report of driver alcohol impairment) to obtain more complete and accurate alcohol data (Subramanian, 2002). We drew information on all fatal crashes involving 16- and 17-year-old drivers—our target group who are effected by GDL laws.

2.1.2 State GDL Laws—The data on GDL laws used by Baker, Chen, and Li (2007) were graciously provided to us by the Johns Hopkins University authors of that earlier study. These data files were modified to incorporate changes in (or modifications to) any of the laws up to the time of our analyses in 2010. We used the IIHS Web site (www.iihs.org), *NHTSA's Digest of Impaired Driving and Selected Beverage Control Laws* (NHTSA, 2010), Lexis-Nexis, and other appropriate sources to identify states that have GDL laws. We recorded the dates these laws were adopted and when any modifications to the laws were made. We also recorded whether the laws provide for a nighttime restriction and/or a passenger limitation. For those with nighttime restrictions, the periods of restriction were also recorded. NHTSA (2006) reported that 17 states adopted a three-stage GDL system with nighttime restrictions between 1996 and 1999 (California, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Louisiana, Maryland, Massachusetts, Michigan, New Hampshire, North Carolina, Ohio, Rhode Island, South Carolina, and South Dakota). The periods for the restrictions and the duration of the restrictions vary by state. The remaining 33 states and DC did not have a three-stage GDL during that earlier timeframe. This provides at least 9 years of post-GDL data (2000–2008) for analyses for the states implementing GDL laws by 1999. Beginning in 2000, 32 states and DC had adopted a three-stage GDL with a nighttime restriction (Alabama, Alaska, Arizona, Arkansas, Colorado, Connecticut, District of Columbia, Hawaii, Idaho, Kansas, Kentucky, Maine, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, Oklahoma, Oregon, Pennsylvania, Tennessee, Texas, Utah, Virginia, Washington, West Virginia, Wisconsin,

and Wyoming). Currently, only one state has a three-stage GDL with no nighttime restrictions (Vermont). Finally, North Dakota became the final state to adopt a three-stage GDL (in effect January 2012). See Tables 3 and 4.

2.2 Analysis Strategy

The number of 16- and 17-year-old drivers involved in fatal crashes was combined from the FARS data because nighttime and passenger restrictions could affect both ages and because of the small sample sizes in FARS for 16-year-old drivers or 17-year-old drivers separately in some states during some years. Counts of 16- and 17-year-old drivers, 19- and 20-year-old drivers, 19- to 25-year-old drivers, and 19- to 29-year-old drivers in nighttime (9 p.m. to 5 a.m.) fatal crashes and counts of 16- and 17-year-old drivers in daytime (5 a.m. to 9 p.m.) fatal crashes were aggregated into a state-by-year data structure in which repeated yearly counts of crashes were nested within states. Parallel age group-specific count aggregates were computed for (a) fatal crashes where passengers were present and (b) fatal crashes with 16- and 17-year-old drivers where no passengers were present, collapsing across the daytime and nighttime periods defined above.

For models examining effects of nighttime driving restrictions on nighttime fatal crashes among 16- and 17-year-old drivers, we computed ratios of nighttime fatal crash counts for 16- and 17-year-old drivers (the numerator) versus nighttime fatal crashes for each of the other three comparison age groups (the denominators), and we computed a ratio of nighttime fatal crashes for 16- and 17-year-old drivers versus daytime fatal crashes for 16- and 17-year-old drivers, resulting in a total of four outcome measures.

To examine effects of nighttime restrictions on alcohol-involved fatal crashes among 16- and 17-year-old drivers (those with BACs≥.01 g/dL), we computed an additional set of parallel ratio measures: alcohol-involved fatal crashes for 16- and 17-year-old drivers versus alcohol-involved crashes for each of the three groups of older drivers and alcohol-involved fatal crashes for 16- and 17-year-old drivers versus non-alcohol-involved crashes for 16- and 17-year-old drivers (those with BACs=.00 g/dL).

To examine effects of passenger restrictions, another set of parallel ratio measures was computed (i.e., three age group comparison ratios plus one passenger present vs. no passengers present ratio for 16- and 17-year-old drivers only).

The use of ratios (e.g., nighttime fatal crashes vs. daytime fatal crashes) as dependent measures controls for state- and year-specific driving and safety conditions to a large extent, thus, reducing the need for covariates that predict fatal crashes (Voas, Romano, & Peck, 2009). Using ratios also controls for differences in jurisdiction (state) size. To reduce skewness in distributions of these ratio measures, we applied a natural log transformation to each one. The distributions of transformed measures closely approximated a normal (Gaussian) form and, thus, were suitable for use in linear mixed models (i.e., mixed models with an identity link function and normally distributed errors).

The nighttime and passenger restrictions are confounded in that some states have both provisions. Therefore, the use of the separate nighttime and passenger crash series from the FARS data helped to clarify the relative role of each restriction.

To examine the effects of GDL restrictions on driving at night and driving with teenage passengers during the intermediate stage of licensing, we estimated a series of random intercept mixed models in which we treated annual measurements of crashes as repeated observations nested within states (18 years per state × 50 states = 900 state-year observations). In these models, the focal predictor was either (a) a three-level categorical

variable coding for the presence/type of nighttime driving restriction at each year for each state (no restriction on nighttime teen driving, nighttime teen driving prohibition with restriction beginning at 11 p.m. or earlier, and teen nighttime driving prohibition with restriction beginning at midnight) or (b) a two-level categorical variable coding for the presence or absence of restrictions on driving with teenage passengers in the car. In addition to testing "main effects" of the implementation of these two GDL restrictions on fatal crashes, we examined how these restrictions interacted with driver gender to determine if GDL implementation had a differential impact for male versus female drivers.

All analyses were conducted using PROC MIXED under SAS version 9.2. Nighttime and passenger restrictions were treated as classification variables, state-level intercepts were modeled as having a random (error) component, and in the "main effec" models, serial autocorrelation among year-level errors was modeled with state-specific AR(1) error structures. Largely due to sparse data in the relatively small gender-specific groups for certain state-year observations, AR(1) error structures could not be successfully estimated in the gender-x-GDL interaction models.

3. RESULTS

3.1 Nighttime Restrictions

Results of our analyses suggest that nighttime restrictions on teenage driving produced reductions in nighttime fatal crashes among 16- and 17-year-old drivers compared to drivers in other age groups, with midnight restrictions producing somewhat more robust reductions than the 11 p.m. or earlier restrictions. The relative reduction in nighttime versus daytime crashes among 16- and 17-year-old drivers was also significant (see Table 5).

Nighttime driving restrictions also appear to have yielded relative reductions in alcohol-involved (BAC ≥ 0.01 g/dL) crashes among 16- and 17-year-olds compared to older drivers and a relative reduction in alcohol-involved versus non-alcohol-involved crashes among 16- and 17-year-olds (see Table 6). Again, the effects of midnight restrictions were more robust (and consistent) than the 11 p.m. or earlier restrictions.

The percentage of difference in *fatal crashes* comparing the intervention (nighttime restriction) state/years to nonintervention state/years is shown in Table 7. Negative numbers indicate lower crash numbers during intervention years compared to nonintervention years. Assuming 16- and 17-year-old drivers and 19- and 20-year-old drivers were influenced equally by other factors in the state (e.g., other laws, general traffic enforcement intensity), the net effect of the night restriction reduction on 16- and 17-year-old driver involvements in nighttime fatal crashes: 18.3% − 8.2% = 10.1% (see Table 7).

The percentage of difference in *drinking driver fatal crashes* comparing the intervention (nighttime restriction) state/years to nonintervention state/years is shown in Table 8. Negative numbers indicate lower crash numbers during intervention years compared to nonintervention years. Again, assuming 16- and 17-year-old drivers and 19- and 20-year-old drivers were influenced equally by other factors in the state (as described earlier), the net effect of the night restriction reduction on drinking driver fatal crashes for 16- and 17-year-olds was 19.4% − 6.8% = 12.6% (see Table 8). No significant gender-x-nighttime restriction interactions were detected.

3.2 Passenger Limitations

The effects of teenaged passenger limitations were significant for comparisons of 16- and 17-year-old drivers versus 19- to 29-year-olds and versus 19- to 25-year-olds, but not when the comparison was limited to 19- and 20-year-olds. The relative reduction in fatal crashes

for 16- and 17-year-old drivers with teenaged passengers versus that for fatal crashes for 16- and 17-year-old drivers without teenaged passengers was significant (see Table 9).

The percentage of difference in crashes comparing the intervention (passenger restriction) years to nonintervention years is shown in Table 10. Once again, negative numbers indicate lower crash numbers during intervention years compared to nonintervention years. Assuming 16- and 17-year-old drivers and 19- and 25-year-old drivers (where the effect was significant) were influenced equally by other factors in the state, the net effect of the passenger limitation on 16- and 17-year-old driver involvements in fatal crashes with teen passengers was 19.2% − 9.9% = 9.3% (see Table 10).

Regarding the *number* of teen passengers in the limitation, in nearly every instance, the only specific comparison that was significant was the comparison between years without any teen passenger restrictions and the years with the strictest possible limits (i.e., no teen passengers permitted). We tested all possible pairwise comparisons and a variety of other comparisons (e.g., one teen passenger allowed vs. two, three, or unlimited teen passengers allowed; no passengers allowed vs. one passenger allowed; no passengers allowed vs. two passengers allowed) for each ratio and found no significant differences except the before and after analyses of the limitation described earlier. No significant gender-x-passenger restriction interactions were detected here either.

4. DISCUSSION

The results from the analyses confirm that nighttime restrictions and teen passenger limitations are important components of the GDL systems. The finding that nighttime restrictions starting at midnight produced more robust reductions in nighttime fatal crashes of 16- and 17-year-old drivers could be due to sample sizes (19 states had the restriction starting at 11 p.m. or earlier; 26 states had midnight or later; 5 states had no night restriction) or enforcement of the provision (or lack thereof). It could be that many parents use a midnight curfew (their personal choice) on their novice drivers regardless of the GDL restriction (especially on weekend nights) even if it officially began at 11 p.m. It also could be the case that many teens and their parents are not aware of when the nighttime restriction begins. In any case, both of these types of restrictions (beginning at midnight and beginning at 11 p.m. or earlier) had significant effects.

It also appears that any teen passenger restriction (whether the limit is none, one, or two) reduces fatal crashes of 16- and 17-year-old drivers with teen passengers. This is the desired effect, even if the law is not strictly enforced, and there is very little evidence indicating that it is. However, when comparing the effects of laws that allow no teen passengers to the laws that allow one, two, or more teen passengers, the GDL laws that permit no teen passengers during the intermediate license stage reduced fatal crashes the most.

The limitations in this study follow:

- Some of the sample sizes for 16- and 17-year-old driver involvements in fatal crashes in the state-by-year analyses were small. This may have accounted for some statistically insignificant findings. It would have been advantageous to have all state crash files for 1990 through 2007 for all states and DC. These files were not readily available for analyses, however, and would be very difficult to obtain in every state for every year dating back to 1990.
- The ratios of nighttime to daytime fatal crashes and teen passengers to no teen passengers in fatal crashes were used as the dependent measures to control, at least in part, for differences in jurisdiction size and general driving and safety trends in

each state and to reduce the need for covariates related to fatal crashes. We were unable to control for other potentially relevant differences across states and years, such as differences in traffic enforcement intensity, publicity surrounding GDL laws, and parental influence on driving where valid measures are very difficult to obtain.

5. CONCLUSIONS

Although studies of individual jurisdictions have indicated that nighttime restrictions and passenger limitations are effective in reducing novice driver crashes, few national studies have focused on these two components of GDL. This national panel study, using different dependent measures, has augmented the past research. This study showed that night restrictions do reduce nighttime fatal crashes involving 16- and 17-year-old drivers by about 10% relative to the fatal crash involvement of older peers. The night restriction was also associated with a 13% reduction in 16- and 17-year-old drinking drivers in nighttime fatal crashes relative to other young (19- to 20-year-old) drivers not affected by the restriction. States that do not have night restrictions should strongly consider adopting them.

The study also showed that teen passenger restrictions significantly reduce fatal crashes involving 16- and 17-year-old drivers with teen passengers by about 9% relative to older drivers (aged 19 to 25). A recent study by Williams, Ali, and Shults (2010) found that the percentage of fatal crashes involving 16- and 17-year-old drivers who had teen passengers present has not changed nationally over a recent 5-year period (2004–2008). In our study, however, the passenger restriction was effective in reducing fatal crashes with teen passengers relative to older peers, and the most effective restriction was the one not allowing any teen passengers.

Therefore, states without teen passenger limitations should also strongly consider adding them to their GDL systems. In addition, states that allow one, two, or more teen passengers during the intermediate stage of licensing should consider modifying that restriction to no teen passengers.

It appears that delaying *full* licensure of young novice drivers via GDL systems is having the desired effect nationally. Most 16- and 17-year-old drivers are either permit holders (where adults aged 21 or older must always be present) or intermediate stage holders (where solo driving is permitted, but with nighttime and teen passenger restrictions). These required stages of driving are, in effect, delaying full licensure for young drivers where no such restrictions are present.

This premise appears to be verified by the Federal Highway Administration's (FHWA, 2008) data on the distribution of licensed drivers. Only 30.7% of 16-year-olds in 2008 had driver’s licenses, and only 49.2% of 17-year-olds had licenses, many of which may have been learner’s permits or provisional licenses (it is not clear when examining those data). These rates compare to 68% of 18-year-olds and 76.7% of 19-year-olds reported to be licensed by FHWA. However, as pointed out by Ferguson, Teoh, and McCartt (2007), caution must be exhibited when interpreting the FHWA data on the licensing of young drivers.

More research is clearly needed on the effects of GDL systems in the United States and other countries around the world. Because of limitations in the FARS data, we still do not have answers to the following questions:

- Is the delay of solo driving the most important aspect of GDL, or are other components more important (e.g., night and passenger restrictions, hours of supervised practice, no violations or crashes in order to graduate to the next phase)?

- Are the lengths of the individual phases of GDL systems important in reducing the crash risk?
- What are the individual GDL effects on 16-year-olds, 17-year-olds, 18-year-olds, and 19-year-olds? Is there any GDL carryover effect on older age groups?

The Appendix contains tables of the ages of licensure for the intermediate- and full-license stages by state. Studies are needed to determine which of these age limits are playing a key role in the safety of young novice drivers.

Highlights of GDL Study for JSR

- We studied the effects of nighttime restrictions and teenaged passenger limitations in graduated driver licensing (GDL) systems on novice driver involvements in fatal crashes.
- Nighttime restrictions were found to reduce 16- and 17-year-old driver involvements in nighttime fatal crashes by an estimated 10% and 16- and 17-year-old drinking drivers in nighttime fatal crashes by 13%.
- Passenger restrictions were found to reduce 16- and 17-year-old driver involvements in fatal crashes with teen passengers by an estimated 9%.
- States without the nighttime or passenger restrictions in their GDL law should strongly consider adopting them.

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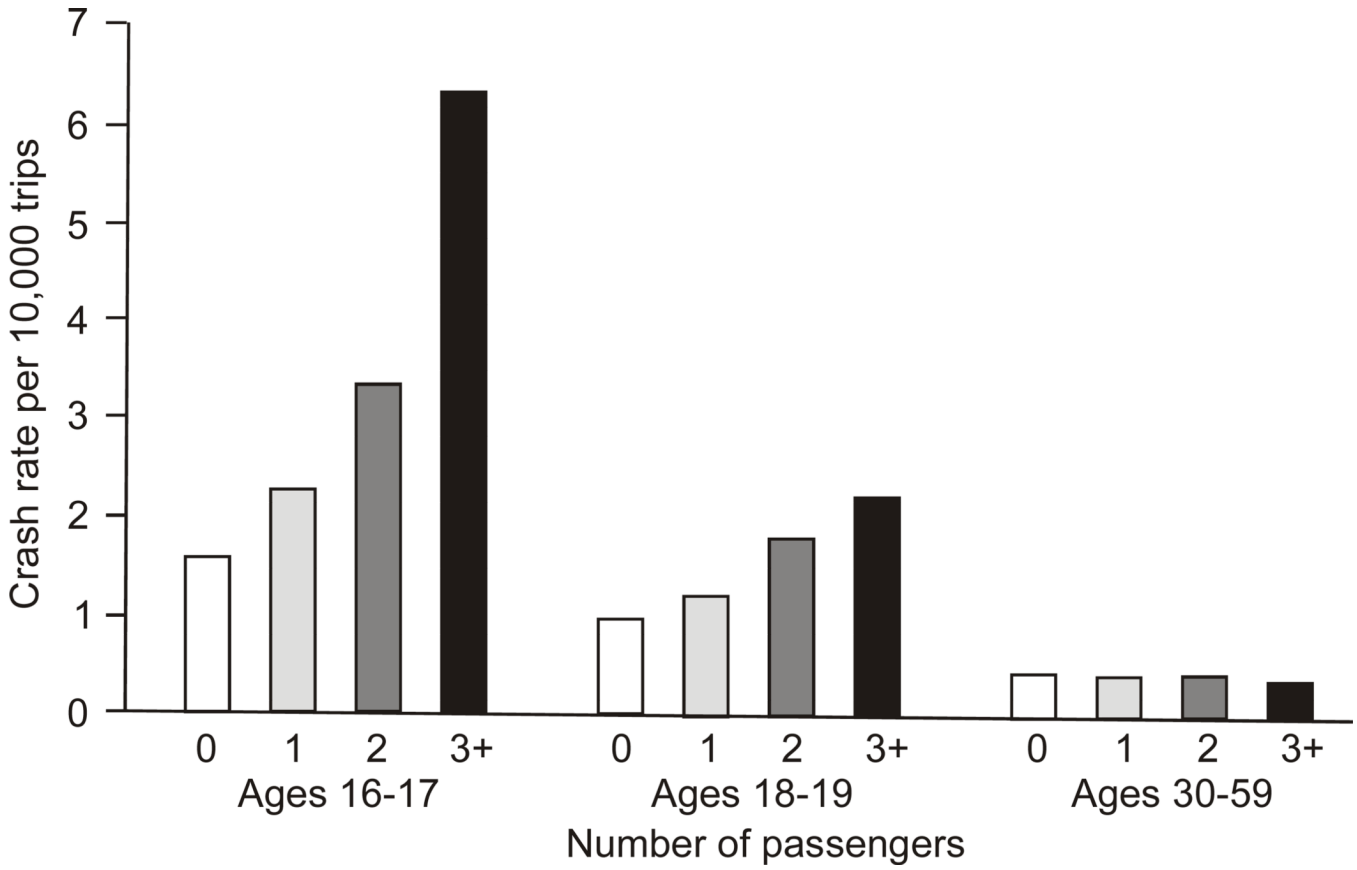

Figure 1.
Crash Rates by Age of Driver and Number of Passengers per 10,000 Trips
(Source: Williams & Ferguson, 2002)

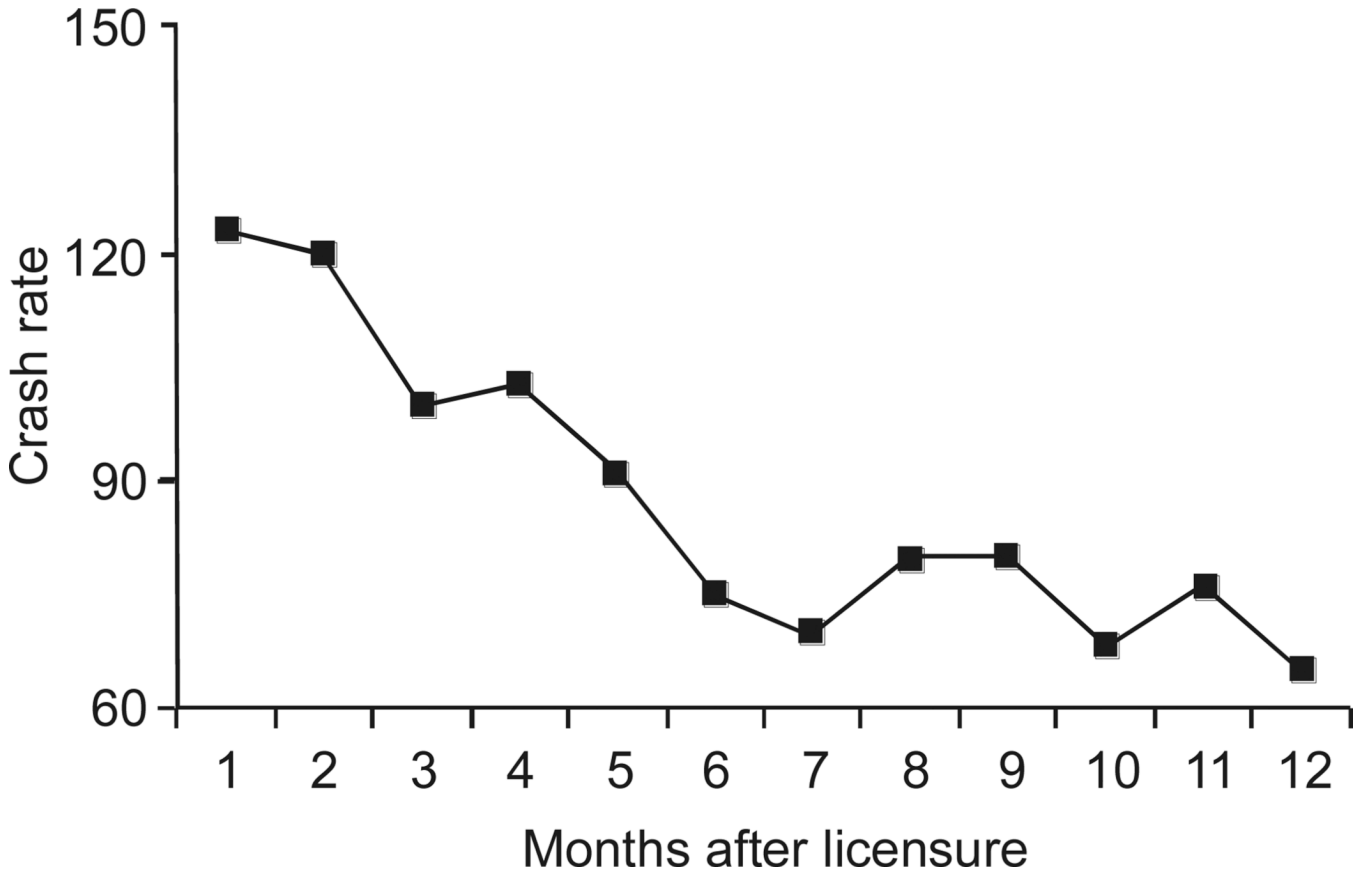

Figure 2.
Novice Drivers' Crash Risk Begins to Drop with Experience
(Source: Mayhew, Simpson & Pak, 2003)

Table 1

Graduated Driver Licensing Systems in the United States: Components and Restrictions of Each Stage
(Source: Expanded and updated from NHTSA, 2008)

Stage 1: Learner's Permit	Stage 2: Intermediate or Provisional License	Stage 3: Full Licensure
• Minimum age requirement • Basic driver education • Vision and knowledge tests and basic skills training • Licensed adult (at least age 21) required in vehicle at all times • Teenage passenger limitations and all occupants must wear safety belts • No alcohol or other drugs while driving • Crash-free and conviction-free for at least 6 months • Parental certification of practice hours • Distinctive permit from other licenses	• Complete Stage 1 • Minimum age requirement • Behind-the-wheel test • Advanced driver education • Licensed adult required in vehicle for all late-night driving • No alcohol or drugs and all occupants must wear safety belts • Teenage passenger restrictions • Driver improvement actions initiated at lower point level than for regular drivers • Crash-free and conviction-free for at least 12 consecutive months • Supervised practice • Distinctive license	• Complete Stage 2 • Minimum age requirement • No alcohol while driving

Summary of Graduated Driver Licensing National Evaluation Studies					
Authors/Year	**Jurisdiction**	**Characteristics of driver population**	**Findings**	**Measures used**	**Comparison group used**
Baker, Chen, Li (2006) NHTSA report	43 states	16-year-old drivers	11% reduction in incidence rate ratio of 16-year-old drivers in FARS	Incidence rate ratios of drivers in FARS	20- to 24-year-olds and 25- to 29-year-olds
Baker, Chen, Li (2007) AAAFTS report	43 states	16-year-old drivers	38% reduction in fatal crashes and 40% reduction in injury crashes for 16-year-old drivers in states with 5 of 7 GDL components. 11% to 19% effect for weak GDL states.	Incidence rate ratios of drivers in FARS and in injury crashes from state crash files	20- to 24-year-olds 25- to 29-year-olds 30- to 54-year-olds
Chen, Baker, Li (2006) *Pediatrics*	43 states	16-year-old drivers	18% to 21% reductions in 16-year-old driver involvements in FARS in states with ≥5 of 7 components.	Incidence rate ratios of drivers in FARS	20- to 24-year-olds and 25- to 29-year-olds
Dee, Grabowski, Morrisey (2005) *J Health Economics*	48 states	15- to 17-year-old drivers	5.6% reduction in traffic fatalities for 15- to 17-year-olds in FARS. 19% reduction in states with "good" GDL.	Differences-in- differences; Differences-in-differences-in-differences	States without GDL laws (DD); 21- to 23-year-olds and 24- to 26-year-olds (DDD)

Summary of Graduated Driver Licensing National Evaluation Studies					
Authors/Year	**Jurisdiction**	**Characteristics of driver population**	**Findings**	**Measures used**	**Comparison group used**
McCartt, Teoh, Fields, Braitman, Hellinga (2009) IIHS publication	50 states	15-, 16-, 17-, and 18- to 20-year-old drivers	30% lower fatal crash rate for 15- to 17-year-olds in FARS in “good” GDL states; 11% lower in “fair” GDL states.	Fatal crash rates per 100,000 population	30- to 59-year-old drivers
Vanlaar, Mayhew, Marcoux, Wets, Brijs, Shope (2009) TIRF publication	46 states & DC 11 Canadian provinces	16-, 17-, 18-, 19-year-old drivers	19% reduction in relative fatality risk of 16-year-old drivers in GDL jurisdictions. No effect on 17-, 18-, 19-year-olds.	Meta-regression analysis of relative fatality risk of drivers	25- to 54-year-old drivers

Table 2

Number of States with GDL Laws and GDL Night Restrictions by Year (1996–2008)* (Source: IIHS, 2010)

Year	GDL law	GDL night restriction
1996	1	1
1997	3	3
1998	8	7
1999	11	9
2000	6	5
2001	7	7
2002	3	2
2003	2	2
2004	0	1
2005	3	5
2006	2	2
2007	1	1
2008	1	2
No GDL law	2	3
Total states with GDL law ***(% across 50 states)***	**48** ***(96%)***	**47** ***(94%)***

*District of Columbia is excluded.

Table 3

Distribution of States by Night Restriction Beginning Hour (Source: IIHS, 2010)

Beginning hour	# States	%
9 p.m.[a]	5	10.6%
10 p.m.	4	8.5%
11 p.m.[b]	11	23.4%
Midnight	19	40.4%
1 a.m.	8	17.0%
Total	47	100.0%

[a] It includes a state with sunset to sunrise, and another state with 6 p.m. EST; 8 p.m. EDT restriction.

[b] It includes two states with 11 p.m., Sunday through Thursday, and midnight, Friday and Saturday restriction; and one with 11 p.m., Sunday through Friday, and 1 a.m., Saturday and Sunday restriction.

Table 4

States with GDL that Later Adopted a Night Restriction (6 states) (Source: IIHS, 2010)

State	GDL law	GDL night restriction
Connecticut	2003	2005
Maine	2000	2003
Minnesota	1999	2008
Nevada	2001	2005
South Dakota	1999	2004
Virginia	1998	2001

Table 5

Effects of Nighttime Restrictions on Nighttime Fatal Crash Counts for 16- and 17-year-old Drivers (As compared to nighttime crash counts for older drivers and as compared to daytime crash counts for 16- and 17-year-old drivers [Ns range from 860 state-years to 871 state-years])

Comparison ratio	t-value 11 p.m. or earlier vs. no restriction	t-value midnight vs. no restriction	Overall F nighttime restriction
16–17 vs. 19–20	−3.24**	−4.70***	F (2, 44) = 15.58***
16–17 vs. 19–25	−3.94***	−6.88***	F (2, 44) = 30.47***
16–17 vs. 19–29	−2.77**	−5.35***	F (2, 44) = 17.71***
16–17 nighttime vs. 16–17 daytime	−3.00**	−3.53**	F (2, 44) = 10.21***

* $p < .05$.

** $p < .01$.

*** $p < .001$

Table 6

Effects of Nighttime Restrictions on Alcohol-Involved Fatal Crash Counts for 16- and 17-Year-Old Drivers (As compared to alcohol-involved crash counts for older drivers and as compared to non-alcohol-involved crash counts for 16- and 17-year-old drivers [Ns range from 824 state-years to 835 state-years]).

Comparison ratio	t-value 11 p.m. or earlier vs. no restriction	t-value midnight vs. no restriction	Overall F nighttime restriction
16–17 vs. 19–20	−1.29	−2.80**	F (2, 44) = 4.55*
16–17 vs. 19–25	−2.33*	−6.16***	F (2, 44) = 21.20***
16–17 vs. 19–29	−1.37	−4.64***	F (2, 44) = 11.43***
16–17 alcohol vs. 16–17 no alcohol	−2.58*	−3.20**	F (2, 44) = 8.09**

* $p < .05$.

** $p < .01$.

*** $p < .001$

Table 7

Percentage of Change in Nighttime Fatal Crash Involvements by Driver Age

Age group and time of crash	Percentage of change
16–17 nighttime	−18.3
19–20 nighttime	−8.2
19–25 nighttime	−1.0
19–29 nighttime	−0.3
16–17 daytime	−9.3

Table 8

Percentage of Change in Drinking Driver Fatal Crashes by Driver Age

Age group + type of crash	Percentage of change
16–17 alcohol-involved	−19.4
19–20 alcohol-involved	−6.8
19–25 alcohol-involved*	−0.0
19–29 alcohol-involved	−0.3
16–17 no alcohol involved	−10.8

* observed value is −.0156%

Table 9

Effects of Teenage Passenger Limitations on Fatal Crash Counts for 16- and 17-Year-Old Drivers with Teenage Passengers
(As compared to crash counts for older drivers with teenage passengers and as compared to crash counts for 16- and 17-year-old drivers without teenage passengers [Ns range from 862 state-years to 876 state-years])

Comparison ratio	t-value restriction vs. no restriction	Overall F passenger restriction
16–17 vs. 19–20	−0.87	F (1, 33) = 0.76
16–17 vs. 19–25	−3.46**	F (1, 34) = 11.95**
16–17 vs. 19–29	−3.42**	F (1, 34) = 11.71**
16–17 with passengers vs. 16–17 no passengers	−4.37***	F (1, 34) = 19.06***

* $p < .05$.

** $p < .01$.

*** $p < .001$

Table 10

Percentage of Change in Fatal Crashes with Teen Passengers by Driver Age

Age Group + type of crash	Percentage of change
16–17 with teen passengers	−19.2
19–20 with teen passengers	−12.2
19–25 with teen passengers	−9.9
19–29 with teen passengers	−10.3
16–17 no teen passengers	−4.5

APPENDIX

Minimum Age for Full Licensing							
State	**Changed from**	**Changed to**	**Effective date of change**	**State**	**Changed from**	**Changed to**	**Effective date of change**
Arizona	16	16, 6 mo.	6/30/2008	Montana	15	16	7/1/2006
California	16	17	7/1/1998	Nebraska	16	17	1/1/1999
Colorado	16	17	7/1/1999	Nevada	15, 9 mo.	16	7/1/2001
Connecticut	16, 4 mo.	16, 7 mo.	10/1/2003	Nevada	16	18	10/1/2005
Connecticut	16, 7 mo.	18	10/1/2005	New Hampshire	16, 6 mo.	18	1/1/1998
Delaware	16	16, 10 mo.	7/1/1999	New Jersey	17	18	1/1/2001
Delaware	16, 10 mo.	17	8/31/2006	New Mexico	15	16, 6 mo.	1/1/2000
District of Columbia	16	18	1/1/2001	North Carolina	16	16, 6 mo.	12/1/1997
Florida	16	18	7/1/1996	Ohio	16	17	1/1/1999
Georgia	16	18	7/1/1997	Ohio	17	18	4/6/2007
Hawaii	15	17	1/9/2006	Oklahoma	16	16, 6 mo.	11/1/2005
Illinois	17	18	1/1/2008	Oregon	16	17	3/1/2000
Indiana	16, 1 mo.	18	7/1/1998	Rhode Island	16	17, 6 mo.	1/1/1999
Iowa	16	17	1/1/1999	Tennessee	16	17	7/1/2001
Kentucky	16, 6 mo.	17	4/1/2007	Texas	16	16, 6 mo.	1/1/2002
Maine	16	16, 3 mo.	8/1/2000	Utah	16	17	7/1/1999
Maine	16, 3 mo.	16, 6 mo.	9/16/2003	Vermont	16	16, 6 mo.	7/1/2000
Maryland	18	17, 9 mo.	10/1/2005	Virginia	16	18	7/1/1998
Michigan	16	17	4/1/1997	Washington	16	17	7/1/2001
Minnesota	16	17	8/1/2008	W. Virginia	16	17	1/1/2001
Missouri	16	18	1/1/2001	Wisconsin	16	16, 9 mo.	9/1/2000
Missouri	18	17, 11 mo.	8/26/2006	Wyoming	16	16, 6 mo.	9/16/2005

Minimum Age for Intermediate Licensing			
State	**Changed from**	**Changed to**	**Effective date of change**
Colorado	16	16, 4 mo.	1/1/1997
Connecticut	16	16, 4 mo.	1/1/1997
Delaware	None	16, 4 mo.	7/1/1999
Delaware	16, 4 mo.	16, 6 mo.	8/31/2006
District of Columbia	16	16, 6 mo.	1/1/2001
Hawaii	15	15, 3 mo.	7/1/1997
Hawaii	15, 3 mo.	16	1/9/2006
Kentucky	16	16, 6 mo.	10/1/1996
Louisiana	15	16	1/1/1998
Maryland	none	16, 1 mo.	7/1/1999
Maryland	16, 1 mo.	16, 3 mo.	10/1/2005
Mississippi	none	16	9/1/1995
Mississippi	16	15, 6 mo.	7/1/2000
Nevada	15, 9 mo.	16	10/1/2005
New Hampshire	none	16, 3 mo.	1/1/1998
New Mexico	15	15, 6 mo.	1/1/2000
New York	16	16, 6 mo.	9/1/2003
Pennsylvania	16	16, 6 mo.	12/22/1999
Rhode Island	16	16, 6 mo.	1/1/1999
South Carolina	15	15, 3 mo.	7/1/1998
South Carolina	15, 3 mo.	15, 6 mo.	3/5/2002
South Dakota	14	14, 3 mo.	1/1/1999
Virginia	16	16, 3 mo.	7/1/2001