A national evaluation of graduated driver licensing laws in the United States

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Abstract

Graduated driver licensing (GDL) laws now exist in all 50 states and the District of Columbia in the United States. These GDL systems are designed to reduce the exposure of young novice drivers to risky situations (such as late-night driving and driving with other teen passengers when alcohol is likely to be involved). Our aims were to determine if (a) GDL laws reduce fatal crash involvements of novice drivers; (b) nighttime and passenger restrictions are effective components, especially in reducing fatal crashes involving young drinking drivers; and (b) there are differential effects of GDL laws based upon driver race and ethnicity. A longitudinal panel study and logistic regression analyses were used to meet the aims. The 1990-2007 Fatality Analysis Reporting System (FARS) data sets were used to determine if changes in crash involvements of young drivers and young drinking drivers were associated with the adoption of GDL laws. GDL laws with stricter components showed stronger relationships to fatal crash reductions (from 8 to 13%), and laws with weak components showed no reductions in crash involvements. 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 novice driver involvements in fatal crashes with teen passengers by an estimated 9%. GDL reductions were largest for young White drivers, followed by African-Americans, and then Asians, with no significant reductions for young Hispanics. States without the nighttime or passenger restrictions in their GDL laws should strongly consider adopting them. The differential effects of GDL laws based on the race and ethnicity of young drivers needs further research.

Background

Motor-vehicle crashes are the leading cause of death for young people aged 15 to 20 in the United States, accounting for approximately 36% of their deaths. Young drivers aged 15 to 20 make up 8 to 9% of the U.S. population but only about 6 to 7% of the licensed drivers; however, they are involved in 11 to 14% of the fatal traffic crashes in recent years. About 22 to 24% of young drivers (aged 15 to 20) involved in fatal crashes are estimated to have been drinking before their crash. The crash rates of 16-year-old drivers are three times greater than 17-year-olds, five times greater than 18-year-olds, and twice those of drivers aged 85.

To address the young driver problem, traffic safety officials from several organizations in the United States developed a licensing system that prolongs the learning process for beginning drivers and restricts their driving to less risky conditions. Typically, GDL programs require three stages: a supervised learning stage of 6 months or more, an intermediate or provisional license stage of several months with restrictions on high-risk driving, and finally, full license privileges with no restrictions. This three-staged national model for GDL has been established so that beginning drivers must demonstrate responsible driving behavior (no traffic offenses) in each stage before advancing to the next stage. After novice drivers have graduated from supervised driving to independent driving, most GDL systems restrict nighttime driving and the number of teen passengers, among other provisions, until the novice driver is fully licensed.

GDL laws now exist in all 50 states and the District of Columbia. These laws generally require three-staged licensing for novice drivers: (a) a learner's permit period—practice driving with a licensed driver aged 21 or older; (b) an intermediate or provisional stage—drive solo only under certain conditions (e.g., restricts late-night driving and limits teen passengers); and (3) a full license with no restrictions (minimum age of 18 in some states). The young driver must meet certain requirements to "graduate" to each stage. Studies of GDL systems in the states have indicated they help reduce the crash rates of young drivers. Table 1 summarizes some of the national studies.

Table 1. 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 30-54 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)
McCartt, Teoh, Fields, Braitman, Hellinga (2009) IIHS Publication	50 states	15- 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 (Vanlaar et al., 2009) TIRF publication	46 states & DC 11 Canadian provinces	16- to 19-year-old drivers	19% reduction in Relative Fatality Risk of 16-year-old drivers in GDL jurisdictions. No effect on 17- to 19-year-olds	Meta-Regression Analysis of Relative Fatality Risk of drivers	25- to 54-year-old drivers

Our aims required three separate studies (a) to determine the overall effectiveness of GDL laws on reducing young novice driver fatal crashes; (b) to evaluate the effectiveness of two key components of GDL laws—the nighttime and passenger restrictions; and (c) to determine if there have been differential effects of GDL laws on young drivers according to their race and ethnicity.

Methods

A longitudinal panel approach (sometimes called a "cross-sectional time-series approach") was used in our first study. We examined annual FARS data for all 50 states and the District of Columbia

(DC) from 1990 through 2007. We combined the state-by-year crash incidences of 16- and 17-year-olds because many state-by-year cells had an incidence rate of zero when these ages were observed separately. DC was excluded due to reporting zero crashes among 16- and 17-year-old drivers in more than half of the years observed after the ages were combined. We applied a Box and Jenkins (1976) ARIMA (Autoregressive Integrated Moving Average) intervention regression method to evaluate the enactment of a GDL law (the intervention) on the fatal crash incidence among 16- and 17-year-old drivers relative to the two older driver age groups.

To account for crash exposure, we computed and compared ratios of the drivers aged 16-17 involved in fatal crashes with two older age groups: 19-20 and 21-25. We used the crash population aged 19-20 and 21-25 as proxy denominators for drivers aged 16-17 to control for most of the driving exposure elements common to both groups. The Insurance Institute for Highway Safety (IIHS) rated a GDL law as "good" if it had five or more of the following seven components: (a) minimum age for a learner's permit, (b) mandatory waiting period before applying for intermediate license, (c) minimum hours of supervised driving, (d) minimum age for intermediate license, (e) nighttime restriction, (f) passenger limitation, and (g) minimum age for full licensing. Regression models for each age-group ratio were separately performed for the three categories of GDL laws (average, good, and less than good). The ratios of interest (drivers aged 16-17 involved in fatal crashes relative to the two other age groups) were then regressed on the GDL laws alone and with each of the four potentially confounding laws and, finally, with all four covariates included in the analysis.

For our second study of the effects of nighttime and passenger restrictions, counts of drivers aged 16-17, 19-20, 19-25, and 19-29 in nighttime (9 p.m. to 5 a.m.) fatal crashes, and counts of drivers aged 16-17 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 with passengers present and (b) fatal crashes with drivers aged 16-17 with no passengers, collapsing across the daytime and nighttime periods previously defined. For models examining effects of nighttime driving restrictions on nighttime fatal crashes among drivers aged 16-17, we computed ratios of nighttime fatal crash counts for drivers aged 16-17 (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 drivers age 16-17 versus daytime fatal crashes for drivers aged 16-17, resulting in four outcome measures. To examine effects of nighttime restrictions on alcohol-involved fatal crashes among drivers aged 16-17 (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 drivers aged 16-17 versus non-alcohol-involved crashes for drivers aged 16-17 (those with BACs=.00 g/dL). To examine effects of passenger restrictions, another set of parallel ratio measures was computed: that is, three age group comparison ratios plus one passenger present versus no passengers present ratio for drivers aged 16-17 only. The use of ratios (e.g., nighttime fatal crashes vs. daytime fatal crashes) as dependent measures largely controls for state- and year-specific driving and safety conditions, reducing the need for covariates that predict fatal crashes. Using ratios also controls for differences in jurisdiction (state) size. To examine the effects of GDL restrictions on driving at night and driving with teenage passengers, 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 x 50 states = 900 state-year observations).

In our third study of GDL effects by race and ethnicity, three logistic regressions were performed, each modeling the likelihood that the driver in the crash would have a BAC>.00, a BAC≥.08, or would have been speeding, respectively. For each of these models, the effect of the adoption of the GDL law in that state on the specific crash type by race/ethnicity using White drivers as the reference was examined. Also included was a time variable (year) to account for trends and dual interactions were conducted between race/ethnicity, age, and the adoption of the GDL law. Analyses of these interactions are considered highly relevant to this study as they were used to test whether the adoption of the GDL law would have a larger effect on drivers aged 15 to 17 than on drivers of other age groups (our hypothesis). Analyses were also conducted to determine whether the GDL law had a proportionally different effect on racial/ethnic groups other than Whites.

Results

We found that the adoption of a GDL law of average strength was associated with a significant decrease in fatal crash involvements of drivers aged 16-17 relative to fatal crash involvements of older drivers. GDL laws rated as "good" by the IIHS (www.iihs.org) showed stronger relationships to fatal crash reductions (about 8 to 13%), and laws rated as "less than good" showed no reductions in crash involvements relative to the older driver comparison groups. States that adopt a basic GDL law can expect a decrease of 7 to 11% in the proportion of drivers aged 16-17 involved in fatal crashes (relative to drivers aged 21-25), depending upon other existing laws that affect novice drivers (Fell, Jones, Romano, & Voas, 2011b).

Nighttime restrictions were found to reduce involvement of drivers aged 16-17 in nighttime fatal crashes by an estimated 10% and *drinking* drivers aged 16-17 in nighttime fatal crashes by 13%. Passenger restrictions were found to reduce involvement of drivers aged 16-17 in fatal crashes with teen passengers by an estimated 9%. These results confirm the effectiveness of these provisions in GDL systems. Our results also suggest that nighttime restrictions on teenage driving reduces nighttime fatal crashes among drivers aged 16-17 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 (Fell, Todd, & Voas, 2011a).

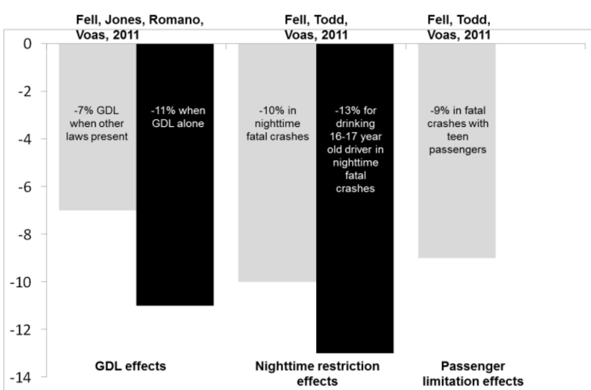

Figure 1. Effects of GDL laws and nighttime and passenger restrictions

The relative reduction in fatal crashes for drivers aged 16-17 with teen passengers versus without teen passengers was significant. The teen passenger limitation was significant only when the comparison was between years without any teen passenger restrictions and the years with the strictest possible limits (i.e., no teen passengers permitted) (Fell, et al., 2011a). Figure 1 summarizes the effects from our first two studies.

In our third study, we found differential effects of GDL laws depending upon the young driver's race and ethnicity. The analysis of states with GDL laws enacted between 2000 and 2007 showed no change for young (aged 16-17) Hispanic drivers in fatal crashes before and after a GDL law was adopted. Overall, GDL reductions were largest and significant for young White drivers, followed by African-Americans, and then Asians, with no significant reductions for young Hispanics. GDL laws also had no apparent effect on speeding-related fatal crashes for any of these novice drivers (Romano, Fell, & Voas, 2011).

Conclusion

States without the nighttime or passenger restrictions in their GDL law should strongly consider adopting them. A recent national survey revealed that Americans support GDL provisions: 70% favored nighttime driving restrictions, and 65% favored limited teen passengers for novice drivers.

Discussion

A recent study of GDL laws (Masten, Foss, & Marshall, 2011) found substantial reductions in fatal crashes of 16-year-old drivers associated with the adoption of strong GDL laws (down 26%), but found increases in fatal crashes for 18-year-olds in those same states (up 12%). The authors suggested that strong GDL laws might have delayed licensure of many youth until they were aged 18 to avoid all the GDL provisions and requirements. Our analysis is shown in Table 2.

Table 2. Estimated changes in fatal crashes and fatalities associated with the adoption of GDL laws in 50 states[a].

	"Any" GDL law			"GOOD" GDL Laws		
Effect measured: GDL law alone	% change[c]	*p* ≤0.05? Y/N	Estimated number of lives saved or lost (S/L) in presence of any GDL law	% change[c]	*p* ≤0.05? Y/N	Estimated number of lives saved or lost (S/L) in presence of a good GDL law
Age of driver[b]						
15	-5.9	N	692 (S)	-3.2	N	375 (S)
16	**-16.9**	**Y**	**1945 (S)**	**-20.4**	**Y**	**2347 (S)**
17	-5.4	N	779 (S)	-5.9	N	851 (S)
18	+4.4	N	1141 (L)	**+10.5**	**Y**	**2724 (L)**
19	+5.6	N	439 (L)	**+10.9**	**Y**	**855 (L)**
20	+0.10	N	76 (L)	+5.9	N	451 (L)

[a] Source: FARS. Methods from Fell, Jones, Romano & Voas (2011). [b] Age ratio used for estimate: Age/21-25. [c] Calculation performed assuming no change in ratio denominator (age/21-25) pre- and post-passage of GDL laws. Numbers in bold are statistically significant at $p \leq .05$.

Using the findings for each age that were significant ($p<.05$), 1,945 lives associated with GDL laws in general were saved by the reductions in fatal crashes involving drivers aged 16. For the "good" GDL laws, there was a net increase in fatalities of 377 due to the increase in fatal crashes by drivers aged 18, with an additional increase of 855 fatalities if the 19-year-old increase is included. "Good" GDL laws resulted in 2,347 lives saved due to the reduction of drivers aged 16 in fatal crashes but were associated with an increase of 2,724 fatalities from fatal crash involvements of drivers aged18.

The outcome of this effort indicates once more that GDL laws save the lives of the population they target: novice drivers aged 15-17. This favorable impact is even larger for the better GDL programs (i.e., the enacted GDL is "good"). These results also indicate that the lives of some drivers aged 15-17 saved by GDL laws are offset among the associated increases in fatal crashes by drivers aged 18-19. The reasons for the conflict in GDL benefits are unclear. They could be caused by (a) drivers aged 18-19 skipping the GDL phases and beginning to drive at a later age, reducing their driving experience; (b) drivers aged 18-9 exhibiting more risk-taking behaviors (e.g., impaired driving, lack of safety belt use, distracted driving) than younger drivers; (c) drivers aged 18-19 having increased exposure to risk for a fatal crash (e.g., more late-night driving; more driving on high-speed roads); and/or (d) drivers aged 18-19 who have gone through the two phases of GDL lacking driving experience under risky conditions because of all the restrictions in the GDL laws. Whatever the reasons, this finding suggests that GDL laws should be applied to protect novice drivers older than ages 16 and 17, perhaps up to age 21. Further research to clarify this finding is needed.

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References

Baker, S.P., Chen, L.H., & Li, G. (2006). National evaluation of graduated driver licensing programs. Washington, DC: U.S. DOT, National Highway Traffic Safety Administration.

Baker, Susan P., Chen, Li-Hui, & Li, Guohua. (2007). Nationwide Review of Graduated Driver Licensing. Washington, DC: AAA Foundation for Traffic Safety.

Box, G.E.P., & Jenkins, G.M. (1976). *Time series analysis: Forecasting and control* (Revised ed.). San Francisco, CA: Holden-Day, Inc.

Chen, L.H., Baker, S.P., & Li, G. (2006). Graduated driver licensing programs and fatal crashes of 16-year-old drivers: A national evaluation. *Pediatrics, 118*(1), 56-62.

Dee, T.S., Grabowski, D.C., & Morrisey, M.A. (2005). Graduated driver licensing and teen traffic fatalities. *Journal of Health Economics, 24*(3), 571-589.

Fell, J. C., Todd, M., & Voas, R. (2011a). A national evaluation of the nighttime and passenger restriction components of graduated driver licensing. *Journal of Safety Research, 42*(4), 283-290.

Fell, James, Jones, Kristina, Romano, Eduardo, & Voas, Robert. (2011b). An evaluation of graduated driver licensing effects on fatal crash involvements of young drivers in the United States. *Traffic Injury Prevention, 12*(5), 423-431.

Masten, S.V., Foss, R.D., & Marshall, S.W. (2011). Graduated driver licensing and fatal crashes involving 16- to 19-year-old drivers. *J of the Am Medical Association, 306*(10), 1098-1103.

McCartt, A.T., Teoh, E.R., Fields, M., Braitman, K.A., & Hellinga, L.A. (2009). Graduated Licensing Laws and Fatal Crashes of Teenage Drivers: A National Study. Arlington, VA: Insurance Institute for Highway Safety.

Romano, E., Fell, J., & Voas, R.B. (2011). The role of race and ethnicity on the effect of graduated driver licensing laws in the United States. *Annals of Advances in Automotive Medicine, 55*, 51-61.

Vanlaar, Ward, Mayhew, Dan, Marcoux, Kyla, Wets, Geert, Brijs, Tom, & Shope, Jean. (2009). An Evaluation of Graduated Driver Licensing Programs in North America. Ottawa, ON: Traffic Injury Research Foundation.