INSURANCE SPECIAL REPORT

Graduated Driver Licensing Laws and Insurance Collision Claim Frequencies of Teenage Drivers

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Summary

Young drivers have collision claim frequencies per insured driver approximately double those of drivers ages 35-55. To reduce the high collision rates among young drivers, many states have adopted graduated driver licensing (GDL) programs. GDL is designed to delay full licensing while allowing beginning drivers to gain experience under lower risk conditions. This study evaluates how the strength of state GDL provisions affect collision claim frequencies of young drivers and the effect on collision claim frequencies of individual GDL components.

State GDL laws have been rated as good, fair, marginal, or poor by the Insurance Institute for Highway Safety (IIHS) based on the number and strength of provisions in the individual components. From Poisson regression analyses, the estimated collision claim frequency of rated drivers age 16 was 22 percent lower for GDL laws rated good compared with laws rated poor. Claim frequencies were 17 percent lower for laws rated fair and 11 percent lower for laws rated marginal, compared with laws rated poor for drivers age 16. The effect of GDL decreased as rated driver age increased. For rated drivers age 19, claim frequencies were 9 percent lower for laws rated good than for laws rated poor.

Collision claim frequencies of rated drivers ages 16-17 were modeled using the GDL components of permit age, required holding period, required practice hours, licensing age, passenger restrictions, and nighttime driving restrictions. Restricting the number of passengers to one or fewer reduced claim frequencies 6 percent, restricting driving after 9 p.m. reduced frequencies 11 percent, and increasing required practice driving by 20 hours reduced frequencies 4 percent. Permit age and licensing age were not significant at the 0.05 level, but the model estimated a 3 percent reduction in claim frequencies for increasing the permit age by 1 year and a 7 percent reduction for increasing the licensing age by 1 year. When combined with the other GDL components, lengthening the permit holding period proved counterproductive, with a slight increase in claim frequencies (2 percent increase for lengthening the permit holding period by 3 months).

This report was done in parallel with an IIHS study evaluating the effect of GDL on the fatal crash involvements of young drivers (McCartt et al., 2009). The IIHS study found similar reductions in losses for both the strength of GDL laws and the strength of GDL components. Compared with laws rated poor, the fatal crash rate for drivers ages 15-17 was 30 percent lower for laws rated good and 11 percent lower for laws rated fair. Specific GDL components were estimated to have large reductions in fatal crash rates for drivers ages 15-17. Delaying the licensing age by 1 year had a 13 percent reduction in the fatal crash involvement rate for drivers ages 15-17, restricting driving after 10 p.m. had a 16 percent reduction, not allowing teenage passengers had a 21 percent reduction, and delaying the permit age by 1 year had a 13 percent reduction. Lengthening the permit holding period and increasing required practice driving had little effect on fatal crash involvement rates.

INTRODUCTION

The Highway Loss Data Institute (HLDI) is a nonprofit public service organization that gathers, processes, and publishes insurance data concerned with human and economic losses resulting from owning and operating motor vehicles.

Young drivers have collision claim frequencies approximately double those of drivers ages 35-55 (HLDI, 2007). The higher crash rates among young drivers result from both immaturity and lack of driving experience. Teenagers have particularly high crash rates during their first months of licensure (Mayhew et al., 2003a; McCartt et al., 2003). Collision risks are especially high at night and when carrying passengers (Chen et al., 2000; Doherty et al., 1998; Ferguson et al., 2007; Preusser et al., 1998; Ulmer et al., 1997; Williams, 2003; Williams et al., 2005).

To reduce the high collision rates among young drivers, many states have adopted graduated driver licensing (GDL) programs. GDL is designed to delay full licensing while allowing beginning drivers to gain experience under lower risk conditions. There are three stages of GDL: learner, intermediate, and unrestricted. A person in the learner stage has passed a written test to receive a learner's permit. All states have minimum age restrictions on when a teenager can apply for a permit. During the learner stage, a person may only drive while supervised by a licensed driver. Before obtaining a driver's license, a person in the learner stage may be required to hold the permit for a minimum length of time and/or complete a minimum number of hours practicing driving. The intermediate stage begins with passing of the driving test. All states have minimum age restrictions for a driver's license. During the intermediate stage, there may be restrictions on nighttime driving and/or restrictions on the number of passengers. The length of these restrictions can be a function of time (e.g., 6 months) or age (e.g., until age 17). At the completion of the restrictions, the person enters the unrestricted stage. For states with no nighttime, passenger, or other restrictions, there is no intermediate stage. In summary, the typical GDL components for the learner stage are permit age, required practice driving, and permit holding period. The typical GDL components for the intermediate stage are licensing age, nighttime driving restrictions, and number of passenger restrictions.

EFFECTS OF GRADUATED LICENSING

Florida is credited with enacting the first GDL program in the United States beginning July 1996. Injury crashes decreased 9 percent for 15-17 year-olds after GDL was introduced (Ulmer et al., 2000). Nova Scotia and California also implemented early GDL programs. In Nova Scotia, there was a 24 percent decrease in crashes for 16 year-olds during the first year and a 37 percent decrease during the first 3 years of the program (Mayhew et al., 1999). California saw an estimated 23 percent reduction in injury and fatal crashes for 16-year-old drivers after GDL's 1998 enactment (Zwicker et al.,2006). US states that have enacted GDL programs typically have found crash rate reductions of 10-30 percent (Fohr et al., 2005; Foss et al., 2001; Hallmark et al., 2008; Mayhew et al., 2003b; Neyens et al., 2008; Shope and Molnar, 2004; Ulmer et al., 2000).

Two studies have examined the strength of GDL laws based on criteria developed by the Insurance Institute for Highway Safety (IIHS). Both used a national database. Dee et al. (2005) found substantial differences among GDL programs, with those rated good by IIHS reducing fatalities 19 percent compared with 6 percent for programs rated fair. Morrisey et al. (2006) found differences in the effect of GDL between daytime and nighttime traffic fatalities. Good GDL programs resulted in a 29 percent reduction in daytime fatalities but only a 10 percent reduction in nighttime fatalities among drivers ages 15-17.

A slightly different approach evaluated the number of GDL components a state adopted. Among 16 year-olds, states with three GDL components (at least a 3-month holding peri-

od, any nighttime restriction, and either at least 30 practice hours or any passenger restriction) had 16-21 percent lower fatal crash involvement rates compared with states with no GDL programs. Fatality involvement rates were 18-21 percent lower for states with five or more GDL components (Chen et al., 2006). Using a more stringent definition of GDL components (one or fewer passengers, nighttime restriction of 10 p.m. or earlier, and holding period of at least 6 months), fatal crash involvement rates for 16 year-olds were 38 percent lower in states with five components and 21 percent lower in states with four component compared with states with no GDL (Baker et al., 2007).

Several studies have quantified the effect of individual GDL components. Nighttime driving restrictions have been found to reduce crashes of young drivers by 40-60 percent during the restricted hours (Foss et al., 2001; Masten and Hagge, 2004; Mayhew et al., 2003a; Shope and Molnar, 2004; Ulmer et al., 2000). Teenage passenger restrictions were found to reduce annual crash involvements among 16 year-olds by 740 in California, 173 in Massachusetts, and 454 in Virginia (Chaudhary et al., 2007). In California, it was estimated that passenger restrictions prevented 816 fatal/injury crashes annually for drivers ages 16-17 (Masten and Hagge, 2004). In the 3 years following introduction of the passenger restrictions in California, the average number of passengers in vehicles driven by 16-year-olds decreased 25 percent (Cooper et al., 2005).

Objective of Study

The purpose of the current study was to evaluate how the strength of state graduated licensing laws affect collision claim frequencies of young drivers and to determine the effect on collision claim frequencies of individual GDL provisions. Results expanded on earlier studies in both determining which GDL components are most effective in reducing claim frequencies and in using the metric collision claim frequency. Using insured driver claim frequency, as opposed to a population-based crash rate, provided the benefit of knowing that the subject group contained only licensed drivers.

GDL affects teenage drivers in two ways: delaying licensure and restricting high-risk driving conditions. In analyzing delay of licensure, using only licensed drivers allowed this study to isolate the driver maturity effect from the "just fewer teenagers driving" or licensure rate effect. An increase in driver maturity through delayed licensure should help a teenager make better decisions while driving and result in lower crash rates. If no increase in maturity occurs with delayed licensure, then the delay only postpones the high crash rate driving. A delay in licensure can result directly from increasing the licensing age, lengthening the permit holding period, or increasing the required practice driving or indirectly from making driving less attractive through restrictions.

The other aspect of GDL involves restricting driving in high-risk conditions. The two most common GDL provisions are restricting the number of passengers and restricting nighttime driving. Restricting nighttime driving will directly reduce a driver's exposure to some crashes (e.g., if a teenager is not allowed to drive between midnight and 5 a.m., then they are not exposed to possible crash risk during the restricted hours). Passenger restrictions are designed to reduce possible distractions from other occupants of the vehicle and allow the beginning driver to focus on driving.

Twenty-nine insurers supply data to HLDI: 21st Century, AAA Northern California, Nevada & Utah, Allstate, American Family, American National Property and Casualty, AMICA, Auto Club Group, Automobile Insurers Bureau of Massachusetts, Chubb, COUNTRY, Erie, Farmers, GEICO, GMAC, High Point, Kentucky Farm Bureau, Liberty Mutual, MetLife Auto and Home, Nationwide, PEMCO, Progressive, Rockingham, Safeco, State Farm, Tennessee Farmers Mutual, The Hartford, The Travelers Companies, Unitrin, and USAA. These companies account for about 80 percent of privately insured passenger vehicles. Coverage and losses from both standard and nonstandard risk are included.

METHODS

COLLISION CLAIM FREQUENCY

Collision insurance covers first party physical damage to a vehicle from a crash. It can be a single- or multiple-vehicle crash. Minor crashes that do not exceed the insured driver's deductible are not included because no claim would be filed. Claim frequency measures how often a person is involved in a collision. The frequency is computed by taking the ratio of the number of claims for a group to the amount of exposure for the group. Exposure is the amount of time an individual vehicle is insured.

RATED DRIVER AGE

The rated driver is the one who typically, for insurance purposes, is considered to represent the greatest loss potential for the insured vehicle. Although this is typically the primary driver, the actual driver at the time of the crash is not available in the HLDI database. Because only the year of birth is provided to HLDI, the exact age of the rated driver is unknown. A January 1 birth date was assumed, resulting in a 2-year range in the actual age for a given rated driver age. For example, the assigned age of 16 in this study can range from an actual age of 15 and 1 day to 16 and 364 days.

In analyzing the strength of states GDL programs, rated driver ages 16-19 were used. The analyses on the effectiveness of individual GDL components focused on the rated drivers most affected by GDL, ages 16 and 17. Only licensed drivers are present in the insurance database. Permit stage drivers are not included.

STATE AND CALENDAR YEAR DATA

The present study used collision coverage and losses for 0-3-year-old passenger vehicles during calendar years 1996-2006. Only newer vehicles were used due to data availability. All states except Massachusetts and New Jersey were included. These two states were excluded due to incomplete data. The combination of 48 states and 11 calendar years produced 528 observations. A GDL law was assigned to a state-year if the law went into effect before October 1 of that year. Laws going into effect October 1 or later were assigned to the following year. A fourth quarter cutoff was used because laws going into effect late in the year would have little or no effect on that calendar year's results.

STATE GDL LAWS

GDL laws are designed to delay full licensing while allowing beginning drivers to gain experience under lower risk conditions. Six of the most common GDL provisions were examined in this study: increasing the learner's permit age, increasing the intermediate license age, requiring a learner's permit holding period, requiring practice driving, restricting night driving, and restricting the number of passengers. The minimum age for a full unrestricted license also was considered but omitted from the study due to its correlation with the start of nighttime and passenger restrictions (i.e., the unrestricted license age would change from the licensing age at the same time that the nighttime or passenger restriction begins). Insufficient data were available to analyze newer laws such as banning cell phone use and texting while driving.

All of the study variables except passenger restrictions were treated as continuous. The passenger restriction was coded into two groups: 0-1 passengers and 2 or more passengers (including no restriction). The separation in coding was made between one and two passengers because the case of two passengers would allow potentially distracting conversations between occupants other than the driver, and a second passenger typically would sit in the rear seat causing the driver to fully take their eyes off of the road when turning to look/talk to the rear passenger. The grouping also provided larger cell counts.

Nighttime driving restriction was measured in the number of restricted hours with 5 a.m. set as the morning cutoff. For example, a night driving restriction of 1 a.m. was coded as 4 hours, and a night driving restriction of 10 p.m. was coded as 7 hours. No restriction was coded as 0 hours. Where completion of driver education changed a GDL requirement, the requirement pertaining to the driver education track was assigned. GDL laws were counted in the present study for both primary and secondary enforcement.

The quantity and quality of GDL laws vary significantly by state. Some states enacted many GDL provisions (i.e., California added a 6-month holding period, 50 hours of practice driving, a midnight nighttime restriction, and no passengers for the first 6 months in 1998). Other states enacted minimal GDL restrictions (i.e., North Dakota added a 6-month holding period in 1999). State GDL components vary not only in their presence or absence but also in their strength. For example, the 1 a.m. night restriction in Missouri would not be expected to have the same impact as the 9 p.m. restriction in North Carolina.

State GDL laws have been rated as good, fair, marginal, or poor by IIHS based on the number and strength of the GDL provisions. Table 1 lists the GDL components and their corresponding points. A detailed list of the state GDL laws is available on the IIHS website (www.iihs.org).

TABLE 1 RATINGS OF STATE GRADUATED LICENSING SYSTEMS

GRADUATED LICENSING COMPONENT	REQUIREMENT	POINTS
Permit age	16 or older	1 point
	Less than 16	0 points
Permit holding period	6 or more months	2 points
	3-5 months	1 point
	Less than 3 months	0 points
Required practice hours	30 or more hours	1 point
	Less than 30 hours	0 points
Restriction on night driving	10 pm or earlier	2 points
	After 10 pm	1 point
	No restriction	0 points
Restriction on number of passengers	1 or fewer passengers	2 points
	2 passengers	1 point
	3 or more passengers	0 points
Duration of night restriction	12 months or more from minimum licensing age	1 point
	Less than 12 months	0 points
Duration of passenger restriction	12 months or more from minimum licensing age	1 point
	Less than 12 months	0 points

GRADUATED LICENSING RATING	POINTS
Good	6 or more points
Fair	4-5 points
Marginal	2-3 points
Poor	less than 2 points

Notes:
Regardless of point totals, no state was rated above marginal if licensing age could be younger than 16 or the state allowed unrestricted driving before age 16, 6 months.

Where completion of driver education changed a requirement, point values were determined for the driver education track.

Controlling for Other Factors

The collision claim frequency for rated drivers ages 35-55 was used as a covariate in the model to control for long-term trends in collision claim frequencies, changes in companies comprising the insurance database, and differing patterns by state due to economic trends, weather, or non-GDL laws. Ages 35-55 were selected as the control because it provided a large stable group that was sufficiently separated from youthful and senior rated drivers (both groups having high collision claim frequencies).

Analysis Methods

Poisson regression was used to model the effect of GDL on the collision claim frequencies of young rated drivers. This method was selected because claim frequencies have a skewed distribution, are never negative, and follow a Poisson process (the number of times an event occurs in fixed period of time; in this case, the number of claims occurring in an insured vehicle year). The analyses were run in SAS using the PROC GENMOD procedure with a log link function and Pearson dispersion adjustment.

Two groups of models were analyzed. The first model examined the strength of state GDL programs by using the GDL rating as the independent variable. The rating of poor was used as the reference value. Analyses were run for ages 16, 17, 18, 19, 16-17, and 16-19. The older teenagers (18-19 year-olds) were included in these initial analyses to assess some theorists' concerns that older teens might suffer from GDL in two ways: either because they substitute as drivers for younger teens who are delaying licensure or because their lack of experience with night driving or passenger distractions results in their crash rate increasing when they graduate from GDL restrictions (Males, 2007; Neyens et al., 2008).

For drivers ages 17-19, an alternative state GDL rating model was run lagging the GDL introduction dates to correspond to the age when 17-19 years-olds were under the GDL provisions. GDL start dates were lagged 1, 2, and 3 years for ages 17, 18, and 19, respectively. For example, Oregon enacted a midnight driving restriction in March 2000. For age 16, the nighttime restriction start date would remain March 2000, but for ages 17, 18, and 19, the start date would be March 2001, March 2002, and March 2003, respectively. Eighteen year-olds in 2000 would never have had their nighttime driving restricted when they were 16, but 18 year-olds in 2002 would have had their nighttime driving restricted when they were 16. GDL component data for earlier calendar years was added to retain 528 state-year observations in these analyses using lagging.

The second group for models used the GDL components (permit age, holding period, practice hours, license age, night restrictions, and passenger restriction) as independent variables. For passenger restriction, "no restriction or 2+ passengers" was used as the reference value. All other variables were treated as continuous. Analyses were produced for the ages most affect by GDL: 16, 17, and 16-17. Both models included the collision claim frequency of rated drivers ages 35-55 as a covariate to control for non-GDL state and time period factors.

Results

Effect of State GDL Ratings

Table 2 summarizes the results of the Poisson regression analyses using the state GDL rating as the independent variable and collision claim frequency as the dependent variable. The claim frequency of rated drivers ages 35-55 was used as a covariate. The table lists the parameter, parameter estimate, e-parameter estimate, standard error, chi-square value, and p-value. The predictors (GDL ratings of good, fair, and marginal) were statistically significant at the 0.05 level for each age (16, 17, 18, and 19) and the age groups 16-17 and 16-19.

Table 2 Poisson Regression Results of Collision Claim Frequencies Regressed on GDL Ratings for Rated Drivers Ages 16-19

Rated Driver Age	Parameter	Estimate	e of Estimate	Standard Error	Chi-Square	P-value
Age 16	Intercept	-2.5521	0.078	0.0574	1973.77	<0.0001
	Covariate	0.1197		0.0092	168.26	<0.0001
	State GDL Rating					
	Good	-0.2541	0.776	0.0311	66.82	<0.0001
	Fair	-0.1829	0.833	0.0255	51.43	<0.0001
	Marginal	-0.1147	0.892	0.0311	13.58	0.0002
	Poor	0	1.000	0		
Age 17	Intercept	-2.6363	0.072	0.0417	4000.95	<0.0001
	Covariate	0.1154		0.0066	303.95	<0.0001
	State GDL Rating					
	Good	-0.1361	0.873	0.0215	40.06	<0.0001
	Fair	-0.1166	0.890	0.0184	40.24	<0.0001
	Marginal	-0.0967	0.908	0.0229	17.79	<0.0001
	Poor	0	1.000	0		
Age 18	Intercept	-2.6414	0.071	0.0333	6292.34	<0.0001
	Covariate	0.1094		0.0053	433.09	<0.0001
	State GDL Rating					
	Good	-0.1060	0.899	0.0173	37.76	<0.0001
	Fair	-0.0830	0.920	0.0149	30.91	<0.0001
	Marginal	-0.0589	0.943	0.0183	10.37	0.0013
	Poor	0	1.000	0		
Age 19	Intercept	-2.6089	0.074	0.0274	9046.37	<0.0001
	Covariate	0.0989		0.0043	531.09	<0.0001
	State GDL Rating					
	Good	-0.0903	0.914	0.0144	39.15	<0.0001
	Fair	-0.0526	0.949	0.0125	17.58	<0.0001
	Marginal	-0.0550	0.946	0.0152	13.15	0.0003
	Poor	0	1.000	0		
Ages 16-17	Intercept	-2.6059	0.074	0.0431	3654.63	<0.0001
	Covariate	0.1166		0.0069	287.68	<0.0001
	State GDL Rating					
	Good	-0.1758	0.839	0.0225	60.85	<0.0001
	Fair	-0.1408	0.869	0.0190	54.69	<0.0001
	Marginal	-0.1028	0.902	0.0236	19.02	<0.0001
	Poor	0	1.000	0		
Ages 16-19	Intercept	-2.6139	0.073	0.0302	7506.32	<0.0001
	Covariate	0.1068		0.0048	503.70	<0.0001
	State GDL Rating					
	Good	-0.1214	0.886	0.0158	59.23	<0.0001
	Fair	-0.0886	0.915	0.0136	42.56	<0.0001
	Marginal	-0.0702	0.932	0.0166	17.87	<0.0001
	Poor	0	1.000	0		

Table 3 and Figure 1 show the predicted percentage reductions in collision claim frequencies for GDL ratings of good, fair, and marginal compared with poor. For each age group, good ratings had the largest percentage change from poor ratings. Rated drivers age 16 in states with good GDL ratings had the greatest predicted decrease in claim frequency of 22 percent. The effect of GDL decreased as age increased, with predicted reductions for good ratings of 13 percent for age 17, 10 percent for age 18, and 9 percent for age 19. The still sizeable effects for ages 18 and 19 may have been due to several factors, including younger siblings of the household driving the vehicle assigned to the rated driver age 18 or 19. No negative effect on post-GDL teenage driving was found contrary to some theories (Males, 2007; Neyens et al., 2008).

TABLE 3 PREDICTED PERCENT REDUCTIONS IN COLLISION CLAIM FREQUENCIES COMPARED WITH POOR GDL RATINGS BY RATED DRIVER AGE

GDL RATING	AGE 16	AGE 17	AGE 18	AGE 19	AGES 16-17	AGES 16-19
Good	22.4%	12.7%	10.1%	8.6%	16.1%	11.4%
Fair	16.7%	11.0%	8.0%	5.1%	13.1%	8.5%
Marginal	10.8%	9.2%	5.7%	5.4%	9.8%	6.8%
Poor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

FIGURE 1 PREDICTED PERCENT REDUCTIONS IN COLLISION CLAIM FREQUENCIES COMPARED WITH POOR GDL RATING BY RATED DRIVER AGE

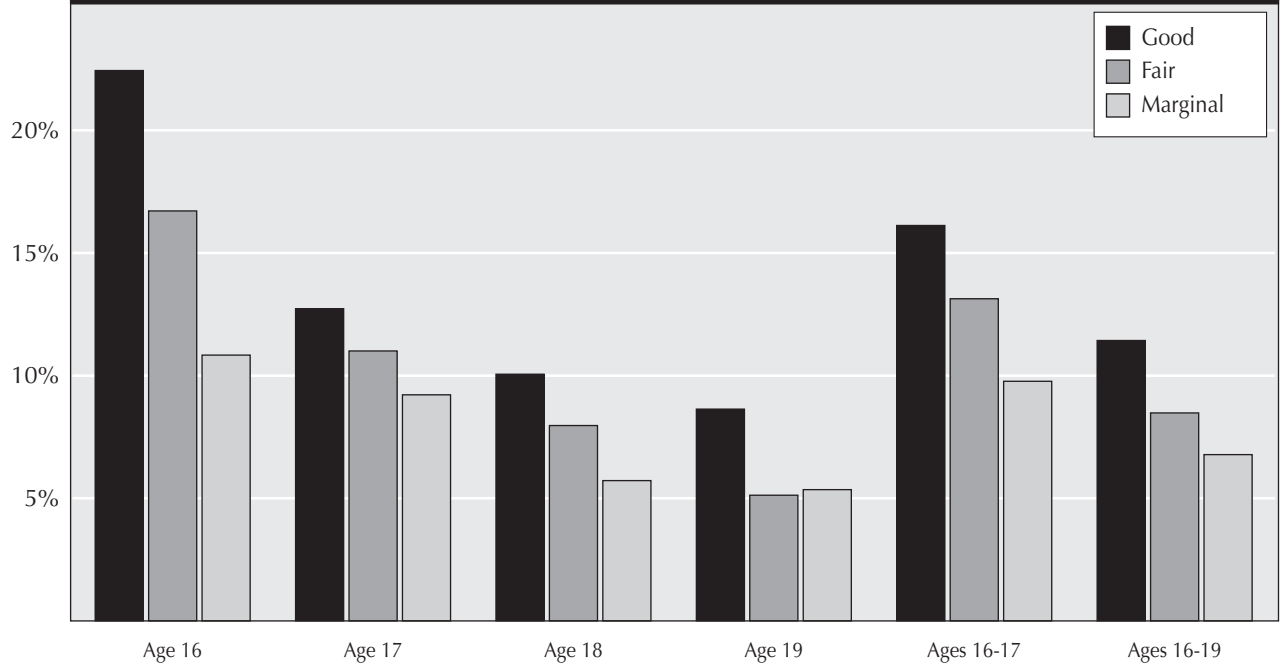


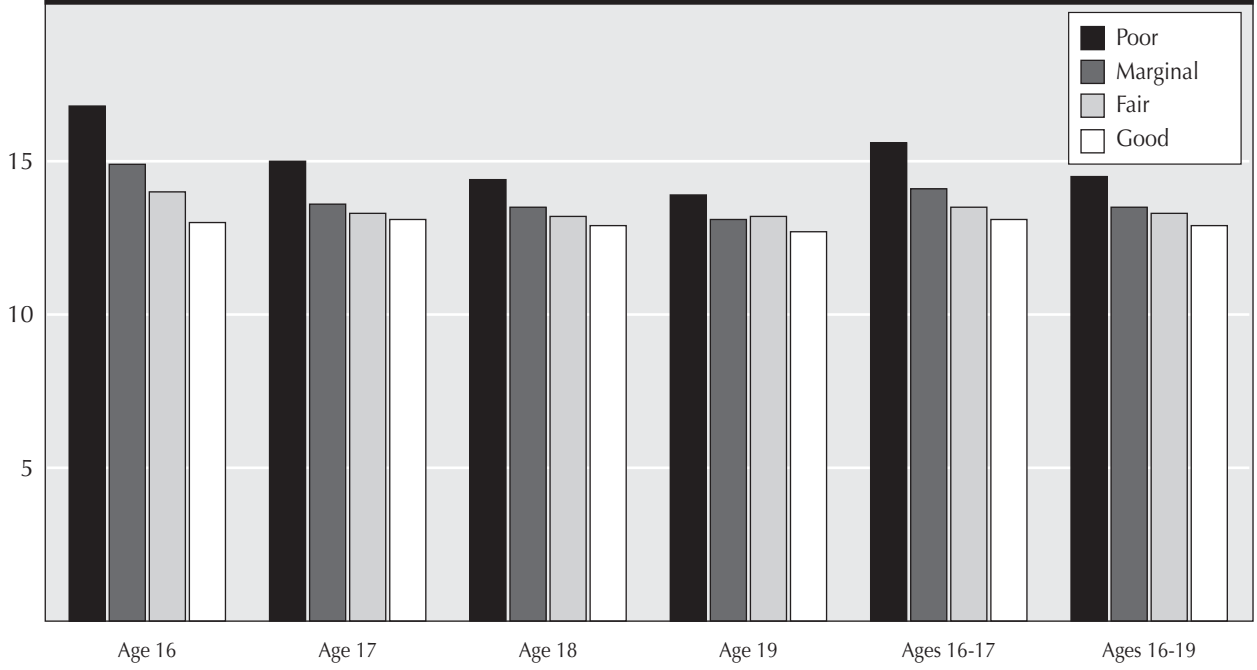
Table 4 and Figure 2 show the estimated collision claim frequencies by GDL rating and rated driver age. Results are expressed in claims per 100 insured vehicle years. A claim frequency of 6.4 was assumed for ages 35-55, the covariate in the model. It was based on the average across all states and years. As seen in Figure 2, although GDL produced significant decreases in collision claim frequencies, claim frequencies for good GDL ratings still were double the average for rated drivers ages 35-55, indicating the potential for additional improvement.

TABLE 4 PREDICTED COLLISION CLAIM FREQUENCIES BY GDL RATING AND RATED DRIVER AGE CLAIMS PER 100 INSURED VEHICLE YEARS

GDL RATING	AGE 16	AGE 17	AGE 18	AGE 19	AGES 16-17	AGES 16-19
Good	13.0	13.1	12.9	12.7	13.1	12.9
Fair	14.0	13.3	13.2	13.2	13.5	13.3
Marginal	14.9	13.6	13.5	13.1	14.1	13.5
Poor	16.8	15.0	14.4	13.9	15.6	14.5

Note: Assumes a claim frequency of 6.4 for ages 35-55, the covariate.

FIGURE 2 PREDICTED COLLISION CLAIM FREQUENCIES BY GDL RATING AND RATED DRIVER AGE*



* Assumes a frequency of 6.4 claims per 100 insured vehicle years for ages 35-55 (the covariate in the model).

Effect of State GDL Ratings Using Lagged Introduction Dates

Table 5 lists the predicted percentage reductions in collision claim frequencies for GDL ratings of good, fair, and marginal compared with poor using lagged introduction dates. Percentages were based on Poisson regression results using the same model as in Table 2 but with lagging. The lagging adjusted the GDL introduction dates forward to correspond to the age when 17-19 year-olds were under GDL provisions applied to 16 year-olds. All rating/age combinations were statistically significant at the 0.05 level.

Compared with the percentage reductions in Table 3 with no lagging, the lagged percentages were lower for age 19, with claim frequencies decreasing from 8.6 to 5.9 percent for good ratings, from 5.1 to 3.8 percent for fair ratings, and from 5.4 to 3.9 percent for marginal ratings. For drivers age 18, percentage reductions with lagging were lower for good ratings but higher for fair and marginal ratings. As expected, lagging had the least effect for drivers age 17 and the most effect for drivers age 19. The addition of lagging to the analyses did not significantly alter the basic pattern of largest percentage reductions for good ratings and the youngest drivers, but no consistent change in results was seen from lagging the GDL introduction dates.

Table 5 Predicted Percent Reductions in Collision Claim Frequencies Compared with Poor GDL Rating by Rated Driver Age with Lag from GDL Introduction

	Rated Driver Age and Lag from GDL Introduction			
	Age 16	Age 17	Age 18	Age 19
GDL Rating	0 Years	1 Year	2 Years	3 Years
Good	22.4%	12.4%	9.2%	5.9%
Fair	16.7%	11.8%	8.4%	3.8%
Marginal	10.8%	10.2%	7.1%	3.9%
Poor	0.0%	0.0%	0.0%	0.0%

Effectiveness of Individual Graduated Licensing Components

Table 6 summarizes the Poisson regression analyses using collision claim frequency for ages 16, 17, and 16-17 as the dependent variable and the individual GDL components (permit age, holding period, practice hours, licensing age, night restrictions, and passenger restrictions) as the independent variables. The claim frequency of rated drivers ages 35-55 was used as a covariate.

Table 6 Poisson Regression Results of Collision Claim Frequencies Regressed on GDL Components for Rated Drivers Ages 16-17

Rated Driver Age	Parameter	Estimate	e of Estimate	Standard Error	Chi-Square	P-value
Age 16	Intercept	-0.1477	0.863	0.6777	0.05	0.8275
	Covariate (claim freq ages 35-55)	0.1345		0.0093	210.20	<0.0001
	Permit Age (years)	-0.0321	0.968	0.0277	1.34	0.2467
	Holding Period (months)	0.0082	1.008	0.0034	5.68	0.0172
	Required Practice (hours)	-0.0031	0.997	0.0005	36.25	<0.0001
	License Age (years)	-0.1262	0.881	0.0522	5.84	0.0157
	Night Restriction*	-0.0213	0.979	0.0043	23.91	<0.0001
	Passenger Restriction					
	0-1 passengers	-0.0889	0.915	0.0228	15.24	<0.0001
	No restriction or 2+ passengers	0	1.000	0		
Age 17	Intercept	-1.5796	0.206	0.4912	10.34	0.0013
	Covariate (claim freq ages 35-55)	0.1215		0.0069	309.83	<0.0001
	Permit Age (years)	-0.0312	0.969	0.0204	2.34	0.1259
	Holding Period (months)	0.0056	1.006	0.0025	5.06	0.0245
	Required Practice (hours)	-0.0017	0.998	0.0004	21.48	<0.0001
	License Age (years)	-0.0402	0.961	0.0392	1.05	0.3049
	Night Restriction*	-0.0123	0.988	0.0031	15.25	<0.0001
	Passenger Restriction					
	0-1 passengers	-0.0441	0.957	0.0159	7.66	0.0057
	No restriction or 2+ passengers	0	1.000	0		
Ages 16-17	Intercept	-1.0567	0.348	0.5014	4.44	0.0351
	Covariate (claim freq ages 35-55)	0.1254		0.0070	321.16	<0.0001
	Permit Age (years)	-0.0332	0.967	0.0207	2.58	0.1084
	Holding Period (months)	0.0062	1.006	0.0026	5.84	0.0157
	Required Practice (hours)	-0.0021	0.998	0.0004	31.93	<0.0001
	License Age (years)	-0.0698	0.933	0.0396	3.11	0.0777
	Night Restriction*	-0.0152	0.985	0.0032	22.26	<0.0001
	Passenger Restriction					
	0-1 passengers	-0.0593	0.942	0.0165	12.92	0.0003
	No restriction or 2+ passengers	0	1.000	0		

* Night restriction is measured in the number of hours before 5 a.m. that is restricted. For example, a night restriction of 1 am is coded as 4 hours and a night restriction of 10 p.m. is coded as 7 hours. No restriction is coded as 0 hours.

Parameter estimates for all GDL components except holding period were negative, indicating a reduction in collision claim frequencies (Table 6). Restricting nighttime driving, restricting the number of passengers to no more than one, and increasing required practice driving were statistically significant at the 0.05 level for age 16, 17, and the combined 16-17. Permit age was not statistically significant for either age, with a p-value of 0.11 for ages 16-17. Licensing age was statistically significant for age 16 (p=0.02) but not for age 17 (p=0.30). Lengthening the required holding period when modeled with the other GDL components was counterproductive, with slight increases in claim frequency (2 percent for lengthening the holding period 3 months for ages 16-17).

Table 7 and Figure 3 show the predicted percentage reductions in collision claim frequencies for drivers ages 16-17 by GDL component. Increasing the permit age by 12 months produced a 3 percent reduction in claim frequencies for age 16. Increasing the licensing age by 12 months produced a larger reduction of 12 percent. For age 16, significant reductions also were seen for increasing required practice driving (6 percent for 20 hours), adding a nighttime driving restriction (14 percent for 10 p.m. restriction), and adding a passenger restriction (9 percent for one or fewer passengers).

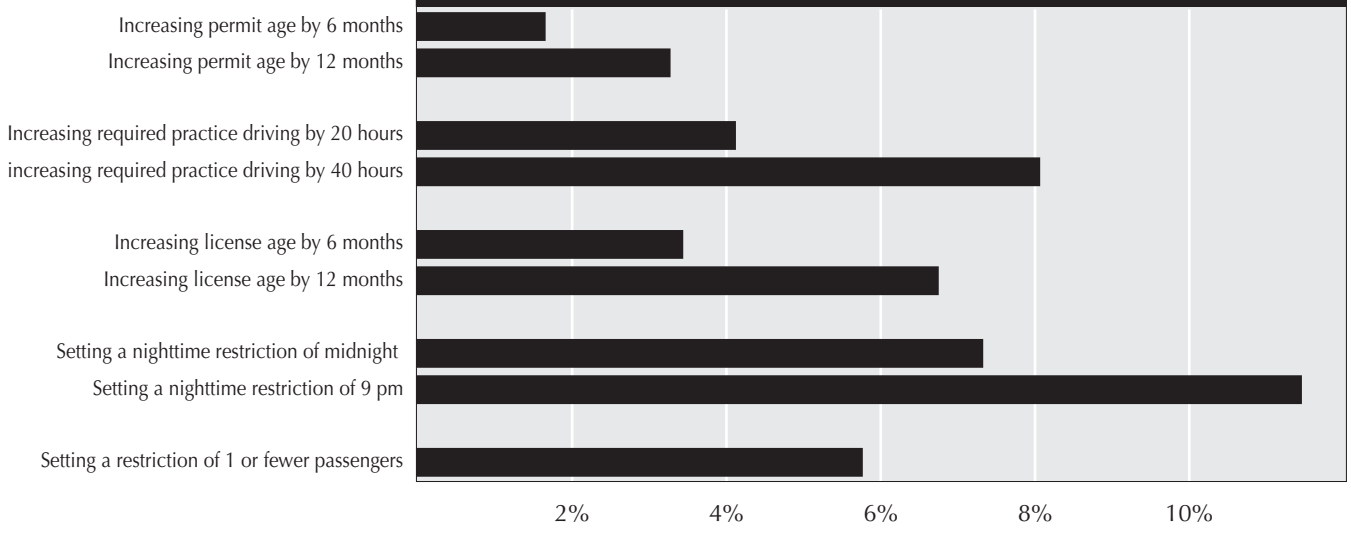
TABLE 7 PERCENT REDUCTIONS IN COLLISION CLAIM FREQUENCIES BASED ON POISSON REGRESSION ANALYSES OF GDL COMPONENTS

	RATED DRIVER AGE		
GDL COMPONENT	16	17	16-17
Increasing permit age by 3 months	0.8%	0.8%	0.8%
Increasing permit age by 6 months	1.6%	1.5%	1.6%
Increasing permit age by 12 months	3.2%	3.1%	3.3%
Increasing required practice driving by 20 hours	**6.0%**	**3.3%**	**4.1%**
Increasing required practice driving by 40 hours	**11.7%**	**6.6%**	**8.1%**
Lengthening permit holding period by 3 months	**-2.5%**	**-1.7%**	**-1.9%**
Lengthening permit holding period by 6 months	**-5.0%**	**-3.4%**	**-3.8%**
Increasing license age by 3 months	**3.1%**	1.0%	1.7%
Increasing license age by 6 months	**6.1%**	2.0%	3.4%
Increasing license age by 12 months	**11.9%**	3.9%	6.7%
Setting a nighttime restriction of midnight	**10.1%**	**6.0%**	**7.3%**
Setting a nighttime restriction of 11 p.m.	**12.0%**	**7.1%**	**8.7%**
Setting a nighttime restriction of 10 p.m.	**13.9%**	**8.2%**	**10.1%**
Setting a nighttime restriction of 9 p.m.	**15.7%**	**9.4%**	**11.4%**
Setting a restriction of 1 or fewer passengers	**8.5%**	**4.3%**	**5.8%**

Results in bold are statistically significant (p<0.05).

Graduated licensing had a smaller effect for drivers age 17. Increasing the licensing age was no longer statistically significant but showed a 4 percent reduction in claim frequency for delaying the licensing age by 12 months. Significant decreases were seen for increasing required practice driving (3 percent for 20 hours), adding a nighttime driving restriction (8 percent for 10 p.m. restriction), and adding a passenger restriction (4 percent for one or fewer passengers).

FIGURE 3 PREDICTED PERCENT REDUCTIONS IN COLLISION CLAIM FREQUENCIES FOR RATED DRIVERS AGES 16-17 BY GDL COMPONENT



The percentage reductions in claim frequencies associated with individual GDL components combine when multiple GDL components are adopted. Table 8 lists the predicted cumulative percentage reductions in claim frequencies as additional GDL components are adopted. Results are in comparison with no GDL restrictions. For age 16, setting a nighttime restriction of 10 p.m. produced an estimated 14 percent reduction in claim frequencies. Adding a passenger restriction of one or fewer passengers increased the percentage reduction to 21 percent. Further additions of a requirement of 20 practice hours and an increase in the permit age of 6 months produced a 27 percent reduction in claim frequencies. This 27 percent reduction is not unlike the 22 percent reduction in claim frequencies for laws rated good (Table 3). Although the cumulative effect results in Table 8 were slightly different from the marginal, fair, and good ratings in Table 3, the two models showed a consistent pattern of larger reductions with stronger GDL provisions.

Table 8 Cumulative Effects of GDL Components on Percentage Reductions of Collision Claim Frequencies Compared with No GDL Restrictions

	Rated Driver Age		
GDL Component	**16**	**17**	**16-17**
Setting nighttime restriction of 10 p.m.	14%	8%	10%
Setting nighttime restriction of 10 p.m. and passenger restriction of one or fewer passengers	21%	12%	15%
Setting nighttime restriction of 10 p.m., setting passenger restriction of one or fewer passengers, and requiring 20 hours of practice driving	26%	15%	19%
Setting nighttime restriction of 10 p.m., setting passenger restriction of one or fewer passengers, requiring 20 hours of practice driving, and increasing permit age by 6 months	27%	16%	20%
Setting nighttime restriction of 10 p.m., setting passenger restriction of one or fewer passengers, requiring 20 hours of practice driving, increasing permit age by 6 months, and increasing licensing age by 6 months	32%	18%	23%

Note: As discussed in the method section, because only year of birth is known age 16 in this study includes ages 15-16 and likewise age 17 includes ages 16-17. This inclusion of younger ages may produce higher results for a given age than if the age range could be limited to only the stated age.

Discussion

Earlier studies have shown the effectiveness of GDL in reducing crashes, injuries, and fatalities of young drivers. Results of the current study confirm the positive effect GDL has had in reducing crashes of young drivers. Findings expanded on earlier studies in two main areas: determining the effectiveness of individual GDL components and restricting the study population to insured licensed drivers.

GDL ratings were found to be significant in predicting collision claim frequencies of young drivers. The largest decreases in claim frequencies were seen for GDL laws with good ratings and the youngest rated drivers. These results are consistent with earlier studies and support the validity of the IIHS rating system. Analysis of individual GDL components produced mixed results. Restricting nighttime driving, restricting the number of passengers to no more than one, and increasing required practice driving produced statistically significant reductions in collision claim frequencies for drivers ages 16 and 17. Licensing age showed statistically significant reductions for age 16 ($p=0.02$) but not for age 17 ($p=0.30$). Permit age was not statistically significant for either age but still reduced claim frequencies. Lengthening the required permit holding period when modeled with the other GDL components was counterproductive, with slight increases in claim frequency. The lack of positive results for permit holding period may reflect its effect being absorbed into the permit age and licensing age components or from its similar purpose to practice driving.

The use of licensed insured drivers, as opposed to population, in computing collision claim frequencies of young drivers allowed this study to focus on safer driving rather than lower licensure rates in analyzing aspects of GDL. Increasing the licensing age directly or indirectly through other GDL components will mean fewer teenagers are licensed to drive and hence fewer crashes regardless if the teenagers are driving safer or not. Lower crash rates are always good but, in evaluating GDL provisions, the ability to isolate greater driver maturity and safer driving from lower licensure rates is important. The reduction in claim frequency for age 16 from licensing delay shows the increased maturity effect.

Collision claim frequency, the measure used in this study, is dominated by relatively minor crashes. About half of collision claims are for damages less than $2,000, excluding the deductible (HLDI, 2009). The similarity of results between this study, based primarily on relatively minor crashes, to studies based on more severe crashes resulting in injuries or deaths shows the broad range of crashes affected by GDL. This range of crashes indicates that GDL is changing more than one aspect of teenage driving.

The present study has some limitations. Using rated driver age as opposed to actual driver age results in some coverage and losses assigned to an incorrect age. It is impossible to know the extent of this problem, but HLDI data has consistently shown higher collision claim frequencies for the youngest and oldest rated drivers (HLDI, 1999, 2002, 2003, 2005, 2007). Only knowing the year of birth also introduces some uncontrolled variance in the analyses, but including younger drivers in an age group would not adversely impact the overall results because they would be subject to the same or more GDL provisions. Collision data was available historically only on relatively new vehicles, but analysis of older vehicle data for 2005-06 found nearly identical relative claim frequencies by rated driver age for vehicles up to 9 years old (HLDI, 2007).

In conjunction with the current HLDI study, IIHS evaluated the strength of state GDL laws and the strength of individual GDL components in reducing fatal crash involvement

rates among teenage drivers (McCartt et al., 2009). The study used a similar methodology to the current study, with Poisson regression analyses and a covariate of fatal crash rate for drivers ages 30-59 to control for state or time factors not related to GDL. For 16-year-old drivers, the fatal crash rate was 41 percent lower for laws rated good compared with laws rated poor. Crash rates were 18 and 7 percent lower for laws rated fair and marginal, respectively. The effect of state GDL ratings diminished as age increased, with percentage reductions generally small and not statistically significant.

The IIHS evaluation of individual GDL components found strong reductions in fatal crash involvement rates for young drivers with restrictions on nighttime driving, restrictions on the number of passengers, increases in licensing age, and increases in permit age. Delaying the licensing age by 1 year had a 13 percent reduction in the fatal crash involvement rate for drivers ages 15-17, restricting driving after 10 p.m. had a 16 percent reduction, not allowing teenage passengers had a 21 percent reduction, and delaying the permit age by 1 year had a 13 percent reduction. Lengthening the permit holding period and increasing required practice driving had little effect on fatal crash involvement rates.

In summary, both the HLDI study based on collision claim frequencies and the IIHS study based on fatal crash involvement rates confirm the importance of strong GDL laws in reducing teenage crashes. Key elements of good GDL systems are nighttime driving restrictions, passenger restrictions, and licensing delay. Permit age delay had a positive but statistically insignificant effect on teenage driver collision claim frequencies. Increasing the required practice driving reduced claim frequencies, but a similar GDL component — permit holding period — had a negative effect.

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