HHS Public Access

Author manuscript

Inj Prev. Author manuscript; available in PMC 2016 April 01.

Published in final edited form as:

Inj Prev. 2015 April ; 21(0): e23–e27. doi:10.1136/injuryprev-2013-040999.

The association of graduated driver licensing with miles driven and fatal crash rates per miles driven among adolescents

Motao Zhu[1,2], **Peter Cummings**[3], **Songzhu Zhao**[2], **Jeffrey H. Coben**[2,4], and **Gordon S. Smith**[5]

[1]Department of Epidemiology, West Virginia University, Morgantown, West Virginia, USA

[2]Injury Control Research Center, West Virginia University, Morgantown, West Virginia, USA

[3]School of Public Health and Harborview injury Prevention & Research Center, University of Washington, Seattle, Washington, USA

[4]Department of Emergency Medicine, West Virginia University, Morgantown, West Virginia, USA

[5]Department of Epidemiology and Public Health, School of Medicine, University of Maryland, Baltimore, Maryland, USA

Abstract

Background—Graduated driver licensing (GDL) laws are associated with reduced crash rates per person-year among adolescents. It is unknown whether adolescents crash less per miles driven or drive less under GDL policies.

Methods—We used data from the US National Household Travel Survey and Fatality Analysis Reporting System for 1995–1996, 2001–2002, and 2008–2009. We compared adolescents subject to GDL laws with those not, by estimating adjusted incidence rate ratios for being a driver in a crash with a death per person-year (aIRRpy) and per miles driven (aIRRm), and adjusted miles driven ratios (aMR) controlling for changes in rates over time.

Results—Comparing persons subject to GDL policies with those not, 16-year-olds had fewer fatal crashes per person-year (aIRRpy 0.63, 95% confidence interval [CI] 0.47, 0.91), drove fewer miles (aMR 0.79, 95% CI 0.63, 0.98), and had lower crash rates per miles driven (aIRRm 0.83, 95% CI 0.65, 1.06). For age 17, the aIRRpy was 0.83 (95% CI 0.60, 1.17), the aMR 0.80 (95% CI 0.63, 1.03), and the aIRRm 1.03 (95% CI 0.80, 1.35). For age 18, the aIRRpy was 0.93 (95% CI 0.72, 1.19), the aMR 0.92 (95% CI 0.77, 1.09), and the aIRRm 1.01 (95% CI 0.84, 1.23).

Correspondence: Motao Zhu, Department of Epidemiology and Injury Control Research Center, West Virginia University, PO Box 9151, Morgantown, West Virginia 26506, USA. mozhu@hsc.wvu.edu..

Contributors: MZ originated and designed the study, participated in data analysis, and led the writing. PC participated in data analysis and substantially revised the manuscript. SZ collected data and conducted analysis. JC and GS critically reviewed and substantially revised the manuscript. MZ had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the overall content.

Competing interests: None.

Ethical approval: Not required.

Data sharing: No additional data available.

Conclusions—If these associations are causal, GDL laws reduced crashes per person-year by about one-third among 16-year-olds; half the reduction was due to fewer crashes per miles driven and half to less driving. For ages 17 and 18, there was no evidence of reduced crash rates per miles driven.

Keywords

Motor vehicle-occupant; Legislation; Policy; Adolescent; accidents

INTRODUCTION

Traffic crashes are the leading cause of death among teenagers in the United States (US), accounting for 27% (2688/9823) of all deaths among 16–19 year olds in 2010.[1] The fatal crash rate per miles driven for 16-year-old drivers was approximately six times that for drivers aged 30–54 years in the US in 2008–2009.[2,3] This excess crash rate is mainly due to inexperience and risky driving behaviors.[4–6] To address this issue, graduated driver licensing (GDL), which is a phased approach to initiating driving, was first introduced in Florida in 1996.[7,8] By January 2012, all states and the District of Columbia had implemented GDL laws.[7,8] State GDL laws require drivers younger than 18 years old to proceed through three phases: an *extended learner phase* with supervised driving for three to twelve months; an *intermediate phase*, which allows unsupervised driving under low-risk conditions such as daylight, but restricts nighttime driving and, in many states, limits adolescent drivers to no more than one or two young passengers; and a *full licensure phase* that permits unsupervised driving at all times.[9]

State-level [8,10–21] and national [22–28] studies have reported a 15 to 40% reduction in crash rate per person-year for persons age 16 years when they are licensed under GDL laws with various strengths. Under GDL laws, adolescents may drive fewer miles because their learner permit phase is extended, they are not allowed to drive at night, or their full licensure is delayed. However, this mileage reduction has not been quantified before. It remains unknown whether the crash rate reduction per person-year occurs because adolescents drive fewer miles under GDL laws or because they have a lower rate of crashing per miles driven. We conducted longitudinal analyses of nationally representative survey and fatal crash data to estimate how GDL laws were associated with both miles driven and fatal crash rates per miles driven.

METHODS

Data about miles driven

Estimates of miles driven were obtained from the 1995–1996, 2001–2002, and 2008–2009 National Household Travel Survey (NHTS). Computer-assisted telephone interviewers collected information about personal characteristics and travel.[3] Respondents were a weighted sample of non-institutionalized US civilians. The NHTS interviewed 95,360 persons from May 1995 through July 1996; 160,758 from March 2001 through April 2002; and 351,275 from March 2008 through April 2009.[3] Respondents kept a diary about all trips during a randomly assigned 24-hour day, including transportation method and trip length. A

total of 80,814 diaries were recorded during 1995–1996; 136,919 during 2001–2002; and 262,934 during 2008–2009. Each respondent was assigned weights for their selection probability, adjusted for non-response and the presence of multiple household phones.[3]

We classified respondents as exposed to a GDL law at the time of their trip diary if they were 16, 17, or 18 years old at that time and their state had a GDL law with a learner phase of at least three months, plus an intermediate phase restriction on either night driving or the number of young passengers.[7] Annual miles driven were estimated based on trips reported in the 24-hour diaries. Average annual miles driven were estimated for four age groups (16, 17, 18 and 20–24 years old), three survey periods, and whether the respondents were exposed to a GDL law. This was done by dividing the total weighted miles accumulated by the group by the weighted number of respondent in the group.

Total annual miles driven by age groups, survey periods, and presence of GDL were created as denominators to calculate crash rates per miles driven. Because not all survey respondents provided trip data, total annual miles driven were estimated by multiplying total annual miles driven estimates from respondents by the relevant age-specific census count, [29] divided by the estimated count, based on the sampling weights, of respondents who provided trip data. The variance for each mileage estimate was computed using the survey jackknife weights.

Counts and rates per miles driven for drivers in crashes with a death

The Fatality Analysis Reporting System contains data for all US crashes involving at least one death within the 30 days following the crash.[2] We obtained counts of drivers 16, 17, 18, and 20–24 years old who were in a crash with a death (hereafter called fatal crashes) from states with (exposed) and without (unexposed) GDL laws for one-year periods that overlapped the three NHTS survey intervals: May through the following April of 1995–1996, 2001–2002, and 2008–2009. These counts were divided by the total annual miles driven for each interval to estimate incidence rates for fatal crashes per miles driven, according to driver age, GDL exposure, and survey period.

Statistical analysis

To estimate the adjusted miles driven ratio (aMR) for miles driven when exposed to GDL compared with miles driven when not exposed, we used variance weighted least squares linear regression[3031] with the log of average miles driven in a year as the outcome and presence of a GDL law as the explanatory variable. The variance used, from the delta method,[32] was the variance of average annual miles driven divided by the average annual miles squared. The regression model included three indicator variables for the four driver age categories (16, 17, 18 and 20–24 years old) and two indicator variables for the three survey periods, to account for temporal trends in miles driven. Drivers 20–24 years of age were included to help adjust for non-GDL factors that influence miles driven and crash rates over time, such as changes in the economy or traffic enforcement.[15–17] The age group 20–24 years was chosen because this group was close to ages 16–18 years and but probably not affected by graduated driver licensing. To estimate the adjusted incidence rate ratio (aIRRm) for being a driver in a fatal crash *per miles driven* in the presence of a GDL law compared

with no GDL law, we used the same regression method with the log of the driver fatal crash rate per miles driven as the outcome.

The fatal crash rate per person-year is the product of miles driven per person-year and fatal crash rate per miles driven (Formula 1). Therefore, to estimate age-specific associations between GDL presence and the adjusted incidence rate ratio (aIRRpy) of being a driver in a fatal crash *per person-year*, we multiplied the GDL-related aMR per person-year and the GDL-related aIRRm for being a driver in a fatal crash per miles driven for each adolescent age group.

$$fatal\ crash\ rate\ per\ person-year = miles\ driven\ per\ person-year \times fatal\ crash\ rate\ per\ miles \quad \text{Formula 1}$$

$$\frac{number\ of\ fatal\ crashes}{number\ of\ person-years} = \frac{number\ of\ miles\ driven}{number\ of\ person-years} \times \frac{number\ of\ fatal\ crashes}{number\ of\ miles\ driven}$$

In some states, new GDL laws did not apply to 16-year-old drivers who had licenses when the laws were passed.[22] As a sensitivity analysis we re-estimated aMRs and aIRRs associated with GDL implementation. We used trip and crash data from a state with a GDL law only if the respondent or driver was: 1) 16 years old and the law in effect for one year or more, 2) 17 years old and the law in effect for two years or more, or 3) 18 years old and the law in effect for three years or more.

RESULTS

Average annual miles driven

Average annual miles driven increased as age increased during all three survey periods (Table 1). When no GDL law was present, the average miles driven for 16 year olds increased considerably from the first to the second survey period, but only slightly for the other ages; miles driven decreased among all groups in the third survey.

Adjusted miles driven ratios

Within each survey period, the average annual miles driven was always less when a GDL law was present for 16 and 17 year olds, but not for 18 year olds (Table 1). On average respondents exposed to a GDL law, compared with those not exposed, drove fewer miles; the aMRs were 0.79 for 16 year olds (95% confidence interval [CI] 0.63, 0.98), 0.80 for 17 year olds (95% CI 0.63, 1.03), and 0.92 for 18 year olds (95% CI 0.77, 1.09).

Adjusted incidence rate ratios for being a driver in a fatal crash per miles driven

The incidence rate for being a driver in a fatal crash per miles driven usually decreased with older age (Table 2). Comparing respondents exposed to GDL laws with those not exposed, 16 year olds had a 17% reduction (95% CI −35%, 6%) in their rate of being a driver in a fatal crash per miles driven, while there was almost no change for those age 17 and 18.

Adjusted incidence rate ratios for being a driver in a fatal crash per person-year

Multiplying the aMR by the aIRRm for being a driver in a fatal crash per miles driven produced aIRRpy for being a driver in a fatal crash per person-year, comparing persons exposed to GDL laws with those not exposed. Sixteen year olds had a 35% reduction (95% CI 9%, 53%) for being a driver in a fatal crash per person-year, while reductions for those 17 and 18 years old were smaller (Table 3).

Sensitivity analysis

When we omitted persons from GDL states who were not exposed to GDL laws for a sufficient time period, the aMR and aIRRs estimates changed only minimally from those in the tables; changes were less than 0.04 for aMRs, and less than 0.06 for aIRRs. This suggests that misclassification of some teenagers as covered by GDL requirements when they were not is not likely to be an important cause of bias in our estimates.

DISCUSSION

We estimated that for adolescents age 16 years, GDL laws were associated with a 35% reduction in the fatal crash rate per person-year. About half of this association was due to a 21% reduction in average miles driven and the other half due to a 17% reduction in the fatal crash rate per miles driven. For those age 17 years, GDL laws were associated with a 17% reduction in the fatal crash rate per person-year; this improvement was attributed to reduced driving miles, with no reduction seen in the fatal crash rate per miles driven. For 18 year olds, GDL laws showed little association with fatal crash rate per person-year, average miles driven, or fatal crash rate per miles driven.

A strength of our study is that by using information from two national datasets we were able to separately estimate the influence of graduated driver licensing on crash rates per miles driven and per person-years, and assess the association with miles driven, which has not previously been done. Our study has certain limitations. The periodic nature of the transport survey impaired our ability to adjust for temporal trends in miles driven and crash rates. The survey sampling scheme does not allow estimates of miles driven and crash rates within all states; this limitation may have impaired our ability to remove confounding bias due to regional variations in miles driven and crash rates. We included all adolescents in our main analysis, and some teenagers might be misclassified as exposed to GDL laws when they were not. This might be a source of bias; the estimated associations did not change greatly when we restricted our analyses to persons covered by GDL laws for a longer period of time. Despite including over 17,000 adolescents, the survey sampling design resulted in wide confidence intervals around our estimates. However, our estimated associations between GDL laws and crash rates per person-year were similar to those of other studies. Previous nationwide studies have reported that GDL laws were associated with reductions in crash rates per person-year for 16 year olds; the aIRRpy of 0.74,[23] 0.62,[24] 0.59,[22] and 0.42[25] are compatible with our estimate of 0.65. For 17 year olds, prior studies have reported aIRRpy of 0.91,[23] 0.81,[22] and 0.70,[25] not very different from our estimate of 0.83. For 18 year olds the reported aIRRs were 1.10,[23] 0.96,[22] and 0.93,[33] similar to our estimate of 0.93.

Other investigators have noted that lack of information about miles driven makes it difficult to understand how GDL laws may work.[91517] The NHTS surveys provide this missing information. We found that graduated driver licensing was associated with a 20% reduction in annual miles driven for both 16- and 17-year-old drivers. Adolescents may drive fewer miles after GDL laws, simply due to the creation of an extended learner permit phase of GDL for 3 to 12 months requiring adult supervision for driving. The requirements of minimum practice hours may prolong the extended learner permit phase. Adolescents may drive fewer miles during the extended learner permit phase because they have to drive under adult supervision and adult drivers, usually parents, are not always available.[34] In addition, the minimum age at which an intermediate licensure can be obtained in many states is usually older than that for full licensure before GDL laws went into effects. Adolescents may drive fewer miles during the intermediate phase of GDL, because they cannot drive during certain hours at night. Furthermore, adolescents may wait until age 18 to obtain leaner permits to avoid GDL restrictions, and therefore not drive when they are 16 or 17.

From 2001–2002 to 2008–2009, average annual miles driven decreased for all four age groups (16, 17, 18, 20–24). This might be linked with the economic recession and high unemployment during 2008–2009. By including drivers 20–24 years of age in our model, and adjusting for temporal changes in crash rates over time among those covered and not covered by a GDL law in each teenage age group, we sought to control for non-GDL factors that influence miles driven over time.[15–17]

Our findings suggest that 16-year-old drivers had a lower crash rate per miles driven under GDL, but 17-year-old drivers did not. This may indicate that adult supervision and/or restrictions on night driving and number of underage passengers, all of which should be most common among 16-year-old drivers, combine to reduce the fatal crash rate per miles driven, but as drivers become older and these restrictions are removed, the influence of GDL on crash rates per miles driven among 17-year-old drivers is neither beneficial nor harmful. In addition, graduation from GDL is possible at age 17 in most states, particularly if the adolescent takes a driver education course.[9]

Teenagers aged 18 years were not substantially impacted by GDL in either driving distance or crash rate per miles driven. Some researchers have hypothesized that 18-year-old drivers may have more crashes after GDL implementation because they drove fewer miles and therefore learned fewer driving skills while driving under GDL laws as 16 and 17 year olds. Or, some teenagers wait until age 18 to get their learner permits to avoid GDL restrictions. However, we found little evidence that GDL affected the driving distance or crash rates of teenagers aged 18 years. A meta-analysis of traffic crash data from four states (California,[35] Florida,[8] Georgia,[11]Wisconsin[21]) reported the pooled rate ratio for 18-year-olds per person-year was 1.00 (95% CI 0.95, 1.04) comparing GDL presence with absence.[36] A study of all fatal crashes for 18-year-olds in the U.S. during 1996–2007 reported a rate ratio per person-year of 0.96 for states with a good GDL rating and 1.03 for states with a fair GDL rating, relative to states with a poor GDL rating.[22] However, another study of all fatal crashes in the U.S. during 1986–2007 reported that GDL was associated with a 10% increase (aRR 1.10, 95% CI 1.03, 1.18) in fatal crash rate per person-year among 18-year-olds.[23] The evidence

currently available does not strongly support the theory that GDL is harmful for 18-year-olds.

CONCLUSIONS

This study was one of the first attempts to assess the extent to which graduated driver licensing affects miles driven and crash rate per miles driven using two national datasets (National Household Travel Survey and Fatality Analysis Reporting System). We found that GDL laws were associated with reduced miles driven and crash rates per miles driven among persons age 16. Persons age 17 years drove fewer miles, but did not show reduced crash rates per miles driven after GDL implementation. GDL was neither beneficial nor harmful among 18-year-old drivers.

Acknowledgements

We express appreciation to Michele Fields and Laurel Sims at the Insurance Institute for Highway Safety for their assistance in describing graduated driver licensing laws, and Herbert Linn at West Virginia University Injury Control Research Center for editorial assistance. These individuals received no compensation for their contributions.

Funding: MZ, PC, SZ, and JC received support from a grant (R21CE001820) from the U.S. National Center for Injury Prevention and Control, Centers for Disease and Prevention. MZ and SZ additionally received support from a grant (R01HD074594) from the U.S. National Institute of Child Health and Human Development. JC additionally received support from a grant (U54GM104942) from the National Institutes of Health and a grant (R49CE002109) from the U.S. National Center for Injury Prevention and Control, Centers for Disease Control and Prevention. GS received support from a grant from the U.S. National Institute on Alcohol Abuse and Alcoholism (R01AA18313). The funding bodies had no input into any aspect of this study. The authors reported no other financial interests related to this research.

References

1. Centers for Disease Control and Prevention. Web-based Injury Statistics Query and Reporting System (WISQARS). Centers for Disease Control and Prevention; Atlanta, GA: 2013. http://www.cdc.gov/injury/wisqars/ [(accessed October 21, 2013)]
2. National Highway Traffic Safety Administration. FARS Analytic Reference Guide 1975 to 2009. National Highway Traffic Safety Administration; Washington, D.C.: 2010. http://www-nrd.nhtsa.dot.gov/Pubs/811352.pdf [(accessed September 19, 2012)]
3. Federal Highway Administration. 2009 National Household Travel Survey: User's Guide. Federal Highway Administration; Washington, DC: 2011. http://nhts.ornl.gov/2009/pub/UsersGuideV1.pdf [(accessed March 22, 2012)]
4. Simons-Morton B, Lerner N, Singer J. The observed effects of teenage passengers on the risky driving behavior of teenage drivers. Accident Analysis & Prevention. 2005; 37(6):973–82. [PubMed: 15921652]
5. Jonah BA, Dawson NE. Youth and risk: age differences in risky driving, risk perception, and risk utility. Alcohol, Drugs and Driving. 1987; 3:13–29.
6. Hedlund J. Novice teen driving: GDL and beyond. Journal of Safety Research. 2007; 38(2):259–66. [PubMed: 17478196]
7. Insurance Institute for Highway Safety. Graduated Driver Licensing Effective Dates. Insurance Institute for Highway Safety; Arlington, VA: 2012. http://www.iihs.org/laws/pdf/gdl_effective_dates.pdf [(accessed March 22, 2012)]
8. Ulmer RG, Preusser DF, Williams AF, Ferguson SA, Farmer CM. Effect of Florida's graduated licensing program on the crash rate of teenage drivers. Accident Analysis & Prevention. 2000; 32(4):527–32. [PubMed: 10868755]

9. Williams AF, Tefft BC, Grabowski JG. Graduated Driver Licensing Research, 2010-Present. Journal of Safety Research. 2012; 43(3):195–203. [PubMed: 22974685]
10. Males M. California's graduated driver license law: Effects on older teenagers. Californian Journal of Health Promotion. 2006; 4(3):207–21.
11. Rios A, Wald M, Nelson SR, Dark KJ, Price ME, Kellermann AL. Impact of Georgia's Teenage and Adult Driver Responsibility Act. Annals of Emergency Medicine. 2006; 47(4):361–69.
12. Hallmark SL, Veneziano DA, Falb S, Pawlovich M, Witt D. Evaluation of Iowa's graduated driver's licensing program. Accident Analysis & Prevention. 2008; 40(4):1401–05. [PubMed: 18606272]
13. Kirley BB, Feller A, Braver E, Langenberg P. Does the Maryland graduated driver licensing law affect both 16-year-old drivers and those who share the road with them? Journal of Safety Research. 2008; 39(3):295–301. [PubMed: 18571571]
14. Shope JT, Molnar LJ. Michigan's graduated driver licensing program: Evaluation of the first four years. Journal of Safety Research. 2004; 35(3):337–44. [PubMed: 15288567]
15. Shope JT, Molnar LJ, Elliott MR, Waller PF. Graduated Driver Licensing in Michigan: Early Impact on Motor Vehicle Crashes Among 16-Year-Old Drivers. JAMA. 2001; 286(13):1593–98. [PubMed: 11585482]
16. Zhu M, Chu H, Li G. Effects of graduated driver licensing on licensure and traffic injury rates in Upstate New York. Accident Analysis & Prevention. 2009; 41(3):531–35. [PubMed: 19393803]
17. Foss RD, Feaganes JR, Rodgman EA. Initial Effects of Graduated Driver Licensing on 16-Year-Old Driver Crashes in North Carolina. JAMA. 2001; 286(13):1588–92. [PubMed: 11585481]
18. Ohio Department of Public Safety. Evaluation of Ohio's graduated driver licensing program. Ohio Department of Public Safety; Columbus, OH: 2001.
19. Coben, JH.; Mckay, MP. Evaluation of the effectiveness of Pennsylvania's graduated driver licensing program. The Center for Violence and Injury Control, Allegheny-Singer Research Institute; Pittsburgh, PA: 2003.
20. Willis, DK. Fatal crashes involving 16 year-old Texas drivers Pre- and Post-GDL: Who, when, where, and why?. Texas Transportation Institute; College Station: 2006.
21. Fohr SA, Layde PM, Guse CE. Graduated driver licensing in Wisconsin: does it create safer drivers? Wisconsin Medical Journal. 2005; 104(7):31–36. [PubMed: 16294597]
22. McCartt AT, Teoh ER, Fields M, Braitman KA, Hellinga LA. Graduated Licensing Laws and Fatal Crashes of Teenage Drivers: A National Study. Traffic Injury Prevention. 2010; 11(3):240–48. [PubMed: 20544567]
23. Masten SV, Foss RD, Marshall SW. Graduated Driver Licensing and Fatal Crashes Involving 16- to 19-Year-Old Drivers. JAMA. 2011; 306(10):1098–103. [PubMed: 21917580]
24. Baker, S.; Chen, L.; Li, G. Nationwide review of graduated driver licensing. AAA Foundation for Traffic Safety; Washington, DC: 2007.
25. Lyon JD, Pan R, Li J. National evaluation of the effect of graduated driver licensing laws on teenager fatality and injury crashes. Journal of Safety Research. 2012; 43(1):29–37. [PubMed: 22385738]
26. Dee TS, Grabowski DC, Morrisey MA. Graduated driver licensing and teen traffic fatalities. Journal of Health Economics. 2005; 24(3):571–89. [PubMed: 15811544]
27. Fell JC, Jones K, Romano E, Voas R. An Evaluation of Graduated Driver Licensing Effects on Fatal Crash Involvements of Young Drivers in the United States. Traffic Injury Prevention. 2011; 12(5):423–31. [PubMed: 21972851]
28. Morrisey MA, Grabowski DC. Gas prices, beer taxes and GDL programmes: effects on auto fatalities among young adults in the US. Applied Economics. 2010; 43(25):3645–54.
29. Census Bureau. [(accessed September 19, 2012)] Population estimates. 2010. http://www.census.gov/popest/data/historical/2000s/vintage_2009/datasets.html
30. Zhu M, Chu H, Greenland S. Biased Standard Errors From Complex Survey Analysis: An Example From Applying Ordinary Least Squares to the National Hospital Ambulatory Medical Care Survey. Annals of Epidemiology. 2011; 21(11):830–34. Erratum 2012; 22(1):70. [PubMed: 21982486]

31. Wooldridge, J. Introductory Econometrics: A Modern Approach. 4th ed. South-Western Cengage Learning; Mason, OH: 2008. p. 276-93.

32. Hosmer, D.; Lemeshow, S. Applied Survival Analysis: Regression Modelling of Time to Event Data. John Wiley; New York: 2008. p. 356

33. Morrisey MA, Grabowski DC. Gas prices, beer taxes and GDL programmes: effects on auto fatalities among young adults in the US. Applied Economics. 2010

34. Scott-Parker BJ, Bates L, Watson BC, King MJ, Hyde MK. The impact of changes to the graduated driver licensing program in Queensland, Australia on the experiences of Learner drivers. Accident Analysis & Prevention. 2011; 43(4):1301–08. [PubMed: 21545858]

35. Males M. California's graduated driver license law: Effect on teenage drivers' deaths through 2005. Journal of Safety Research. 2007; 38(6):651–59. [PubMed: 18054596]

36. Zhu M, Cummings P, Chu H, Coben JH, Li G. Graduated driver licensing and motor vehicle crashes involving teenage drivers: an exploratory age-stratified meta-analysis. Injury Prevention. 2013; 19(1):49–57. [PubMed: 23211352]

What this paper adds

What is already known on this subject

- Graduated Driver Licensing laws are associated with a 15 to 40% reduction in crash rates per person-year for persons aged 16 years.
- Few studies have examined whether this rate reduction occurs because adolescent drive fewer miles under GDL laws or because they have a lower rate of crashing per miles driven.

What this study adds

- GDL laws reduced crashes per person-year by approximately one-third among persons age 16; about half the reduction was due to fewer crashes per miles driven and half to less driving.
- For ages 17 and 18, there was no evidence of reduced crash rates per miles driven.

Table 1

Average annual miles driven by age, year, and graduated driver licensing exposure[a]

Age (yr)	Year	Graduated driver licensing exposure[b]	No. of respondents with trip diaries	Average annual miles driven	Adjusted miles driven ratio (aMR) (95% CI)[c]
16	1995–1996	Absent	1,272	2,851	
	2001–2002	Absent	634	4,156	
		Present	1,289	2,907	
	2008–2009	Absent	130	2,332	
		Present	3,081	1,652	
	total		6,406		0.79 (0.63, 0.98)
17	1995–1996	Absent	1,145	6,018	
	2001–2002	Absent	615	6,128	
		Present	1,123	5,425	
	2008–2009	Absent	108	4,268	
		Present	3,007	3,711	
	total		5,998		0.80 (0.63, 1.03)
18	1995–1996	Absent	1,099	7,507	
	2001–2002	Absent	481	7,605	
		Present	883	6,923	
	2008–2009	Absent	98	5,656	
		Present	2,359	5,857	
	total		4,920		0.92 (0.77, 1.09)
20–24	1995–1996	Not applicable	4,314	10,727	
	2001–2002	Not applicable	5,638	10,827	
	2008–2009	Not applicable	6,519	9,222	
	total		16,471		

Abbreviation: aMR: adjusted miles driven ratio: average annual miles driven exposed to graduated driver licensing (GDL) / average miles driven unexposed to GDL; CI: confidence interval; GDL: graduated driver licensing.

[a] Data from the National Household Travel Survey.

[b] Exposure to GDL means living in a state that has graduated driver licensing laws to restrict adolescent driving.

[c] Adjusted miles driven ratios (aMR) compare the average miles driven by respondents exposed to GDL with those not exposed, adjusted for changes over time as well as changes among drivers 20–24 years.

Table 2

Incidence rates per mile of driving for being a driver in a fatal crash by age, year, and graduated driver licensing exposure[a]

Age (yr)	Year	Graduated driver licensing exposure[b]	No. of drivers in fatal crashes	Rate per 100 million miles driven	Adjusted incidence rate ratio per miles (aIRRm) (95% CI)[c]
16	1995–1996	Absent	1,310	12.5	
	2001–2002	Absent	319	7.8	
		Present	707	8.5	
	2008–2009	Absent	41	9.8	
		Present	486	8.1	
					0.83 (0.65, 1.06)
17	1995–1996	Absent	1,431	6.7	
	2001–2002	Absent	453	8.6	
		Present	956	7.2	
	2008–2009	Absent	59	5.7	
		Present	791	5.5	
					1.03 (0.80, 1.35)
18	1995–1996	Absent	1,703	6.4	
	2001–2002	Absent	523	6.3	
		Present	1,279	6.2	
	2008–2009	Absent	84	5.6	
		Present	1,170	4.8	
					1.01 (0.84, 1.23)
20–24	1995–1996	Not applicable	7,004	3.7	
	2001–2002	Not applicable	7,237	3.3	
	2008–2009	Not applicable	5,587	2.8	

Abbreviation: aIRRm: adjusted incidence rate ratio per miles driven; CI: confidence interval; GDL: graduated driver licensing.

[a]Data from the National Household Travel Survey and Fatality Analysis Reporting System.

[b]Exposure to GDL means living in a state that has graduated driver licensing laws to restrict adolescent driving.

[c]Adjusted incidence rate ratios (aIRRm) compare the rates per miles driven for drivers exposed to GDL with those not exposed, adjusted for changes in rates over time as well as changes among drivers 20–24 years.

Table 3

Adjusted incidence rate ratios (aIRRpy) for being a driver in a fatal crash per person-year, comparing persons exposed to GDL laws with those not exposed[a,b]

Age (yr)	aIRRpy	95% CI
16	0.65	0.47, 0.91
17	0.83	0.60, 1.17
18	0.93	0.72, 1.19

Abbreviation: aIRRpy: adjusted incidence rate ratio per person-year; CI: confidence interval.

[a] Exposure to GDL means living in a state that has graduated driver licensing laws to restrict adolescent driving.

[b] aIRRpy adjusted for changes over time as well as changes among drivers 20–24 years.