Association of Graduated Driver Licensing With Driver, Non-Driver, and Total Fatalities Among Adolescents

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Introduction: Graduated driver licensing systems typically require an extended learner permit phase, and create night-time driving or passenger restrictions for adolescent drivers. Restricted driving might increase the use of alternative transportation to replace driving and consequently increase crashes and injuries for passengers, bus riders, pedestrians, and bicyclists. This study examined whether graduated driver licensing increases non-driver fatalities among adolescents, and whether it reduces total traffic fatalities combining drivers and non-drivers.

Methods: Longitudinal analyses were conducted using data from the 1995–2012 U.S. Fatality Analysis Reporting System. Adjusted rate ratios were estimated for being fatally injured in a crash according to: (1) presence/absence of a graduated driver licensing system; and (2) four levels of graduated driver licensing systems (absent, weak, medium, strong). Analyses were conducted in 2015.

Results: Among adolescents aged 16 years, graduated driver licensing was not associated with increased passenger fatalities (adjusted rate ratio, 0.96; 95% CI=0.90, 1.03) or pedestrian and bicyclist fatalities (adjusted rate ratio, 1.09; 95% CI=0.85, 1.39), but was associated with an 11% reduction in total traffic fatalities. Among those aged 17 years, graduated driver licensing was not associated with increased fatalities as passengers, pedestrians, or bicyclists, and was not associated with reduced total traffic fatalities.

Conclusions: In general, graduated driver licensing systems were not associated with increased fatalities as passengers, pedestrians, bicyclists, and bus riders. Graduated driver licensing systems were associated with reduced total fatalities of adolescents aged 16 years.
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Introduction

Motor vehicle crashes are a major source of morbidity and mortality worldwide, causing 20–50 million injuries and 1.2 million fatalities annually,[1] and are the leading cause of death among people aged 15–29 years globally.[1,2] Young novice drivers have the highest crash rate; per miles driven, the fatal crash rate per miles driven for drivers aged 16 years was approximately six times that for drivers aged 30–54 years in the U.S. in 2008–2009.[3,4] This excess crash risk is mainly due to inexperience and risky driving behaviors.[5–7] To address this public health issue, states have implemented graduated driver licensing (GDL), a phased approach to initiating driving, which was first introduced in Florida in 1996.[8,9] By January 2012, all states and the District of Columbia (DC) had implemented some form of GDL.[8,9] In general, it requires drivers aged younger than 18 years to proceed through three phases: an extended learner permit phase with supervised driving for 3–12 months; an intermediate phase, which allows unsupervised driving under low-risk conditions, such as daylight, but restricts night-time driving and, in many states, limits the number of passengers a novice young driver can have in their vehicle; and a full licensure phase that permits unsupervised driving at all times.[10]

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Previous studies have suggested that GDL is typically associated with a 15%–40% reduction in crash rates of drivers aged 16 years.[9,11–24] However, few studies have considered the outcomes involving adolescents aged 16–17 years traveling as passengers, bicyclists, pedestrians, and bus riders.[12,23,25] Adolescents in California were reported to use the following transportation alternatives to adapt to the night-time and passenger restrictions: have a parent or older adult as a supervising passenger; use of walking, biking, and bus; move their travel time to daytime; driving separately instead of one teenage driver with passengers; or violate the restriction.[26] Shifting to riding with parents or use of bus would be far safer, as would driving alone in the daytime by rearranging the time or event.[27,28] However, shifting travel to walking or biking could be dangerous based on per-trip fatality rates.[29] Similarly, the increased use of alternative transportation (riding as a passenger with parents or other adults, use of public transportation, bicycling, and walking) might increase crashes and injuries for passengers, bus riders, pedestrians, and bicyclists, canceling out the reduced driver injuries. A New York study suggested that pedestrian and bicyclist injuries might increase after GDL implementation.[23] However, this study was limited by a small sample size and a limited ability to control for confounding. Therefore, longitudinal analyses were conducted using traffic fatalities in all 50 states and DC to overcome previous methodologic difficulties and examine whether GDL was associated with fatalities among adolescents aged 16–17 years who traveled as passengers, bicyclists, and pedestrians. The authors also examined the association with total fatalities among those aged 16–17 years, including fatalities to drivers, passengers, bicyclists, pedestrians, and bus riders.

Methods

Measures

The Fatality Analysis Reporting System is maintained by the National Highway Traffic Safety Administration and contains data for all motor vehicle crashes that result in at least one fatality within 30 days of the crash on public roads in the U.S.[30] Counts of fatalities were obtained among adolescents aged 16–17 years who were in a crash as passengers in passenger vehicles, bicyclists, pedestrians, bus riders, and drivers of passenger vehicles by state, year (1995–2012), and quarter. The National Highway Traffic Safety Administration's definition was applied to identify passenger vehicles, which includes passenger cars, light trucks, vans, and utility vehicles.[30] Pedestrians and bicyclists were combined in analysis. Owing to the limited number of fatalities, bus riders were not analyzed as a separate group and instead were grouped with passengers, pedestrians, and bicyclists as non-drivers.

The GDL systems were classified in two ways: (1) presence/absence; and (2) with four levels (absent, weak, medium, strong) for each U.S. state for each quarter year of the 18-year study period.

The presence/absence of GDL was defined with a learner's permit phase of at least 3 months, plus an intermediate phase restriction on either night driving or the number of young passengers.[8] Further, GDL systems were classified as weak, medium, and strong, based on whether they had none, one, or at least two of the following three components, respectively: (1) an intermediate phase night-time driving restriction that begins by 10:00 PM; (2) an intermediate phase passenger restriction of no more than one passenger; and (3) a minimum entry age for the intermediate phase of 16.5 years.

Midyear population estimates by state, age, and year were obtained from the U.S. Census Bureau, and quarterly values were interpolated linearly.[31]

The presence of other traffic safety laws may confound the relationship between GDL and fatalities. States' impaired driving laws (i.e., minimum blood alcohol concentration of 0.08 g/dL or 0.10 g/dL, zero tolerance laws, and mandatory license suspensions for driving under the influence offenses), maximum speed limits (i.e., 55, 65, 70, or ≥75 miles per hour), and seatbelt laws (i.e., no law, primary enforcement law, secondary enforcement law) were obtained from two sources. The first source, Dr. Scott Masten,[17] provided a data set of these laws spanning 1986–2008 in his previous research. Additional data were obtained from the Insurance Institute for Highway Safety (IIHS).[32] As a national authority on traffic laws, IIHS tracks transportation legislations and makes data freely available in the public domain on a continuing basis. The IIHS website can be searched to obtain accurate information on each state's traffic law changes.

Quarterly unemployment rates were obtained for each state from the U.S. Bureau of Labor Statistics.[33] Quarterly per capita income estimates were obtained for each state from the U.S. Bureau of Economic Analysis.[34] The national annual Consumer Price Index was used to adjust for inflation.[35] The annual unleaded gasoline price for each state was obtained from the Energy Information Administration,[36] and then adjusted for inflation using the national annual Consumer Price Index.

Statistical Analysis

To estimate per-person year rates of fatality, fatalities counts were divided by population estimates.

Adjusted fatality rate ratios (ARRs) in the presence of a GDL system compared with no GDL system were estimated using Poisson regression. The outcome was the quarterly count of fatalities with an offset equal to the log of the population for that quarter. Generalized estimating equations were used to account for the repeated measures from each state over the study period, and an autoregressive working correlation structure was employed. Regression models included terms for year (linear spline terms with knots at 2001 and 2004), quarter (three indicator variables for four quarters), age (0 for 16 years, 1 for 17 years), and GDL (0 for absence, 1 for presence), as well as an interaction for age and GDL to allow examination of whether the association between GDL and fatality rates vary by age. The following traffic laws were included in the model:

1. rural interstate speed limits (55, 65, 70, or ≥75 miles per hour);
2. seat belt laws (none, primary enforcement law, secondary enforcement law);
3. blood alcohol concentration limit for driving (0.08 g/dL or 0.10 g/dL);