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Duane F. Shell
University of Nebraska-Lincoln, dshell2@unl.edu

Ian Newman
University of Nebraska-Lincoln, inewman1@unl.edu

Ana Lucía Córdova Cazar
University of Nebraska-Lincoln, al.cordovacazar@huskers.unl.edu

Jill M. Heese
University of Nebraska-Lincoln

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Driver education and teen crashes and traffic violations in the first two years of driving in a graduated licensing system

Duane F. Shell [a,*], Ian M. Newman [a], Ana Lucía Córdova-Cazar [b], Jill M. Heese [b]

[a] Nebraska Prevention Center for Alcohol and Drug Abuse, Department of Educational Psychology, 114 TEAC, University of Nebraska-Lincoln, Lincoln, NE 68588-0345, USA
[b] Survey Research and Methodology Program, UNL Gallup Research Center, 933 Oldfather Hall, University of Nebraska-Lincoln, Lincoln, NE 68588-0366, USA

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A B S T R A C T

Our primary research question was whether teens obtaining their intermediate-level provisional operators permit (POP) in a graduated driver licensing (GDL) environment through driver education differed in crashes and traffic violations from teens who obtained their POP by completing a supervised driving certification log without taking driver education. A descriptive epidemiological study examining a census of all teen drivers in Nebraska (151,880 teens, 48.6% girls, 51.4% boys) during an eight year period from 2003 to 2010 was conducted. The driver education cohort had significantly fewer crashes, injury or fatal crashes, violations, and alcohol-related violations than the certification log cohort in both years one and two of driving following receipt of the POP. Hierarchical logistic regression was conducted, controlling for gender, race/ethnicity, median household income, urban–rural residence, and age receiving the POP. In both year one and two of driving, teens in the certification log cohort had higher odds of a crash, injury or fatal crash, violation, or alcohol-related violation. Findings support that relative to a supervised driving certification log approach, teens taking driver education are less likely to be involved in crashes or to receive a traffic violation during their first two years of driving in an intermediate stage in a graduated driver licensing system. Because teen crash and fatality rates are highest at ages 16–18, these reductions are especially meaningful. Driver education appears to make a difference in teen traffic outcomes at a time when risk is highest.

1. Introduction

Driver education programs for teen drivers are designed to prepare beginning drivers for license testing and licensing (Mayhew et al., 2014; Thomas et al., 2012). Driver education courses typically combine both classroom instruction on topics such as vehicle safety, laws and regulations, vehicle operation, and factors affecting driving (alcohol, road conditions, distraction, etc.) and behind-the-wheel driving practice with a trained instructor. Most examinations of driver education have focused on crashes (Lonero and Mayhew, 2010). This makes sense as crashes, especially fatal crashes, are the most significant and important negative outcome for teen drivers. Traffic violations, however, represent another type of important negative outcome. Whether due to inexperience or deliberate decision, most risky driving such as speeding, driving too close, texting, or recklessness is also driving that is in violation of driving statutes. Higher instances of violations have been found to be associated with teen fatal crashes (Gonzales et al., 2005).

1.1. Early studies of driver education

Prior evaluations are mixed on whether driver education produces benefits in terms of fewer crashes and traffic violations. The most comprehensive prospective experimental study of driver education was the DeKalb project (Smith, 1983; Smith and Blatt, 1987; Lund et al., 1986). Crashes per licensed driver were lower in a comprehensive driver education group in the first six months, but reductions in crashes per licensed driver were off-set by earlier licensing. No effects were found for violations. Subsequent long-term analyses of the DeKalb data for up to six years have found conflicting evidence for and against benefits for driver education groups (Smith and Blatt, 1987; Lund et al., 1986). Findings have generated considerable controversy about both the utility of the randomized trial, confounding of the control group, and debate

* Corresponding author. Tel.: +1 402 472 6981; fax: +1 402 472 8319.
E-mail addresses: dshell2@unl.edu (D.F. Shell), ainewman1@unl.edu (I.M. Newman), al.cordovacazar@huskers.unl.edu (A.L. Córdova-Cazar), jheese2001@yahoo.com (J.M. Heese).

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about the quality and appropriateness of various statistical analyses applied (Mayhew et al., 1998; Peck, 2011).

Following the DeKalb project, controlled trial studies in Australia (Strang et al., 1982; Wynne-Jones and Hurst 1984) and Sweden (Gregersen, 1994) produced mixed but mostly non-significant results on crashes, but sample size limitations reduced power and effects again were compromised by earlier licensing in driver education groups. A number of quasi-experimental studies have been conducted (Lonero et al., 2005; Maycock 1995; McKenna et al., 2000). As with controlled trial studies, there have been mixed results with the majority of studies showing no significant effects on crashes or violations, some studies showing reductions in crashes for those taking driver education, and some studies showing an increase in crashes for driver education. Problems with all of these studies include confounds from small sample sizes to poor response rates for self-report surveys (Lonero and Mayhew 2010). Finally, Levy (1990) used econometric modeling to examine factors influencing fatal crash rates in 47 states. He concluded that a mandatory driver education requirement had a small but significant association with fewer fatalities in 15–17 year olds. Recent comprehensive reviews of these studies can be found in Lonero and Mayhew (2010),Peck (2011), and Thomas et al. (2012).

1.2. Graduated driver licensing

In part because of the generally disappointing results from early studies of driver education, traffic safety efforts for teen drivers changed in the 1990's to an emphasis on graduated driver licensing (GDL). Graduated driver licensing typically consists of a three phase approach. During an initial "learner" phase, all driving by the teen must be supervised by an adult fully licensed driver. During an intermediate phase, driving unsupervised is allowed but is subject to various restrictions such as time (e.g., no night driving) or number of passengers. Finally, after a defined period in the intermediate phase, unrestricted driving or regular licensing occurs, usually with some minimum age typically 17 or 18. Unlike the mixed results for driver education, Baker et al. (2007) in a comprehensive review, concluded that GDL has reduced the incidents of fatal traffic crashes in the 15–17 year old age groups. The potential role of driver education in the GDL environment, however, is poorly understood. Most formal studies of driver education occurred before wide-spread adoption of GDL in the 1990's and 2000's and there have been few systematic studies of driver education since wide-spread adoption of GDL (Mayhew, 2007; Thomas et al., 2012).

Recent studies suggest that driver education may produce positive effects in the GDL environment. Zhao et al. (2006) examining drivers in Ontario Canada's learner stage of the GDL, found that driver education graduates reported fewer crashes and driver education was the only factor significantly associated with lower crash rate. Vanlaar et al. (2009) in a study of 46 states and 11 Canadian Provinces, found that mandatory driver education as a condition of the learner stage of GDL resulted in a 34.5% reduction in relative fatality risk for 18 year olds, but no reduction for 16 or 19 year olds. Despite these suggestive findings, a review of studies on driver education within the GDL environment by Thomas et al. (2012) concluded that there was little solid evidence that driver education impacts teen crashes or other outcomes. New studies of teen driver education in Manitoba and Oregon since the Thomas et al. review, however, found that driver education increased knowledge and safe driving practices and that, in Oregon, taking driver education was associated with lower rates of crashes and citations (Mayhew et al., 2014). Even with these new findings, however, studies have not provided a clear-cut answer to whether driver education can help reduce teen crashes and citations in the graduated driver licensing environment.

1.3. The present study

The objective of this study was to examine whether teens taking driver education differed in crashes and moving traffic violations from teens not taking driver education within a graduated driver licensing (GDL) environment. The first two years of driving have been found to be a critical period for teen crashes, linked to levels of inexperience (Foss et al., 2011). Because of the unique risk in these years, the first two years of independent driving in the graduated licensing system were examined. We conducted a descriptive epidemiological study examining a census of all teen drivers obtaining the intermediate stage provisional operators permit (POP) in Nebraska during an eight year period from 2003 to 2010. To apply for the provisional operators permit (POP) in the graduated driver licensing (GDL) system in Nebraska, teens must complete either (1) 50 h of adult supervised driving documented on a Certification Form or (2) a certified driver education course. All other administrative aspects of the Nebraska GDL process are the same for both groups. This allows comparison of subsequent traffic violations between the cohort of age 16 teens who completed driver education and the cohort of teens who completed the 50 h of supervised driving, but not driver education, without confounds from different licensing procedures for the driver education and supervised driving groups that have been common in other studies, such as time discounting for taking driver education.

This study builds on recent findings by Mayhew et al. (2014). A key difference between this study and Mayhew et al. concerns the role of driver education within the graduated licensing environment. In Oregon where their study was conducted, driver education is done in combination with required supervised driving but reduces the number of hours of supervised driving from 100 to 50 h for obtaining the Oregon equivalent to the POP. In Nebraska, driver education is an alternative method to 50 h of supervised driving for obtaining the POP. Teens do one or the other but not both. This provides a more clear delineation of the effects of driver education separate from the effects of adult supervised driving.

Our primary research question was whether there was a difference in occurrence of traffic crashes and moving violations between the cohort of teens who obtained their provisional operators permit (POP) through driver education and the cohort of teens who obtained their POP by completing 50 h of adult supervised driving.

1.3.1. Nebraska graduated driver licensing system

Nebraska has a modified three-stage graduated driver licensing (GDL) system. In the standard sequence, a teen first obtains a learner's permit (LPD-learner stage) at age 15 which is valid for one year. LPD holders must be accompanied at all times by a licensed driver who is at least 21 years old. At age 16, a teen can apply for the provisional operators permit (POP-intermediate stage) that is the focus of this study. The POP allows a teen to operate a motor vehicle unsupervised in Nebraska from 6 a.m. to 12 midnight, from 12 midnight to 6 a.m. if they are driving to or from home to work or a school activity, and anytime if accompanied by a parent or licensed driver age 21 or older. During the first six months of the POP, drivers are restricted to no more than one passenger who is not an immediate family member and who is under age 19. A POP can be held for up to two years until age 18 at which time, the teen must acquire a regular unrestricted operator's license. A teen who has held a POP for at least 12 months and not accumulated three or more points for traffic citations on their driving record can apply for an operator's license at age 17. In rural areas a teen may obtain a school permit (SCP) prior to the POP at age 14. The SCP is valid until age 16 when a POP must be obtained. The SCP allows a teen to operate a motor vehicle unsupervised to and from school to attend classes and school related extracurricular activities or any time when accompanied by a licensed driver who is at least 21 years old. To apply for a SCP, the teen must meet the same criteria as for the POP.

To apply for a POP, the teen must do one of the following: (1) complete a Department of Motor Vehicles (DMV) approved driver education safety course and pass written and driving tests given by the driver education safety course instructor, or (2) present to the driver licensing staff a 50 h Certification Form (log) signed by a parent, guardian or licensed driver who is at least 21 years old. The 50 h Certification Form must be obtained from the DMV and must indicate that at least 10 h of motor vehicle operation was between sunset and sunrise. If a teen has a SCP, they do not have to redo the driver education course or 50 h Certification Form when obtaining the POP.

1.3.2. Driver education course requirements

Requirements for certification of a Driver Safety Education Course are set forth in the Nebraska Administrative Code for the Department of Motor Vehicles. Instruction must include a minimum of 20 h of classroom instruction and 5 h of behind-the-wheel instruction. In competency-based courses which evaluate students against established criteria and are taught by competency certified instructors, students must complete at least 2 h behind the wheel. All other standards and requirements are the same for competency and regular courses. Classroom content must include motor vehicle laws, vehicle operating tasks, occupant protection, establishing vehicle position, limited space movements, traffic flow tasks, driving environment, factors affecting performance (e.g., risk, attitude, emotion), other roadway users (e.g., pedestrians, motorcycles), alcohol and other drugs, insurance, and responses to vehicle failure/driver error. Behind-the-wheel content must include car control, mixing with traffic, and response to traffic conditions. Nebraska's prescribed driver education curriculum meets some but not all of the guidelines in the standards developed by the National Highway Traffic Safety Administration (NHTSA) (2012).

2. Method

2.1. Study Population

The study population was a census of all 151,880 Nebraska teens (89.1% White non-Hispanic, 3.1% African–American, 1.9% Hispanic, 1.6% Asian, .6% Native American, 3.7% other) who received their Provisional Operator's Permit (POP) between January 1, 2003 and December 31, 2010. There were 73,786 (48.6%) girls and 78,084 (51.4%) boys. Urban areas were defined as the three counties containing the state's two cities of over 240,000 population along with their contiguous metropolitan areas. These urban areas contain approximately 48% of the state population. In the study population, 70,891 (46.7%) were from urban areas and 80,989 (53.3%) were from rural areas matching the general state population demographics.

For analysis of year two crashes and violations, a subset of the study population consisting of those who received their POP between January 1, 2003 and December 31, 2009 was used. This sample consisted of 132,133 Nebraska teens (89.4% White non-Hispanic, 3.0% African–American, 1.3% Hispanic, 1.6% Asian, 0.6% Native American, 4.0% other). There were 64,128 (48.5%) girls and 68,005 (51.5%) boys with 61,605 (46.6%) from urban areas and 70,528 (53.4%) from rural areas.

The census included all teens obtaining a POP during the study period, with the exception of 154 teens for whom POP documentation records were incomplete. Teens who moved out-of-state, as indicated by traffic records license surrender data, also were removed unless they had an accident or a citation prior to surrender. This resulted in the removal of 707 teens from the year one analyses and 1675 teens from the year two analysis.

Data on school permit holders was not available prior to 2007. Within the approximately half of the study population with school permit (SCP) data, 12.7% of the year 1 population and 15.4% of the year 2 sub-population held a SCP. SCP permit holders did not differ from non-SCP permit holders in whether they obtained their POP through driver education or certification log in either the year 1 (12.8% driver education; 12.5% log; χ^2 (1) = 1.63, p = .202) or year 2 (15.4% driver education; 15.3% log; χ^2 (1) = 0.18, p = 0.668) populations. Because SCP data prior to 2007 is not available, SCP cannot be statistically controlled in analyses. But the lack of significant difference in the percentages of SCP holders in the driver education and certification log cohorts reduces the likelihood of bias in the comparison of driver education to the certification log due to a teen having a SCP.

2.2. Data sources

Driver information data including demographics, provisional operator permit licensing data, and citations for traffic violations were obtained from Nebraska traffic records data maintained by the Nebraska Department of Roads and Nebraska Office of Highway Safety. Traffic records data contains the record of all traffic violations in the state of Nebraska that have resulted in a conviction. The data does not contain any records of citations that have been excused because of pre-trial diversion programs. Citation issuance date was used for analysis regardless of when the actual conviction occurred. Only moving violations and secondary violations reflecting risky behaviors (e.g., no seatbelt) were used.

Crash data was obtained from the Crash Outcome Data Evaluation System (CODES) maintained by the Nebraska Department of Health and Human Services. CODES is a collaboration between the Nebraska Department of Health and Human Services and the National Highway Traffic Safety Administration (NHTSA). Unlike the Fatal Accident Reporting System (FARS), CODES contains information on all crashes not just fatal crashes. Data were retrieved from Nebraska traffic records data and CODES in 2008, 2011, and 2012 containing records for all teens receiving a POP from the years 2003 to 2010 inclusive. Final data cleaning and verification was done in summer 2012.

Having a crash or violation within the first year after receiving the POP was computed by adding one year to the date that the POP was issued and then determining whether a crash or violation occurred within that one year period based on the crash date from CODES or the citation issuance date from traffic records data. Having a crash within the second year after receiving the POP was computed by adding two years to the date that the POP was issued and then determining whether a crash or violation occurred between the one year and two year dates. Having an injury or fatal crash was determined by a CODES accident severity code of 1 (fatal), 2 (disabling injury), or 3 (visible injury). Having a DUI violation was determined by a violation code of any DUI violation. The majority of teens (70.5%) obtained their POP within the first two months after age 16 and 90.2% obtained their POP prior to age 17. Regardless of the teen's age at receipt of the POP, tracking was done based on the date the POP was obtained as this reflects the first time fully unaccompanied driving is allowed for the majority of the time and is the start point for intermediate stage POP graduated licensing restrictions.

Household income was estimated from U.S. Census five-year median household income (12 months, inflation-adjusted) from the American Community Survey (ACS) estimates for 2005–2009. Median household income was determined in two ways. In the seven Nebraska counties that had more census tracts than Zip codes, census tract information within the county was used.

Permanent address from licensing records was geocoded to census tracts utilizing TomTom's Tele Atlas software (www.geocode.com). Geocodes were used to obtain ACS median household income for the 85,210 teens in these counties from the U.S. Census' website, FactFinder2. For the remaining 86 counties, census tract was assigned to zip code using the University of Michigan's census tract to zip code cross-walk (http://www.psc.isr.umich.edu/dis/census/Features/tract2zip/methods.html). ACS median household income by tract then was obtained from the U.S. Census' website FactFinder2 and proportionately allocated within Zip code based on the tract proportion within Zip area.

2.3. Analysis

All analyses were run on SPSS versions 20 through 22. To control for potential confounds due to gender, ethnicity, residence, age at which the POP was obtained, and income differences between teens in the driver education and certification log cohorts, hierarchical logistic regression was conducted. In the first step, dummy coded gender, ethnicity (White non-Hispanic vs other racial/ethnic groups), and urban vs rural residence, and z-score transformed ACS median household income and POP age were entered as a control block. In the second step, dummy coded POP cohort (driver education vs certification log) was entered. Significance for POP cohort was determined by change in χ^2 at step 2.

3. Results

3.1. Demographics

In the study population, 80,685 (53.1%) teens were in the driver education cohort and 71,195 (46.9%) were in the certification log cohort. Teens in the driver education cohort were significantly more likely to be girls (54.6–51.7% boys), be of White non-Hispanic ethnicity (56.0–29.4% non-White), have higher median household income ($60,344–$52,561), reside in an urban area (57.9–48.9% rural), and be younger on average at the time they obtained their POP (16.15–16.33 years).

3.2. Crashes and violations in the POP first year

In year one of driving following the POP, 18,097 teens (11.9%) had a crash and 3568 teens (2.3%) had an injury or fatal crash. The driver education cohort had significantly fewer crashes (8395; 11.1%) than the certification log cohort (9162; 12.9%), χ^2 (1) = 116.10, $p < 0.0001$ and significantly fewer injury or fatal crashes (1717; 2.1%) than the certification log cohort (1851; 2.6%), χ^2 (1) = 36.71, $p < 0.0001$. For violations, 21,458 teens (14.1%) had a violation and 160 (0.1%) had a DUI violation. The driver education cohort had significantly fewer violations (8395; 10.4%) than the certification log cohort (13,063; 18.3%), χ^2 (1) = 1967.12, $p < 0.0001$ and significantly fewer alcohol-related violations (46; 0.1%) than the certification log cohort (114; 0.2%), χ^2 (1) = 38.21, $p < 0.0001$.

POP cohort accounted for significant increase in prediction for crashes and injury/fatal crashes during the first year of driving following the POP (Table 1). Relative to other predictors, teens in the certification log cohort had the second highest odds of a crash (1.22) and highest odds of an injury/fatal crash (1.24). Teens of living in urban areas and in households with lower median income had higher odds of being in a crash or an injury/fatal crash and teens of White non-Hispanic ethnicity had higher odds of being in an injury/fatal crash. Unexpectedly, girls had higher odds of having a crash or injury/fatal crash than boys.

Table 1
Logistic regression predicting crashes in the first year of driving following POP.

Predictor	$\Delta\chi^2$	B	SE	OR	95% CI
Crash					
Step 1	338.38***				
Race/ethnicity (1 = other, 0 = White)		−0.024	0.026	0.977	[0.928, 1.028]
Urbanicity (1 = urban, 0 = rural)		0.326***	0.018	1.385	[1.336, 1.435]
Household income		−0.058***	0.009	0.943	[0.927, 0.960]
Gender (1 = boy, 0 = girl)		−0.037*	0.016	0.964	[0.934, 0.994]
POP age		0.001	0.008	1.001	[0.985, 1.018]
Constant		−2.139***	0.015	0.118	
Step 2	142.40***				
Race/ethnicity (1 = other, 0 = White)		−0.063	0.026	0.939	[0.892, 0.989]
Urbanicity (1 = urban, 0 = rural)		0.337***	0.018	1.401	[1.352, 1.452]
Household income		−0.046***	0.009	0.955	[0.939, 0.973]
Gender (1 = boy, 0 = girl)		−0.042**	0.016	0.959	[0.930, 0.989]
POP age		−0.013	0.008	0.987	[0.971, 1.003]
POP cohort(1 = log, 0 = DE)		0.197***	0.016	1.218	[1.179, 1.258]
Constant		−2.233***	0.017	0.107	
Injury/fatal crash					
Step 1	47.16***				
Race/ethnicity (1 = other, 0 = White)		−0.149*	0.058	0.862	[0.768, 0.966]
Urbanicity (1 = urban, 0 = rural)		0.102**	0.039	1.107	[1.025, 1.195]
Household income		−0.065**	0.020	0.937	[0.901, 0.975]
Gender (1 = boy, 0 = girl)		−0.171***	0.034	0.843	[0.789, 0.901]
POP age		0.040*	0.017	1.041	[1.007, 1.077]
Constant		−3.676***	0.030	0.025	
Step 2	36.66***				
Race/ethnicity (1 = other, 0 = White)		−0.191**	0.059	0.826	[0.736, 0.927]
Urbanicity (1 = urban, 0 = rural)		0.114**	0.039	1.121	[1.038, 1.210]
Household income		−0.051*	0.020	0.950	[0.913, 0.989]
Gender (1 = boy, 0 = girl)		−0.176***	0.034	0.838	[0.784, 0.896]
POP age		0.025	0.017	1.025	[0.991, 1.061]
POP cohort(1 = log, 0 = DE)		0.213***	0.035	1.237	[1.155, 1.326]
Constant		−3.780***	0.035	0.023	

OR: odds ratio; CI: confidence interval; DE: driver education.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

POP cohort accounted for a significant increase in prediction for both violations and alcohol-related violations during the first year of driving following the POP (Table 2). Relative to other predictors, teens in the certification log cohort had the highest odds of a violation (1.74). Boys, teens of non-White race/ethnicity, teens living in urban areas, teens in households with lower median income, and teens obtaining their POP at a higher age had higher odds of receiving a violation. Teens in the certification log cohort had higher odds of an alcohol-related violation (1.63). Boys and teens who obtained their POP at an older age had higher odds of having an alcohol-related violation.

Table 2
Logistic regression predicting violations in the first year of driving following POP.

Predictor	$\Delta\chi^2$	B	SE	OR	95% CI
Violation					
Step 1	2768.76***				
Race/ethnicity (1 = other, 0 = White)		0.316***	0.022	1.371	[1.313, 1.432]
Urbanicity (1 = urban, 0 = rural)		0.196***	0.017	1.216	[1.176, 1.257]
Household income		−0.190***	0.009	0.827	[0.812, 0.842]
Gender (1 = boy, 0 = girl)		0.516***	0.015	1.676	[1.627, 1.727]
POP age		0.152***	0.007	1.164	[1.148, 1.180]
Constant		−2.245***	0.015	0.106	
Step 2	1253.51***				
Race/ethnicity (1 = other, 0 = White)		0.208***	0.022	1.232	[1.179, 1.287]
Urbanicity (1 = urban, 0 = rural)		0.229***	0.017	1.257	[1.216, 1.300]
Household income		−0.153***	0.009	0.858	[0.843, 0.874]
Gender (1 = boy, 0 = girl)		0.506***	0.015	1.659	[1.610, 1.709]
POP age		0.115***	0.007	1.122	[1.106, 1.138]
POP method(1 = log, 0 = DE)		0.553***	0.016	1.738	[1.686, 1.793]
Constant		−2.529***	0.017	0.080	
DUI violation					
Step 1	298.72***				
Race/ethnicity (1 = other, 0 = White)		−0.185	0.213	0.831	[0.547, 1.263]
Urbanicity (1 = urban, 0 = rural)		−0.162	0.172	0.850	[0.607, 1.191]
Household income		−0.211*	0.106	0.810	[0.659, 0.997]
Gender (1 = boy, 0 = girl)		1.036***	0.183	2.819	[1.969, 4.034]
POP age		0.848***	0.051	2.335	[2.112, 2.580]
Constant		−8.003***	0.193	0.000	
Step 2	7.40**				
Race/ethnicity (1 = other, 0 = White)		−0.260	0.215	0.771	[.506, 1.175]
Urbanicity (1 = urban, 0 = rural)		−0.120	0.172	0.887	[.633, 1.242]
Household income		−0.176	0.106	0.839	[.681, 1.033]
Gender (1 = boy, 0 = girl)		1.027***	0.183	2.793	[1.952, 3.998]
POP age		0.820***	0.052	2.271	[2.051, 2.516]
POP method(1 = log, 0 = DE)		0.486**	0.183	1.626	[1.136, 2.329]
Constant		−8.271***	0.233	0.000	

OR: odds ratio; CI: confidence interval; DE: driver education.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

3.3. Crashes and violations in the POP second year

In year two of driving following the POP, 11,775 teens (8.9%) had a crash and 2167 teens (1.6%) had an injury or fatal crash. The driver education cohort had significantly fewer crashes (5940; 8.4%) than the certification log cohort (5835; 9.5%), χ^2 (1) = 44.31, $p < 0.0001$ and significantly fewer injury or fatal crashes (1064; 1.5%) than the certification log cohort (1103; 1.8%), χ^2 (1) = 16.12, $p < 0.0001$. For violations, 22,324 teens (16.9%) had a violation and 522 (0.4%) had a DUI violation. The driver education cohort had significantly fewer violations (9453; 13.4%) than the certification log cohort (12,871; 20.9%), χ^2 (1) = 1311.32, $p < 0.0001$ and significantly fewer alcohol-related violations (158; 0.2%) than the certification log cohort (364; 0.6%), χ^2 (1) = 112.35, $p < 0.0001$.

POP cohort accounted for significant increase in prediction for crashes and injury/fatal crashes during the second year of driving following the POP (Table 3). Relative to other predictors, teens in the certification log cohort had the second highest odds of a crash (1.14) or injury/fatal crash (1.19). Teens living in urban areas and teens living in households with lower median income had higher odds of being in a crash or an injury/fatal crash and teens of non-White ethnicity and had higher odds of being in a crash. Unlike year

Table 3
Logistic regression predicting crashes in the second year of driving following POP.

Predictor	$\Delta\chi^2$	B	SE	OR	95% CI
Crash					
Step 1	198.49***				
Race/ethnicity (1 = other, 0 = White)		0.103**	0.031	1.109	[1.043, 1.179]
Urbanicity (1 = urban, 0 = rural)		0.281***	0.022	1.325	[1.269, 1.384]
Household income		−0.070***	0.011	0.932	[0.912, 0.953]
Gender (1 = boy, 0 = girl)		0.058**	0.019	1.059	[1.020, 1.100]
POP age		−0.020*	0.010	0.980	[0.961, 0.999]
Constant		−2.504***	0.018	0.082	
Step 2	41.65***				
Race/ethnicity (1 = other, 0 = White)		0.077*	0.031	1.080	[1.015, 1.148]
Urbanicity (1 = urban, 0 = rural)		0.288***	0.022	1.333	[1.277, 1.392]
Household income		−0.062***	0.011	0.940	[.919, 0.961]
Gender (1 = boy, 0 = girl)		0.054**	0.019	1.055	[1.016, 1.096]
POP age		−0.029**	0.010	0.971	[0.952, 0.991]
POP cohort(1 = log, 0 = DE)		0.130***	0.020	1.138	[1.095, 1.184]
Constant		−2.564***	0.020	0.077	
Injury/fatal crash					
Step 1	19.20**				
Race/ethnicity (1 = other, 0 = White)		0.019	0.072	1.020	[0.886, 1.173]
Urbanicity (1 = urban, 0 = rural)		0.171**	0.050	1.186	[1.076, 1.307]
Household income		−0.087**	0.026	0.917	[0.871, 0.964]
Gender (1 = boy, 0 = girl)		0.067	0.043	1.069	[0.982, 1.164]
POP age		−0.016	0.022	0.984	[0.941, 1.028]
Constant		−4.214***	0.040	0.015	
Step 2	14.53***				
Race/ethnicity (1 = other, 0 = White)		−0.016	0.072	0.984	[0.855, 1.134]
Urbanicity (1 = urban, 0 = rural)		0.179***	0.050	1.196	[1.085, 1.318]
Mean household income		−0.076**	0.026	0.927	[0.881, 0.975]
Gender (1 = boy, 0 = girl)		0.062	0.043	1.064	[0.977, 1.159]
POP age		−0.028	0.023	0.972	[0.930, 1.016]
POP cohort(1 = log, 0 = DE)		0.171***	0.045	1.187	[1.087, 1.296]
Constant		−4.295***	0.046	0.014	

OR: odds ratio; CI: confidence interval; DE: driver education.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

1, boys had higher odds of having a crash but there were no differences in injury/fatal crashes. Teens obtaining their POP at an older age had lower odds of a crash but there were no differences in injury/fatal crashes.

POP cohort accounted for a significant increase in prediction for violations and alcohol-related violations during the second year of driving following the POP (Table 4). Teens in the certification log cohort had the second highest odds of a violation (1.59). As in year one, boys, teens of non-White race/ethnicity, teens living in urban areas, teens in households with lower median income, and teens obtaining their POP at an older age had higher odds of receiving a violation. Teens in the certification log cohort had more than double the odds of an alcohol-related violation (2.05) and certification log cohort was the second strongest predictor. Boys, teens living in urban areas, and teens obtaining their POP at an older age had higher odds of an alcohol-related violation.

Table 4
Logistic regression predicting violations in the second year of driving following POP.

Predictor	$\Delta\chi^2$	B	SE	OR	95% CI
Violation					
Step 1	2562.05***				
Race/ethnicity (1 = other, 0 = White)		0.327***	0.022	1.387	[1.327, 1.450
Urbanicity (1 = urban, 0 = rural)		0.282***	0.017	1.326	[1.283, 1.371]
Household income		−0.176***	0.009	0.839	[0.824, 0.854]
Gender (1 = boy, 0 = girl)		0.504***	0.015	1.655	[1.607, 1.705]
POP age		0.120***	0.007	1.127	[1.112, 1.143]
Constant		−2.063***	0.015	0.127	
Step 2	802.07***				
Race/ethnicity (1 = other, 0 = White)		0.240***	0.023	1.271	[1.216, 1.329]
Urbanicity (1 = urban, 0 = rural)		0.305***	0.017	1.357	[1.313, 1.402]
Household income		−0.147***	0.009	0.884	[0.848, 0.879]
Gender (1 = boy, 0 = girl)		0.495***	0.015	1.641	[1.592, 1.690]
POP age		0.091***	0.007	1.096	[1.081, 1.111]
POP cohort(1 = log, 0 = DE)		0.438***	0.016	1.550	[1.504, 1.598]
Constant		−2.279***	0.017	0.102	
DUI violation					
Step 1	354.60***				
Race/ethnicity (1 = other, 0 = White)		0.318**	0.116	1.374	[1.095, 1.724]
Urbanicity (1 = urban, 0 = rural)		0.252*	0.097	1.286	[1.063, 1.556]
Household income		−0.136**	0.052	0.873	[0.789, 0.966]
Gender (1 = boy, 0 = girl)		1.021***	0.101	2.776	[2.278, 3.383]
POP age		0.432***	0.031	1.541	[1.451, 1.636]
Constant		−6.504***	0.103	0.001	
Step 2	55.02***				
Race/ethnicity (1 = other, 0 = White)		0.194	0.116	1.214	[0.966, 1.525]
Urbanicity (1 = urban, 0 = rural)		0.291**	0.097	1.338	[1.106, 1.618]
Household income		−0.085	0.052	0.918	[0.829, 1.017]
Gender (1 = boy, 0 = girl)		1.004***	0.101	2.730	[2.240, 3.328]
POP age		0.394***	0.031	1.482	[1.395, 1.576]
POP cohort(1 = log, 0 = DE)		0.718***	0.100	2.051	[1.687, 2.495]
Constant		−6.898***	0.121	0.001	

OR: odds ratio; CI: confidence interval; DE: driver education.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

4. Discussion

In relation to our primary research question, the cohort of teens who obtained their provisional operators permit (POP) through driver education had significantly lower prevalence of a crash, injury/fatal crash, traffic violation, or DUI in both the first and second year of driving after obtaining their POP than the cohort of teens who obtained their POP through 50 h of adult supervised driving. When controlling for gender, ethnicity (White non-Hispanic vs other racial/ethnic groups), urban vs rural residence, ACS median household income, and age at which the POP was obtained, teens in the certification log cohort had higher odds of a crash, injury/fatal crash, traffic violation, and DUI in both the first and second year of driving after obtaining the POP. The two year period of the POP covers ages 16–17. About 70% of teens received their POP within the first two months after turning age 16, so their two years of driving occurred during these ages. Remaining teens completed their two-years while age 18, at the oldest. These are known high risk ages for teen crashes as crashes and injury or fatal crashes are highest in these years (Shope and Bingham, 2008; Foss et al., 2011). The higher crash risk likely is due to both the inexperience of teen drivers and the increased amount of unsupervised solo driving allowed in the intermediate stage of the GDL. Because the 16–18 age range for the two years of driving after obtaining the POP examined in this study corresponds to this high risk period, the findings suggest that driver education potentially makes an important contribution to reducing crashes and violations during this critical period.

Foss et al. (2011) in examining North Carolina's GDL, which is similar to the Nebraska certification log method, identified several teen driver behaviors that were associated with crashes including inattention, failing to yield, exceeding safe speed for conditions, crossing the center line/going the wrong way, overcorrecting, exceeding the speed limit, and improper turning. They suggested that teen drivers lacked knowledge of how to handle the full range of driving situations and that parental training during the supervised training period (log) may vary in comprehensiveness and quality. Mayhew et al. (2014) found that teens taking driver education had higher scores on tests of these types of knowledge as well as better performance on tests of driving skills. Their findings suggest that formal driver education may provide a more thorough and consistent training and instruction than informal parent or adult training, thereby accelerating teens' learning and better preparing them for unsupervised driving. Knowledge about and training in all of these driver behaviors are covered in the Nebraska Driver Education curriculum and driving practice within the course. This formal instruction provides one possible explanation for the lower prevalence of crashes and violations for Nebraska teens who take driver education, although further research into the mechanisms that might have produced the observed outcomes favoring driver education is clearly needed.

4.1. Strengths and limitations

This study overcomes many of the limitations present in prior research and evaluations of driver education (see Beanland et al., 2013; Lonero and Mayhew, 2010; Peck, 2011; Thomas et al., 2012). The study was a census of all Nebraska teen drivers receiving their provisional operators permit during the study period. The large study population eliminated problems of reduced power due to inadequate sample sizes identified by Peck (2011). The use of a census population also eliminated problems in sampling and sample attrition that have affected many prior studies, especially attempts at randomized trials (Lonero and Mayhew, 2010; Peck, 2011). We were able to control for important demographic characteristics that may have confounded findings in previous studies. Most significantly, we were able to draw on the presence of both driver education and comparable non-driver education cohorts in Nebraska. Teens can choose either driver education or a certification log, but all other aspects of the Nebraska GDL are the same for both. There is no time or age advantage for the driver education group, which eliminated a significant confound found in other studies.

Despite these strengths, there are still limitations. The study is confined to a single small, predominantly rural state that may not be representative of the majority of states. The study is not a true randomized controlled experiment, as teens self-select whether they will take driver education or do the certification log. There are clear demographic differences in this choice, with certification log the choice of rural, male, non-White, poorer, and older teens. We were able to apply statistical controls to these demographic differences, but statistical procedures cannot fully compensate for random assignment.

We do not know anything about the psychological characteristics of teens who choose to take driver education vs those who do the 50 h of supervised driving. Mayhew et al. (2014) found a number of differences on these types of variables between teens choosing to take driver education and those who do not. There may be meaningful psychological factors that account for differences in the crash and violation outcomes of the driver education and certification log cohorts, although analyses by Mayhew et al. (2014) suggested that these types of psychological factors may not make much difference in findings when demographic controls, like those used in this study, are applied.

We lacked control over the quality of driver education courses. Although all must meet state standards for approval, we cannot determine how well each individual course was delivered and how much specific curriculum and driving practice differed. We have no way of knowing how much supervision was actually done during the supervised driving recorded in the certification log, the quality of that supervision, or what additional training and education teens using the certification log may have received. Also, we have no way of knowing how much additional supervised driving practice was done by teens in the driver education cohort.

5. Conclusions

The overall conclusion that can be drawn from this study is that relative to a supervised driving certification log approach, teens taking driver education appear to have fewer crashes and injury or fatal crashes as well as fewer traffic violations and alcohol-related traffic violations during their first two years of independent driving. These differences were independent of gender, ethnicity, urban or rural residence, socio-economic level, and age at which the provisional license was obtained. Although Mayhew et al. (2014) also conducted a population level census analysis; this is the first study to provide a census population level direct comparison between driver education and an alternative licensing method where all other administrative aspects of the GDL licensing process were the same for both groups. Teens either did driver education or the adult supervised driving log, but not both. This differs from Mayhew et al. (2014) where teens did both, but the driver education group had fewer required hours of supervised driving. This strengthens confidence in the conclusion that it was driver education that had the positive impact on reducing crashes and violations for teen drivers in their first two years of driving.

The findings appear counter to the prevalent argument that driver education is ineffective (e.g., Thomas et al., 2012). Results from this study, when considered with those of Mayhew et al. (2014), suggest that driver education is a meaningfully effective approach to reducing traffic crashes and especially injury or fatal crashes among teens. The study examined only the first two years of driving, so we cannot determine how long any effects of driver education last. But because teen crash and fatality rates are highest at ages of 16–18 during their first two years of driving, the identified reductions are especially meaningful. Driver education appears to makes a difference at a time when risk is highest. Although not as serious as crashes, violations reflect risky driving that can be a contributing factor to crashes (Blows et al., 2005; Shope and Bingham, 2008). The knowledge that teens learned in driver education about traffic laws and regulations and about safe vs risky driving appears to have led to reductions in actual risky and illegal behaviors as evidenced by lower incidents of traffic violations and DUI by teens completing driver education in this study.

In Nebraska, driver education appears to be an important tool for reducing crashes and risky driving as reflected in traffic violations within the context of graduated driver licensing. Along with the recent findings by Mayhew et al. (2014) also showing positive impacts of driver education on crashes and violations in Oregon, the results suggest a need to reexamine thinking about the effectiveness of driver education and the role of driver education in the graduated driver licensing environment. Although, we cannot draw strong causal conclusions from the population level analyses in this study and Mayhew et al. (2014), the findings do provide guidance for policy. Our findings along with Mayhew et al. (2014) suggest that driver education enhances the effectiveness of GDL. Rather than viewing GDL as a replacement for driver education, GDL and driver education are best viewed as complementary. Their complementary relationship argues for policies that broaden the availability of driver education within the GDL environment. Findings also support greater promotion of driver education to teens and their parents, as well as greater dissemination about the benefits of driver education to the general public, as tools to increase teen participation in driver education. Certainly, the findings from this study and Mayhew et al. (2014) indicate a need for further studies to examine the effectiveness of driver education and how to best employ driver education to enhance the effectiveness of graduated driver licensing as well as, to identify those aspects of driver education that may be producing these positive outcomes.

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