**Teen Driver Safety Metrics
Effectiveness of NJ's GDL Law in Improving Teen Driver Safety**

FINAL REPORT
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16. Abstract

The goal of this research program was to determine the effectiveness of New Jersey's Graduated Driver License (GDL) law in reducing motor vehicle crashes, injuries, fatalities and property damage for novice drivers, typically 16-20 years of age. The specific objectives were to (1) evaluate NJ crash data to determine if teen driver crashes and fatalities in New Jersey have significantly declined since enactment of a GDL law in 2001, (2) evaluate Motor Vehicle Commission driver history data to determine if teen driver traffic violations in New Jersey have significantly declined since enactment of a GDL law in 2001, (3) evaluate the effectiveness of the September 2008 directive banning plea-bargains for drivers with a Graduated Driver License, (4) evaluate effectiveness of new May 2010 GDL regulations on additional hour of curfew and passenger restrictions, (5) conduct an analysis of recidivism among teen drivers

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1. INTRODUCTION AND BACKGROUND

The New Jersey Graduated Driver's License (GDL) program is one of the most progressive and stringent GDL systems in place in the United States. The NJ GDL program was instituted on January 1, 2001. Like other GDL programs in the U.S., the NJ GDL program is intended to provide teen drivers with a progressive system that allows for growth in their driving abilities through experience. The regulations are meant to limit exposure to more complicated driving scenarios. Specifically, the age at which full driving privileges are allowed is extended compared to previous licensing systems, the hours in which teens are allowed to drive are restricted, and the number of passengers allowed in a vehicle driven by a teen is also limited. These are all means intended to lessen the number of crashes and fatalities in vehicles driven by teens.

Although the NJ system is the most stringent GDL system in the US, little research has been conducted to determine the effectiveness of the New Jersey GDL program. Williams et al (2010) performed a preliminary analysis of the New Jersey GDL regulations, however this study only included data up to 2005.[1] The study reported crash and fatality reductions for teen drivers in New Jersey in the years immediately following GDL. Specifically, when normalized by adult crash rates (crashes per age-specific census counts), 16 year old drivers experienced a 43 percent reduction in crash rate and 17 year old drivers experienced a 25 percent reduction in crash rate.

Several important enhancements have been made to the NJ GDL program since the Williams study. In March 2007, the State of New Jersey initiated a Teen Driving Commission which was charged with evaluating the state of teen driving in New Jersey and making recommendations that would reduce crashes involving teens.[2]

Since the publication of the Commission's report in 2008, New Jersey has implemented many of the recommendations in the report as well as other enhancements to the NJ GDL. On September 17, 2008, the New Jersey Attorney General placed a ban on plea-agreements for traffic violations charged to teen drivers. Previously, teen traffic offenses were believed to be frequently plea-bargained to 'Unsafe Operation' – a citation which carried no points and hence would not trigger MVC remedial programs for teens. In addition, in May 2010, the State of New Jersey modified the GDL program to include the following:

- Passenger Restrictions. Restrict teen drivers with a learner's permit or probationary license to carry only one passenger unless the parent/guardian was in the vehicle.

- Night Driving Restriction. For teen drivers with either a learner's permit or probationary license, no driving is allowed between 11:01pm to 5am. Previously the curfew was midnight to 5am for probationary licenses.

- Probationary License Placard (Kyleigh's Law). Teen drivers a probationary license -must display an identifying placard on their vehicles.

Objective

The objective of this study is to determine the effectiveness of the New Jersey Graduated Driver's License (GDL) program in reducing teen crashes, traffic fatalities and traffic violations.

Background and Previous Research

In the United States since 2000 there has been an average of 5,300 fatalities in motor vehicle crashes involving a teen driver every year (FARS, 2000-2008). This accounts for 14.6 percent of all fatalities in motor vehicle crashes, yet, according to the Federal Highway Administration, teen drivers only account for 4.8 percent of all licensed drivers.[3] Furthermore, 4,900 teens die every year in motor vehicle crashes, comprising 11.7 percent of all fatalities. The Insurance Institute for Highway Safety (IIHS) reports that motor vehicle crashes are the leading cause of death for all persons aged 13-19 years old.[4] This is all despite a decline in overall teen fatalities over the last two decades as shown in figure 2.
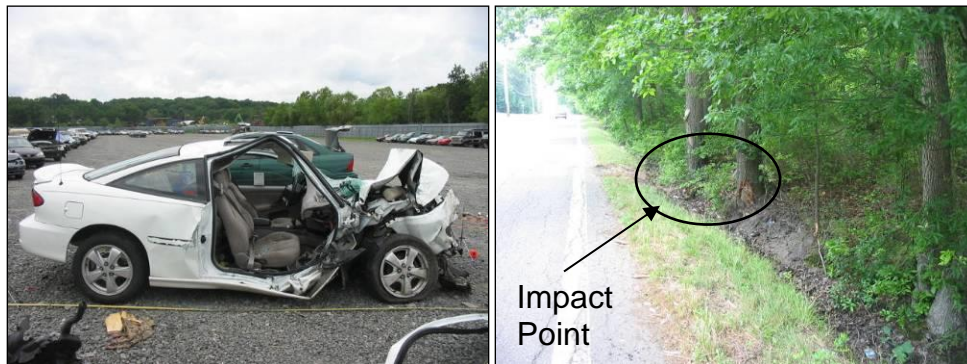
Figure 1. Teen Drivers are particularly at risk of crashes at night. In this New Jersey crash, a 17-year old driver struck a tree after leaving the road minutes before midnight. The impact fractured the lumbar spine of the teen's passenger (NASS/CDS Case 2005-04-070)
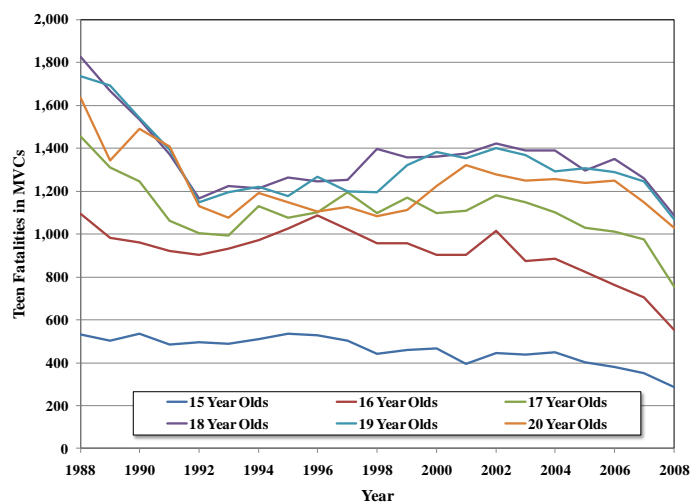
Figure 2. Teen Fatalities in motor vehicle crashes by age from 1988-2008 (FARS 1988-2008).

Teen motor vehicle crashes (MVCs) are believed to occur for a number of reasons ranging from driver inexperience, inability to deal with distractions, and a propensity for excessive risk taking among some teens.[5,6] Support of these findings has led to significant changes in the way that teens are exposed to driving.

Graduated Driver Licensing

Graduated driver licensing (GDL) programs have been widely enacted to reduce the crash involvement of teenagers. The fundamental theory behind GDL programs is that driving skills are acquired through practice and experience. Furthermore, novice drivers need time to accumulate the experiences necessary to develop their driving skills. Also, it has been demonstrated that driver responsibility increases with age. Thus, placing restrictions on younger drivers may lead to a reduction in accident rates for the affected age group.[7] The recognition of these teen-specific crash factors has led to a basic GDL framework that is designed to address these issues. A typical GDL system includes three stages of licensure and various restrictions that gradually expose the new driver to more challenging situations. The following characteristics are employed in the majority of GDL programs worldwide:

Stage 1: Learner's Permit

- Supervised driving with a licensed driver
- 6-12 month duration

Stage 2: Provisional License

- Unsupervised driving
- 6-24 month duration
- Passenger Restrictions
- Night driving restrictions

Stage 3: Full Licensure

- Full driving privileges
- Barring no traffic violations / crashes while under GDL regulation

Teen Drivers

The universe of literature concerning GDL is large. The literature describes the complex issues associated with teen drivers and the effectiveness of policies to reduce teen crash risk. The large volume of research on teen driving has provided insight into the successes and failures of licensing systems worldwide and offered perspective about why teens are in particular need of intervention and training prior to licensure.

Naturally, teenagers have not reached a maximal maturity in many areas of life, including their approach to driving.[8] Furthermore, it has been shown that any beginning driver, regardless of age or maturity, possesses a higher crash risk as compared to more experienced drivers.[9,10] Novice drivers possess the highest crash risk in the first

6 months of driving, and crash risk steadily declines with age.[10] Both age (i.e. maturity) and experience have been identified as the largest contributors to increased teen crash risk.[See references 6, 8, 10, 11, 12, and 13.] This has created what has been labeled the "Teen Driver Paradox".[8] Essentially, the teen driver paradox states that teen drivers require experience to develop their driving skills but increasing their exposure concurrently increases their chances of a crash. Deery (1999) reported that teen drivers are quite adept at acquiring basic driving skills.[14] However, their limited experience does not allow them to develop the high-order cognitive abilities required to safely address many complex driving situations. Furthermore, Brown and Groeger (1988) reported that risk perception is controlled by two inputs: 1) information on the potential hazards and 2) information on a person's abilities to handle these hazards.[15] A recent study examined the driving abilities of Finnish and Dutch novice drivers and found that 30-40 percent of novice drivers over estimate their own driving abilities.[16]

To mitigate these influences, GDL programs have been adopted by many countries and across the United States. The central focus is to gradually expose new drivers to increasingly difficult driving environments. Historically, many new drivers in the United States have gone through a driver training course that exposed them to driving environments under the supervision of a certified instructor. However, it has been found that traditional driver education courses alone have not been effective at reducing crash risk of new drivers.[17] Instead, increasing the time that a teen is under direct supervision of a licensed driver can help to provide more situational training. This is addressed by enlisting the support and supervision of parents. The inclusion of the learner's permit in a GDL program can be considered as an apprenticeship-style solution to the need for increased supervision and training for a teen driver.[8] Under the skilled direction of an experienced driver, the teen (apprentice) gains event specific training that hones their abilities. Crashes under supervised conditions are relatively infrequent. Therefore, this has provided a lower risk, gradual, and exposure based training process for the new driver.[12] In fact, Gregersen et al (2000) investigated the effects of a regulation change that lowered the minimum age for obtaining a permit (from 17 ½ to 16 years old) while maintaining the minimum age for full licensure (18 years old).[18] It was shown that teen drivers who had a prolonged stay in the permit stage had lower crash rates after full licensure as compared to those who spent less time in the permit stage. Most importantly, it was found that the decrease in crash rate for licensed drivers who spent more time in the permit stage was not offset by an increase in supervised driving crash rate. Therefore, it was concluded that the experience gained through supervised driving was in fact producing better drivers after licensure, despite the fact that they began supervised driving at a younger age.

Presumably, once a teen driver has completed the learner's stage of licensure, they would be ready to face the challenges of driving with the knowledge and experience they have acquired. However, other complications and distractions come with unsupervised driving, namely distractions from passengers and an increase in risky behavior. In fact, it has been shown that crash risk for teen drivers is the highest in the first month of unsupervised licensing.[10] Efforts to minimize factors that may increase the likelihood of an unsupervised teen driver crash are an important component of GDL regulation. For instance, the number of passengers in a teen driver vehicle has been

shown to be directly correlated to increased crash risk.[19] As a result, restrictions on the number of allowed passengers for those licensed in the provisional stages has become an integral part of many GDL programs.[6] Furthermore, a restriction on nighttime driving has also been shown to effectively reduce crashes during this time frame.[20,21] While this may be largely due to a reduction in exposure, it may also allow the teen driver to gain more experience prior to undertaking the challenges associated with nighttime driving. It was found that while only 14 percent of the miles driven by a teen occurred between 9pm and 5:59am, these hours accounted for 39 percent of all teen MVC fatalities prior to GDL implementation.[22]

The implementation of GDL programs is dependent on legislative change, and thus, potential obstacles. It has been suggested that resistance to the program may result from a belief that restrictions on teen driving are "unfair" to teen drivers who would not be considered high risk. However, many GDL proponents argue that, regardless of individual differences in maturity or propensity for risk taking, all beginner drivers are subject to increases in crash risk because of inexperience, thus necessitating a progressive licensing system.[8] Also, in a program that requires direct parental involvement, it is necessary that the parent be committed to the process. Interviews of both parents and teens have shown strong support for GDL.[23] This will help to advance the process of enhancing the current GDL programs.

<u>Graduated Driver License in the United States</u>

The licensing of new drivers in United States has been an enterprise controlled by the individual States. As a result, there has always been a large variation in the requirements and restrictions associated with licensing. Historically, many of the pre-GDL licensing systems included varied learners permit requirements. The learner's permit was instituted to increase the amount of supervised driving prior to full licensing. However many States had little or no requirements that dictated how long a driver had to remain in this stage.[8] In 1977, the National Highway Traffic Safety Administration (NHTSA) outlined their recommendations for a progressive system of licensing new drivers. This was intended to promote upgrades in the structure and requirements of State licensing programs. These recommendations were an improvement over many of the existing systems, however, they were never fully introduced in the United States.[8,12] In fact, it was not until 1987 when New Zealand became the first Government to introduce what would be considered a modern GDL system.[24] Ontario implemented the first GDL system in North America in 1994 and Florida was the first State to implement a modern GDL system in the U.S. in 1996.[25,26] All States have updated their licensing laws since this time to include at least some features of a modern GDL program. However, significant differences exist in the requirements and restrictions associated with each State licensing laws. As a result, the Insurance Institute for Highway Safety (IIHS) has created a scoring system to evaluate each State's licensing laws based on what they consider an "Optimal" program.[27] The requirements for such a program are given below:

IIHS Optimal GDL Requirements

- 3 stages (Learners Permit (supervised), Provisional License (unsupervised), and Unrestricted License)
- Entry age of 16 years old
- 30-50 hours of supervised practice
- Restrict night driving at 9 or 10 pm
- No teen passengers / no more than one teen passenger
- Learners permit for at least 6 months
- Unrestricted licensure at 18 years old

Graduated Driver License Regulation by State

The varying regulations included in the licensing laws of each State and Washington D.C. are included in the table 1.[27] IIHS has scored each of these GDL systems as either "Good (G)," "Fair (F)," "Marginal (M)," or "Poor (P)" based on how well they match up with the optimal system that IIHS has outlined. Currently, 35 States have a "Good" rating, 10 have a "Fair" rating, 6 have a "Marginal" rating and no State received a "Poor" rating.

Table 1. The GDL regulations of each State and Washington D.C.[27]

IIHS Rating	State	Learner Stage			Intermediate Stage Restrictions on Driving while Unsupervised			Minimum Age at Which Restrictions May Be Lifted	
		Min. Entry Age	Mandatory Holding Period	Min. Amount of Supervised Driving	Min. Age	Unsupervised Driving Prohibited	Restriction on Passengers (family members excepted unless otherwise noted)	Nighttime Restriction	Passenger Restriction
G	Optimal provisions	16 yr.	6 mo	30–50 hr	16 yr., 6 mo	9/10 pm–5 am	No more than 1 teenage passenger*	Until age 18	Until age 18
G	Alabama	15 yr.	6 mo	30 hr (none with driver ed.)	16 yr.	Midnight–6 am	No more than 1 passengers	17 yr.	17 yr.
G	Alaska	14 yr.	6 mo	40 hr, 10 of which must be at night or in inclement weather	16 yr.	1 am–5 am	First 6 mo: No passengers	16 yr., 6 mo	16 yr., 6 mo
F	Arizona	15 yr., 6 mo	6 mo	30 hr, 10 of which must be at night (none with driver ed.)	16 yr.	Midnight–5 am	First 6 mo: No more than 1 passenger younger than 18 yr.	16 yr., 6 mo	16 yr., 6 mo
G	Arkansas	14 yr.	6 mo	None	16 yr.	11 pm–4 am	No more than 1 passenger	18 yr.	18 yr.
G	California	15 yr., 6 mo	6 mo	50 hr, 10 of which must be at night	16 yr.	11 pm–5 am	First 12 mo: No passengers younger than 20 yr. (limited exception for immediate family)	17 yr.	17 yr.
G	Colorado	15 yr.	12 mo	50 hr, 10 of which must be at night	16 yr.	Midnight–5 am	First 6 mo: No passengers Second 6 mo: No more than 1 passenger	17 yr.	17 yr.
G	Connecticut	16 yr.	6 mo (4 mo with driver ed.)	40 hr	16 yr., 4 mo	11 pm–5 am	First 6 mo: No passengers other than parents or driving instructor; Second 6 mo: No passengers other than parents, driving instructor, or members of immediate family	18 yr.	17 yr., 4 mo
G	Delaware	16 yr.	6 mo	50 hr, 10 of which must be at night	16 yr., 6 mo	10 pm–6 am	No more than 1 passenger	17 yr.	17 yr.

IIHS Rating	State	Learner Stage			Intermediate Stage Restrictions on Driving while Unsupervised			Minimum Age at Which Restrictions May Be Lifted	
		Min. Entry Age	Mandatory Holding Period	Min. Amount of Supervised Driving	Min. Age	Unsupervised Driving Prohibited	Restriction on Passengers (family members excepted unless otherwise noted)	Nighttime Restriction	Passenger Restriction
G	Washington, D.C.	16 yr.	6 mo	40 hr in learner's stage; 10 hr at night in intermediate stage	16 yr., 6 mo	September–June: 11 pm–6 am Su–Th, 12:01 am–6 am Sa–Su; July–August: 12:01am–6 am	First 6 mo: No passengers; Thereafter, no more than 2 passengers	18 yr.	18 yr.
F	Florida	15 yr.	12 mo	50 hr, 10 of which must be at night	16 yr.	11 pm–6 am (age 16), 1 am–5 am (age 17)	None	18 yr.	—
G	Georgia	15 yr.	12 mo	40 hr, 6 of which must be at night	16 yr.	Midnight–6 am	First 6 mo: No passengers Second 6 mo: No more than 1 passenger younger than 21 yr. Thereafter, no more than 3 passengers	18 yr.	18 yr.
G	Hawaii	15 yr., 6 mo	6 mo	50 hr, 10 of which must be at night	16 yr.	11 pm–5 am	No more than 1 passenger younger than 18 yr. (household members excepted)	17 yr.	17 yr.
M	Idaho	14 yr., 6 mo	6 mo	50 hr, 10 of which must be at night	15 yr.	Sunset to sunrise	First 6 mo: Licensees 16 yr. and younger can have no more than 1 passenger younger than 17 yr.	16 yr.	15 yr., 6 mo
G	Illinois	15 yr.	9 mo	50 hr, 10 of which must be at night	16 yr.	Starts 10 pm Su–Th, 11 pm Fri–Sat, ends 6 am	First 12 mo: No more than 1 passenger younger than 20 yr.	18 yr.	17 yr.
G	Indiana	15 yr., 6 mo	6 mo	50 hr, 10 of which must be at night	16 yr., 6 mo (16 yr., 9 mo without driver ed.)	First 180 days, 10 pm-5 am then 11 pm–5 am Su–F 1 am–5 am Sa–Su	First 180 days: No passengers	18 yr.	17 yr. (17 yr., 3 mo. without driver ed.)
4	Iowa	14 yr.	6 mo	20 hr, 2 of which must be at night	16 yr.	12:30 am–5 am	None	17 yr.	—

IIHS Rating	State	Learner Stage			Intermediate Stage Restrictions on Driving while Unsupervised			Minimum Age at Which Restrictions May Be Lifted	
		Min. Entry Age	Mandatory Holding Period	Min. Amount of Supervised Driving	Min. Age	Unsupervised Driving Prohibited	Restriction on Passengers (family members excepted unless otherwise noted)	Nighttime Restriction	Passenger Restriction
G	Kansas	14 yr.	12 mo (eff 1/1/10)	25 hr, in learner phase; 25 hr before age 16; 10 of the 50 hr must be at night	16 yr.	9 pm–5 am (eff 1/1/10)	First 6 mo: No more than 1 passenger younger than 18 (eff 1/1/10)	16 yr., 6 mo (eff 1/1/10)	16 yr., 6 mo (eff 1/1/10)
G	Kentucky	16 yr.	6 mo	60 hr, 10 of which must be at night	16 yr., 6 mo	Midnight–6 am	No more than 1 passenger younger than 20 unless supervised by a driving instructor	17 yr.	17 yr.
F	Louisiana	15 yr.	6 mo	35 hr	16 yr.	11 pm–5 am	None	17 yr.	—
G	Maine	15 yr.	6 mo	35 hr, 5 of which must be at night	16 yr.	Midnight–5 am	First 180 days: No passengers	16 yr., 6 mo	16 yr., 6 mo
G	Maryland	15 yr., 9 mo	9 mo	60 hr, 10 of which must be at night	16 yr., 6 mo	Midnight–5 am	First 5 mo: No passengers younger than 18	18 yr.	16 yr., 11 mo
G	Massachusetts	16 yr.	6 mo	40 hr	16 yr., 6 mo	12:30 am–5 am (between 12:30 am–1:00 am and 4:00 am–5:00 am the night driving and passenger restrictions are subject to enforcement;)	First 6 mo: No passengers younger than 18	18 yr.	17 yr.
F	Michigan	14 yr., 9 mo	6 mo	50 hr, 10 of which must be at night	16 yr.	Midnight–5 am	None	17 yr.	—
G	Minnesota	15 yr.	6 mo	30 hr, 10 of which must be at night	16 yr.	First 6 mo: Midnight–5 am	First 6 mo: No more than 1 passenger younger than 20 Second 6 mo: No more than 3 passengers younger than 20	16 yr., 6 mo	17 yr.
F	Mississippi	15 yr.	12 mo	None	16 yr.	10 pm–6 am Sun–Thu; 11:30 pm–6 am Fri–Sat	None	16 yr., 6 mo	—

IIHS Rating	State	Learner Stage			Intermediate Stage Restrictions on Driving while Unsupervised			Minimum Age at Which Restrictions May Be Lifted	
		Min. Entry Age	Mandatory Holding Period	Min. Amount of Supervised Driving	Min. Age	Unsupervised Driving Prohibited	Restriction on Passengers (family members excepted unless otherwise noted)	Nighttime Restriction	Passenger Restriction
G	Missouri	15 yr.	6 mo	40 hr, 10 of which must be at night	16 yr.	1 am–5 am	First 6 mo: No more than 1 passenger younger than 19 yr. Thereafter: No more than 3 passengers younger than 19 yr.	17 yr., 11 mo	17 yr., 11 mo
M	Montana	14 yr., 6 mo	6 mo	50 hr, 10 of which must be at night	15 yr.	11 pm-5 am	First 6 mo: No more than 1 passenger younger than 18 yr. Second 6 mo: No more than 3 passengers younger than 18 yr.	16 yr.	16 yr.
G	Nebraska	15 yr.	6 mo	50 hr, 10 of which must be at night (none with driver ed.)	16 yr.	Midnight–6 am	First 6 mo: No more than 1 passenger younger than 19 yr.	17 yr.	16 yr., 6 mo
G	Nevada	15 yr., 6 mo	6 mo	50 hr, 10 of which must be at night	16 yr.	10 pm–5 am	First 6 mo: No passengers younger than 18 yr.	18 yr.	16 yr., 6 mo
F	New Hampshire	15 yr., 6 mo	None	40 hr, 10 of which must be at night	16 yr.	1 am–5 am	First 6 mo: No more than 1 passenger younger than 25 yr.	17 yr., 1 mo	16 yr., 6 mo
G	New Jersey	16 yr.	6 mo	None	17 yr.	Midnight–5 am until 5/1/10; then 11 pm–5 am	No more than 1 passenger (household members excepted) until 5/1/10 when the exception will be limited to the drivers' dependents	18 yr.	18 yr.
M	New Mexico	15 yr.	6 mo	50 hr, 10 of which must be at night	15 yr., 6 mo	Midnight–5 am	No more than 1 passenger younger than 21 yr.	16 yr., 6 mo	16 yr., 6 mo
G	New York	16 yr.	6 mo (eff 2/22/10)	50 hr, 15 of which must be at night (eff 2/22/10)	16 yr., 6 mo	9 pm–5 am	No more than 1 passengers younger than 21 yr. (eff 2/22/10)	17 yr. (18 yr. without driver ed.)	17 yr. (18 yr. without driver ed.)

IIHS Rating	State	Learner Stage			Intermediate Stage Restrictions on Driving while Unsupervised			Minimum Age at Which Restrictions May Be Lifted	
		Min. Entry Age	Mandatory Holding Period	Min. Amount of Supervised Driving	Min. Age	Unsupervised Driving Prohibited	Restriction on Passengers (family members excepted unless otherwise noted)	Nighttime Restriction	Passenger Restriction
G	North Carolina	15 yr.	12 mo	None	16 yr.	9 pm–5 am	No more than 1 passenger < 21yr.; if a family member younger than 21 yr. is already a passenger then no other passengers younger than 21 who are not family members	16 yr., 6 mo	16 yr., 6 mo
M	North Dakota	14 yr.	6 mo	None	16 yr.		—		
G	Ohio	15 yr., 6 mo	6 mo	50 hr, 10 of which must be at night	16 yr.	Midnight–6 am (age 16) 1 am–5 am (age 17)	No more than 1 passenger	18 yr.	17 yr.
G	Oklahoma	15 yr., 6 mo	6 mo	50 hr, 10 of which must be at night	16 yr.	10 pm–5 am	No more than 1 passenger	16 yr., 6 mo (17 yr. without driver ed.)	16 yr., 6 mo (17 yr. without driver ed.)
G	Oregon	15 yr.	6 mo	50 hr (100 hr without driver ed.)	16 yr.	Midnight–5 am	First 6 mo: No passengers younger than 20 yr. Second 6 mo: No more than 3 passengers younger than 20 yr.	17 yr.	17 yr.
G	Pennsylvania	16 yr.	6 mo	50 hr	16 yr., 6 mo	11 pm–5 am	None	17 yr. (18 yr. without driver ed.)	—
G	Rhode Island	16 yr.	6 mo	50 hr, 10 of which must be at night	16 yr., 6 mo	1 am–5 am	First 12 mo: No more than 1 passenger younger than 21 yr.	17 yr., 6 mo	17 yr., 6 mo
M	South Carolina	15 yr.	6 mo	40 hr, 10 of which must be at night	15 yr., 6 mo	6 pm–6 am EST, 8 pm–6 am EDT	No more than 2 passengers younger than 21 yr. (driving to and from school excepted)	16 yr., 6 mo	16 yr., 6 mo

IIHS Rating	State	Learner Stage			Intermediate Stage Restrictions on Driving while Unsupervised			Minimum Age at Which Restrictions May Be Lifted	
		Min. Entry Age	Mandatory Holding Period	Min. Amount of Supervised Driving	Min. Age	Unsupervised Driving Prohibited	Restriction on Passengers (family members excepted unless otherwise noted)	Nighttime Restriction	Passenger Restriction
M	South Dakota	14 yr.	6 mo (3 mo with driver ed.)	None	14 yr., 6 mo (14 yr., 3 mo with driver ed.)	10 pm–6 am	None	16 yr.	—
G	Tennessee	15 yr.	6 mo	50 hr, 10 of which must be at night	16 yr.	11 pm–6 am	No more than 1 passenger	17 yr.	17 yr.
G	Texas	15 yr.	6 mo	20 hr, 10 of which must be at night	16 yr.	Midnight–5 am	No more than 1 passenger younger than 21 yr.	17 yr.	17 yr.
G	Utah	15 yr.	6 mo	40 hr, 10 of which must be at night	16 yr.	Midnight–5 am	First 6 mo: No passengers	17 yr.	16 yr., 6 mo
F	Vermont	15 yr.	1 yr	40 hr, 10 of which must be at night	16 yr.	None	No passengers	—	16 yr., 6 mo
G	Virginia	15 yr., 6 mo	9 mo	45 hr, 15 of which must be at night	16 yr., 3 mo	Midnight-4 am	First 12 mo: No more than 1 passenger younger than 18 yr.; thereafter, no more than 3 passengers younger than 18 yr.	18 yr.	18 yr.
G	Washington	15 yr.	6 mo	50 hr, 10 of which must be at night	16 yr.	1 am–5 am	First 6 mo: No passengers younger than 20 yr. Second 6 mo: No more than 3 passengers younger than 20 yr.	17 yr.	17 yr.
G	West Virginia	15 yr.	6 mo	50 hr, 10 of which must be at night (none with driver ed.)	16 yr.	10 pm–5 am	First 6 mo: No passengers younger than 20 yr. Second 6 mo: No more than 1 passenger younger than 20 yr.	17 yr.	17 yr.
G	Wisconsin	15 yr., 6 mo	6 mo	30 hr, 10 of which must be at night	16 yr.	Midnight–5 am	No more than 1 passenger	16 yr., 9 mo	16 yr., 9 mo
F	Wyoming	15 yr.	10 days	50 hr, 10 of which must be at night	16 yr.	11 pm–5 am	No more than 1 passenger younger than 18 yr.	16 yr., 6 mo	16 yr., 6 mo

<u>The STANDUP Act</u>

The **S**afe **T**een **a**nd **N**ovice **D**river **U**niform **P**rotection Act (STANDUP Act) was introduced to the House of Representatives in April of 2009. The bill proposes that States that adhere to a minimum set of GDL regulations be awarded incentive grants. The minimum requirements include:

- Three stage licensing process (learner's permit, intermediate license, basic license).
- Minimum entry age of 16 years old.
- Nighttime driving restrictions until full licensure at 18 years old.
- Cell phone / texting while driving prohibited until full licensure at 18 years old.
- Passengers restricted to no more than one non-family member passenger until full licensure at 18 years old, unless accompanied by a licensed driver over 21 years old.

Any State that adopts these regulations would be awarded an incentive grant for each of the three years following enactment. Currently, only New Jersey and Washington D.C. adhere to all of these regulations with their enacted GDL laws. However, many States have instituted regulations that include at least some of these recommendations.

<u>Graduated Driver Licensing in New Jersey</u>

Teen fatalities in New Jersey continue to occur at a rate of roughly 80 deaths per year despite the implementation of a Graduated Driving Licensing in 2001. In response to this unresolved issue, the State of New Jersey instituted a Teen Driver Study Commission (TDSC) to seek new methods to reduce both the number and severity of crashes involving novice drivers.

The New Jersey GDL program is considered to be one of the most progressive and stringent in the United States. It is comprised of three stages of licensure for new teen drivers: learner's permit at a minimum of 16 years of age; probationary license at 17 years old; and a basic license at 18 years old. Each phase carries restrictions which reduce novice driver exposure to risky situations, such as driving at night. In New Jersey, the learner's permit requires a minimum of six months of supervised driving. The provisional license allows unsupervised driving for one year, but carries several restrictions including a ban on driving between 11:01pm-5:00am, and limits on the number of passengers. At each stage, these restrictions are gradually lifted if the driver adheres to the GDL regulations until full driving privilege is reached. The New Jersey GDL has been given a "Good" ranking by the IIHS standards. The only IIHS recommended regulation that is missing from the New Jersey system is a requirement of at least 30 hours of supervised driving for drivers in the learner's stage. The New Jersey GDL system also lost a ranking point for a night-time restriction that occurs after 10 pm. The current specifications of the New Jersey GDL laws at the time of this report are the following:

1. **Learner's Permit (Supervised**)
   - Requirements
     - Minimum age, 16
     - Display reflective decal on the license plate
     - Pass vision screening and written test
     - Complete 6 hour behind-the-wheel driver training (required for 16 year olds, optional for 17-20 year olds)
   - Restrictions
     - Must be accompanied by an adult who is at least 21 years of age and has held a NJ driver license for at least 3 years
     - Limit of one, non-family member passenger; may transport as many family member passengers as there are seat belts in the vehicle
     - No driving between 11:01 p.m. and 5 a.m.
     - No use of hand-held or hands-free wireless, interactive devices (cell phones, iPods, video games)
     - Driver and all passengers must wear seat belts
2. **Probationary License (unsupervised)**
   - Requirements
     - Minimum age, 17
     - Display reflective decal on the license plate
     - Complete all requirements of the learner's permit listed above
     - Hold learner's permit for a minimum of six months without suspensions or postponements
     - Pass road test
   - Restrictions
     - Limit of one passenger, unless accompanied by a parent or guardian
     - No driving between 11:01 p.m. and 5 a.m. (waiver available for employment and religious activities and/or emergency situations)
     - No use of hand-held or hands-free wireless interactive devices (cell phones, ipods, video games)
     - Driver and all passengers must wear seat belts
3. **Basic License (unsupervised, no restrictions)**
   - Requirements
     - Minimum age 18
     - Hold provisional license for a minimum of 12 months without suspensions or postponements
     - Complete all the requirements of the provisional license

A table that exhibits how the New Jersey GDL system compares to the GDL in Washington D.C. and the recommendations of IIHS and the STAND UP Act are given in table 2.

Table 2. The GDL recommendations of IIHS and the STAND UP Act compared to those in place in New Jersey Washington D.C.[27]

	Learner Stage			Intermediate Stage			Minimum Exit Age	
	Min. Entry Age	Holding Period	Min. Supervised Driving	Min. Age	Night Restrictions	Passenger Restriction	Nighttime Restriction	Passenger Restriction
IIHS	16 yr.	6 mo	30–50 hr	16 yr., 6 mo	9/10 pm – 5 am	No more than 1 teenage passenger	18 yr.	18 yr.
STAND UP Act	16 yr.	-	-	-	None Specified	No more than 1 teenage passenger	18 yr.	18 yr.
New Jersey	16 yr.	6 mo	-	17 yr.	11pm – 5am	No more than 1 passenger	18 yr.	18 yr.
Washington, D.C.	16 yr.	6 mo	50 hr	16 yr., 6 mo	11pm – 6am	No more than 2 passenger	18 yr.	18 yr.

Enhancements to the Current GDL Regulations

The TDSC report offered a series of recommendations to revise, update, and strengthen New Jersey's Graduated Driver Licensing (GDL) program. As a direct result of the 47 recommendations provided by the TDSC report, a number of legislative bills have been proposed and/or signed into law that allow for further enhancements to the current GDL regulations. This includes "Kyleigh's Law," named after Kyleigh D'Alessio, a 16 teen year old that was killed in a vehicle driven by a fellow teen. Changes to the New Jersey GDL requirements include a requirement that all permit and provisional license drivers display a reflective decal on their vehicle that identifies them as a GDL driver. This is meant to make it easier for law enforcement to identify teen drivers and monitor their behavior. Also, the nighttime restrictions for provisional license drivers were moved from midnight to 11 pm and the number of passengers was reduced to one, regardless of family affiliation, unless accompanied by a parent or guardian. All of these new regulations went into effect on May 1, 2010.

Other requirements that have been presented but are waiting for approval will require teen drivers to log 50 hours of supervised practice driving for those who participate in 6 hours of behind-the-wheel training. The proposed law would require 100 hours for those who do not participate in the behind-the-wheel training before receiving their provisional license. In addition, it has been proposed that the minimum length of time that a teen must hold a permit before being allowed to obtain a provisional license be extended from 6 months to 12 months.

Finally, a directive from the New Jersey Attorney General, Anne Milgram, eliminated plea agreements for GDL holders, effective September 17, 2008. It was found that many teen drivers had entered plea agreements after receiving traffic violations. Under a plea agreement, a fine was assessed but all points on the driver's license were removed. This allowed teen drivers who were cited for a violation to circumvent rules that would have resulted in postponements in the GDL licensing process. It was thought

that if teens were no longer able to avoid the GDL penalties associated with receiving a violation, they may become more conscientious drivers.

The Need to Evaluate New Jersey's GDL Law

Both the original GDL regulations and the subsequent enhancements were meant to improve teen driver safety and ability. However, as noted in recommendation 1.9 in the TDSC report, without an analysis of real world crash and traffic violation data, improvements based on GDL implementation are only speculative. Also, it would be sensible to establish the potential benefits of the enacted and proposed enhancements, including an analysis of the ban on plea agreements for GDL holders.

The benefits of the stringent New Jersey GDL may allow for an early evaluation of the STANDUP Act, prior to its enactment. At the time of this thesis, New Jersey and Washington D.C. were the only two jurisdictions in the United States that met or exceeded the STANDUP act minimum regulations. With the availability of New Jersey police reports and the Motor Vehicle Commission's (MVC) violations records, it is possible to identify the benefits that are unique to a more stringent licensing program. In particular, the effectiveness of the New Jersey GDL program, compared to other programs, may provide insight into the effectiveness of increasing the minimum age requirements for all stages and regulations.

Previous Graduated Driver License Effectiveness studies

A number of research efforts that have highlighted the successes of the current GDL programs. Studies, both domestically and abroad, have shown reductions in crash rates associated with GDL regulations. It has been shown that the crash rates in the first year of restricted, unsupervised driving have been reduced by 14-24 percent. However, only a 3-6 percent reduction in crash rates in the first year of unrestricted, unsupervised driving has been identified.[See references 20, 28, 29, and 30.] This indicates that the improvements in teen crash rates seen with GDL are most pronounced while the drivers are subject to the regulations of GDL.

Similarly, studies have shown reductions in the fatality rates of teen drivers as well. However, it has been found that the fatality rates amongst teens can vary by age. All studies that investigated the fatality rate for drivers in the first year of unsupervised driving who are subject to nighttime and or passenger restrictions showed a decrease in fatality rates of 15-57 percent with GDL implementation.[See references 20, 21, 28, 31, 32, 33, and 34.] However, the fatality rates for teenage drivers who have graduated from the GDL programs are more mixed. For example, Males (2007) noted a decrease in fatality rates for 16 year old drivers but an increase in fatality rates for 18 year olds, resulting in an overall increase in fatality rates for all teen drivers under GDL regulation in California.[34] Agent (2001) also found an overall increase in teen driver fatality rates from the pre-GDL period to the GDL era.[31] However, it was found that the fatality rates of teen driver decreased for 16 and 18 year olds, while increasing for 17 and 19 year olds.

These studies have indicated that crash rates involving teens may have been reduced, but the severest crashes (i.e. fatal crashes) involving teen drivers may not have

changed, particularly for those who have graduated from the GDL program. It is possible that the restrictions of GDL have reduced exposure and increased driver conscientiousness while subject to the regulations of the program. It is difficult, however, to determine if these effects translate into more conscientious or prepared drivers after graduation from GDL.

2. THE EFFECTIVENESS OF NEW JERSEY'S GRADUATED DRIVER'S LICENSE REGULATIONS IN REDUCING TEEN DRIVER CRASH AND FATALITY RATES

Introduction

Graduated Driver Licensing (GDL) was introduced in New Jersey in 2001. This licensing system allows new drivers to gain driving experience under a more controlled environment by restricting conditions under which new drivers can operate a vehicle. The current New Jersey system has three tiers of licensure: (1) examination permit, (2) probationary license, and (3) full license. The permit can be obtained at age 16, and drivers with a permit are required to have a supervising driver in the passenger seat. After at least six months of holding a permit and a minimum age of 17, drivers can obtain a probationary license. The probationary license does not require drivers to be supervised, but does restrict the number of passengers in the vehicle and the time during which the vehicle can be operated. As the final tier, drivers can obtain a full license with no restrictions at age 18 or after the probationary license has been held for a year.

Since the enactment of GDL in 2001, two initiatives have been instituted which impact the regulations on those with a GDL. On September 17, 2008, the New Jersey Attorney General banned GDL participants from plea-bargaining from a point-carrying violation to a zero point-carrying violation.[35] Next, Kyleigh's Law was passed on May 1, 2010, requiring those in the GDL system to display a decal on the front and rear license plates.[36] Another law enacted simultaneously with Kyleigh's law amended the restrictions on those with a GDL.[36] Drivers with a probationary license are not allowed to drive between 11:01 pm and 5:00 am. Previously, those with a probationary license were not allowed to drive between 12:01 am and 5:00 am. Additionally, those on a probationary license are limited to only one other passenger, including family members, unless accompanied by a parent or guardian. Hands-free and hand held devices cannot be used at any time, and seat belts must be worn by the driver and all passengers and all times.[37]

Objective

The objective of this study is to determine the effect of the GDL laws on teen crash rates in New Jersey. All three major components of the NJ GDL law were evaluated, including the original GDL law implemented in 2001, banning of plea-bargaining in 2008, and the Kyleigh's Law in 2010.

Data Sources

The following section describes the data sources used to compute the effectiveness of the NJ GDL program in reducing teen crashes and teen crash related fatalities.

NJCRASH

The largest source of data for crashes in the State of New Jersey is the NJCRASH database provided by the New Jersey Department of Transportation (NJDOT). This publicly available database is a record of all police reported crashes in New Jersey from 1997-2012. The NJCRASH data is available in two separate formats: 1997-2000 crash years and 2001-2012 crash years. The format changeover coincided with the implementation of the GDL program. As a result, the formatting, and any differences directly related to the change in formatting were considered as possible confounding factors when comparing the licensing populations. This is of particular importance because the 1997-2000 crash data is known to have data quality problems.

Fatal Automotive Reporting System (FARS)

The Fatal Automotive Reporting System (FARS) is a database of all traffic related fatalities in the United States starting in 1975. The database is maintained by the National Highway Traffic Safety Administration (NHTSA) and includes all automotive related fatalities on public roadways where the person died of crash related injuries within 30 days of the crash. This data was used to investigate the effect of GDL on the number of teen fatalities and fatal crashes involving teen drivers in New Jersey with the implementation of GDL.

Methods

The NJCRASH database from 1997-June, 2012 was used for this analysis. Only drivers with a New Jersey license were included, since the GDL laws would not apply to out-of-State teen drivers. Relative crash rates were computed using three different metrics were computed: teen crashes to adult crashes not involving a teen driver, single vehicle teen crashes to single vehicle adult crashes, and teen drivers in crashes to adult drivers in crashes.

Crashes from 1997-1999 were used as the pre-GDL phase. The year 2000 was not included in this pre-GDL phase in order to reduce the influence of teens obtaining licenses before the GDL laws were implemented. Case years 2000-2004 were removed. This approach has two advantages. First, this limits the influence that the GDL implementation may have had on teen licensing trends. This includes variations in teen licensing just prior to and just following GDL implementation. Uncharacteristic swings in licensing may be the result of teens trying to avoid the new, stricter regulations by licensing before the changes were instituted.[20, 28, 38] Secondly, by defining the GDL period as 2005-2011, we ensured that only teen drivers who were licensed under the GDL regulation were included. The removal of the 2000-2004 case years produced two distinct populations of teen drivers: 1) 16-20 years olds licensed prior to GDL regulation (pre-GDL) and 2) 16-20 year olds licensed under GDL regulation (GDL era). Lastly, the months that new legislation was introduced were not included in the analysis to reduce the effects of these transition months.

Fatalities in New Jersey

The FARS data was used to compute the number of teen fatalities and fatalities associated with teen drivers in New Jersey. Three different metrics were used to investigate fatal crashes: (1) teen fatalities in crashes, (2) fatalities in cars driven by teen drivers, and (3) teen fatalities in cars driven by teen drivers.

Measuring Crash Rate

A major challenge in selecting a measurement of crash rate was identifying a suitable measure of exposure. We needed to normalize the number of crashes for the fact that the number of teen drivers on NJ highways is unlikely to have remained constant over the 1997-2012 time period. As shown in figure 3, the population in New Jersey has grown and the number of vehicle miles traveled (VMT) has generally increased over this period. It was important to account for these changes when comparing crash rates across multiple years. In general, these trends may be accounted for by dividing the number of crashes by an exposure metric that is known to have changed over time.
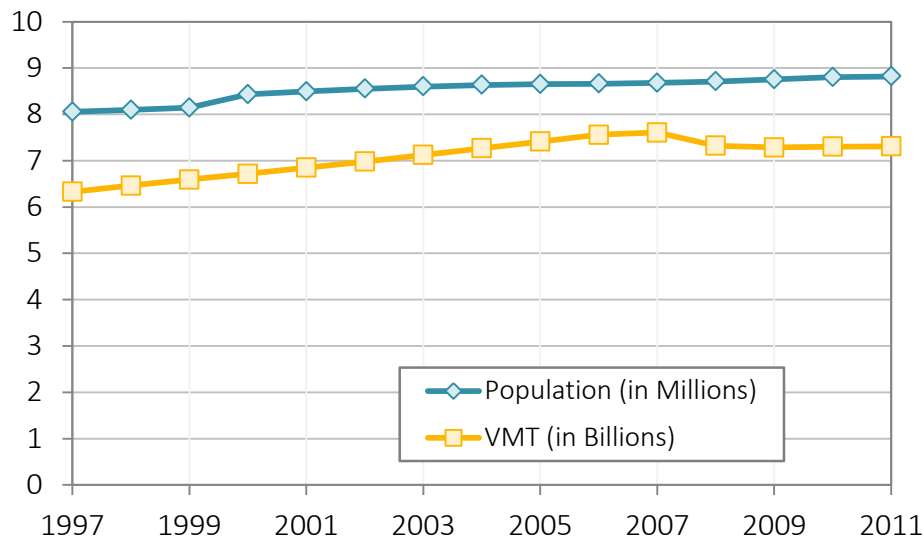
Figure 3. The annual population in New Jersey according to the United States Census Bureau and the annual total vehicle miles traveled (VMT) in New Jersey according to the New Jersey Department of Transportation[39,40]

While VMT is a widely used exposure measure, it was not possible to obtain data pertaining to individual age groups within New Jersey, e.g. teens. [39,40] Another exposure measure would be the number of licensed teen drivers in New Jersey. The Federal Highway Administration (FHWA) publishes an annual report of the number of licensed drivers by age and State.[3] Unfortunately, this data is reported to have errors.[41] IIHS reports that there were large variations in year-to-year violation counts for some States and there appeared to be issues associated with the reporting of the number of licensed teen drivers. Our inspection of the FHWA licensing dataset also found that 16 year old drivers appeared to be largely under reported in New Jersey.

From 2007-2009 there were less than two hundred 16 year old drivers reported each year. Instead, our study used the population of teens of driving age as a surrogate for the number of licensed drivers. This exposure measure however suffers from the fact that not all teens of driving age are licensed; however census data was the only available, reliable age-specific exposure metric for New Jersey teens.

Crash Rate Ratio

One other factor that affects crash rates for a specific group of drivers is the overall crash rate of the driving population. Direct comparison of the teen crash rate before and after GDL will confound with the other contributing factors. For example, if the number of overall drivers and vehicles on New Jersey roads increases with time, it may influence environmental factors such as congestion and traffic speeds, thus affecting the crash rate for all drivers in the before and after period.

We assumed that most factors affecting teen drivers will likely also affect adult drivers in the same time period. However, the GDL law will only affect teen crash rates. Therefore, changes in the crash rate ratio for the teen population relative to the reference adult population before and after GDL was implemented should be due to GDL law. For this study, the reference adult population consisted of an age range where the drivers were not subject to the GDL regulations, but were assumed to be exposed to the same changes in driving environment.

For these reasons, we adopted a teen-to-adult crash rate ratio to represent the relative risk between teen and adult as defined as follows:

$$Teen\ to\ Adult\ Crash\ Rate\ Ratio = \frac{Teen\ Crash\ Rate}{Adult\ Crash\ Rate} = \frac{Teen\ Crashes/Teen\ Population}{Adult\ Crashes/Adult\ Population} \qquad (1)$$

The adult crash rate in equation (1) provides a reference baseline that represents the general driving risk in New Jersey for the given period. Adult drivers were defined as those between 35 and 55 years of age. For the study period, the 35-55 driving population included no drivers who were licensed under the GDL regulations. All the crash rate ratios were estimated using the following two age groups:

- Teen Drivers: 16 – 20 years of age
- Adult Drivers: 35 – 55 years of age

Figure 4 presents the number of crashes for each of these age groups from 1997-2012. These crash counts account for the total number of crashes involving at least one teen driver or at least one adult driver. A crash involving both a teen and an adult driver would be double counted, as both a teen crash and an adult crash in figure 4. Fluctuations in annual crash counts were observed for all driver ages from 1997-2000 based on the NJCRASH data. However, it was assumed that the problems in this dataset were evenly distributed across all crashes, regardless of age. Thus, the effects of these inconsistencies were canceled out when normalizing the teen crash rates by the adult crash rates. As shown in figure 4, the adult and teen crashes by year appear

to follow the same uneven distributions by year, thus increasing confidence in the assumption that the errors are evenly distributed across all driver ages.
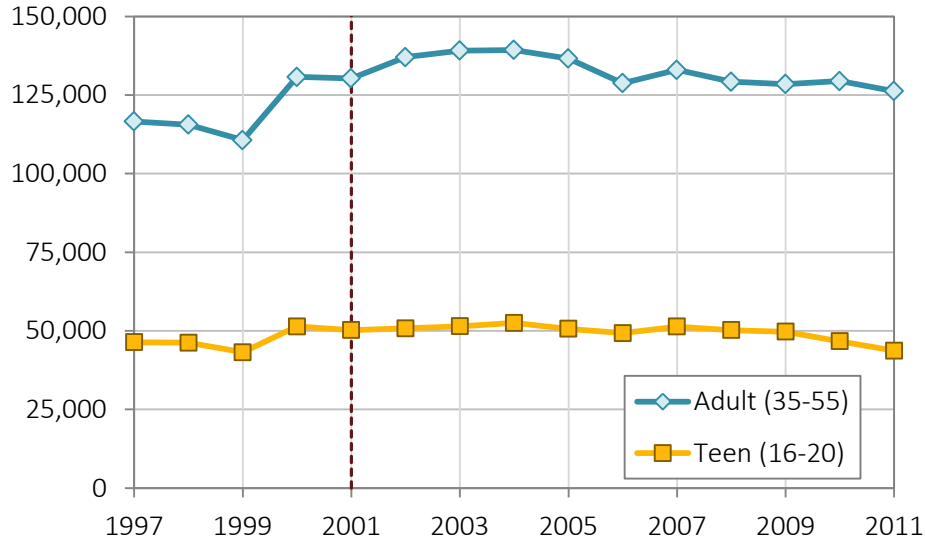
Figure 4. The total number of crashes involving teen drivers and the total number of crashes involving adult drivers (NJCRASH 1997-2011)

Negative Binomial Regression Model

We used the negative binomial (NB) regression to model crash risk. The NB model is the state-of-the-practice in modeling crash frequency.[42] The general setting of the model is as follows. Let Y_{ij} be the number of crash for age group i and time period j.

The NB model assumes

$$Y_{ij} \sim NB(E_{ij}\lambda_{ij})$$

where E_{ij} is the number of drivers for age group i and time period j. The λ_{ij} represents the expected crash rate for age i and time period j. A log-link function was used to link the expected crash rate with age and time factor:

$$log(\lambda_{ij}) = \beta_0 + \beta^{Age}X_{ij}^{Age} + \beta^{GDL}X_{ij}^{GDL} + \beta^{Age\,GDL}X_{ij}^{Age}X_{ij}^{GDL} + Month(x_{Month}) \qquad (2)$$

where

$$X_{ij}^{Age} = \begin{cases} 1 & teen \\ 0 & adult \end{cases} \text{ and } X_{ij}^{GDL} = \begin{cases} 0 & Before\,GDL \\ 1 & After\,GDL \end{cases}$$

In the above model setup, the exponential of the regression coefficient $\beta^{Age\,GDL}$ corresponds to the Teen to Adult Crash Rate Ratio in the post-GDL period and before-GDL period. The 95 percent confidence intervals were computed for the relative rates.

The negative binomial distribution was used instead Poisson models to account for potential over dispersion issue, which occurs when the variation about a fitted value is greater than what is consistent with the Poisson distribution (i.e. the variance of the fitted variable is not equal to the mean). The negative binomial compensates for the level of over dispersion within the model and computes the variance accordingly.[42]

Separate models were constructed for each age group (16-20), as well as for all teens combined. In the comparison of the different GDL time periods, this model was used for each of the three crash rate metrics:

- Teen crashes to adult crashes not involving a teen driver
- Single-vehicle teen crashes to single-vehicle adult crashes
- Teen drivers in crashes to adult drivers in crashes.

Teen crashes are those that involved at least one teen driver. If two teen drivers crashed with each other this would only be counted as one teen crash. The teen driver crash rate metric accounts for this by analyzing all teens involved in crashes. Therefore, the aforementioned crash would be counted twice in the teen driver crash metric.

This model was used to investigate changes in crash rates between three different time periods. Table 3 summarizes these comparisons and the months used for each analysis.

Table 3. GDL Time Periods used in Negative Binomial Model for Crash Rates

GDL Change	Comparative Period	Post-Change Analysis Months	Comparative Analysis Months
GDL Implementation	Pre-GDL	Jan 2005 - Aug 2008	Jan 1997 - Dec 1999
Plea-bargain Ban	GDL Implementation	Oct 2008 - Apr 2010	Jan 2005 - Aug 2008
Kyleigh's Law/New Restrictions	GDL Implementation	Jun 2010 - Jun 2012	Jan 2005 - Aug 2008

Results

Figure 5 shows the total number of crashes per age group 1997 through 2011. The number of crashes for 17 and 18 year old drivers has been gradually decreasing over the past five years. Additionally, in the pre-GDL period, there was a large variation in number of crashes by age. However, in 2011, there is nearly no difference in the number of crashes between the different age groups (with the exception of 16 year olds who have few crashes compared to teens aged 17-20).
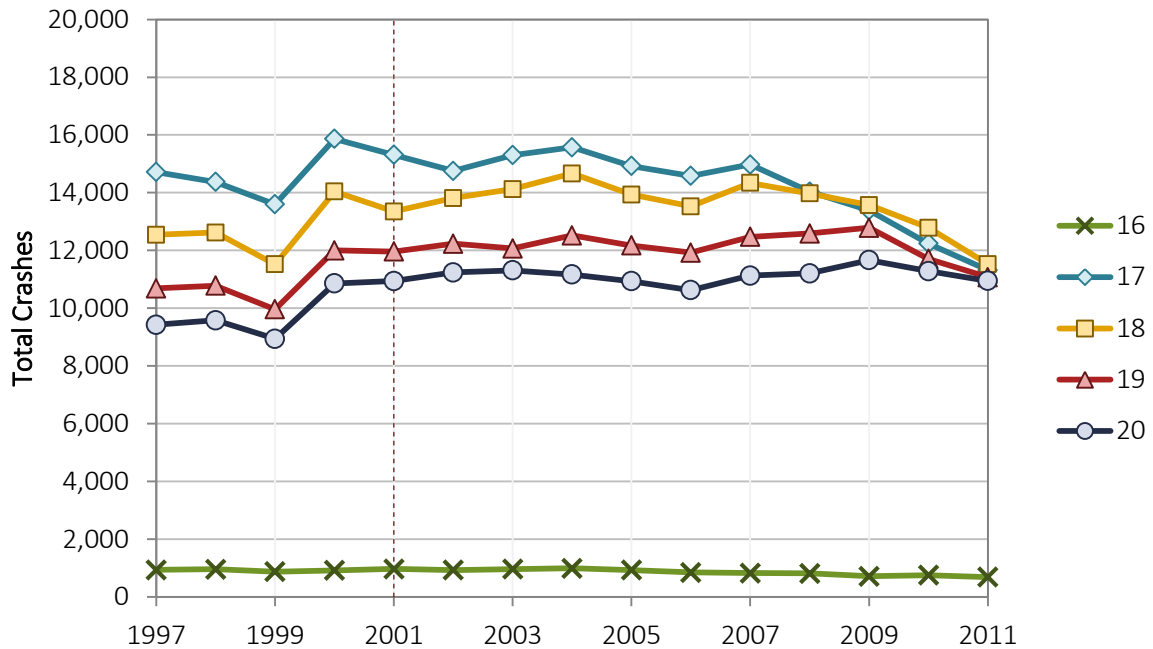
Figure 5. Distribution of teen driver crashes per year (NJCRASH 1997-2012)

However, the number of crashes per month was shown to vary seasonally. Crashes per month from 2007 through 2011 are shown in figure 6 as an example of this variation. Crashes in other years exhibited similar trends. For both teens and adults, the greatest number of crashes generally occurred in the summer or winter months.
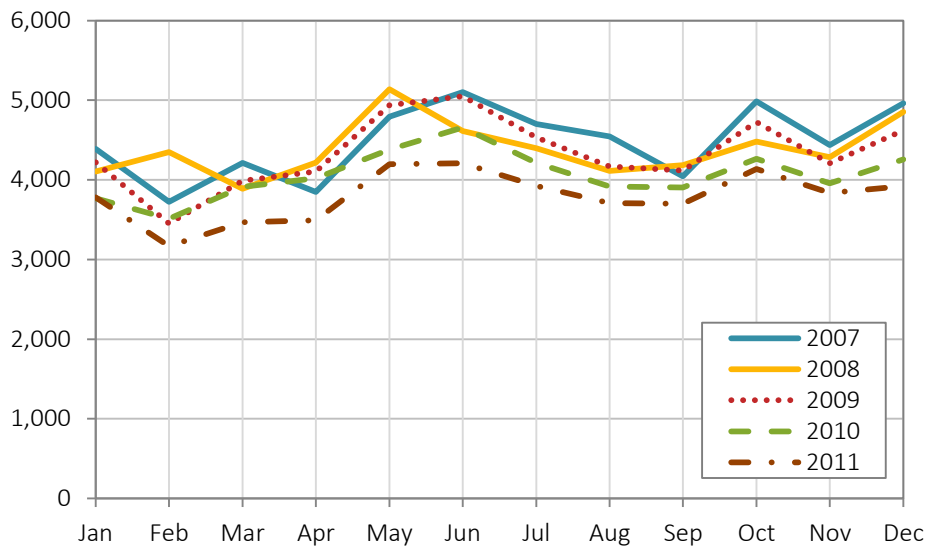
Figure 6. Total crashes per month for all teen drivers by year (Ages 16-20, NJCRASH 2007- 2011)

Fatal Crashes

From 1997-2011 there were 7,421 fatalities for either drivers or passengers of vehicles. The distribution of fatalities by age is shown in figure 7. Generally, the number of teen fatalities has been decreasing since 2006. Likewise, the number of adult fatalities also decreased over the same time period. Figure 8 shows the number fatalities associated with teen crashes in New Jersey. For reference, the total number of teen fatalities is also included, though these were not necessarily in vehicles driven by a teen.
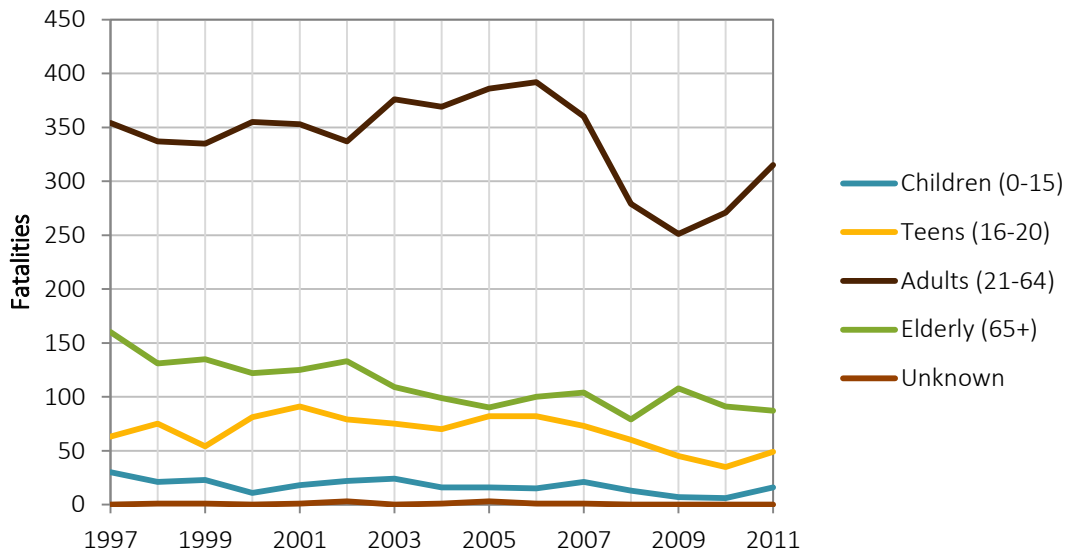
Figure 7. Driver and Passenger Fatalities in New Jersey (FARS 1997-2011)
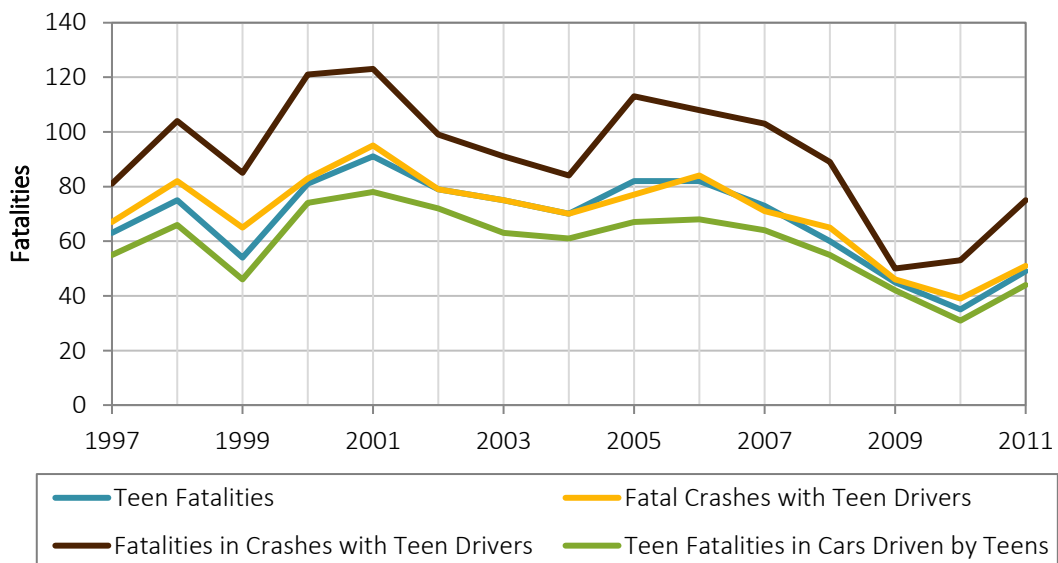
Figure 8. Fatalities associated with teen crashes (FARS 1997-2011)

Teen Crashes and Teen Fatalities by County

To determine the statewide distribution of teen crashes in the post-GDL time period, teen crash metrics were computed for each county based on NJCRASH 2005-2010. This range of crash years would only include teen drivers who were licensed under the GDL regulations. The average annual population by county is given in figure 9. The five counties with the largest number of teen driver crashes from 2005- June 2012 are given in figure 10. Figure 11 normalizes the number of teen driver crashes by county to the number of adult driver crashes to note the five counties with the highest normalized teen crash rates.
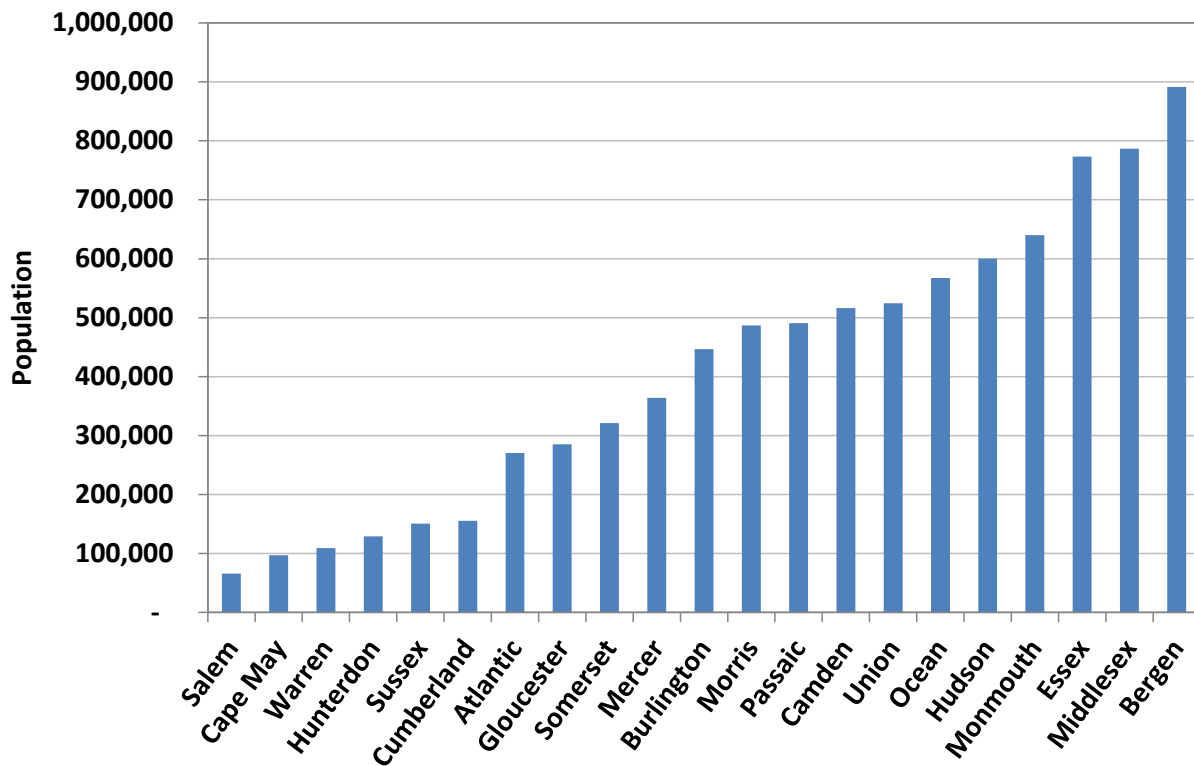
Figure 9. The average annual New Jersey Population from 2005-2010 by county (USCB, 2010)
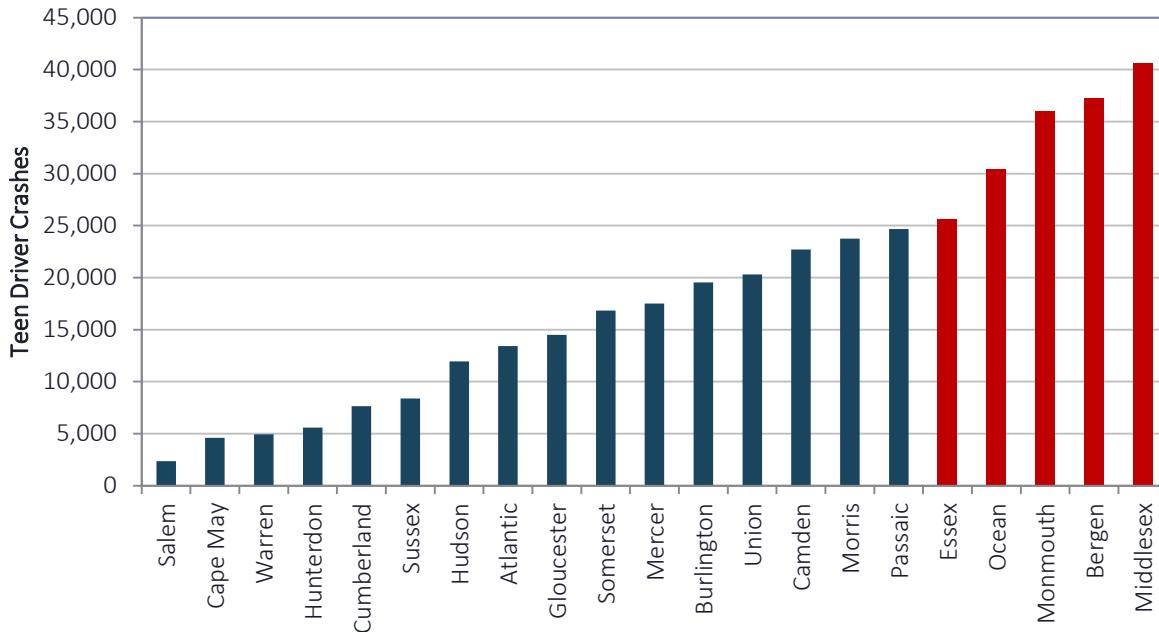
Figure 10. Teen Driver Crashes by County (2005-June 2012)
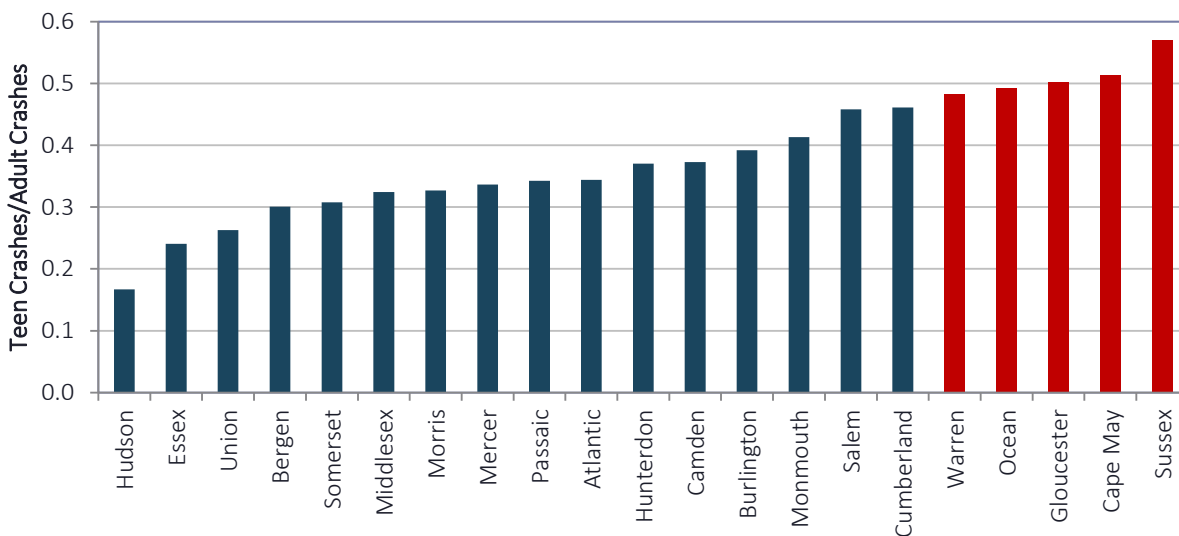
Figure 11. Crash Rates per County (2005-June 2012)

Crash Rate Ratio

The relative annual crash rate ratio for teens in each age group compared to adult drivers was computed as in equation (1). The crash rate ratios were normalized by the yearly population. The annual relative crash rates for total crashes, single vehicle crashes, and drivers involved in crashes are shown in figure 12 through figure 14, respectively. The relative crash rates also exhibit fluctuation based on the month of the crash.
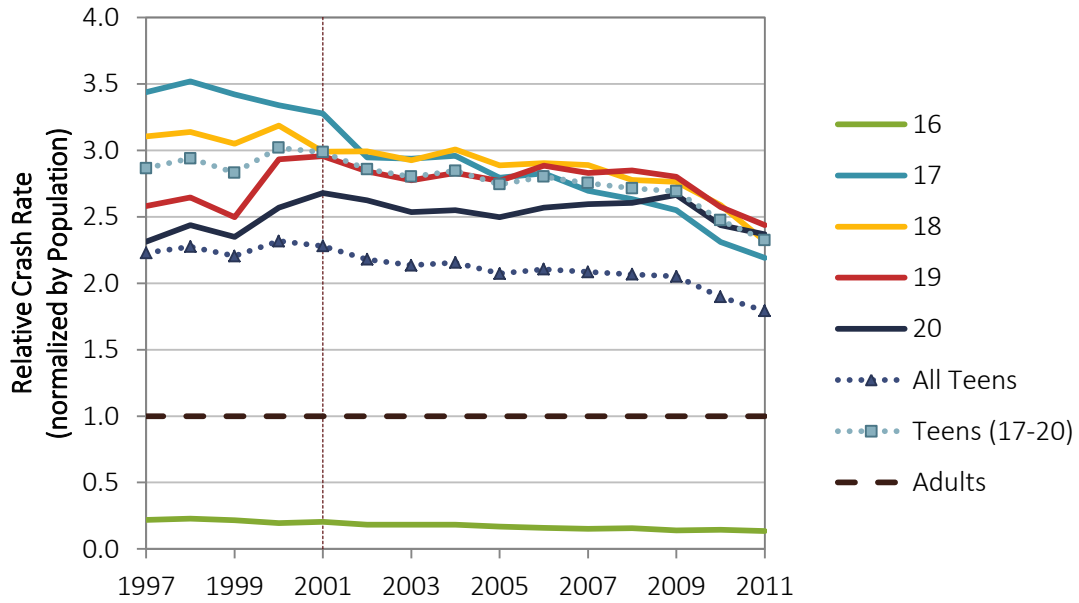
Figure 12. Relative rate ratio of all teen crashes to adult crashes not involving a teen (normalized by population)
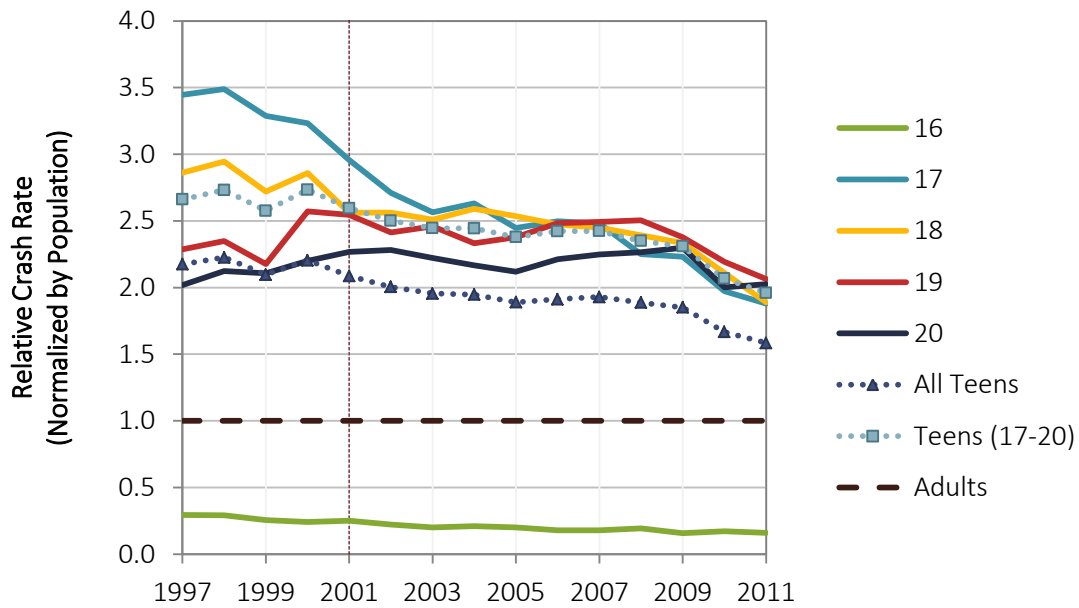
Figure 13. Relative rate of single-vehicle teen crashes to single-vehicle adult crashes (normalized by population)
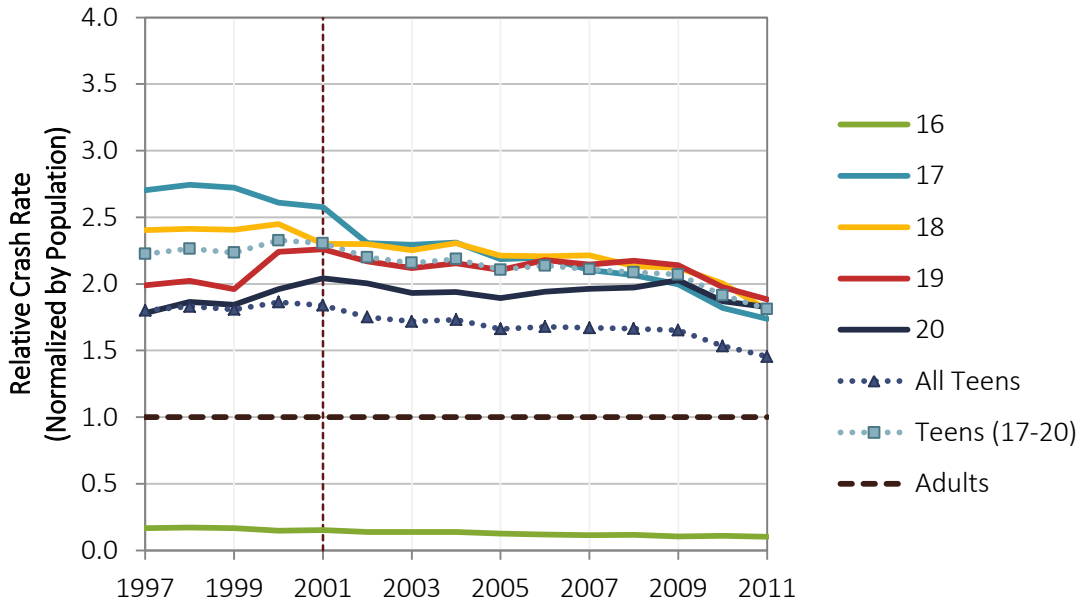
Figure 14. Relative rate ratio of teen drivers in crashes to adult drivers in crashes (normalized by population)

Relative Risk of Crashes

Using the negative binomial regression model previously described, the relative crash rate for teens (as compared to adults) between different GDL phases was computed. Table 4 shows the relative crash rate for teens between pre-GDL period months and post-GDL period prior to the plea bargain ban by age group and crash type. As described in table 3, the pre-GDL period was between January 1997 and December 1999 and the post-GDL period was between January 2005 and August 2008. There was a significant decrease in crash rate for teens aged 16-18 after the GDL system was implemented. The greatest effect was experienced by 16 year olds for all three crash metrics. However, for 19 and 20 year olds there was a significant increase in the relative crash rate for teens after the GDL took effect.

Table 4. Relative crash rates for teen drivers compared to adult drivers after GDL implementation

Age	All Crashes		Single Vehicle Crashes		Teen Drivers in Crashes	
16	0.72 (0.63 - 0.83)	*	0.68 (0.61 - 0.75)	*	0.71 (0.66 - 0.77)	*
17	0.80 (0.76 - 0.83)	*	0.72 (0.68 - 0.75)	*	0.79 (0.76 - 0.82)	*
18	0.93 (0.89 - 0.97)	*	0.87 (0.82 - 0.92)	*	0.91 (0.87 - 0.96)	*
19	1.10 (1.05 - 1.15)	*	1.08 (1.02 - 1.15)	*	1.08 (1.03 - 1.13)	*
20	1.09 (1.04 - 1.13)	*	1.06 (1.01 - 1.11)	*	1.06 (1.02 - 1.11)	*
All Teens (16-20)	*0.93 (0.90 - 0.97)*	*	*0.88 (0.84 - 0.93)*	*	*0.92 (0.88 - 0.96)*	*

* Statistically significant result (p < 0.05)
Reference: Teen to Adult Crash Rate Ratio from Jan 1997 to Dec 1999

Similar models were then used to compute the relative crash rates of teens before and after the plea bargain ban. The time frames for comparison are given in table 3. As shown in table 5, 17 and 18 year olds had a significant decrease in crashes in all crash categories over these time periods. Overall, the rate of single vehicle crashes among teen drivers decreased. However, the plea bargain ban will likely have a greater effect on violations than crash rates.

Table 5. Relative crash rates for teen drivers compared to adult drivers after plea bargain ban

Age	All Crashes	Single Vehicle Crashes	Teen Drivers in Crashes
16	0.91 (0.73 - 1.13)	0.81 (0.70 - 0.93) *	0.84 (0.76 - 0.93) *
17	0.90 (0.86 - 0.95) *	0.88 (0.83 - 0.94) *	0.91 (0.87 - 0.95) *
18	0.94 (0.89 - 0.99) *	0.92 (0.86 - 0.99) *	0.94 (0.89 - 1.00)
19	0.96 (0.91 - 1.01)	0.95 (0.89 - 1.02)	0.97 (0.92 - 1.02)
20	1.00 (0.95 - 1.05)	1.00 (0.94 - 1.07)	1.01 (0.96 - 1.06)
All Teens (16-20)	*0.96 (0.91 - 1.00)*	*0.94 (0.89 - 1.00)* *	*0.96 (0.92 - 1.01)*

* Statistically significant result ($p < 0.05$)
Reference: Teen to Adult Crash Rate Ratio from Jan 2005 to Aug 2008

Lastly, the relative crash rate between the post-GDL period and after the new GDL restrictions was estimated using the Negative Binomial regression analysis. The months included for these time periods are shown in table 3. As shown in table 6, there was an overall decrease in crash rate after the implementation of the new GDL restrictions and Kyleigh's Law. The only teen group that did not have a significant decrease in crash rates for at least one of the crash categories was the 16 year old group. However, the point estimates for this group show a decrease in crash rates.

Table 6. Relative crash rates for teen drivers after Kyleigh's Law and new GDL restrictions based on a Negative Binomial Regression analysis

Age	All Crashes	Single Vehicle Crashes	Teen Drivers in Crashes
16	0.83 (0.64 - 1.08)	0.91 (0.79 - 1.04)	0.89 (0.81 - 0.98) *
17	0.81 (0.78 - 0.84) *	0.79 (0.75 - 0.84) *	0.82 (0.79 - 0.86) *
18	0.83 (0.79 - 0.88) *	0.79 (0.74 - 0.85) *	0.84 (0.80 - 0.89) *
19	0.86 (0.82 - 0.90) *	0.85 (0.80 - 0.90) *	0.88 (0.84 - 0.92) *
20	0.92 (0.88 - 0.96) *	0.90 (0.84 - 0.95) *	0.93 (0.89 - 0.97) *
All Teens (16-20)	*0.87 (0.83 - 0.91)* *	*0.84 (0.80 - 0.89)* *	*0.88 (0.84 - 0.92)* *

* Statistically significant result ($p < 0.05$)
Reference: Teen to Adult Crash Rate Ratio from Jan 2005 to Aug 2008

Comparing the New Jersey Model to the US

Other studies, both domestically and abroad, have shown similar successes associated with GDL regulations. However, because of New Jersey's strict licensing regulations, it was not completely appropriate to directly compare the crash rates of a particular age group against the same age group from another State. Instead, this section compares the New Jersey effectiveness results to those reported for teens of an age corresponding to a similar licensing stage in another State. The reported effectiveness for other GDL programs in the United States are given in table 7.

Table 7. Reported crash rate effectiveness measures from other GDL programs in the United States

State	Author	Teen Population	Adult Population	Pre-GDL	GDL	% Difference
Michigan	Shope et al, 2001	16*	25+*	2.170	1.630	-24.9%
Maryland	Kirley et al, 2008	16	30-59	-	-	-18.0%
California	Rice et al, 2004	16	25-34	-	-	-23.0%
		17	25-34	-	-	-6.0%
California	Zwicker et al, 2006	16	24-55	-	-	-23.0%
North Carolina	Foss, 2001	16	25-54	-	-	-27.0%
Florida	Ulmer et al, 2000	15*	25-54*	0.140	0.110	-21.4%
		16*	25-54*	1.230	1.090	-11.4%
		17*	25-54*	1.630	1.530	-6.1%
		18*	25-54*	1.870	1.870	0.0%
Connecticut	Ulmer et al, 2001	16*	25-54*	1.280	1.000	-21.9%
		17*	25-54*	1.620	1.710	5.6%
		18*	25-54*	1.820	1.990	9.3%
Kentucky	Agent,2001	16-19	20+	0.168	0.160	-4.8%
New Jersey	Daniello, 2013	16-20*	35-55*	2.34	2.19	-6.3%
		16*	35-55*	0.22	0.16	-27.5%
		17*	35-55*	3.46	2.75	-20.4%
		18*	35-55*	3.11	2.89	-7.1%
		19*	35-55*	2.57	2.84	10.4%
		20*	35-55*	2.39	2.57	7.7%

*Normalized by Population

A study by Rice et al (2004) investigated the crash rates of 16 (minimum age for a provisional license) and reported a 23 percent and 20 percent reduction in 16 year old crash rates in California when normalized by the crash rates of 25-34 year olds in 2000 and 2001 (GDL era), when compared to the same crash ratio in 1997 (pre-GDL).[28] In a similar study Foss et al (2001) computed a crash ratio for 16 year old (minimum age for a provisional license) drivers normalized to the crash rates of 25-54 year olds in North Carolina.[20] The crash ratios of two years pre-GDL (1996 and 1997) were compared to the crash ratios of one year in the GDL era (1999). The crash ratio in 1999 was 23 percent lower compared to the ratio in 1996 and 28 percent lower when compared to 1997. Fohr et al (2005) showed a 13.8 percent reduction in 16 year old crashes post-GDL when normalized by 25-59 year old drivers in Wisconsin.[29] Interestingly, Kirley et al (2008) found a statistically significant 18 percent (CI: 29%-4%) reduction in crash rates for 16 year old drivers when normalized to population but a statistically insignificant 9 percent (CI:-7%-27%) increase in crash rate when normalized to the number of licensed drivers in Maryland.[30] An appropriate comparison population from the New Jersey population would be 17 year old drivers because this is the minimum age for restricted but unsupervised driving. Our study showed 20.4 percent reduction in 17 year old driver involved crashes. This is in the same range as what was seen from other State GDL programs.

The same study by Rice et al (2004) also investigated the crash rates 17 year olds (minimum age for GDL graduation).[28] However, only a 6 percent and 3 percent reduction was seen for 17 year olds in these same years. Similarly, Fohr et al (2005) only showed a 6.2 percent reduction in 17 year old crashes in the GDL era when normalized by 25-59 year old drivers in Wisconsin.[29] Our study showed an 7.1 percent reduction in the rate of 18 year old driver involved crashes in all counties. Again, the New Jersey GDL program appears to possess an effectiveness which is in line with other, similar studies.

Each of the referenced studies employed different statistical approaches to present their results, making it difficult to directly compare with the results of the New Jersey experience. For example, the results presented in the literature often compared only one year pre-GDL vs. one year in the GDL era. The effectiveness values presented in our study were averaged over a much larger range of crash years both before and after GDL implementation. Despite, the differences in GDL regulations and effectiveness calculation methodologies, the computed GDL effectiveness metrics for New Jersey appear to reflect the conclusions of similar studies with regard to teens that were licensed under the regulations of GDL programs nationwide.

Our study also includes older teens (18-20 years old); these ages were not included in other studies. This provides a unique perspective. It was found that while 18 year old crashes decreased in a similar manner as other reported by other studies that analyzed the crash rates of teen drivers in their first year after GDL implementation. However, the crash rates of 19-20 year old drivers increased significantly. This suggests that teen drivers in New Jersey who have graduated from the GDL program are actually more likely to be in a crash when compared to their pre-GDL peers.

Williams et al (2010) Comparison

A study performed by Williams et al (2010) investigated the effectiveness of the New Jersey GDL program as well. However, their methodology varied from our study in some significant ways.[1] First, fewer crash years were included in their analysis: the pre-GDL period was defined as 1998-2000 and the GDL period was defined as 2002-2005. Furthermore, the study compared the crash and fatality rates for drivers aged 16-24 years old. This becomes a methodological issue because some drivers included in the time period defined as the GDL era were not licensed under the GDL system. Also, our study showed that normalized crash rates did not appear to reach a constant rate for all teen drivers (16-20 years old) until 2005, the last year of data included in the Williams study. We speculated that the crash rates did not plateau until 2005 because GDL did indeed have an effect on the crash rates of teen drivers and it was not until 2005 that all 16-20 year old drivers would have been licensed under the New Jersey GDL system. However, Williams et al stated that their rationale for limiting the dataset in this way was to eliminate some of the known errors in the dataset, particularly from 1997-2001. Despite these differences, the results published by Williams et al showed similar GDL effectiveness calculations when compared to our study. It was reported that there was a 16 percent reduction in crash rate for 17 year old drivers and a 10 percent reduction in crash rate for 18 year old drivers. This compares to our 18.8 percent reduction in 17 year old driver crashes and 8.2 percent reduction in 18 year old driver crashes. Also, Williams et al stated that crash rates of 19 and 20-24 year old drivers were not significantly different from pre-GDL to GDL time periods. However, this would be expected because many of the drivers in these age groups would have been licensed prior to GDL implementation. In contrast, our study only looked at 19-20 year old drivers who were licensed after GDL implementation and found that the crash rates actually increased when compared to pre-GDL drivers of the same age.[1]

County Analysis

New Jersey is the most densely populated State in the United States, yet it is comprised of a wide range of rural and urban landscapes. As such, the distribution of crashes across the 21 counties can vary greatly. As shown in figure 10, 43 percent of all teen crashes from 2005-2009 in New Jersey occurred in five counties: Essex, Ocean, Monmouth, Bergen, and Middlesex. For these analyses, the 2005-2009 crash period was chosen to determine the counties where teen driver issues are most prevalent after GDL implementation. The large teen driver crash counts in these five counties are most likely due to larger populations. However, it is interesting to note how teen crashes rates normalized to adult crash rates within individual counties vary, regardless of population. The five counties with the highest ratio of teen crashes vs. adult crashes included four counties with relatively low populations (Sussex, Gloucester, Warren, and Cape May counties) and only one with a relatively high population (Ocean county). This suggests that the remaining issues may be more prevalent in low population areas.

<u>Limitations</u>

With regard to crash rate, it appears as though the GDL has succeeded in reducing crash risk for teen drivers who are under the regulations of GDL in New Jersey. However, the limitations of this research must be acknowledged. First, the 1997-2000 NJCRASH format has data quality problems. However, if we assume that these errors are evenly distributed across both the teen and adult driving populations, and as a result are cancelled out through the use of age group normalization.

The exposure metric used in these analyses was age range-specific New Jersey census counts. The assumption for using this data as an exposure metric would be that the census counts are at least proportional to the number of drivers for each age range. Therefore, if the proportion of licensed teens per population and the number of licensed adults per population remain relatively constant, then all reported results would decrease by a constant scaling factor for each year relative to the number of licensed drivers. However, this assumption may not be completely accurate. First, it was shown that the ratio of teens vs. adults was not constant from 1997-2009. Also, with the new regulations associated with the GDL program, it is very probable that the proportion of licensed teens has changed from the pre-GDL period to the GDL period. Nonetheless, reliable licensing data was not available for New Jersey drivers, and as such, the census data served as the best available normalizing exposure metric.

Finally, an induced exposure approach was utilized to account for changes in the driving environment for all drivers that are unrelated to GDL implementation. An underlying assumption of this approach is that the ratio of exposure, e.g. vehicle miles traveled, for teen and adult drivers would have remained constant with time. However, it is possible that the travel exposure of teen drivers decreased after GDL implementation as a direct result of the restrictions that were instituted as part of the program. Unfortunately, age-specific VMT was not available for New Jersey drivers so a check of this assumption was not possible.

Conclusions

Three different crash metrics were investigated for this study: total crashes, single vehicle crashes, and drivers involved in crashes. Crash rates were modeled using a negative binomial distribution, and relative crash rates between teen and adult drivers were compared. This study investigated the effects of GDL implementation, as well as the effects of new laws and restrictions for teens with a GDL.

Generally, the total number of teen crashes (drivers aged 16-20) has been decreasing each year after the implementation of the GDL system. Moreover, the teen crash rate compared to adult drivers (and normalized by teen and adult populations) has also been decreasing. After the GDL was implemented, crash rates decreased for 16-18 year old drivers. In 2011, the crash rates were nearly the same for all teens in this age range, whereas in the pre-GDL period these rates varied greatly.

Decreases in relative crash rates were observed for teen drivers aged 16-18. However, significant increases in crash rates were seen for 19 and 20 year old drivers over the

periods investigated. The GDL system is designed to provide experience for younger drivers, thus the greater decrease for younger teens was expected.

After the implementation of the plea bargain ban in September, 2008, crash rates for 17 and 18 year old teen drivers significantly decreased in the period from October, 2008 through April, 2010 as compared to the period between January, 2005 and August, 2008. Also, 16 year old drivers had a significant decrease in the number of single vehicle crashes after the implementation of the no-plea bargain.

Lastly, the crash rates from January, 2005 and August, 2008 were compared to those after new restrictions were added to the GDL in May, 2010. Along with these new restrictions, Kyleigh's Law was passed, requiring teen drivers to display a decal on the license plate while driving. From June, 2010 to December, 2011 a significant decrease in teen crash rates was observed as compared to those from January, 2005 and August, 2008. It should be noted that this decrease also may incorporate effects of the plea bargain ban, since the comparative period is before the ban was implemented.

3. THE EFFECTIVENESS OF NEW JERSEY'S GRADUATED DRIVER'S LICENSE REGULATIONS ON TEEN DRIVER VIOLATION RATES

Introduction

Many States have reported reductions in the crash rates for teen drivers after GDL implementation. Monitoring crash rates, however, does not evaluate how teen driver behavior in risky, but non-crash, events may have changed as a result of GDL implementation. It is unclear whether or not the behaviors of teen drivers have changed after GDL implementation. One method for comparing teen driver behaviors before and after GDL implementation is to investigate the type and frequency of violations for teen drivers in both the pre-GDL period and after GDL implementation. If GDL has improved the driving behavior of teens, we would hope to see a reduction in the number of traffic violations and a change in the type of traffic violations.

<u>Graduated Driver's Licensing</u>

Graduated driving licensing laws have been implemented in all 50 U.S. States and the Washington, D.C.[43] GDL licensing regulations allow for the gradual accumulation of driving experience for teen drivers through practice in lower risk driving scenarios. These programs often require a period of supervised driving, restrictions on the number of passengers, restrictions on the hours of operation, or any combination of these and other regulations. In 1996, Florida became the first State to implement a modern GDL system in the U.S.[25,26] All other States have updated their licensing laws since this time to include at least some features of a GDL program. However, significant differences exist between each State's licensing laws.

The New Jersey GDL program is considered to be one of the most progressive and stringent in the United States.[1] It is comprised of three stages of licensure for new teen drivers: learner's permit at a minimum of 16 years of age; provisional license at 17 years old; and a basic license at 18 years old. Each phase carries restrictions which reduce novice driver exposure to risky situations, such as driving at night. In New Jersey, the learner's permit requires a minimum of six months of supervised driving. The provisional license allows unsupervised driving for one year, but carries several restrictions including a ban on driving between 11pm and 5am, and limits on the number of passengers. At each stage, these restrictions are gradually lifted if the driver is violation-free until full driving privileges are reached. Our analysis of the New Jersey GDL system has shown that after GDL implementation, the crash rate for 16 year old drivers has decreased by 30 percent and the crash rate for 17 year old drivers has decreased by 19 percent. This is similar to the 20-30 percent reduction from shown in other published reports concerning GDL programs in the United States.[8,44,45]

<u>Violation Analysis</u>

While the literature on crash and fatality rates for teen drivers following GDL is large, analyses of violation rates for teen drivers are limited. Nonetheless, a few studies have shown reductions in the number of teen driver violations or convictions after the

implementation of GDL within a given State. Raymond et al (2007) reported a reduction in the teen driver conviction rate after the implementation of GDL in Oregon.[46] However, these rates were not compared to a non-GDL population (e.g. adult drivers) to see if this trend was teen-specific or simply a reflection of a statewide trend. On the other hand, the rate of license suspensions for teen drivers were normalized to the rate of suspension for adult drivers and it was found that teen drivers had a lower suspension rate after GDL implementation. Also, 18- and 19-year old novice drivers had higher conviction and suspension rates compared to 16- and 17- year old novice drivers. It was stated that this is most likely a reflection of differences in exposure rather than a result of differences in driver behavior or ability. This is because, in Oregon, teens that are licensed after turning 18 are not subject to the requirements of GDL. Furthermore, GDL restrictions are lifted for all drivers when they turn 18, regardless of their progress in the GDL program. Interestingly, teens that were licensed at 18- or 19-year old (i.e. no GDL regulation) were shown to have lower convictions rates after GDL implementation when compared to the same population pre-GDL. This indicates that while conviction rates may have decreased for 16- and 17-year olds, this result is not entirely an effect of GDL because the rates decreased for non-GDL drivers as well.

A study performed by Falb (2005) reported a 47-56 percent decline in the number of 16-year old driver violations in the 3-6 years after GDL implementation in Iowa.[47] Sixteen years old is the minimum age for a provisional license in Iowa. This study only compared the violation rates to those of the last year before GDL implementation and did not specify if the number 16-year old licensed drivers declined as well. However, such a dramatic decrease reveals a promising result following GDL implementation.

Other reports have touched upon the types of violations that teens receive. For example, a study found that the citation risk for teen drivers is highest in their first few months of licensure.[48] Furthermore, a study performed prior to GDL implementation in the United States reported that teen drivers, when involved in multiple vehicle crashes, were more likely to be cited for errors when compared to adult drivers.[49] To date, however, little is published on how GDL implementation has influenced the traffic violation rate of teen drivers.

In the New Jersey GDL program, penalties are triggered when violation points are accumulated by a teen driver. In the event that a teen driver is convicted of a violation that carries two points, a warning letter is sent to the driver to instruct them that if they are convicted of another point carrying violation while a GDL driver, they will be subject to further penalty. Following the accumulation of three or more points while holding a GDL license, the driver is required to participate in a four hour probationary driver program (PDP) safe driving course. After the completion of this course, the GDL driver is given a credit of three violation points on their record, but subjected to a 12-month probationary period. During this time, if the driver is convicted of another point carrying violation, their license will be suspended. For non-GDL drivers, license suspensions most often occur after the accumulation of more than 12 violation points. However, point credits can be awarded if the driver is violation-free for a year or completes a driver improvement program.

Despite the existence of this GDL penalty program, problems have been identified in this point-based monitoring approach. The TDSC Report found that the system that was in place to track the violations of teen drivers was limited in its principal role. First, certain violations, such as failing to wear a seat belt, result in a fine but no points on the license. As a result, the infraction would not count towards a GDL sanction, despite the fact that belt-use by all passengers in a GDL driven vehicle is required and is the responsibility of the GDL driver, per GDL regulation. Furthermore, many teens were pleading to a lesser charge of "Unsafe Operator" when a more severe violation was originally assessed. "Unsafe Operator" carries a fine and no points, and as a result will not count towards GDL sanctions for the teen driver. In response to this practice, the New Jersey Attorney General banned plea agreements that resulted in point-carrying violations being reduced to non-point carrying violations for all GDL drivers, effective on September 17, 2008.[35] The ban on plea agreements was meant to be a temporary solution until an event based system could be instated. An event based system is being developed by the New Jersey Motor Vehicle Commission (NJ MVC) that will track all violations of all drivers in the GDL program, regardless of points.

Objective

The objective of this study is to determine the frequency of traffic violations teen drivers in New Jersey, and to compare these to the frequency of traffic violations for adult drivers. A secondary goal is to analyze the effect of the plea bargain ban on recidivism amongst teens.

Methods

The approach of this study was to compare teen driver traffic violation rates and crash rates before and after the implementation of GDL and changes in regulation of the GDL laws. This study contains two analyses that identify changes associated with the ban on plea-agreements. The NJ MVC dataset was used to determine the effect on violation rates and violation types for teen drivers. Additionally, the Administrative Office of the Courts (AOC) records in New Jersey were used to identify the extent of the plea-agreement problem before the ban.

Effect of Graduated Driver License Regulations on Violation Rates

The New Jersey Motor Vehicle Commission (MVC) driver history dataset from 1997-2012 was used to analyze violations over this time period. This dataset contains a record of all events reported in driver history including, but not limited to, violations, suspensions, and crashes. Details associated with each event, such as the date and violation point value, were also included in the data set. Lastly, driver information such as date of birth and gender was included. Driver age at the time of each event was computed from the event date and the date of birth. All personal identifiers, e.g. name and address, were removed from the dataset prior to analysis.

For this study, teen drivers were defined as those between the ages of 16 and 20, inclusive. Teen drivers were compared to a control group of adult drivers of ages ranging between 35 and 55 years, inclusive.   Since GDL was implemented in New

Jersey in 2001, this age range for adults ensures that they were not subjected to these licensing laws. However, they were exposed to the same driving environment.

All events with event type 'V' (Violation) were included in this analysis. Analyses were conducted on all violations, i.e. both point-carrying violations and zero-point violations. Drivers with all license classes were included (Basic, Commercial, Motorcycle, etc.). Those drivers who never held a NJ license (License Class 'I') were excluded from the analysis.

The dataset received in October, 2012 included driver history events which occurred through August 23, 2012. Since there was only a partial year of data available for 2012, this year was excluded from analyses of violations per year. However, events through June, 2012 were included in monthly analyses.

Teen and Adult Crash Rate Ratio

Violation rates were computed by dividing the number of teen violations by the number of adult violations, as shown in equation 1. The number of adult violations was used since adults were exposed to the same driving environment and provides a means of normalization.

$$Teen\ to\ Adult\ Violation\ Rate\ Ratio = \frac{Teen\ Violations/Teen\ Population}{Adult\ Violations/Adult\ Population} \quad (1)$$

Negative Binomial Model of Violations

We used the negative binomial regression to model violation rate risk. The general setting of the model is as follows. Let Y_{ij} be the number of violations for age group i and time period j.

The NB model assumes

$$Y_{ij} \sim NB(E_{ij}\lambda_{ij})$$

where E_{ij} is the number of drivers for age group i and time period j. The λ_{ij} represents the violation rate for age i and time period j and month k. A log-link function was used to link the expected violation rate with age and time factor:

$$log(\lambda_{ijk}) = \beta_0 + \beta^{DriverAge}X_{ijk}^{Age} + \beta^{GDL}X_{GDL} + \beta^{AgeGDL}X_{ijk}^{Age}X_{ijk}^{GDL} + Month(x_{Month})) \quad (3)$$

where

$$X_{ij}^{Age} = \begin{cases} 1 & teen \\ 0 & adult \end{cases} \text{ and } X_{ij}^{GDL} = \begin{cases} 0 & Before\ GDL \\ 1 & After\ GDL \end{cases}$$

In the above model setup, the exponential of the regression coefficient β^{AgeGDL} corresponds to the Teen to Adult Violation Rate Ratio for the different GDL periods. The 95 percent confidence intervals were computed for the relative rates. The negative binomial distribution was used instead Poisson models to account for potential over dispersion issue. Over dispersion occurs when the variation about a fitted value is greater than what is consistent with the Poisson distribution (i.e. the variance of the fitted variable is not equal to the mean). The negative binomial compensates for the level of over dispersion within the model and computes the variance accordingly.[42]

Separate models were constructed for each age group (16-20), as well as for all teens combined. Adults were used as a comparison for all these models. In the comparison of the different GDL time periods, this model was used for three different violation types: all violations, zero point violations, and point-carrying violations. Lastly, we conducted three comparisons for the different GDL time periods. Table 8 summarizes these comparisons and the time periods used for each analysis.

Table 8. GDL Time Periods used in Negative Binomial Model for Violation Rates

GDL Change	Comparative Period	Post-Change Analysis Months	Comparative Analysis Months
GDL Implementation	Pre-GDL	Jan 2005 - Aug 2008	Jan 1997 - Dec 1999
Plea-bargain Ban	GDL Implementation	Oct 2008 - Apr 2010	Jan 2005 - Aug 2008
Kyleigh's Law/New Restrictions	GDL Implementation	Jun 2010 - Jun 2012	Jan 2005 - Aug 2008

Extent of Plea Agreement

The AOC dataset that we obtained consisted of all amended violations in New Jersey. Included in the dataset was information on the original violation code, amended violation code, the event date, and the court appearance date. This allowed us to analyze the characteristics of traffic violation plea-agreements in New Jersey. The AOC dataset does not explicitly contain driver age or birthdate, but birth month and birth year are coded into the driver's license number in New Jersey. Therefore, it was possible to conduct an age-specific analysis of the plea-agreement trends despite the lack of a given age or date-of-birth field in the dataset. As a result, the age of the driver at the time that the violation was originally given was computed. For confidentiality, the date of birth code was pulled from the Driver License Number and a random driver record number was assigned to each record. The final dataset that we used for all analyses included no personal identifiers and the original dataset was stored in a separate, secure location.

This dataset contained amended violation records for November 1, 2004-November 30, 2007. Therefore, it was not possible to compare the violation trends before and after the implementation of the plea-agreement ban. Nonetheless, it was possible to identify the trends associated with plea-agreements for teen drivers before the implementation of the ban.

The AOC dataset allowed us to identify the ways that teen drivers had been using the plea-agreements to circumvent the penalties built into the GDL legislation. Specifically, we were able to identify the most amended violations as well as identify which violations were most commonly amended, i.e. the original violations. This also helped to explain changes in the violation frequencies that were seen in the MVC database from the pre-ban to post-ban periods. The New Jersey driver's license number contains the driver's birth month and birth year. In order to compute the age of drivers in the AOC dataset, the driver's license number had to be decoded. However, not all records in the dataset contained a full license number. In some cases, the license number was in an unknown format. In all, 84 percent of the records had a full driver's license number that could be used to determine driver date of birth. It was assumed that the distribution of the violations from the records with a full license number were representative of all the amended violations.

Results

From 1997-2011 there were 11 million violations in New Jersey, with an average of 750,000 violations per year. Teen drivers had a total of over 1.7 million violations over the 15 year period, averaging 117,000 violations per year. Figure 15 shows the number of violation events by year for teen drivers, adult drivers, and all drivers in New Jersey. As shown, violations peaked in 2008 for drivers of all ages. Since then, violations have in general been decreasing.
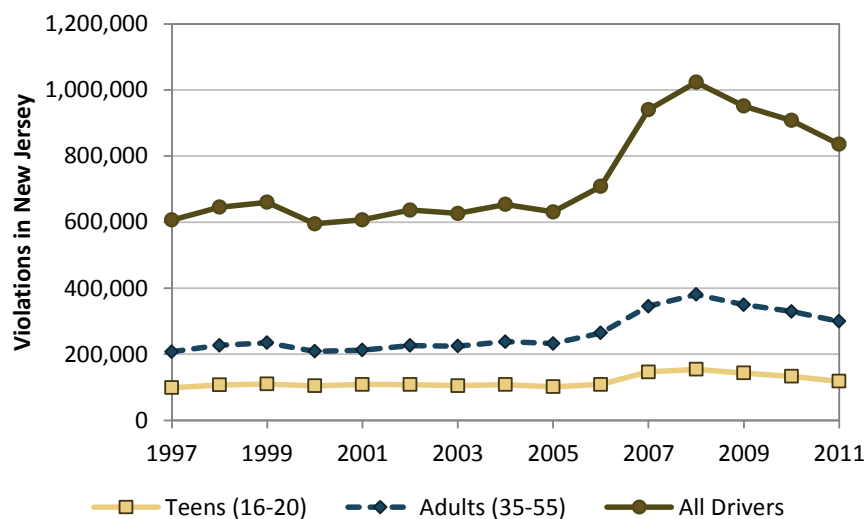
Figure 15. Violations per Year in New Jersey (1997-2011)

The number of violations fluctuated widely by month and exhibited a seasonal pattern. Figure 16 shows the number of violations per month for 2007-2012. There were more violations for both teens and adults in the early summer months. The number of violations is generally lowest between December and January.
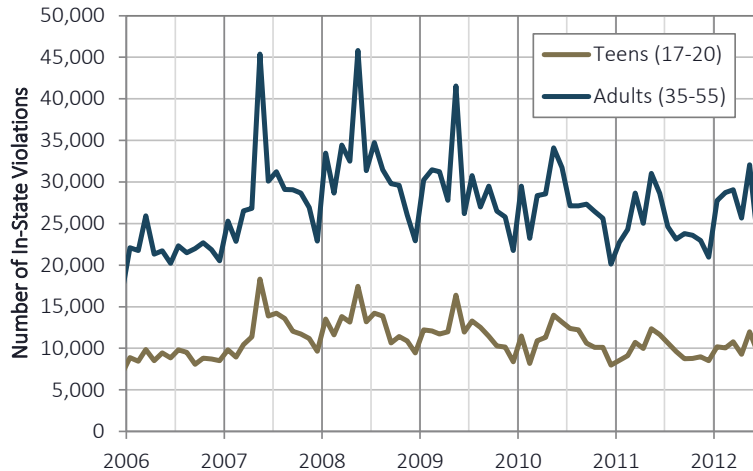
Figure 16. Number of Violations by Month (01/2006-06/2012)

Effect of Graduated Driver License Regulations on Violation Types

The ten most frequent violations were tabulated for teens and adults over the 15 year time period. These violations accounted for 78 percent of all teen violations and 76 percent of all adult violations. Figure 17 shows the ten most frequent violations, regardless of whether or not the violation carried points. As shown, speeding was the most common violation. The second most common violation was 'Unsafe Operation of a Motor Vehicle.' Both of these violations were common for teens than for adults. Adults had a greater likelihood of receiving a violation due to failure to observe a traffic control device than teens.
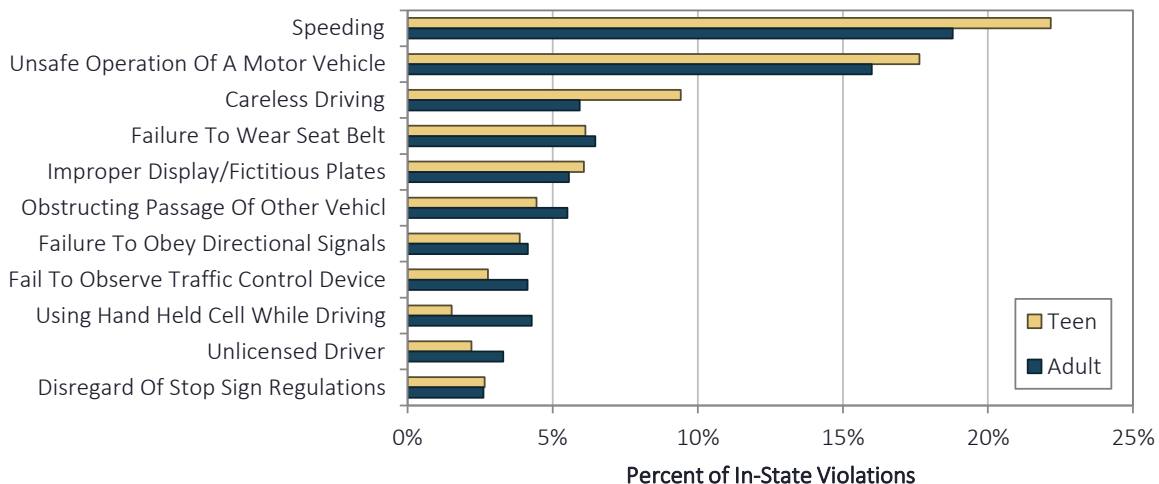
Figure 17. Distribution of Most Common Violations (1997-2011)

Next, zero point violations were investigated. The most common zero-point violation for both teens and adults was 'Unsafe Operation of a Motor Vehicle,' as shown in figure 18.

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These top violations accounted for 85 percent of all zero-point carrying violations for teens and 88 percent of those for adults. Using a cell phone was more common for adults than for teens.
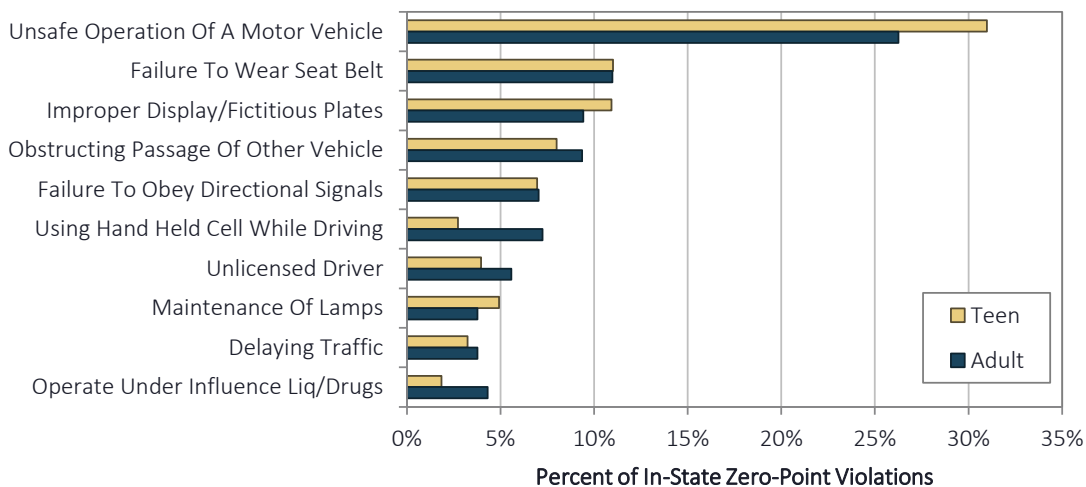
Figure 18. Ten Most Common Zero Point-Carrying Violations (1997-2011)

Figure 19 shows the ten most common point-carrying violations for teens as adults. Speeding accounted for about 50 percent of all point-carrying violations for both teens and adults. Careless driving was the second most common point-carrying violation for teens and adults. Table 9 shows the potential point values associated with each of these violations.

Figure 19. Ten Most Common Point-Carrying Violations (1997-2011)

Table 9. Point values for common point-carrying violations (NJMVC)

Violation	Points			
	2	3	4	5
Speeding	x		x	x
Careless Driving	x			
Fail to Observe Traffic Control Device	x			
Disregard Of Stop Sign Regulations	x			
Improper Oper-Hwys W/ Marked Lanes	x			
Improper Passing			x	
Improper Right and Left Turns		x		
Improper Turn Marked Course		x		
Improper Turn Traffic Control Signal		x		
Failure To Give Proper Signal	x			
Unsafe Operation of A Motor Vehicle*			x	
Wrong Way On One Way Street	x			

* Only a point carrying violation if driving with a suspended license

We next investigated the effect of each of the laws enacted during the GDL period. Our approach was to compare the number of point-carrying violations and zero point-carrying violations for teens in the time periods before and after these laws took effect. Three different periods were compared: (1) GDL implementation before the plea bargain ban, (2) after implementation of the plea bargain ban and before implementation of Kyleigh's Law and new restrictions, and (3) after implementation of the plea bargain ban and Kyleigh's laws and the new restrictions. Common zero point-carrying violations are shown in figure 20 for these different periods of the GDL law in New Jersey and the pre-GDL phase. In 2000, the "Unsafe Operation of Vehicle" violation was introduced, which explains the small number of citations in the pre-GDL phase for this violation.

As shown, 'Unsafe Operation of Vehicle' was most common after GDL was implemented, but before the no-plea bargain law was introduced. However, 'Failure to Wear a Seat Belt' was cited more often after the plea-bargain ban was introduced. Also, 'Use of Hand-Held Device' violation citations appear to have increased for the second two time periods during GDL. This is likely related to the fact that using a hand-held device became a primary offense in New Jersey on March 1, 2008 (PL 2007, c.198).
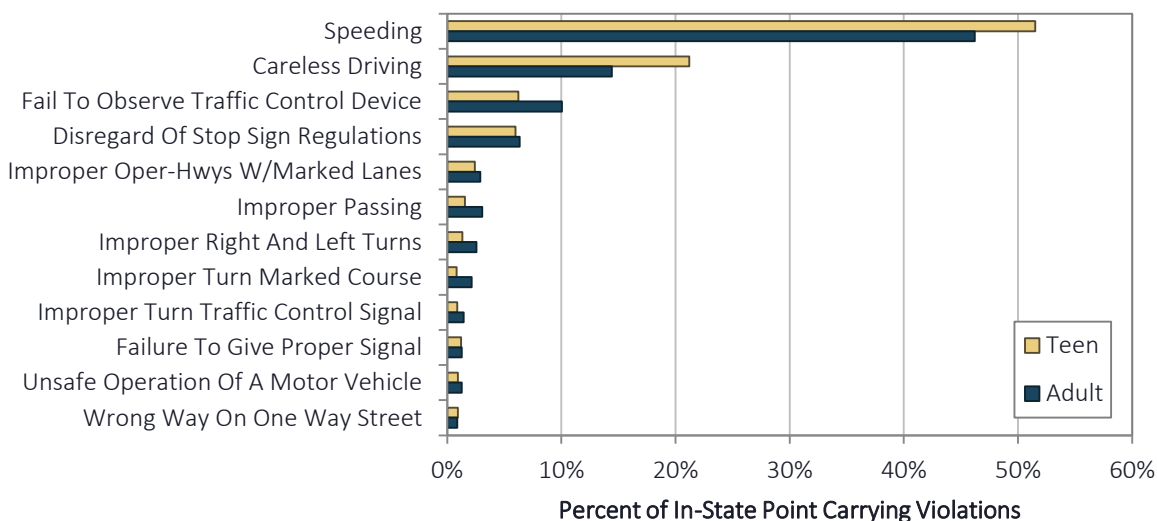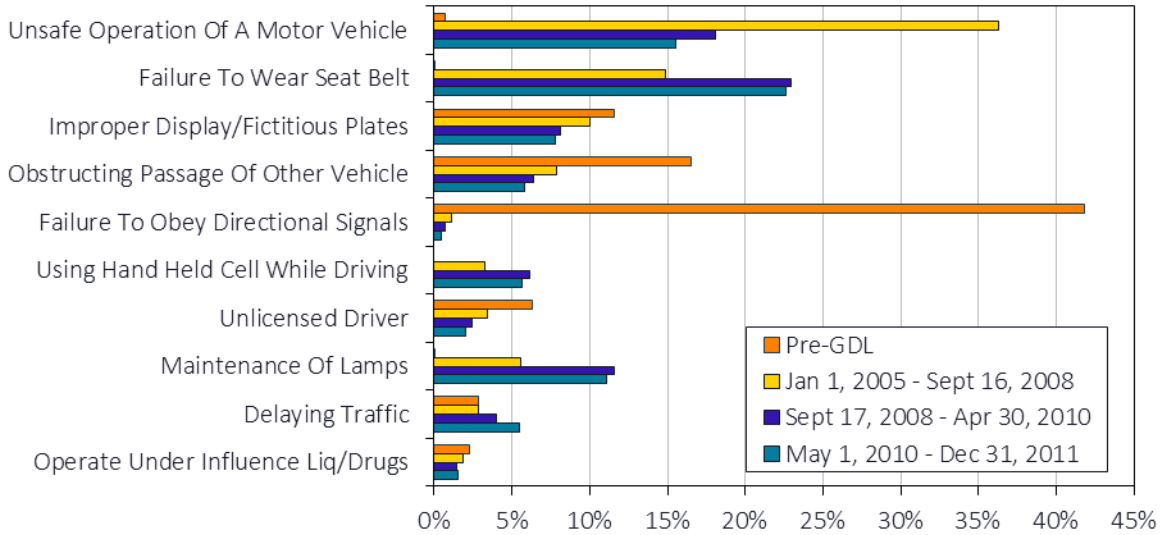
Figure 20. Ten Most Common Zero Point-Carrying Violations by Time Period

Lastly, the ten most common point-carrying violations were analyzed over the same time periods. As shown in figure 21, speeding was the most common point carrying violation for all time periods analyzed. Though the percent of speeding violations decreased over time, the percent of 'Careless Driving' violations increased each time period.
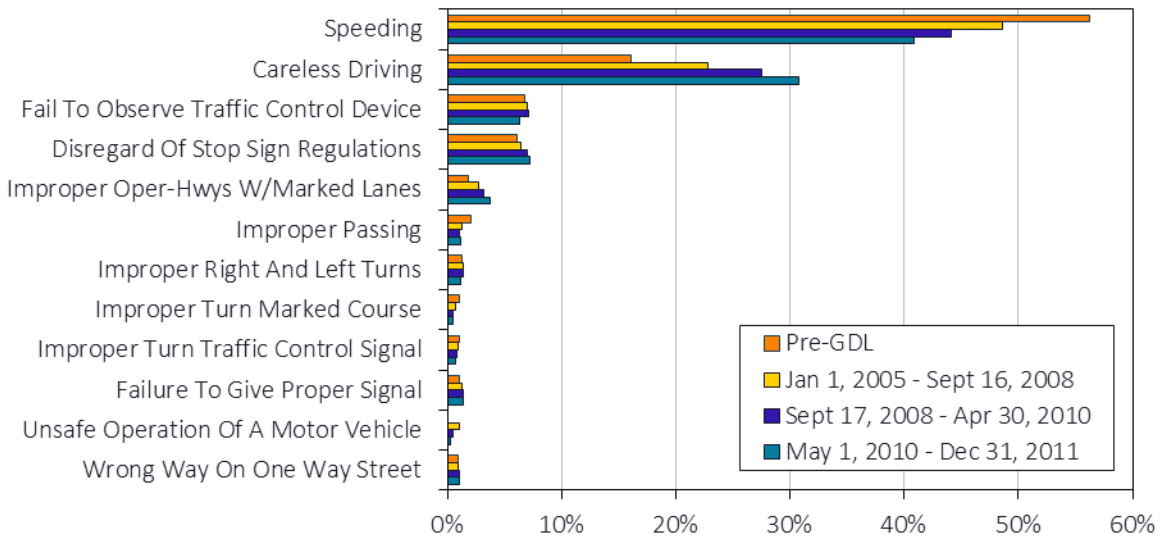

Figure 21. Ten Most Common Point-Carrying Violations by Time Period

Based on an evaluation of the AOC data, more violations were pleaded to "Unsafe Operation" than any other violation before the plea-agreement ban, as shown in table

11. The most common plea-bargained violations were "Speeding" and "Careless Driving" as shown in table 10. These two violations types were also among the top ten amended violations. Seven of the ten most frequent original violations were point-carrying violations. Alternatively, only two of the top ten amended violations were point carrying violations.

Table 10. Top 10 original violation types given for 16 and 17 year old drivers in New Jersey (AOC, 2004-2007)

Violation	Count	%	Points
Speeding	17,420	42%	2/4/5
Careless driving	10,827	26%	2
Failure to obey stop or yield signs	2,513	6%	2
Failure to observe traffic signal	1,864	4%	2
Reckless driving	1,062	3%	2
Driving without Insurance	956	2%	0
Improper Passing	901	2%	4
Driving with an expired license	627	1%	0
Failure to observe traffic lanes	617	1%	2
Violation of GDL Restrictions	388	1%	0
Total	41,820	100%	-

Table 11. Top 10 amended violation types for 16 and 17 year old drivers in New Jersey (AOC, 2004-2007)

Violation	Count	%	Points
Unsafe Driving	25,306	61%	0
Speeding	6,582	16%	2/4/5
Obstructing passage of vehicles	3,448	8%	0
Failure to possess ID, registration, or insurance card	1,776	4%	0
Careless driving	1,310	3%	2
Vehicle in unsafe condition	458	1%	0
Use of a cell phone while driving	440	1%	0
Delaying traffic	436	1%	0
Driving with an expired license	389	1%	0
Failure to Report Accident	284	1%	0
Total	41,820	100%	-

Effect of Graduated Driver License Regulations on Violation Rates

As shown in figure 15, violations have declined for teens since 2008. However, violations have also declined for our adult control group over this same time period, and

hence does not allow us to know whether this decline in teen violations was due to GDL or some other factor experienced by both teens and adults. Our approach was instead to investigate the ratio of teen to adult violations as a function of time for both point-carrying and zero-point carrying violations. As adults are not subject to GDL but drive on the same highways and are subject to the same level of enforcement, this is a simple method of controlling for changes in the traffic environment over time. If GDL had no effect on teens, the ratio should stay constant. If GDL had a beneficial effect, the ratio should decrease.

As shown in figure 22, the ratio of teen to adult violations zero point-carrying violations (normalized by population) decreased over the time period investigated. As shown in figure 15, the total number of violations for both the teen and adult group generally decreased after 2008. The rate of zero point-carrying violations for teen drivers, as compared to adult drivers, generally decreased over time. The violation rate among 17 year olds decreased the most of all age groups investigated. These rates were computed using on an annual basis.
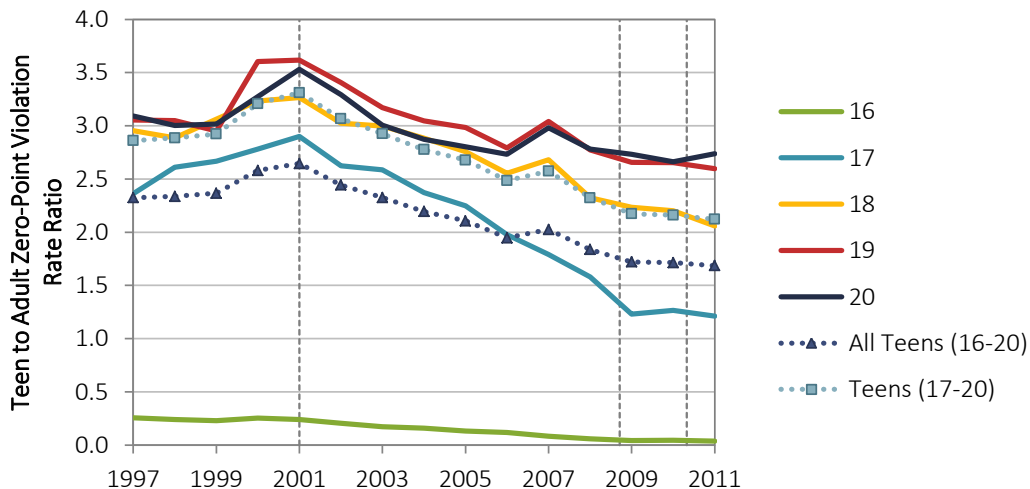
Figure 22. Teen Violation Rate for Zero Point-Carrying Violations (1997-2011)

However, the ratio of teen to adult point-carrying violations stayed relatively constant over time for older teens, as shown in figure 23. This suggests that GDL had little effect on the rate of point-carrying violations for teens. Seventeen year old drivers had the lowest violation rate among all age groups investigated, with the exception of 16-year old drivers.
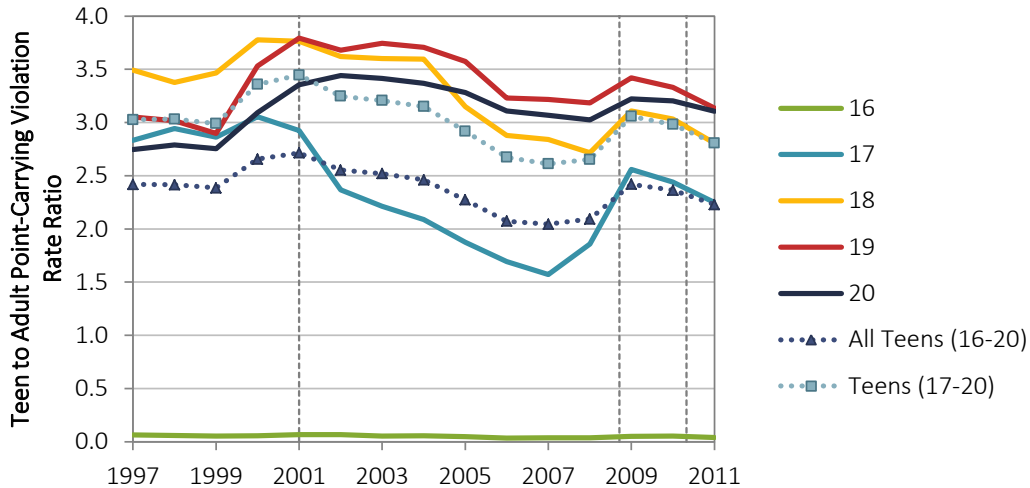
Figure 23. Teen Violation Rate for Point-Carrying Violations (1997-2011)

Next, the ten most common violations were analyzed as a function of time for both teen and adult drivers, as shown in figure 24 and figure 25 respectively. As previously described, 'Unsafe Operation of a Motor Vehicle' became a violation in 2000. The number of speeding citations has decreased over time, though the violations included in our dataset are those mandated by courts. Thus, we do not know the original violation. The number of violations for using a hand-held device exceeded those for 'Unsafe Operation of a Motor Vehicle' starting in 2010 for adults. However, this was not one of the ten most common violations for teens. 'Using a Handheld Cell While Driving' was the 14th most common violation among teens (1.5%). Additionally, 'Failure to Wear a Seat Belt' surpassed 'Unsafe Operation of a Motor Vehicle' in 2008 for both adults and teens.

Figure 26 and figure 27 present the top point-carrying violations for teens and adults as a function of time. Speeding was the most common point carrying violation for both teens and adults for all years analyzed. The second most common point-carrying violation for teens was 'Careless Driving'. However, for adults, 'Careless Driving' and 'Failure to Observe a Traffic Control Device' were nearly equally as common for all years.
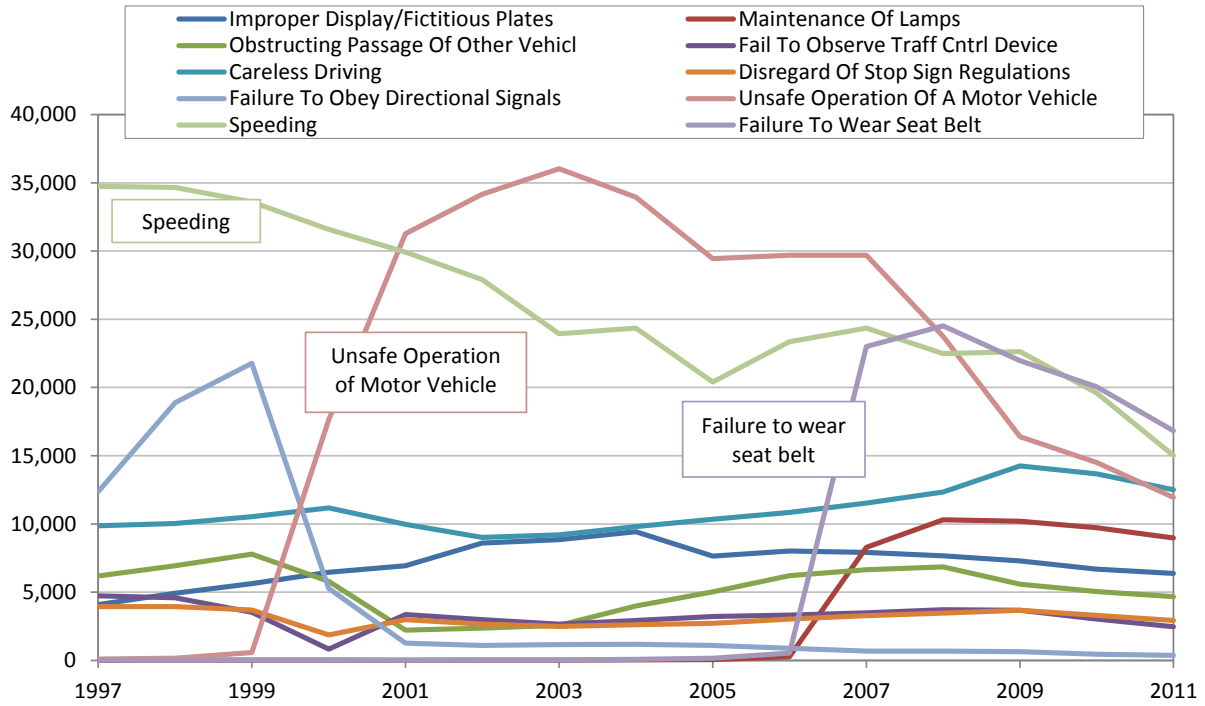
Figure 24. Ten Most Common Violations for Teens (1997-2012)
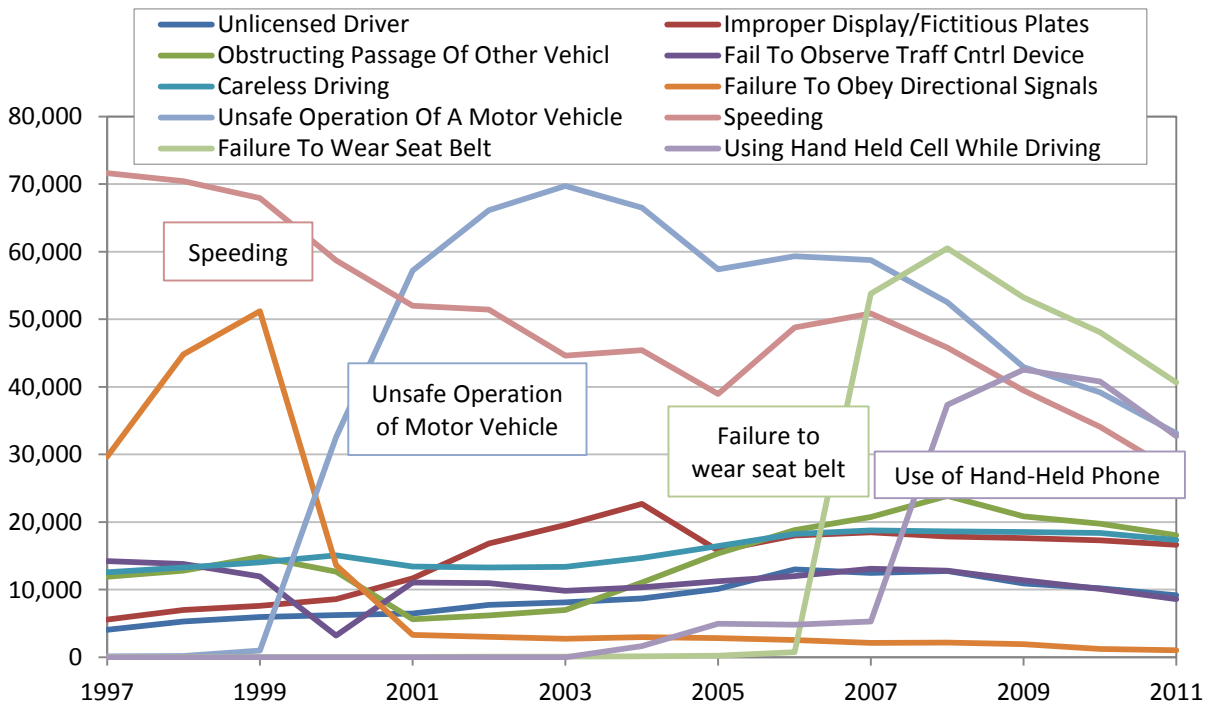
Figure 25. Ten Most Common Violations for Adults (1997-2012)
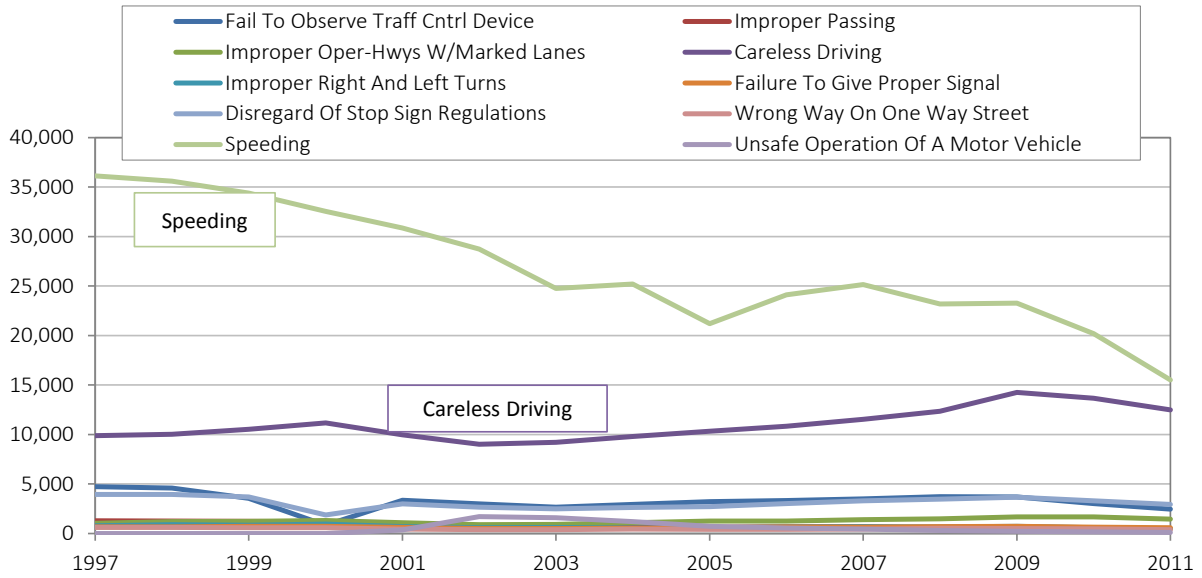
Figure 26. Ten Most Common Point Carrying Violations for Teens (1997-2011)
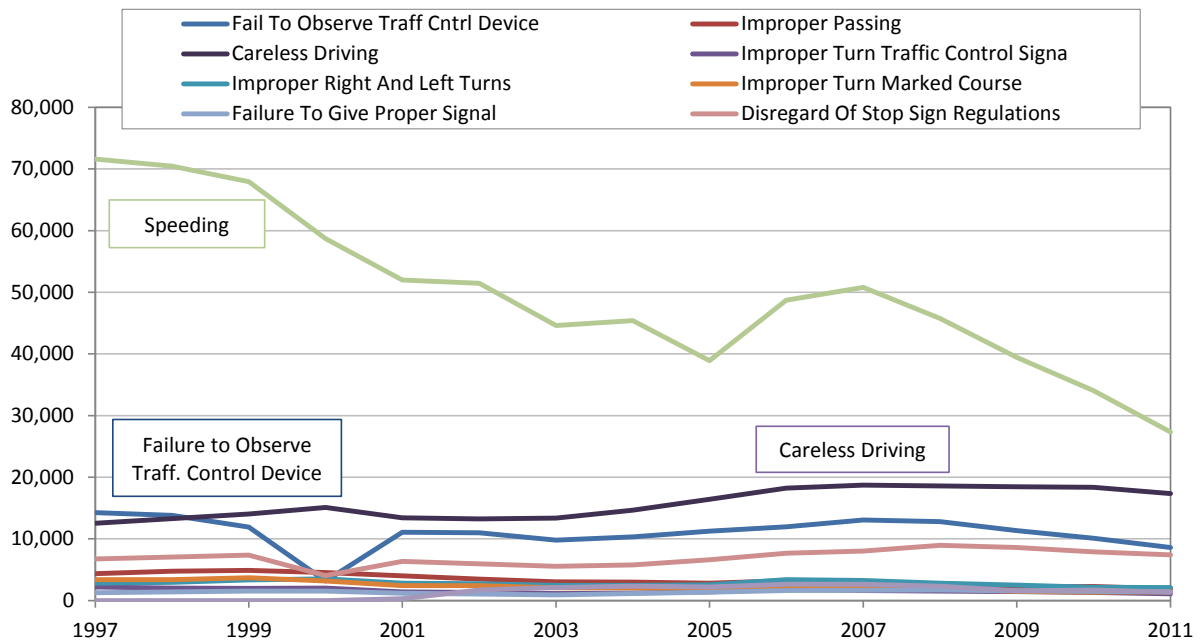
Figure 27. Ten Most Common Point Carrying Violations for Adults (1997-2012)

The negative binomial model was constructed to estimate the relative change in violation rates between teens and adults between different phases of the GDL period. First, the change in violations rates before the GDL was implemented to the initial GDL phase between January 2005 and August 2008 (prior to the implementation of the plea bargain ban). Relative violation rate is defined in equation (3).

Table 12. Change in relative violation rate before and after GDL implementation

Age	All Violations		Zero-Point Violations		Point Carrying Violations	
16	0.56 (0.50 - 0.63)	*	0.40 (0.35 - 0.46)	*	0.66 (0.58 - 0.75)	*
17	0.66 (0.60 - 0.73)	*	0.74 (0.64 - 0.86)	*	0.58 (0.56 - 0.62)	*
18	0.83 (0.75 - 0.93)	*	0.88 (0.75 - 1.03)		0.84 (0.79 - 0.89)	*
19	1.02 (0.92 - 1.14)		0.97 (0.83 - 1.15)		1.10 (1.04 - 1.16)	*
20	1.03 (0.92 - 1.15)		0.95 (0.80 - 1.12)		1.13 (1.07 - 1.19)	*
All Teens (16-20)	*0.86 (0.77 - 0.95)*	*	*0.85 (0.73 - 1.00)*		*0.87 (0.83 - 0.92)*	*

* Statistically significant result (p < 0.05)
Reference: Relative violation rate for teens from Jan 1997-Dec 1999

As shown table 12, there was a significant reduction in violation rate for teen drivers between the ages of 16 and 18 after the implementation of the GDL law. Likewise, both point-carrying violation rates were significantly decreased for these age groups after GDL employed, and a significant decrease in zero-point violations was seen for 16-17 year old drivers. However, there was a significant increase in point-carrying violation rates for 19 and 20 year-old drivers in the post-GDL period. The GDL law appears to have reduced the relative violation rates for teens driving on a probationary license. However, once teens graduate from GDL, the violation rate increased.

Next, the relative violation rate in post-GDL periods before and after the implementation of the plea bargain ban was compared. As shown in table 13, there was a significant decrease in violation rates for 16 year old drivers for both all violations. There was a significant decrease in zero-point violations for 16 and 17 year old drivers. This was accompanied by a significant increase in point-carrying violations for these age groups. Since the plea bargain ban prevents teens from converting a point-carrying violation to a zero-point violation, this increase in point carrying violations was expected.

Table 13. Relative violation rate for teen drivers before and after the plea bargain ban

Age	All Violations		Zero-Point Violations		Point Carrying Violations	
16	0.59 (0.51 - 0.69)	*	0.44 (0.37 - 0.53)	*	1.24 (1.05 - 1.46)	*
17	0.89 (0.78 - 1.01)		0.65 (0.54 - 0.77)	*	1.50 (1.41 - 1.61)	*
18	0.90 (0.79 - 1.04)		0.84 (0.69 - 1.03)		1.06 (0.98 - 1.14)	
19	0.93 (0.81 - 1.08)		0.90 (0.73 - 1.11)		1.02 (0.95 - 1.10)	
20	0.95 (0.82 - 1.11)		0.94 (0.76 - 1.16)		1.01 (0.95 - 1.09)	
All Teens (16-20)	*0.93 (0.81 - 1.08)*		*0.85 (0.70 - 1.04)*		*1.13 (1.06 - 1.21)*	*

* Statistically significant result (p < 0.05)
Reference: Relative violation rate for teens from Jan 2005 -Aug 2008

Lastly, the rate of violations after the implementation of Kyleigh's Law and the new GDL restrictions was compared to the initial post-GDL phase (table 14). These relative rates also include effects of the plea bargain ban since it was implemented between the two study periods. There was a significant decrease in the rate of all violations and the rate

of zero-point violations for 16-18 year old drivers. Seventeen year old drivers were the only group who experienced a significant change in point-carrying violation rates. As seen after the plea bargain ban implementation, the rate of point carrying violations significantly increased as compared to the initial GDL period.

Table 14. Relative violation rate for teen drivers after the Kyleigh's Law and new restrictions

Age	All Violations		Zero-Point Violations		Point Carrying Violations	
16	0.53 (0.46 - 0.62)	*	0.39 (0.33 - 0.47)	*	1.15 (0.98 - 1.36)	
17	0.84 (0.75 - 0.94)	*	0.65 (0.56 - 0.76)	*	1.36 (1.28 - 1.46)	*
18	0.85 (0.75 - 0.96)	*	0.80 (0.67 - 0.95)	*	0.98 (0.91 - 1.06)	
19	0.89 (0.79 - 1.01)		0.88 (0.74 - 1.06)		0.95 (0.89 - 1.02)	
20	0.95 (0.83 - 1.08)		0.94 (0.78 - 1.13)		0.99 (0.92 - 1.06)	
All Teens (16-20)	*0.90 (0.80 - 1.02)*		*0.85 (0.71 - 1.01)*		*1.07 (1.00 - 1.14)*	

* Statistically significant result (p < 0.05)
Reference: Relative violation rate for teens from Jan 2005 -Aug 2008

Conclusions

This study has investigated the effect of changes to GDL law on violations and violation rates for teens in New Jersey. GDL was initially enacted on Jan. 1, 2001. Nearly eight years later, the NJ Attorney General banned those with a graduated driver license (GDL) from plea-bargaining traffic violations. Under this directive, a person with a GDL who received a violation with points could not plea for a different violation that did not carry any points. In May 2010 the most recent set of regulations for those with a GDL were enacted. First, Kyleigh's Law requires those with a GDL to display a decal signaling they are a GDL driver on the front and rear license plate. Also, new restrictions on number of passengers and permissible driving times were placed on those with a probationary license. The following are our conclusions:

- The overall number of violations remained relatively constant between 1997 and 2006. From 2006-2008, violations increased for both the teen (17 to 20 year old) population and adult (35 to 55 year old) population. Since 2008, the overall number of violations has been decreasing across the State. The most common violation for both teens and adults over the 15 year period studies was speeding. Speeding was more prevalent in teen violations than in adult violations.

- The most common violation that did not carry any points was unsafe operation of a motor vehicle. This specific violation was first enacted in 2000 and was the most common violation for adults from 2003 to 2005. Likewise, this was the most cited violation for teens from 2002 to 2006. After the enactment of the plea-bargain ban, this violation was cited 50 percent less frequently. Since 2007 the most common violation for teens has remained speeding. The number of 'Unsafe Operation of Motor Vehicle' violations for adults also decreased over the same time period.

- Unsafe driving was the most common amended violation prior to the plea bargain ban took effect. Prior to the plea ban, speeding accounted for 42 percent of all original violations, and only 16 percent of amended violations.

- A greater percentage of 'Careless Driving' violations by teens was seen after each GDL law enactment. With this increase, also came a decrease in the percentage of violations that where 'Speeding' violations.

- Using a hand-held phone while driving was one of the ten most common violations for adults; however, this was not the case for teen drivers. Under current GDL laws, teens are banned from using a phone, both hand-held and hands-free, and texting while driving.

- Since the enactment of GDL, the rate of zero point violations for teens, as compared to adults, has generally decreased. However, after the enactment of the no-plea bargain law, the rate of point carrying violations for teens as compared to adults initially increased (from 2007 to 2009), and has generally been decreasing since 2009. Overall, 17 year-old drivers had lower violation rates for both point-carrying and zero point-carrying violations than 18-, 19-, and 20-year old drivers.

- Significant decreases in violation rates were seen after the start of the GDL for 16-18 year old drivers. The relative rate of violations for 17 year olds in the years after the GDL was enacted was about two-thirds of that in years prior to GDL. However, there was a significant increase in point-carrying violation rates for 19 and 20 year-old drivers in the post-GDL period; 19 and 20 year olds were about 1.1 times more likely to have a point carrying violation after the GDL was enacted. After the implementation of Kyleigh's law and the new GDL restrictions, there was a significant decrease in the rate of all violations and the rate of zero-point violations for 16-18 year old drivers. Relative violation rates for 17 year old drivers were about 0.8 times than those before any changes were made to the GDL laws.

4. EFFECT OF THE PLEA BARGAIN BAN ON RECIDIVISM AMONG TEEN DRIVERS

Introduction

Traffic violations are a negative reinforcement for negative behavior. Violations may or may not carry points, and those with points are for more severe violations than those without. However, even after receiving one violation, many drivers still continue to be cited for traffic violations. The act of receiving this second violation, and all violations thereafter, is defined as recidivism. Even though driver's behavior has been negatively reinforced, they continue to repeat the same behavior.

If a teen driver in a GDL program commits a traffic violation or fails to comply with a GDL restriction (e.g. nighttime driving, cell phone use), GDL programs in several states assess driver privilege penalties. In New Jersey, the accumulation of violations can result in three sanctions: 1) a postponement of advancements through the GDL program, 2) require participation in a safe driving course, or 3) license suspension. Currently, these penalties are triggered when violation points are accumulated by a teen driver. In the event that a teen driver is convicted of a violation that carries two points, a warning letter is sent to the driver to instruct them that if they are convicted of another point carrying violation while a GDL driver, they will be subject to further penalty. Following the accumulation of three or more points while holding a GDL license, the driver is required to participate in a four hour probationary driver program (PDP) safe driving course. After the completion of this course, the GDL driver is given a credit of three violation points on their record, but subjected to a 12-month probationary period. During this time, if the driver is convicted of another point carrying violation, their license will be suspended.

In New Jersey, there were teens that received point carrying violations, but subsequently pleaded to have these more severe violations changed to a zero-point violation in court.[35] On September 17, 2008, the New Jersey Attorney General banned GDL participants from pleading a point-carrying violation to a zero point-carrying violation.[35] It is anticipated that this ban would further encourage teen drivers to follow the rules of the road since the consequences are more severe. Moreover, this should further discourage teens from recidivism, or having multiple violations.

Objective

The objective of this chapter is to determine the effect of the plea bargain ban on recidivism rates among teen drivers.

Methods

The NJ MVC data from 2005-2011 was used to analyze the frequency of violations among teen drivers in the periods before and after the plea bargain ban. The plea bargain ban took effect on September 17, 2008.[35] Teen drivers were again defined as

drivers between the ages of 17 and 20 since this analysis was conducted based on when the driver received his/her license (minimum age of 17).

The period before the plea bargain ban was defined between October 1, 2005 and August 31, 2008. September was excluded from the analysis to reduce the effects of the new law on the analysis. Likewise, the period after the plea bargain ban was defined between October 1, 2008 and August 31, 2011. The same month range was used for both the before and after period to accommodate seasonal fluctuations in the number of violations. Only active violations that occurred in New Jersey were included in this study since the plea bargain-ban mainly affects this group of violations.

The reported GDL license date was used to determine when each driver received a probationary license. However, from the data, it was unclear as to when the driver received a basic license. New Jersey Law mandates that all drivers licensed under the age of 21 in New Jersey hold the probationary license for at least one year.[37] Since the driver must hold the probationary license for this length of time, violations within one year of receiving this license were assumed to have occurred while the driver was in the probationary period. Nonetheless, not all drivers receive a basic license exactly one year from receiving a probationary license. Therefore, a second analysis was conducted to include violations within two years of receiving the probationary license.

Only drivers who were licensed in either of the periods of interest for this study were included in the analysis. Additionally, these studies were limited to drivers who completed either one or two years within a period of interest for the study. A driver who was licensed in the period before plea bargain ban, but did not complete a year of driving until after the ban took effect was excluded from the dataset for this study.

The effectiveness of the plea bargain ban on recidivism was analyzed using three metrics:

- Total violations within one or two years of receiving a GDL license.
- Accumulated points within one or two years of receiving a GDL license.
- Odds ratio of multiple violations to a single violation within one or two years of receiving a GDL license before and after the implementation of the plea bargain ban.

Number of Violations and Points Accumulated

The number of violations was tallied for each driver in the periods before and after the plea bargain ban. This was done separately for zero point and point-carrying violations. However, these sets were not exclusive of each other; if a driver had one zero point and one point-carrying violation, they appeared in each tally as having only one violation. Total violations (zero point and point-carrying) were also computed, and the driver previously described would appear as having two total violations.

Next, the cumulative number of points a driver received within one and two years after licensure was tallied. Only drivers with violations were included in this analysis. For

each violation reported in the NJ MVC dataset, the number of points received was also reported. These reported points were used for this analysis. This analysis did not account for any reduction in points due to defensive driving courses. Only violations that occurred between the dates of interest were included in the analysis.

Odds of Multiple Violations

Recidivism can be defined as the probability of having multiple violations, given that a driver has had a violation. Overall, the probability of recidivism can be defined as

$$P(Recidivism) = \frac{Drivers\ with\ 2 + Violations}{Drivers\ with\ Violations} \tag{4}$$

This probability of recidivism can be extended to compute the odds of recidivism. The relationship between odds and probability is shown in equation (5). The odds of having multiple violations versus a single violation were computed for the period before the plea bargain and after the plea bargain using equation (6).

$$Odds = \frac{P}{1 - P} \tag{5}$$

$$Odds_{Multiple\ Violations} = \frac{Teen\ Drivers\ with\ 2 + Violations}{Teen\ Drivers\ with\ 1\ Violation} \tag{6}$$

To compare the periods before and after the plea bargain ban, the odds ratio (OR) of multiple violations was computed as

$$Odds\ Ratio_{Mult.\ Violations}$$
$$= \frac{\left(\dfrac{Teen\ Drivers\ with\ 2 + Violations}{Teen\ Drivers\ with\ 1\ Violation}\right)_{post-Plea\ Bargain\ Ban}}{\left(\dfrac{Teen\ Drivers\ with\ 2 + Violations}{Teen\ Drivers\ with\ 1\ Violation}\right)_{pre-Plea\ Bargain\ Ban}} \tag{7}$$

If the OR is greater than 1, the likelihood of having multiple violations was greater during the period after the plea bargain ban. The confidence limits were computed using Mantel-Hansel statistics. All analyses were conducted using SAS 9.2 (SAS Institute, Cary, North Carolina).

Results

There were 98,774 teen drivers included in the analysis of drivers with violations one year after licensure and 72,434 drivers included in the analysis of drivers with violations two years after licensure. The distribution of licensure age and the period during which each driver received a license is shown in figure 28. There was approximately the same number of drivers included in the study for each period (before and after the ban). The

decreased number of drivers in the period two years from the date of licensure is due to fewer drivers having completed two years of driving within the study period.

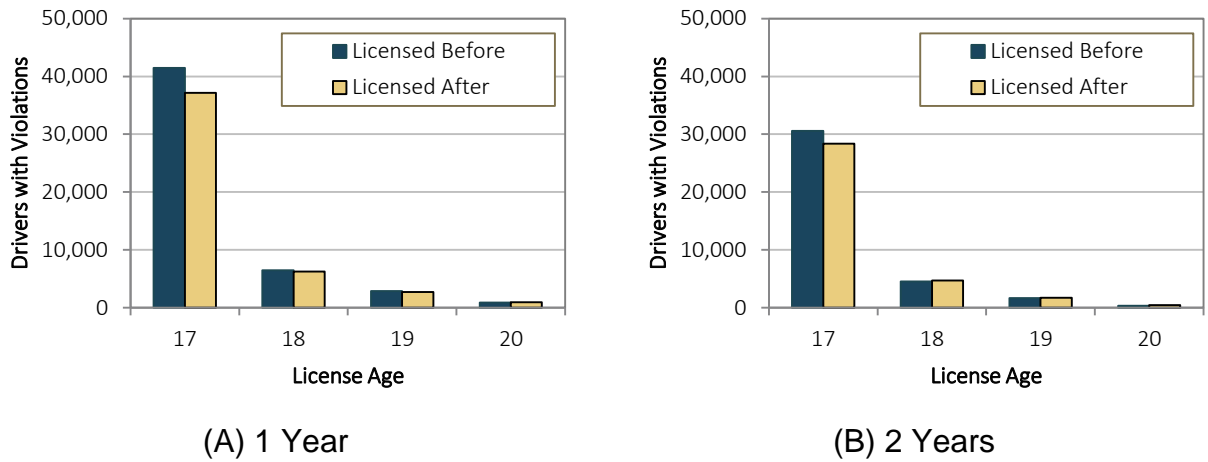(A) 1 Year   (B) 2 Years

Figure 28. License age of drivers with violations by license issue period for (A) drivers with violations one year after licensure and (B) drivers with violations two years after licensure

For comparison, figure 29 shows the number of teen drivers who completed either one or two years of licensure during the pre-plea bargain ban period or the post-plea bargain ban period. The number of drivers who completed two years of licensure is lower than those who completed one year of licensure since the time frame is longer.

(A) 1 Year   (B) 2 Years
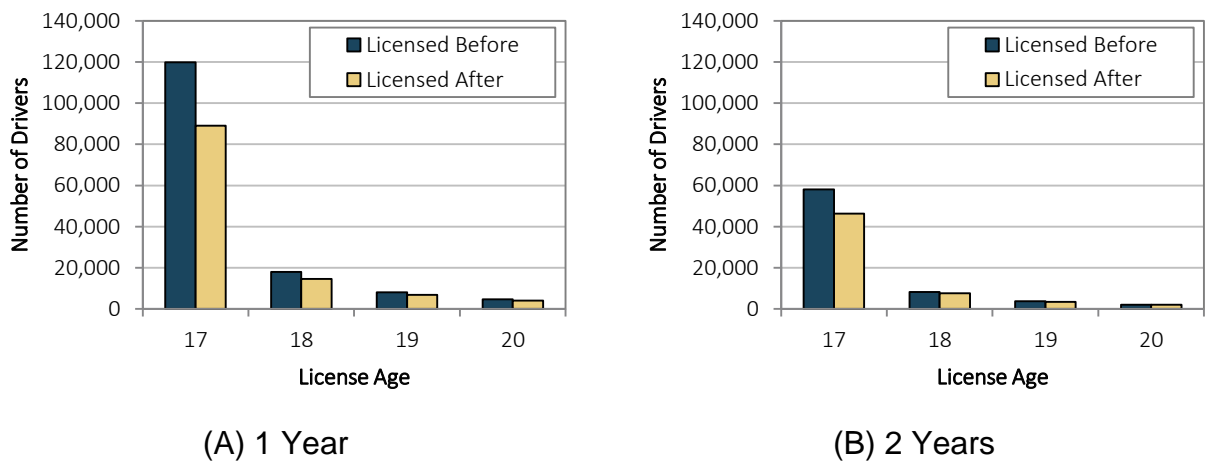
Figure 29. License age of drivers by license issue period for (A) drivers who completed one year of licensure and (B) drivers with violations two years after licensure

Number of Violations and Cumulative Points

Figure 30 shows the distribution of the cumulative number of violations per driver for the periods before and after the plea bargain ban was implemented for drivers one year and two years after licensure, respectively. Overall, there were more drivers with violations in the period after the plea bargain ban than before the plea bargain ban. However, the

total number of violations was comparable for drivers with violations one year after licensure in both the period before and after the plea bargain ban was enacted. In the pre-plea bargain ban period, 69 percent of teens with violations had received only one violation within a year of licensure and 31 percent received two or more violations. Comparatively, in the post-plea bargain ban period, 66 percent of teens with violations were cited with one violation and 34 percent had multiple violations.

(A) 1 Year (B) 2 Years
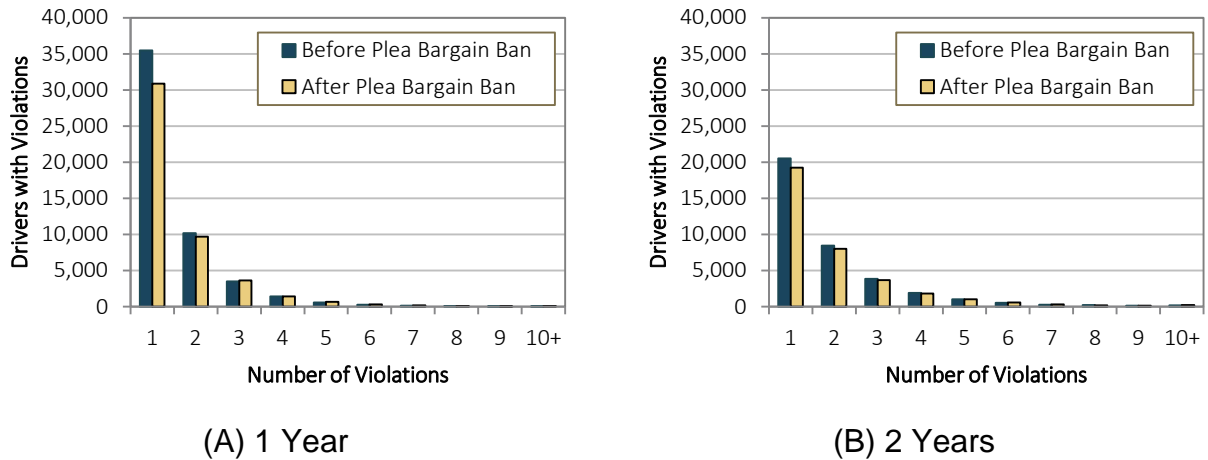
Figure 30. Cumulative violations after (A) one year of licensure and (B) two years of licensure

Next, the number of drivers with zero point and point carrying violations was computed. Again, these groups are not exclusive of each other since drivers may have both a zero point and point carrying violation. Figure 31 shows the number of drivers with zero point violations both one and two years after licensure. Fewer drivers had zero point violations within a year of licensure after the plea bargain ban.
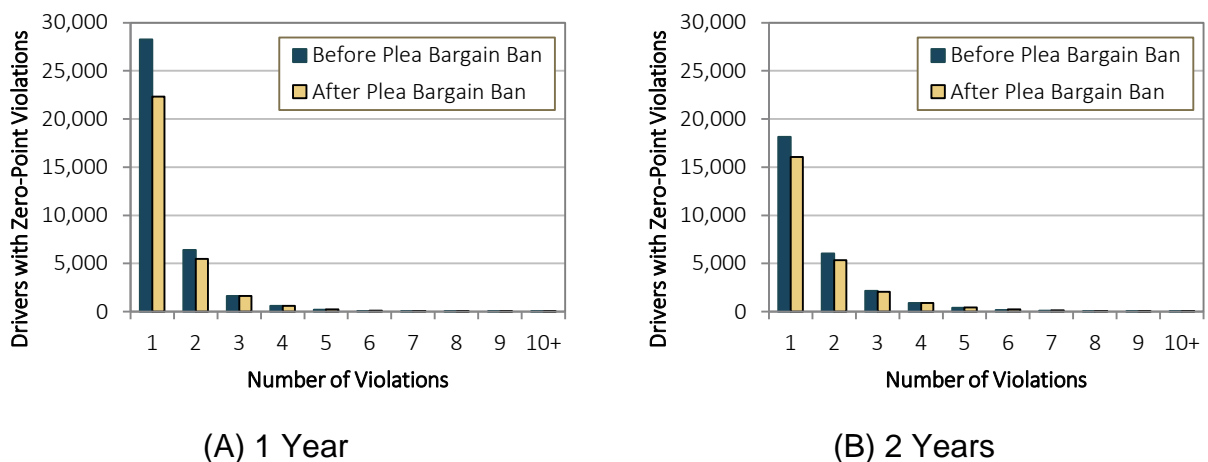

(A) 1 Year (B) 2 Years

Figure 31. Cumulative zero point violations (A) one year after licensure and (B) two years after licensure

Likewise, the number of drivers with point-carrying violations is shown in figure 32 for one and two years after licensure. As shown, the number of drivers with point-carrying

violations increased after the plea bargain ban was implemented for drivers both one and two years after licensure.

(A) 1 Year

(B) 2 Years
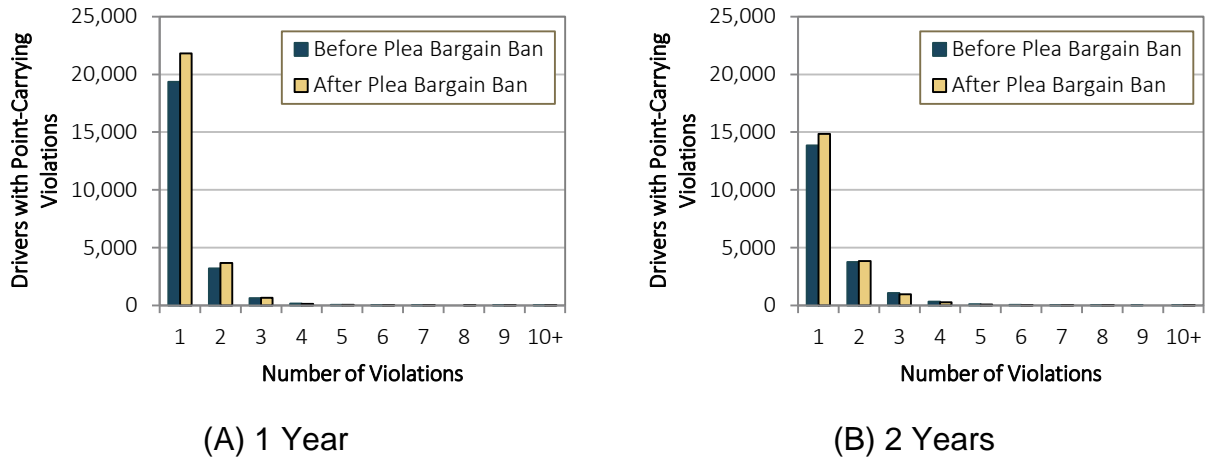
Figure 32. Cumulative point-carrying violations (A) one year after licensure and (B) two years after licensure

Figure 33 shows the number of drivers by their cumulative number of points both before and after the plea bargain ban. As previously discussed, only drivers with violations are included in these charts, thus the number of drivers with zero cumulative points is those who received only zero-point violations. It should be noted that this chart does not give a measure of multiple violations; e.g. those with a two-point violation and a zero-point violation would be tallied the same as those who received only a two-point violation. The number of drivers with an accumulation of two points increased after the plea bargain ban was implemented (figure 33). This was complemented by a decrease in drivers with zero-point violations for drivers both one and two years after licensure.
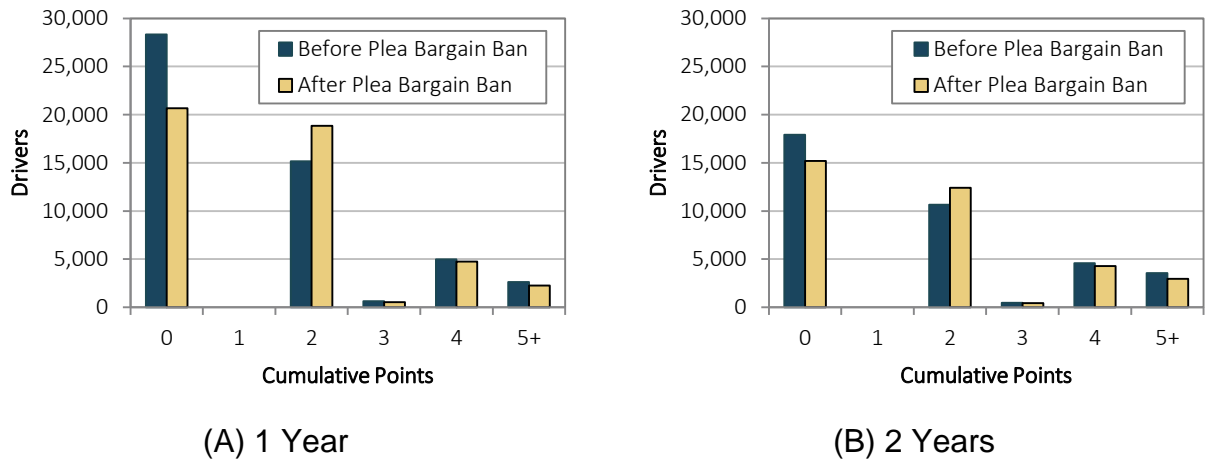

(A) 1 Year

(B) 2 Years

Figure 33. Cumulative points for drivers with violations (A) one year after licensure and (B) two years after licensure

The odds of having multiple violations one year after licensure significantly increased after the implementation of the plea bargain ban (figure 34). There was also a significant increase in the odds of having multiple zero point violations both one and two years after licensure after the implementation of the plea bargain ban. However, two years after licensure, there was a significant decrease in the odds of having multiple point carrying violations.
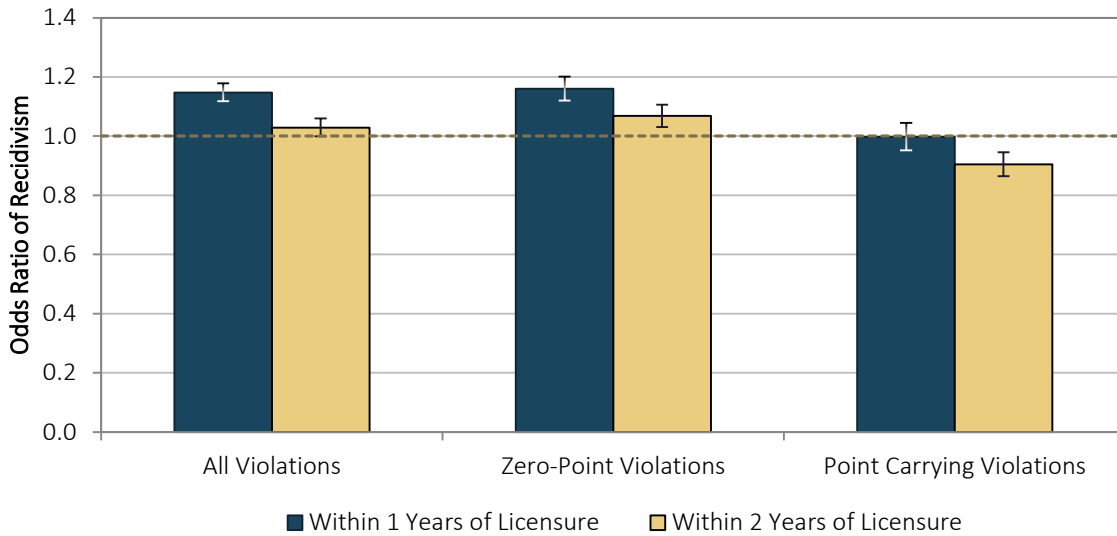
Figure 34. Odds Ratio of multiple violations as compared to one violation before and after the plea bargain ban (Oct. 2005-Aug. 2008; Oct. 2008- Aug., 2011)

Discussion

One limitation of this method is that it is restricted to drivers who both received their license and completed a specified amount of driving with the period before or after the plea bargain ban took effect. Since there are few years included in this period, this analysis excludes a large portion of teens that received their license in the period before the ban, but did not complete one or two years of driving within the period. Likewise, teens licensed towards the end of the period after the ban took effect were also not included since they did not complete the specified driving period.

It should be noted that the groups of drivers with point-carrying and zero-point carrying violations are not mutually exclusive. A driver with one point carrying violation and one zero-point carrying violation would appear as having a single violation in each of these analyses, but having multiple violations in the analysis of all violations.

All analyses were conducted based on only court-ordered violations. Therefore, we do not know if drivers with zero-point violations in the period before the plea bargain ban took effect had received this violation or had bargained to this violation. Additionally, the effects of out-of-State violations were not included in this analysis.

This increase in recidivism rates was unexpected; however, we have a couple theories as to why this may have occurred. One theory is that the behavior of people who were more likely to receive multiple violations was not changed by the enactment of the plea bargain ban, though it did affect those who may have only received one violation. Therefore, since the recidivism metric is normalized with drivers who had one violation, the odds of recidivism increased since fewer people receive one violation. A second theory is that the first year after the plea bargain ban was passed is a transition year, where drivers are becoming aware of the new law.

Conclusions

After the implementation of the plea bargain ban, the number of teen drivers with point carrying violations increased. Likewise, there was a decrease in the number of teen drivers with zero-point carrying violations. However, there was a significant increase in drivers with multiple zero-point carrying violations after the plea bargain ban was employed. Additionally, the likelihood of drivers having multiple violations overall increased between the two comparative periods.

There was a significant increase in the odds of having multiple point carrying violations one year after licensure between the two time frames. This increase is also supported by the analysis of cumulative points, which showed that more teen drivers in this period accumulated two points on their license than teens in the period immediately before the ban was implemented. Likewise, point-carrying violation rates for teens as compared to adults increased initially after the plea bargain ban was enacted, as demonstrated in Chapter 3. However, two years after licensure, teens had a significant decrease in the odds of recidivism after the ban was enacted. Though there was an initial increase in the likelihood of recidivism one year after receiving a license, the plea bargain ban is effective in reducing the likelihood of recidivism for point carrying violations over a longer time frame.

5. CONCLUSIONS

The New Jersey Graduated Driver's License (GDL) program is one of the most progressive and stringent GDL systems in place in the United States. The NJ GDL program was instituted on January 1, 2001. Like other GDL programs in the U.S., the NJ GDL program is intended to provide teen drivers with a progressive system that allows for growth in their driving abilities through experience. The regulations are meant to limit exposure to more complicated driving scenarios. Specifically, the age at which full driving privileges are allowed is extended compared to previous licensing systems, the hours in which teens are allowed to drive are restricted, and the number of passengers allowed in a vehicle driven by a teen is also limited. These are all means intended to lessen the number of crashes and fatalities in vehicles driven by teens.

Since the enactment of GDL in 2001, two initiatives have been instituted which impact the regulations on those with a GDL. On September 17, 2008, the New Jersey Attorney General banned GDL participants from plea-bargaining from a point-carrying violation to a zero point-carrying violation.[35] Next, Kyleigh's Law was passed on May 1, 2010, requiring those in the GDL system to display a decal on the front and rear license plates.[36] Another law enacted simultaneously with Kyleigh's law amended the restrictions on those with a GDL.[36] Drivers with a probationary license are not allowed to drive between 11:01 pm and 5:00 am. Previously, those with a probationary license were not allowed to drive between 12:01 am and 5:00 am. Additionally, those on a probationary license are limited to only one other passenger, including family members, unless accompanied by a parent or guardian. Hands-free and hand held devices cannot be used at any time, and seat belts must be worn by the driver and all passengers and all times.[37]

The objective of this study is to determine the effectiveness of the New Jersey Graduated Driver's License (GDL) program and the additional GDL initiatives in reducing teen crashes, traffic fatalities and traffic violations.

Four different data sets were used to conduct this study. Both the NJCRASH and the national Fatality Analysis Reporting System (FARS) databases were utilized to investigate the effect of GDL on crash rates. The New Jersey Motor Vehicle Commission (NJMVC) database of driver history and the Administrative Office of the Courts (AOC) records in New Jersey were used to analyze the effects of GDL laws on violations. Teen driver crashes and violations were compared to adult driver crashes and violations as a normalizing metric. For our study, teen drivers were defined as 16-20 year old drivers and adult drivers were defined as 35-55 year old drivers.

The conclusions on the effect of each of the GDL initiatives are discussed below. Each is evaluated in the context of crashes and crash rates as well as for violations and violation rates.

Effect of Graduated Driver License Implementation

The pre-GDL period was defined as January 1997-December 1999 and the post-GDL period was defined as January 2005-August 2008. The years 2001-2004 were excluded to ensure all teens in the post-GDL period became licensed through the GDL system. Additionally, 2000 was excluded to reduce the effect of more teens becoming licensed before the GDL laws went into effect. The effects of the GDL implementation on crashes and violations are discussed below.

Crashes and Crash Rates

- Generally, the total number of teen crashes (drivers aged 16-20) has been decreasing each year after the implementation of the GDL system. Seventeen year old drivers experienced the largest decrease in crashes. Likewise, fatalities among teens generally decreased after 2006.

- Prior to the GDL laws, there was variation in the number of crashes involving drivers of each teen age year. However, this variation decreased drastically in 2009 and later years. Likewise, variation in the relative crash rates of teen drivers as compared to adults drivers decreased over time.

- After GDL was implemented, 16-18 year old drivers experienced a significant decrease in crash rates, as compared to adult crashes. For seventeen year old drivers, the rate of crashes in the post-GDL period was only 0.80 (95% CI: 0.76-0.83) than that of seventeen year olds in the pre-GDL period. However, there was also a significant increase in crash rates amongst 19-20 year old drivers. After GDL, the crash rate was about 1.1 times that of the pre-GDL crash rates for these age groups. It may be that 17-18 year old drivers on a probationary were not experiencing as many driving scenarios, and then exposed to them as an older teen.

Violations and Violation Rates

- The overall number of violations remained relatively constant between 1997 and 2006. From 2006-2008, violations increased for both the teen (17 to 20 year old) population and adult (35 to 55 year old) population.

- The most common violation that did not carry any points was unsafe operation of a motor vehicle. This specific violation was first enacted in 2000 and was the most common violation for adults from 2003 to 2005. Likewise, this was the most cited violation for teens from 2002 to 2006.

- Significant decreases in violation rates were seen after the start of the GDL for 16-18 year old drivers. The relative rate of violations for 17 year olds in the years after the GDL was enacted was about two-thirds of that in years prior to GDL. However, as shown with crash rates, there was a significant increase in point-carrying violation rates for 19 and 20 year-old drivers in the post-GDL period; 19 and 20 year olds were about 1.1 times more likely to have a point carrying violation after the GDL was enacted.

Effect of Plea Bargain Ban

The plea bargain was implemented on September 17, 2008. For the analysis of crash rates, we defined the period before the plea bargain ban from January 2005 to August 2008 and the period after the plea bargain ban from October 2008 to April 2010.

Crashes and Crash Rates

- After the implementation of the plea bargain ban in September, 2008, crash rates for 17 and 18 year old teen drivers significantly decreased in the period from October, 2008 through April, 2010 as compared to the period between January, 2005 and August, 2008. Seventeen year old drivers had a crash rate 0.90 (95% CI: 0.86-0.95) times the crash rate in the period immediately before the plea bargain ban. No significant change in crash rates was seen for 19-20 year old drivers.

- Teen drivers between the ages of 16 and 18 had a significant decrease in the number of single vehicle crashes after the implementation of the no-plea bargain.

Violations and Violation Rates

- After the enactment of the plea-bargain ban, the 'Unsafe Operation of a Motor Vehicle' violation was cited 50 percent less frequently. This is a zero-point violation that was shown to be the most commonly amended violation in the period prior to the plea bargain.

- Zero-point violation rates among teen drivers significantly decreased among 16-17 year old teen drivers after the plea bargain ban was implemented. However, there was also a significant increase in point-carrying violations for these age groups. This implies that the plea-bargain ban is effective in preventing teens from converting point carrying violations to zero point violations.

- Sixteen year old drivers had a violation rate 0.6 times that in the pre-plea bargain ban period. This was the only age group to experience a significant decrease in all violations.

This analysis was conducted based on the number of violations a teen drivers received within the first or second year of driving. Since there were evident seasonal variations in the number violations and this component of the analysis was not normalized by adult driver violations, equal time periods before and after the plea bargain ban were used. The before and after periods of the plea bargain ban were defined as October 2005-August 2008 and October 2008-August 2011, respectively. Our conclusions on the effect of the plea bargain ban on recidivism rates are as follows:

- There was a significant increase in the odds of having multiple point carrying violations one year after licensure after the plea bargain ban was implemented. Likewise, more teen drivers in this period group accumulated two points on their license than teens in the period immediately before the ban was implemented.

- The likelihood of recidivism two years after licensure significantly decreased after the plea bargain ban was implemented. Though there was an initial increase in the likelihood of recidivism one year after receiving a license, the plea bargain ban is effective in reducing the likelihood of recidivism for point carrying violations over a longer time frame.

Effect of Kyleigh's Law and New Graduated Driver License Restrictions

At the time of this report, Kyleigh's Law and the new GDL restrictions implemented in May 2010 were the latest changes to the GDL laws. The effect of these laws was analyzed by comparing crash and violation rates (both point-carrying and non-point carrying) after they were enacted to violation rates prior to any changes were made to the initial GDL system. Therefore, the period before these changes was defined as January 2005-August 2008 and the period after was defined as June 2010 to June 2012 for the violation analysis. Our conclusions about the effects of these regulations on crash and violation rates are summarized below.

Crashes and Crash Rates

- Significant decreases in crash rates for teens from 17-20 were seen after Kyleigh's Law and the new GDL restrictions were implemented. For 17 year olds, crash rate ratios after these laws took effect were 0.81 (95% CI: 0.78-0.84) times those from before any changes were made to the GDL laws. This decrease also takes into account any crash rate violations from the plea bargain ban.

Violations and Violation Rates

- There was a significant decrease in the rate of all violations and the rate of zero-point violations for 16-18 year old drivers after these laws were enacted. Relative

violation rates for 17 year old drivers were about 0.8 times than those before any changes were made to the GDL laws.

- A significant increase in the relative violation rate of point carrying violations among 17 year old drivers was seen after these laws were enacted. The rate was 1.36 (95% CI: 1.28-1.46) times greater after these laws were passed than prior to any changes in the GDL laws. However, the plea bargain ban took effect between these two time periods, and this increase in violations may be affected by that policy change.

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