

# EVALUATION OF GRADUATED DRIVER LICENSING IN NEW JERSEY: PHASE 1

FINAL REPORT  
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Submitted by

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16. Abstract  New Jersey started enforcing a graduated driver license (GDL) system on January 1, 2001. The system requires a three-step process for full licensing: learner's permit at 16 years of age at the earliest; provisional license at 17; and, a basic license at 18. This report is the first phase of an evaluation of the New Jersey GDL system. The number and types of traffic crashes, traffic violations, and license suspensions in New Jersey by age for the years immediately before 2001 were analyzed. The second phase will look at the same type of data after 2001 and will compare the results to the pre 2001 analysis to determine what the impact of GDL has been. The analysis of the pre-2001 data shows that 17 year olds have substantially more crashes and violations per 10,000 people compared to other drivers. A higher percentage of their crashes are single vehicle crashes. In addition, a much higher percent of their crashes are due to unsafe speed, and a higher percent of their crashes are due to inattention, and a failure to obey traffic control devices or yield right of way, compared to middle aged drivers. A higher percent of their violations are due to speeding than any other age group, and a higher percent are due to careless driving than for middle-aged drivers, but not for older drivers.			
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## **SUMMARY**

### **Background**

Many studies have shown that teenage drivers tend to have more traffic accidents than other age groups. This is particularly true for people in their first year of driving. In particular, they have a higher rate of accidents late at night and when driving with other teenagers in the car. One solution that has been tried in many jurisdictions is graduated driver licensing (GDL). GDL requires an intermediate phase for novice drivers before they have full driving privileges. During the extra phase, the novice driver's privileges are restricted, typically by not allowing them to drive between certain hours at night, not allowing them to carry passengers, or similar restrictions. A literature review of evaluations of GDL laws in 13 different jurisdictions has shown that all of them had at least some positive impact.

New Jersey has passed a GDL law that took effect on January 1, 2001. The New Jersey GDL requires three phases:

1. Special learner's permit for 16 year olds, during which the new driver must be supervised by an experienced driver over 21;
2. Provisional license for 17 year olds who have completed minimum of six months with a learner's permit, during which the new driver may not drive between Midnight and 5 AM and may not have more than one un-related passenger, unless supervised by a passenger over 21; and
3. Basic driver's license for 18 year olds who have completed the first two stages.

The New Jersey law requires an evaluation of the impact of the GDL system. This study is the first phase of the evaluation and is primarily an analysis of driving behavior by age before the enactment of the GDL law. Phase two will analyze driving behavior after the enactment of the law and will compare it to the pre-law analysis in order to determine the impact of the GDL system in New Jersey.

### **Data and Approach**

The study analyzed traffic crashes in New Jersey from 1993 to 2000, excepting 1996 and 1997, by the ages of the drivers that were involved in the crash, as well as traffic violations and license suspensions from 1996 to 1999. The crash data represent the police records and were provided by the New Jersey Department of Transportation (NJDOT). The violation and suspension data were provided by the NJ Division of Motor Vehicles. Because of incomplete and incompatible data, most of the analyses of crashes were based on the 1998 to 2000 crash data. Because a single crash may involve several drivers of differing ages, the unit of analysis was a driver involvement in a crash.

## Results

The analysis showed that teenage drivers in New Jersey experience the same high crash involvements as in other states. In fact, for the period 1998 to 2000, the numbers of involvements for 17 year olds were more than 50 percent higher than those for 22 year olds or any older group. The numbers of involvements for drivers 18 through 21 drop off rapidly with increase in age, but are still higher than for any older age group. This is true despite the likelihood that drivers in these age groups probably drive less than other ages.

The following are the crash characteristics that most distinguish the 17 year old or 17, 18, and 19 year old drivers from older cohorts:

- Higher percentage of crashes occur after dark
- More crashes occur on local roads
- Lower percent of crashes are fatal compared to older drivers, but higher percent are fatal or injury crashes than for the middle aged driver
- Lower percent occur during the AM commute peak period, but higher percent of fatal and injury crashes occur during early morning between 5:00 and 7:00 a.m.
- Much higher percent of crashes are single vehicle crashes
- For 17 year olds, higher percent of left-turn crashes than middle aged drivers (but not drivers over 75)
- Higher percent of crashes due to inattention than middle aged drivers
- Higher percent of crashes due to failure to obey traffic control devices or failure to yield than middle aged drivers
- Much higher percent of crashes due to unsafe speed
- Lower percent of crashes due to backing unsafely

The data included an “apparent contributing circumstance” for each vehicle/driver based on the judgment of the police officer. The circumstances that suggest the driver was at fault (e.g., unsafe speed) were summed, as were circumstances that do not suggest the driver’s fault (e.g., roadway defects), and the ratio of at-fault to not-at-fault circumstances was calculated. This “quasi-involvement” ratio was then plotted against driver age. The result was U-shaped with respect to age, indicating that the youngest and oldest drivers were more likely to be at fault than middle-aged drivers.

Suspension rates for the 17 through 21 year old drivers were considerably higher than those for 45 through 85 years, although the 17 year olds had the lowest suspension rates among the 21 and younger age groups, and the 19 year olds had the highest. The most common reason for suspension for 17 and 18 year olds was failure to complete a probationary program, and for the 19, 20 and 21 year olds, it was persistent violations.

The rate of traffic violations per person for the 17 through 21 year olds is more than twice as high as for middle aged or older driver. The 18 year olds have the highest rate. The most common reason for violations among the 17 through 21 year olds is speeding.

However, speeding is the most common cause for all age groups up to 75 years old. The type of violation that most distinguish the younger drivers from middle aged drivers was careless driving; almost 14 percent of violations among the 17 year olds were for careless driving, while 6 to 7 percent of middle aged drivers' violations were for careless driving.

## **Conclusions**

None of the characteristics of young drivers in New Jersey were significantly different from what has been documented in the literature. The New Jersey provisional license under GDL restricts novice drivers from driving between midnight and 5 a.m., and places a restriction on carrying passengers who are not household members. The data do not allow the study of crashes with and without passengers, but in phase 2, the crash rate for young drivers and the percent of crashes after dark and between the hours of midnight to 5 AM along with other characteristics will be compared to the phase one results.

## 1. INTRODUCTION

Teenage drivers have extremely high crash rates due to immaturity and lack of driving experience. For people 15 to 20 years of age, motor vehicle crashes are the leading cause of death.<sup>(1)</sup> Sixteen year olds have the highest crash rate per licensed driver and per miles driven. Nighttime driving is especially hazardous for teenage drivers: 20 percent of their driving is done during the nighttime, whereas 50 percent of crashes occur at that time.<sup>(2)</sup> Crashes with teenage drivers are overwhelmingly single vehicle crashes, involve speeding, and involve one or more passengers, often other teenagers.<sup>(2,3)</sup>

Formal driver education has been presented as a means of reducing the crash propensity of teenage and novice drivers. The goal of driver education is to provide student drivers with the knowledge and skills necessary to safely and efficiently operate a motor vehicle. Some have argued that lack of emphasis on driver education<sup>1</sup> has resulted in increased crash propensity of novice drivers. However, Williams<sup>(4)</sup>, indicates that “driver education programs in the United States that have been scientifically evaluated have not been shown to be associated with crash reductions”. This is because crashes involving novice drivers are not always due to poor skill. They are also due to attitudes and decision-making skills which driver education alone does not address effectively. In addition, in some cases, driver education has encouraged early licensure among teenagers leading to an increase in the number of crashes.<sup>(5)</sup>

Graduated driver licensing (GDL) has been proposed as one way to reduce the involvement of teenage drivers in crashes.<sup>(6)</sup> Although GDL was initially discussed in the 1970's,<sup>(2)</sup> it has become more popular in this country in the last five years. The main objectives of GDL are to provide young novice drivers with “practice in developing driving skills over an extended period of time, and increased time in supervised behind-the-wheel training during daylight and nighttime hours.”<sup>(1)</sup> Typically, there are three stages in GDL: learner's permit (stage 1), intermediate license (stage 2), and full or unrestricted license (stage 3). During stage 1, basic driver education is provided and supervision is required at all times. If there are no crashes or convictions during this period, the learner is allowed to advance to stage 2. Stage 2 has fewer restrictions, such as unsupervised driving during day light hours. However, there may be other restrictions, e.g., a nighttime curfew, restrictions on the number and characteristics of passengers and types of roads.<sup>(7)</sup> If the driver does not have any convictions or crashes during stage 2 and passes a road test, he / she is given a full or unrestricted license.

Based on research of the effectiveness of different types of driver restrictions, Williams<sup>(8)</sup> has proposed the following ten components that should be part of a graduated licensing system:

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<sup>1</sup> It has been estimated that the “number of high schools offering on the road training has fallen by about half since 1975.” (See Wald.<sup>(9)</sup>)

1. Limit driving by all 16 and 17 year olds. Essentially, this implies that drivers younger than 18 should not be given a full unrestricted license.
2. Don't lower the learner's permit age. In some states, with the introduction of GDL, the permit age was lowered to give more time for supervised driving. However, Williams<sup>(8)</sup> argues that lowering the permit age may encourage unsupervised driving and early exits from graduated licensing.
3. Require beginners to hold learner's permits for six months or more. This will encourage more learning under supervision.
4. Involve parents (or guardians) in the learning process. This will ensure that driving is done with active supervision.
5. Be sure a night driving curfew is part of the program. As discussed earlier, young novice drivers are over-represented in nighttime crashes and a nighttime curfew would reduce crash propensity. Foss<sup>(10)</sup> feels that the curfew should start at 10 p.m. instead of midnight as some states have proposed.
6. Set alcohol tolerance at zero for drivers younger than 21. Most states and jurisdictions already have this restriction in place.
7. Restrict teenage passengers in vehicles with unsupervised beginners. Recent work by Chen, Baker, Braver, and Li<sup>(11)</sup> has indicated that the presence of passengers can increase the crash propensity of novice drivers probably due to peer pressure. Fewer passengers can also mean the reduction of injuries and fatalities in case of a severe crash.
8. Consider prohibiting beginners on high-speed roads. This restriction is not present in most GDL and other driving restriction programs. However, Williams<sup>(8)</sup> based on his review of other research found that "two-thirds of the fatal crashes of 15 year old learning drivers under supervision occur on high speed highways including interstates".
9. Emphasize belt use. It is well documented that seat belts can reduce injuries in the case of severe crashes. Belt use has been found to be the lowest among teenagers, at least in the U.S.<sup>(12)</sup>
10. Don't rely on driver education. As discussed earlier, driver education alone has not been very effective. Williams<sup>(8)</sup> feels that driver education can be included in a GDL program as long as it does not allow teens to graduate faster. Some have recommended a two-stage education program – an initial course to teach basic skills and another course later to teach and encourage safe driving skills.<sup>(13)</sup>

According to the Insurance Institute for Highway Safety, forty North American jurisdictions (34 U.S. states, the District of Columbia, four Canadian provinces, and one

Canadian territory) have passed legislation to implement a three-stage GDL program<sup>2</sup>. Other jurisdictions have enacted only parts of the recommended GDL program. In addition, some states do not allow their police to stop young drivers solely for night driving violations or passenger restrictions.

### **Graduated licensing in New Jersey**

Before the implementation of GDL in New Jersey, “learner permits were available at age 16 if they were enrolled in driver education. Until the completion of the class, they had to be accompanied by a driver education instructor. Drivers with learner permits were not allowed to drive between 12:01 a.m. and 5:00 a.m. Those who waited until age 17 to apply for a learner’s permit had to be accompanied by a licensed driver with 3 years of experience and the permit must be held for 20 days. Permits issued to applications age 17 and older were valid for 90 days. A full unrestricted license was available at age 17.”<sup>(15)</sup>

New Jersey’s GDL became effective on January 1, 2001 and includes two or three stages for getting a basic driver’s license, depending on the age of the driver.<sup>3</sup> Both processes require a vision test and a written test before any permits or licenses are issued.

Sixteen-year-old drivers follow a three-stage process to get a driver’s license:

- Stage 1 (Special learner’s permit). This may be issued to a person over 16 years of age. He/she is required to take an approved behind-the-wheel driving education course. All driving must be supervised by a New Jersey licensed driver who is at least 21 years of age with a minimum of three years of experience and who supervises from the front passenger seat. Driving is prohibited between 11:01 p.m. and 5:00 a.m. Passengers are limited to one person plus anyone sharing the same residence (in addition to the supervising driver).
- Stage 2 (Provisional license). Teens 17 years or older who have successfully completed the learner permit stage with a minimum of six months of supervised driving experience can get a provisional license after passing a road test under low-risk conditions. During this stage, driving is prohibited between 12:01 a.m. and 5 a.m. except for work or religious reasons<sup>4</sup>. If the driver is at least 21 years of age, hour restrictions do not apply. Passengers are limited to one person, plus anyone sharing the same residence. If the provisional license holder or any passenger is 21 or older, passenger restrictions do not apply. Drivers have to complete a minimum of one year of unsupervised driving in this stage.

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<sup>2</sup> This information is correct as of October 2001 and can be found at the IIHS website.<sup>(14)</sup>

<sup>3</sup> See the New Jersey Motor Vehicle Services website.<sup>(16)</sup> Recently, the research team was informed that there have been some changes to the GDL law in New Jersey, and is in the process of reviewing these changes.

<sup>4</sup> Drivers are required to carry a letter from their employer or religious organization indicating such a need.

- Stage 3 (Basic driver's license). Drivers over 18 who successfully complete the provisional licensing stage can get a basic driver's license.

Seventeen years old drivers can follow a two-step process to get a driver's license:

- Stage 1 (Examination permit). Drivers over 17 can get an examination permit. During the first step of this stage, permit holders must have a supervising driver in the front seat for the first 6 months if permit holder is under 21, and for 3 months if the permit holder is 21 or older. Supervising driver must be at least 21 years of age with a minimum of 3 years of driving experience. Following this step, they should pass a road test that will lead them to the next step, i.e., driving unsupervised. Permit holders may drive unsupervised for 6 months if they are under 21, and 9 months if they are 21 or older. Permit holders may not drive from 12:01 a.m. to 5:00 a.m. except with a written waiver from employer or religious authority. Restrictions do not apply if permit holder is 21 or older. Passengers are limited to one person plus anyone sharing the same residence. If permit holder or passenger is 21 or older, passenger restrictions do not apply.
- Stage 2 (Basic driver's license). Drivers over 18 who successfully complete the examination permit stage can get a basic driver's license.

The Insurance Institute for Highway Safety has rated the young driver licensing laws of all the 50 states and the District of Columbia, as Good, Acceptable, Marginal, or Poor. New Jersey is one of nine jurisdictions that were rated as having a Good young driver licensing law<sup>5</sup>.

### **Objectives of this Study**

Accidents result in tremendous costs to society. Graduated licensing is an expensive effort that has been instituted with the intention to reduce the crash propensity of teenage drivers. The overall objective of this study is to verify if GDL is indeed effective in its purpose, and thus is beneficial to New Jersey citizens. Evaluation is also required under the law (PL 1998 Ch 108 c.39:3 -13.6 Evaluation).

This study will be conducted in two phases. This report describes the activities completed in Phase 1. Phase 2 will begin when crash and violation data are available for at least 1 year after the implementation of GDL.

Phase 1 involved the following tasks:

1. Literature Review. This task included two activities: (i) a detailed review of literature on driver behavior and safety characteristics of young and novice drivers (presented in Appendix A), (ii) a review of results from other states and

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<sup>5</sup> This is correct as of October 2001, and can be obtained at the IIHS website.<sup>(17)</sup>

countries that have implemented GDL and other driver restriction programs (presented in Section 2).

2. Methods to Assess the Effectiveness of GDL. This task developed the approach that will be followed in Phase 2 to evaluate the effectiveness of graduated driver licensing in New Jersey. The advantages and disadvantages of different approaches have been identified. A summary is presented in Section 3.
3. Characteristics of crashes. This task utilized data on crashes and violations in New Jersey to study the characteristics of crashes involving young drivers compared to middle aged and older drivers. Crash variables such as time of day, weather, lighting, driver action, and contributing circumstances, were included. Types of violation included speeding, failure to yield, and effect of alcohol. The results of this analysis are presented in Section 4.

Phase 2 will be undertaken in 2002 or 2003 and will compare crash and violation data after GDL with crash and violation data pre-GDL by using the methodologies presented in Section 3 of this report.

## 2. EFFECTIVENESS OF GDL AND OTHER DRIVER RESTRICTION PROGRAMS

The GDL concept was introduced in the 1970's and 1980's through provisional licensing and demonstration programs in Maryland, California, and Oregon. These systems were not three-phase GDL programs but did include some of the features. New Zealand is credited with having implemented the first 3-phase GDL program in 1987. Ontario, Canada, implemented a 3-phase GDL program in April 1994. Florida was the first State in this country to implement a 3-phase GDL program in 1996. Some programs (e.g., Nova Scotia and Florida) have been evaluated in depth and detailed published results are available on changes in crash propensity as well as the behavior and opinion of parents and teenagers about the program. For some of the programs, only a brief outline of the results has been published. This section presents descriptions of thirteen programs implemented in other states and countries in chronological order along with published results about their effectiveness.

### **Maryland**

Maryland instituted a provisional licensing program in January 1979.<sup>(18)</sup> Under this program, applicants got a learner's permit at not less than 15 years and 9 months of age. The learner's permit was valid for 3 months and supervision was required at all times by a licensed driver who was at least 21 years old. If a driver was at least 16 years of age, a provisional license could be issued provided the learner's permit had been in effect for at least 14 days, and the applicant has successfully completed driver education and passed an on-road performance test. With a provisional license, a driver cannot drive between 1:00 a.m. and 6:00 a.m. unless accompanied by an adult. When a driver reaches his/her 18<sup>th</sup> birthday or after six months of conviction-free driving have been accumulated with a provisional license, the driver may apply for a regular license.

To study the effectiveness of the provisional licensing program, monthly crash data from 1975 to 1982 were analyzed using time series analysis. Surprisingly, results indicated that the nighttime restriction failed to reduce accidents during the hours of restriction. However, the program produced an estimated 10 percent reduction in convictions and a possible 5 percent reduction in (daytime) accidents among drivers operating on provisional licenses. The authors of this study indicate that the oil crisis may have affected the driving patterns of young and old drivers differently, and probably was a confounding factor.

### **California (provisional licensing demonstration program)**

On October 1, 1983, California implemented a 'provisional licensing' demonstration program for novice drivers under 18.<sup>(19)</sup> Under the program, drivers licensed at 16 or 17 years of age are required to complete "additional parent-supervised practice, wait longer after failing a written or drive test before retesting, and are subject to post-licensing control actions at lower negligent-operator point counts".

To assess the effectiveness of the provisional licensing program, time series analysis was conducted using monthly data from 1979 until 1986. Accident rates were calculated by dividing the number of crashes by the population of that particular age group. Provisional licensing was associated with a statistically significant reduction in the rate of total accidents among 15 through 17 year olds statewide. The estimated reduction was 5.3 percent of their average rate before the program, representing a net savings of 2,436 accidents per year.

## **Oregon**

Oregon implemented a provisional licensing program on October 3, 1989, imposing a set of special requirements for obtaining and keeping a drivers license for drivers younger than 18.<sup>(20)</sup> The testing elements of the program consisted of a knowledge test about safe driving practices and a 28-day waiting period between attempts for drivers who fail the road test. The provisional driver-improvement program was similar to a program that applied to all Oregon drivers. The main difference is that progressive driver-improvement actions are taken on the basis of fewer convictions for the younger drivers.

Two groups of drivers were compared to assess the effectiveness of the provisional licensing program. The treatment (provisional) group consisted of 16 and 17 year old drivers who passed a road test in October and November of 1989. The control group consisted of teenage drivers in the same age group who passed a road test in August and September 1989 and were issued a non-provisional license.

Males with provisional licenses had approximately 16% fewer accidents in their first year of driving than male drivers with non-provisional licenses. However, no differences were evident for female licensees, and no differences in traffic violations were evident for either sex.

## **New Zealand**

New Zealand introduced a graduated driver licensing system on August 1, 1987.<sup>(21)</sup> Prior to GDL, a full license could be applied for at 15 years of age, and involved passing a written, oral, and practical driving test. With the introduction of GDL, a three stage process was introduced: learner license, restricted license, and full license. The learner license can be applied for at 15 years of age and involves passing a written, oral, and eyesight test. With this license, the young driver has to be accompanied at all times by a supervisor. This learner license is held for six months, but the time can be reduced to three months if the learner earns a certificate of competency from a driving instructor. To obtain the second type of license, called a restricted license, a practical driving test must be passed. There are three main conditions to the restricted license: no driving between 10 p.m. and 5 a.m. unless accompanied by a supervisor, and no carrying of passengers unless accompanied by a supervisor. The restricted license is held for 18 months, but the time can be reduced to nine months by completing a defensive driving

course or an advanced driving course. After completing the restricted licensing stage, a full license can be applied for. Violations of the GDL conditions are penalized of up to six months additional time under the learner or restricted license.

To study the effectiveness of the new driving program, crash data from New Zealand Health Information Services (HIS) national hospital morbidity data files from 1979 to 1992 were included. For this study, cases were restricted to discharges from public hospitals. Victims were divided into three groups: 15-19 year olds, 20-24 year olds, and 25 years of age and older.

The introduction of GDL was closely followed by a substantial reduction in crash injuries among all ages: 15-19 year age group (23%), 20-24 year olds (12 percent), and 25 years and older (16 percent). The authors argued that the reductions in the 20 years and older age groups suggested that “factors other than the GDL were operating to reduce crashes for all ages, and that the reduction associated with the introduction of GDL among the 15-19 year age group was likely to be significantly less than 23 percent”. They felt that the reduction in injuries to the youngest age group due to GDL could be between 7 percent (23 percent – 16 percent) and 23 percent.

Time series data on licensing found a reduction in the number of licensed drivers over time indicating that the reduction in injuries among the youngest age group may have been partly due to the overall reduction in exposure.

### **Ontario, Canada**

Ontario introduced a GDL on April 1, 1994.<sup>(22)</sup> Drivers have to be at least 16 to enter the first stage, which lasts 12 months but can be reduced to eight months by completing an approved driver education course. During this stage, supervision is required by a fully licensed driver who has at least four years of experience. In addition, the number of passengers should not exceed the operable seat belts in the rear seats. There is a midnight to 5:00 a.m. curfew, and first stage drivers are not allowed to drive on freeways and urban expressways. Drivers can enter the second stage by successfully completing a basic on-road examination of operating skill. Supervision is not required in the second stage.

To assess the effectiveness of GDL, the crash histories of the 1993 and 1995 novice driver populations were compared. The collision rates calculated for 1993 novice drivers included all collisions occurring in 1993 and 1994 involving drivers who became novice drivers in 1993 (that is, pre-GDL). The collision rates calculated for 1995 novice drivers include all collisions occurring in 1995 and 1996 involving drivers who became novice drivers in 1995 or post-GDL. Collision rates for 1995 novice drivers were 31 percent lower than the rate of 1993 novice drivers. For male drivers, rates were 29 percent lower; for female drivers the rate was 36 percent lower. Over the same time period, only a 4 percent drop was observed for the general driving population.

## **Nova Scotia, Canada**

Nova Scotia introduced a graduated driver licensing program in October 1994.<sup>(23)</sup> This program applies to all novice drivers, regardless of their age, and spans 30 months in two stages: a 6-month learner phase (LP) followed by a 24-month newly licensed driver phase (NDLP). During the LP, supervision is required by an experienced driver, and no other passengers are allowed. The LP can be reduced to three months if the novice completes a recognized driver education or training course.

To enter the NDLP phase, the learner must pass a road test. During NDLP, there is a night driving restriction in which unsupervised driving is not permitted between midnight and 5 a.m., only one front-seat passenger is allowed, and the number of rear-seat passengers is limited to the number of available seat belts. To graduate from the NLDP phase, the novice must complete a 6-hour defensive driving course or a recognized driver-training course, but no time discount is given for doing so. License suspensions during either the LP or NLDP delay graduation to the next stage by the minimum time required in that stage.

Before GDL, the novice held the learner's license for only 60 days, and no restrictions applied during the subsequent probationary phase.

To study the effectiveness of the program, two groups of novice drivers were selected. The first group included drivers licensed for the first time before October 1994, and the second group was drivers licensed after October 1994. The number of crashes per 10,000 population for the two groups were compared. In addition, monthly crash data for 16-year-old drivers were examined for an extended period – from January 1986, before the program was implemented, through December 1997, more than 3 years after its implementation.

The internal control group involved drivers aged 25 and older who would be largely unaffected by the graduated licensing program. The external control groups came from three jurisdictions without graduated licensing: New Brunswick and Saskatchewan in Canada, and the State of Maine, USA.

Crash ratios were calculated by dividing the crash rate for the target group by the crash rate for drivers ages 25 and older. Among the 16-year-old drivers in Nova Scotia, there was a 23.8% decrease in crash ratio and a 33.9% decrease in the injury ratio between 1993 and 1995; these changes were statistically significant. In contrast, no significant declines in crash ratios occurred in the comparison jurisdictions. Among 17-year old drivers in Nova Scotia, no significant decreases in crash ratios were detected.

The analyses were repeated for 16 and 17 year old drivers in Nova Scotia, comparing their crash ratios in 1993 with those in 1995 and 1996. This showed a further decline in the crash ratios for 16 year old drivers in 1996, the second year of the program, i.e., from a crash ratio of 1.62 in 1993 to 1.23 in 1995 and 1.04 in 1996. This represented a statistically significant 35.8 percent decline in the overall crash ratio for 16 year olds

between 1993 and 1996, and a 48.1 percent decrease in their injury crash ratio from 1993 to 1996. There was also a significant decline during this period in crash ratios for 17 year old drivers in Nova Scotia; they experienced an 11 percent decline in their overall crash ratio and a 17 percent decline in injury crash ratio.

The time series analysis revealed significant reductions in total crashes and injury crashes among 16-year-old drivers, after implementation of GDL. There was a significant abrupt change of 6.59 crashes per month following implementation. There was also an even larger, gradual permanent change representing an average decrease of 19.57 crashes per month, and 6.83 injury crashes per month.

Since the Nova Scotia program focuses on all novice drivers, further analysis looked at all novice drivers. There was a significant reduction in crash rates for novice drivers in all age groups, not just 16-year-old drivers. The greatest improvement was actually observed for novice drivers ages 25 and older. Their crash rate dropped by 42.7 percent, from 875 in 1993 to 501.8 in 1995. The reduction for 16-year-old novices was very comparable with that for novices aged 17 to 24, i.e., decreases of 21.7 percent and 21.0 percent, respectively.

#### Survey of Parents and Teenagers

Telephone interviews were conducted in the province of Nova Scotia during the spring of 1996 with 450 novice drivers age 16 to 18.<sup>(24)</sup> In addition, telephone interviews with 500 parents of teenagers ages 16 to 18 were conducted during the summer and fall of 1996. The teenagers and parents interviewed were not from the same households because of the sensitive nature of some of the questions.

Among parents of teenagers in the LP stage, 87 percent approved and 3 percent disapproved of the GDL system. Among parents of teenagers in the NDLP stage, 92 percent approved of the system.

Teenagers were less enthusiastic about graduated licensing, but the majority approved the program. 61 percent of teenagers in the LP stage and 67 percent of teenagers in the NDLP stage approved the program.

97 percent of parents agreed with the supervision requirement. Among parents of LP drivers, 86 percent agreed with the night restriction and the passenger restriction, and 82 percent agreed with the defensive driving requirement.

66 percent of learners agreed with the requirements for supervision and no other passengers. However, relatively few newly licensed drivers supported the night restriction (only 28 percent strongly agreed or agreed with it).

## Florida

On July 1, 1996, Florida instituted a graduated licensing program for drivers younger than 18.<sup>(25)</sup> Prior to the graduated licensing law, 15 year olds in Florida could obtain a restricted license that allowed driving when accompanied by a licensed driver at least 18 years old. Drivers age 15 to 15 1/2 were allowed to drive during daylight hours only, but drivers older than 15 1/2 year were not restricted. Unrestricted licenses could be obtained at age 16.

With GDL, the requirement to hold a learner's license for six months applies to all 15, 16, and 17 year olds seeking licensure. Holders of learner's permit were initially prohibited from driving between 7 p.m. and 6 a.m. Amendments that took effect July 1, 1997, allow supervised driving until 10 p.m. for those who have held the learner's license for three months. Sixteen year olds now are restricted from driving between 11 p.m. and 6 a.m., and 17 year olds are restricted from driving between 1 a.m. and 5 a.m., unless supervised. The greater effects of points for moving violation convictions applies to 15 through 17 year olds.

Crash rates based on the number of fatal and injury crash-involved drivers per 10,000 population were calculated for 1995-1997. Crash ratios were then derived by dividing the crash rate for the teenagers by the rate for the 25-54 year old drivers, employed as a reference group. Alabama, a neighboring state without a three-stage GDL program, was included as an external control group.

Results indicated statistically significant declines in the crash ratios for 15, 16, and 17 year olds but not for 18 year olds. Overall, the reduction for 15-17 year olds was 9 percent. The reduction was greatest among 15 year olds, down 19 percent, with an 11 percent decline for 16 year olds and 7 percent decline for 17 year olds. There were no significant changes for drivers in any age group in Alabama.

There was a 29 percent increase in learner's licenses issued to 15 year olds in 1997 compared to 1995. During the same time period, there was a 14 percent increase in licenses issued to 16 year olds. This indicates that the reduction in the crashes of the young drivers was not due to a reduction in the number of licenses.

### Survey of the Driving Behavior of Teenagers

High school juniors and seniors in Fall 1996 and Fall 1998 were asked to complete a two-page self-administered survey to examine the effects of the graduated licensing law on learning to drive, licensing, driving experiences, and attitudes.<sup>(26)</sup>

Overall, the results of the survey revealed that young drivers were spending more time on the road under supervision. Specifically, the distribution of reported number of miles driven with a permit changed significantly from 1996 to 1998. The percentage who estimated that they drove 100 miles or less declined from 26% to 20%, whereas the percentage who reported driving more than 500 miles increased from 33% to 38%.

Increases also occurred in the percentage of teenagers who reported some practice driving with either a supervisor or alone. There was also a decrease in the percentage of licensed drivers who reported no practice driving or less than 20 hours of practice driving with a parent or guardian, and an increase in the percentages with 20-49 hours and 50 hours or more.

The percentage of licensed teenagers who reported being involved in a crash declined from 30% to 27%. The percentage of licensed drivers who reported that they had ever driven after drinking decreased from 24% in 1996 to 20% in 1998. The percentage who reported that they had ever ridden with friends who had been drinking also declined, from 41% in 1996 to 37% in 1998.

## **Connecticut**

On January 1, 1997, Connecticut modified its licensing requirements for 16 and 17-year olds by adopting one component of graduated licensing: a mandatory learner's permit, which novice drivers are required to hold for six months (or four months with driver's education).<sup>(27)</sup> With the learner's permit, only supervised driving is permitted, and driving on limited access highways is prohibited for the first 90 days of the permit period. Prior to January 1, 1997, 16 or 17 year olds seeking to obtain a driver's license were only required to have a home training or driving school certificate, involving a 5-hour course of study on safe driving practices and a minimum of six hours of behind-the-wheel instruction.

Crash rates based on the number of fatal and injury crash-involved drivers per 10,000 population were calculated for 16, 17, and 18 year olds in 1996 and 1997. Crash ratios then were formed by dividing the crash rate for each of these age groups by the rate for 25-54 year olds, used as a reference group. Similar ratios were also calculated for six New York counties (Dutchess, Orange, Putnam, Rockland, Ulster, and Westchester) that lie immediately to the west of Connecticut.

Results revealed that from 1996 to 1997, crash rate ratios (for injury and fatal crashes) declined by almost 22 percent, a statistically significant change. Crashes in January 1997 were 60 percent higher than in January 1996. The authors of the study felt that this was possibly brought about by a rush to license among 16 year olds just before the new system was implemented. Crash involvements in February and March 1997 were about equal to those a year earlier and then fell sharply for each of the remaining months of the year.

During the same time period, the crash rate ratio for 16 year old drivers in the New York counties also declined, but the difference was not statistically significant. Ratios for 17 and 18 year olds in Connecticut and New York did not change significantly.

## **Kentucky**

Kentucky's GDL program was implemented in 1996.<sup>(28)</sup> This program includes a restriction on driving after midnight during the six-month learning permit stage and a six-point limit on traffic violations up to age 18. In addition, there is a requirement for a four-hour driving safety education class. There are no special limits on the number and age of passengers for teen drivers. When this report was published, the authors indicated that there is no intermediate (or provisional) license stage as in other states with a three-stage GDL program.

Three years of crash data before implementation of GDL (1993-1995) were compared with three years after implementation of GDL (1997-1999). Results indicated a 32% decrease in the crash rate involving 16-year-old drivers from pre-GDL (1993-1995 average) to post-GDL (1997-1999); and a 5% increase in the crash rate for 17-year-old drivers. However, there was a difference between drivers age 16 to 16 1/2 vs. drivers age 16 1/2 to 17. The latter age group (age 16 1/2 to 17) had a 3% increase in the number of crashes post-GDL. During the same time period, there was an 8.6% increase in total motor vehicle crashes for 17 year old drivers, a 7.1% increase in total motor vehicle crashes for 19 year old drivers, and 3.2% increase in total motor vehicle crashes in the 'drivers over 19 years old' age group.

Total motor vehicle crashes per 1000 drivers were examined over a three-year period for both a pre-GDL age cohort group (age 16 in 1994) and for a post-GDL age cohort group (at age 16 in 1997). Despite a lower crash rate initially (at age 16), the crash rate for the post-GDL age group surpassed the pre-GDL crash rate in the second year (at age 17) and third year (at age 18). Based on these results, the authors suggested a need for increasing restrictions on teen drivers who have completed the permit stage (age 16 1/2 to 17), ensuring that they received adequate driving instruction and experience.

## **Michigan**

Michigan implemented a new graduated licensing program for young novice drivers in April 1997.<sup>(29)</sup> Apparently, this was the first U.S. program that required that a responsible adult provide extended supervised practice and certify that such practice was provided before the young driver could be licensed to drive without adult supervision. The responsible adult, usually a parent or guardian, is required to provide a minimum of 50 hours of supervision, including at least 10 hours at night. In addition, unsupervised driving during the hours of midnight to 5 a.m. is postponed until at least age 17, and longer if a clean record has not been maintained for a sufficient length of time. Graduation to the next highest level of licensure (level 2) may be postponed until the young driver has maintained a conviction-free record for a specified period of time. Currently, Michigan does not have a passenger restriction.

To assess the effectiveness of the program, data from one full year before the implementation of GDL, 1996, was compared with two full years following its

implementation, 1998 and 1999. In addition, comparisons were made between crashes of 16 year old drivers and crashes of drivers 25 years or older. Crash rates were calculated by dividing the number of crashes by the population of that particular age group. Crash ratios were calculated by dividing the rates of 16 year old drivers by the rates for 25 years and older.

Results indicated that the risk of being involved in a motor vehicle crash in 1999 was 25% lower than in 1996 for 16 year olds, a statistically significant difference. Nighttime crashes decreased by a larger amount (53%) compared to day crashes (24%).

Some reduction in crashes could be explained by teens delaying GDL licensure. Indeed, Michigan experienced a 22% decrease in the statewide proportion of 16 year olds licensed to drive independently. Reductions in crashes, however, exceeded that decrease, especially in the case of nighttime crashes.

### Survey of Parental Views

A survey was conducted of parents (or other certified supervisors) of novice drivers under age 18 applying for Level 2 licensure that would allow unsupervised driving except during the night curfew.<sup>(30)</sup> The survey was administered over a one-week period in July 1998, when many young drivers were seeking Level 2 licensure. The total number of useable surveys was 814.

Nearly all parents (97%) expressed approval of the graduated licensing program in Michigan, which is consistent with results from previous studies of parental views of graduated licensing programs. Surprisingly, parents reported supervising the driving practice of their sons and daughters an average of 75 hours, far above the state's required 50 hours. Similarly, parents also reported supervising the students' practice an average period of nearly 30 weeks, which is slightly longer than the 24 weeks established by the state as the minimum time over which supervised practice must occur.

### **North Carolina**

The North Carolina GDL system, implemented December 1, 1997, requires beginning drivers who are at least 15 years old and younger than 18 years to hold level 1 licenses, which allow driving only while supervised by a designated adult for a full year.<sup>(31)</sup> After completing the final six months of level 1 licensure with no traffic violations and passing road test, a driver may move to level 2 licensure that allows unsupervised driving from 5 a.m. to 9 p.m., and supervised driving at any time. On completion of at least six continuous months at this level with no traffic violations, drivers graduate to a full, unrestricted license. Before GDL, persons 15 years or older could begin driving if supervised and persons 16 years or older could begin with no supervision and with no practice besides that obtained during driver education.

To study the effectiveness of GDL, crash data for 16 year old drivers from December 1, 1998 through November 30, 1999 (referred to as 1999) were compared to data for 16 year olds from 1996 and 1997 (December 1, 1995, through November 30, 1997). Poisson regression analysis was used to test for the predicted decrease in crash involvements for 16 year old drivers. The regression equation included classification variables for the year the crash occurred (1996, 1997, and 1999), number of licensed drivers, and the age group of the driver (16 years and 25-54 years).

Overall, crash rates for 16 year olds increased slightly from 1111 (per 10,000 population) in 1996 to 1181 in 1997, then declined substantially, following implementation of GDL, to 855 in 1999. Sixteen year olds were 23% less likely to experience a crash in 1999 than in 1996. Sixteen year old fatal crash involvement was reduced by more than half in 1999 compared with either 1996 or 1997, whereas involvement in nonfatal injury crashes declined by 28% (1999 vs. 1996) to 32% (1999 vs. 1997) and non-injury crashes decreased by 23% (1999 vs. 1996) to 27% (1999 vs. 1997). For the 25-54 years age group, crashes increased by 5.6% after adjusting for changes in population.

The study also found an increase in licensing among young drivers during the last few months of 1997 because teens rushed to become licensed before GDL took place.

### Opinions of Teens and Parents

During Spring 1999, telephone interviews were conducted with 600 teens and 600 parents. 96% of parents highly approved or somewhat approved graduated licensing.<sup>(32)</sup> 86% of urban/suburban parents and 83% of rural parents felt that the requirement of 12 months supervised driving was 'about right'. More than 80% of parents agreed or strongly agreed with the nighttime driving restriction for the first six months with a level 2 driver's license. 97% of parents agreed or strongly agreed with the requirement to maintain six months of ticket free driving. More than 90% of parents found it to be either very easy or moderately easy to find time to supervise their son or daughter's driving.

### **California (3 stage GDL)**

California implemented a three-stage GDL program in July 1998 including nighttime and passenger restrictions.<sup>(33)</sup> The GDL rules apply only to drivers younger than 18. Learner permits can be issued for people who are 15 years old; intermediate licenses can be issued for 16 year olds; and a full-privilege license at 17. The learner permit has to be held for at least six months. During this period, parents have to certify that their son or daughter has driven at least 50 hours under supervision including 10 hours at night. There is also a curfew from midnight to 5 a.m. unless an adult age 25 or older is present. No passengers younger than 20 are allowed during the intermediate period unless a person 25 years or older is also present in the vehicle. Before this GDL program, learner permits could be obtained at 15, but had to be held only for 30 days, and full driving privileges were available at 16.

Preliminary results from this program indicate that in 1999, “teenage passenger deaths and injuries when traveling with 16 year old drivers declined by 23% compared with the 5 prior years.”<sup>(34)</sup> The GDL system was also overwhelmingly supported by the parents: “among parents whose children were subject to the new requirements, 79% were strongly in favor of the new system and only 4% were neutral were opposed. Most teenagers approved the new permit rules, and the majority of teenagers favored the night restriction, but only about one-third endorsed the passenger restriction.”<sup>(33)</sup>

## Ohio

Ohio’s graduated driver license law became effective on January 1, 1999.<sup>(35)</sup> Under the law, driver license holders under age 17 must be supervised by a parent or guardian. If the permit holder is under 18, the permit has to be held for at least six months. The GDL system also requires 50 hours of driving (ten at night) with a parent or guardian, in addition to driver training.

Crash data for pre-GDL and post-GDL groups were compared in order to assess the effectiveness of the program. The pre-GDL group consisted of drivers aged 16 and 17 in the years 1996 and 1997. The post-GDL group consisted of drivers who were 15 1/2 years old on or after July 1, 1998, thus eligible for a driver license on or after January 1, 1999, and who received their license under the new GDL law. Crash rates were calculated by dividing the number of crashes by population for that age group.

The crash involvement rate of the post-GDL group was 23% less than that of their pre-GDL counterparts; the at-fault crash rate of the post-GDL group was 1% less than the pre-GDL group. The involvement fatal crash rate of the post-GDL group was 24% less than that of their pre-GDL counterparts; and the at-fault fatal crash rates were 7% less than that of the pre-GDL group.

## Summary

Despite the differences in the programs and in the evaluation methods, *all thirteen of the GDL programs that were evaluated showed some improvement in at least one measure.* Overall, the results emphasize the importance of restrictions to driving at both the learner’s permit stage and the intermediate stage. In addition to the differences in the various programs, it is important to remember that New Jersey is one of the few States that required drivers to be at least 17 years old to get a license even *before* the implementation of GDL in 2001. Before GDL, many states allowed a full unrestricted license at age 16 or earlier. In fact, a study conducted in the mid nineties<sup>(50)</sup>, found that *crash involvement rates for 16-year- old drivers were lower in New Jersey* compared to New York, Connecticut, Pennsylvania, and Delaware. However, the study also found that the *involvement rate for 17 year olds was highest in New Jersey* among these states “possibly because of a high rate of licensure among 17 year olds in New Jersey and / or possibly because these individuals did not have much driving experience as their counterparts in other states many of whom where licensed at age 16”. Because of

the differences in program components, evaluation methods, and exogenous (and generally uncontrolled for) variables, it is difficult to speculate on the change in crash rates or other safety measures that could be expected from the New Jersey GDL program, although one could expect some reduction for the 17 year old drivers.

The evaluations that surveyed either parents or novice drivers concerning their views on the program show support in almost all cases. Parental approval is particularly strong, varying from 79 % to 98 % approval depending upon the program or specific restriction. The approval of the novice drivers less unanimous, but in only one case was it below 50%.

The rest of this report looks specifically at New Jersey. The next chapter discusses methods that may be used to evaluate the New Jersey GDL program. The fourth chapter analyzes the pre-GDL crash and violation data for New Jersey.

### **3. METHODS TO ASSESS EFFECTIVENESS OF GDL**

This section gives an overview of different analysis methods and data sources that can be used to evaluate the effectiveness of graduated driver licensing in New Jersey.

#### **Crash and Violation Data**

To assess the effectiveness of the GDL program, it is important to have accurate data on crashes and violations. Police reports are the most easily available source of data on reported crashes although their reliability has been questioned<sup>6</sup>. This study will utilize crash data from police reports provided by the New Jersey Department of Transportation (NJDOT). The research team obtained crash data from NJDOT for 1993, 1994, 1995, 1998, 1999, and 2000<sup>7</sup>. The variables extracted include traffic control devices, accident type, driver characteristics including date of birth and gender, data and time of collision, severity, environmental conditions, contributing factors, and presence of alcohol.

Data on violations and suspension orders for drivers age 16-21 and 40 and older were obtained from New Jersey Department of Motor Vehicle (NJDMV)'s driver history records for 1990 through 1994 and 1996 through 2000<sup>8</sup>. NJDMV records over 1600 different types of events in this database. Some of these events include information on type of violation and suspension. The research team identified a list of events that were extracted from these records. These events consisted of driving related violations and suspensions such as: speeding, reckless driving, failure to yield, disobeying a traffic control device, following too close, careless driving, driving under influence, failure to wear a seat belt, leaving scene of a crash, non-compliance with driver license / permit requirements, and other driving related violations and suspensions.

#### **Frequency and Rate of Crashes and Violations**

To determine the effectiveness of GDL in reducing crashes and violations, two types of measures will be considered: (i) frequency of crashes and violations, and (ii) crash and violation rates.

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<sup>6</sup> According to a study conducted in Indiana, certain variables such as vertical road character, accident severity, and road surface composition, may not be accurately reported in police reports. This conclusion was based on a detailed analysis of approximately 124 crashes. The study also found that the percentage of accidents reported was lower for less severe accidents. See Shinar, Treat, and McDonald<sup>(36)</sup> for more detail.

<sup>7</sup> Data were provided for 3 additional years also, i.e., 1991, 1992, and 1997. Data from 1991 and 1992 were not used since they were limited to certain types of roads only and hence not consistent with the other years. Regarding 1997, the research team was informed that some crash records may have been entered more than once in the computer data base. Hence, the research team decided not to use them. Data from 1996 are not available.

<sup>8</sup> Data for 1995 were also requested. However, data for the 16-21 age group in 1995, were not provided.

## Frequency of Crashes and Violations

In using this measure, the objective would be to ascertain if the GDL program has resulted in a reduction in the total number of crashes and violations involving teenagers and drivers. A similar comparison can also be made for injury and fatal crashes. One way to determine if the GDL program has been effective is to look at the percentage difference between the number of crashes and violations before the implementation of the program, with the number of crashes and violations after the implementation of the program. As discussed in Section 2, most GDL programs have seen a reduction in the number of crashes and fatalities, although the magnitude of reduction has ranged from 5% to 40%.

The number of crashes represent 'count data,' i.e., they can only be non-negative integers, and some researchers have proposed the use of poisson and negative binomial regression models to study the relationship between crashes and other variables.<sup>(37)</sup> Foss, Feaganes, and Rodgman<sup>(31)</sup> estimated poisson regression models to study the effectiveness of the GDL program in North Carolina.

Despite the usefulness of this measure, it is important to recognize that counts of total accidents do not reflect changes in exposure levels in different age groups due to GDL. This is especially important because GDL programs restrict the mobility of teenage drivers and may result in significant changes in driver behavior and their decision on when they would apply for their licenses. For example, in Nova Scotia, there was a dramatic increase in the number of individuals applying for their learner's licenses issued just before the introduction of GDL.<sup>(23)</sup> This was followed by a decrease in the number of individuals applying for their licenses just after the introduction of GDL. To account for driving patterns, one can either include exposure as an independent variable in a regression-type model, or calculate crash and violation rates. Issues associated with calculation of rates are discussed below.

## Crash and Violation Rates

Crash or violation rates are defined as the ratio of the number of crashes or violations to a measure of exposure. There has been considerable debate in the research community on what measures should be used to define exposure.<sup>(See references 38,39,40,41, and 42)</sup> Some popular examples include the number of miles driven, number of subject population, and number of licensed drivers. Some studies have also used a method called quasi-induced exposure that uses crash data as a surrogate for exposure. Following is a discussion of these examples and methods:

### *Number of Miles Driven*

This measure of exposure is often used in safety research. However, it is extremely difficult to obtain data on the number of miles driven by age. One possibility is to use data from the NPTS and ATS<sup>9</sup>. Data from the 1995 NPTS have been used to assess

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<sup>9</sup> NPTS – Nationwide Personal Transportation Survey; ATS – American Travel Survey.<sup>(43)</sup>

the risk of fatal crashes for 16 and 17 year old drivers associated with carrying passengers.<sup>(11)</sup> This analysis was conducted at the national level using crash data from the Fatality Analysis Reporting System (FARS) and the General Estimates System (GES). However, the sample size that was used in these surveys is not sufficient to estimate travel patterns at the state or city level.

### *Population*

This is a commonly used exposure measure in studies that have evaluated other GDL systems <sup>(See for example references 23 and 44)</sup> probably because this information is relatively easy to obtain. However, this measure does not account for the amount of driving or the number of people who are licensed in a particular age group.

### *Number of Licensed Drivers*

Most previous researchers have monitored the effect of GDL programs on the number of licensed drivers.<sup>(21,23,44)</sup> As discussed earlier, Nova Scotia found a reduction in the number of applications for licenses immediately after the introduction of GDL. However, there was 41.2% reduction in the number of crashes involving learners between 1993 (pre-GDL) and 1995 (post-GDL), which was higher than the 27% reduction in the number of learners between 1993 and 1995. Hence, the reduction in crashes was only partially due to the drop in the number of learners. Unlike Nova Scotia, Florida had an increase in the number of licenses issued during the period when GDL was implemented. From 1995 (pre-GDL) to 1997 (post-GDL), there was a 29% increase in the number of 15 year old learners and a 18% reduction in the number of fatal / injury crashes for these drivers. Similarly, during the same period, for 16 year olds, there was a 14% increase in the number of licensed drivers, and a 10% reduction in the number of fatal and injury crashes.

Based on preliminary information from NJDOT and NJDMV, it seems that New Jersey does not have a historical record of the number of licenses by age group. Hence, it will be difficult to use this variable as a measure of exposure.

### *Quasi-Induced Exposure*

The term 'quasi-induced exposure' was first used by Haight<sup>(45)</sup> and is based on an assumption that in most two-vehicle crashes, one driver is 'at-fault', or responsible for the crash, and the other driver is an 'innocent victim', or not responsible for the crash. It is further assumed that the innocent victims constitute a random sample of driver-vehicle combinations, and their number is directly proportional to that group's exposure. Using these assumptions, this method involves the calculation of a relative involvement ratio for a particular group of drivers. The ratio is defined as follows:

$$\text{Relative Involvement Ratio (Group A)} = \frac{D - \text{at} - \text{fault}}{D - \text{innocent}}$$

where,

'D-at-fault' represents the proportion of crashes in which drivers from group A are at-fault, and 'D-innocent' victim represents the proportion of crashes in which drivers from group A are innocent victims. If the relative involvement ratio for a particular group is equal to 1.0, it is inferred that this group causes crashes proportional to their presence on the road. If the ratio is greater than 1.0, this group is over-represented in crashes, and if the ratio is less than 1.0, it is under-represented in crashes. This ratio can be calculated for different groups of drivers for different types of crashes.

This method has had some popularity because it can be used to assess crash risk when conventional measures of exposure such as number of miles driven are not available. This method has been used to study problems of older drivers.<sup>(46, 47)</sup> However, there are several issues that need to be studied:

1. This method is not very useful to analyze two-vehicle crashes in which both drivers are at-fault or neither of them are at-fault. In addition, this method is not very useful in analyzing single vehicle crashes, which are over-represented in young driver records.
2. At least one study has briefly indicated that there may be a bias when the police officer assigns fault to one driver and innocence to the other.<sup>(48)</sup> For example, it is possible that the police officer may be biased against young or older drivers.
3. This method is based on the assumption that the innocent victims are directly proportional to the exposure for that particular group of drivers. A few studies have tried to address this question and have generally concluded that it is a reasonable assumption.<sup>(48, 49)</sup>
4. For this method to be useful, information should be recorded on the driver(s) that was (were) responsible for the crash. In the New Jersey crash report, the police officer records some information called 'Charge' for every driver involved in the crash. However, this information does not follow any coding scheme and is not usable. The crash report also includes a variable called 'apparent contributing circumstances' that is recorded based on the police officer's judgment on how the crash happened. The research team used this variable as a surrogate for responsibility (see the next section).

## **Comparison of Crash and Violation Rates**

To assess the effect of GDL on crashes and violations, two types of comparisons can be made: (i) direct before-after comparisons, and (ii) interrupted time series analysis. The first method involves the direct comparison of at least one year of data on crash and violation rates before implementation of GDL, with at least one year of data on crash and violation rates after implementation of GDL. The second method involves the analysis of trends in crash and violations rates over the past 10 years.

## Before-After Comparisons

To make a valid before-after comparison of crash and violation rates on teenage drivers, it is necessary to establish internal and external controls. Proper use of control groups will ensure that results are not confounded by other changes in the driving environment that may affect all age groups. An example of an internal control group could be drivers in the age group 25-54 who are minimally affected by most GDL programs. One way to use this control is to calculate a ratio, i.e., ratio of crash rate of teenage drivers with the crash rate of drivers 25-54. Studies of other GDL and driver restriction programs have frequently used non-teenage drivers as the control group.<sup>(See references 23,25,27,44, and 50)</sup>

An example of an external control group could be a surrounding state that does not have a GDL program. Again, studies of other GDL programs have used external controls. For example, when Florida's GDL program was evaluated, crash data from the neighboring state of Alabama, which did not have a GDL program, was used as an external control group.<sup>(44)</sup> When Nova Scotia's GDL program was evaluated, data from New Brunswick, Saskatchewan, and Maine were used as control groups.<sup>(23)</sup> Some have argued that when external controls are used, the analysis should focus only on injury and fatal crashes because different jurisdictions have different thresholds in reporting property damage only crashes.<sup>(23,44)</sup>

Proper statistical tests are necessary to make valid conclusions. This is especially true when ratios are being compared. For example, let T-NJ represent the crash rate of teenage drivers in New Jersey, i.e., the number of crashes per individual for teenage drivers, and let C-NJ represent the crash rate of the control group (say drivers between 25 and 54 years old) in New Jersey. The ratio of T-NJ and C-NJ would be the crash rate ratio for New Jersey. Similarly, one can define a similar crash ratio for New York, a neighboring state, as the ratio of T-NY and C-NY. In reality, both these ratios are random variables. Hence, to statistically test the difference between two crash ratios, one has to know the variance of the ratio of the crash rates. This may be difficult to calculate. However, it has been argued that since the control group has many more drivers compared to the teenage driver population, its variance would be relatively small, and the crash rate of control groups can be considered as a constant.<sup>(50)</sup> With this assumption, the crash rate ratios can be approximated by normal distributions and the Z-statistic can be calculated based on the conventional large sample test for proportions. Later studies<sup>(44)</sup> have followed the method outlined by Ferguson et al.<sup>(50)</sup> to statistically test crash rate ratios. Similar methods could be followed for comparing rate ratios for violations and suspensions.

Regarding the statistical analysis of involvement ratios, Davis and Gao<sup>(51)</sup> have developed a method based on the fact that a cross tabulation of two-vehicle crashes of at-fault and innocent victim drivers forms a contingency table. They argue that statistical methods derived from contingency table analysis can be used to make

inferences. In addition, they demonstrate the use of an odds-ratio<sup>10</sup> statistic to obtain confidence intervals and test hypotheses while comparing involvement rate ratios.

### Interrupted Time Series Analysis

Interrupted time series analysis, also called intervention time series analysis, is used to ensure that the changes in crash and violation rates are specifically due to the GDL program and cannot be explained by long-term trends (see Figure 1). In this method, crash and violation rates are compiled for several years (say 10 years) before the implementation of GDL. The analysis can be conducted using a procedure called the ARIMA (Auto-Regressive Integrated Moving Average) process.<sup>(52)</sup> Different types of interventions such as, abrupt-permanent, abrupt-temporary, and gradual-permanent, can be tested. Since, it may take a few months before all novice drivers are licensed under the new GDL system, previous studies have used the time series analysis technique to assess if there is an abrupt-permanent change and a gradual-permanent change following the introduction of the program.<sup>(23)</sup>

### **Characteristics of Crashes and Violations**

In addition to the study of crash and violation rates, it would be useful to study the characteristics of these crashes and violations. Following are some questions that may be studied:

1. Did GDL reduce night-time crashes as a percentage of total crashes for teenage novice drivers?
2. Did GDL reduce severe crashes as a percentage of total crashes for teenage novice drivers?
3. Did GDL alter the percentage of certain types of crashes for teenage novice drivers, e.g., single vehicle vs. multiple vehicle crashes?
4. Did GDL change driver behavior?, e.g., did the program reduce certain types of violations such as speeding and reckless driving?
5. How often did teenagers violate the night-time curfew and passenger restrictions specified in the GDL program?

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<sup>10</sup> Odds-ratio represents the ratio of odds. For example, consider a hypothetical situation with young and middle aged drivers. If young drivers are involved in 130 crashes in which they are at-fault, and 100 crashes in which they are innocent, their odds of being at-fault would be 1.3:1, and the relative involvement ratio would be 1.3. Similarly, if middle aged drivers are involved in 100 crashes in which they are at-fault and 125 crashes in which they are innocent, their odds of being at-fault would be 0.8:1, and their relative involvement ratio would be 0.8. The odds ratio (the involvement rate ratio) between young and middle aged drivers would then be 1.3/0.8. Using the method developed by Davis and Gao,<sup>(51)</sup> it is possible to determine the confidence intervals for this ratio and ascertain if the difference between the involvement ratios of young and middle aged drivers is statistically significant.

6. Is the GDL program more effective in certain parts / counties in New Jersey compared to the others?
7. Is the GDL program more or less effective with male or female novice drivers?

The pre-GDL analysis will look at how these variables are distributed across age categories in anticipation of comparing post-GDL data to them in Phase 2.

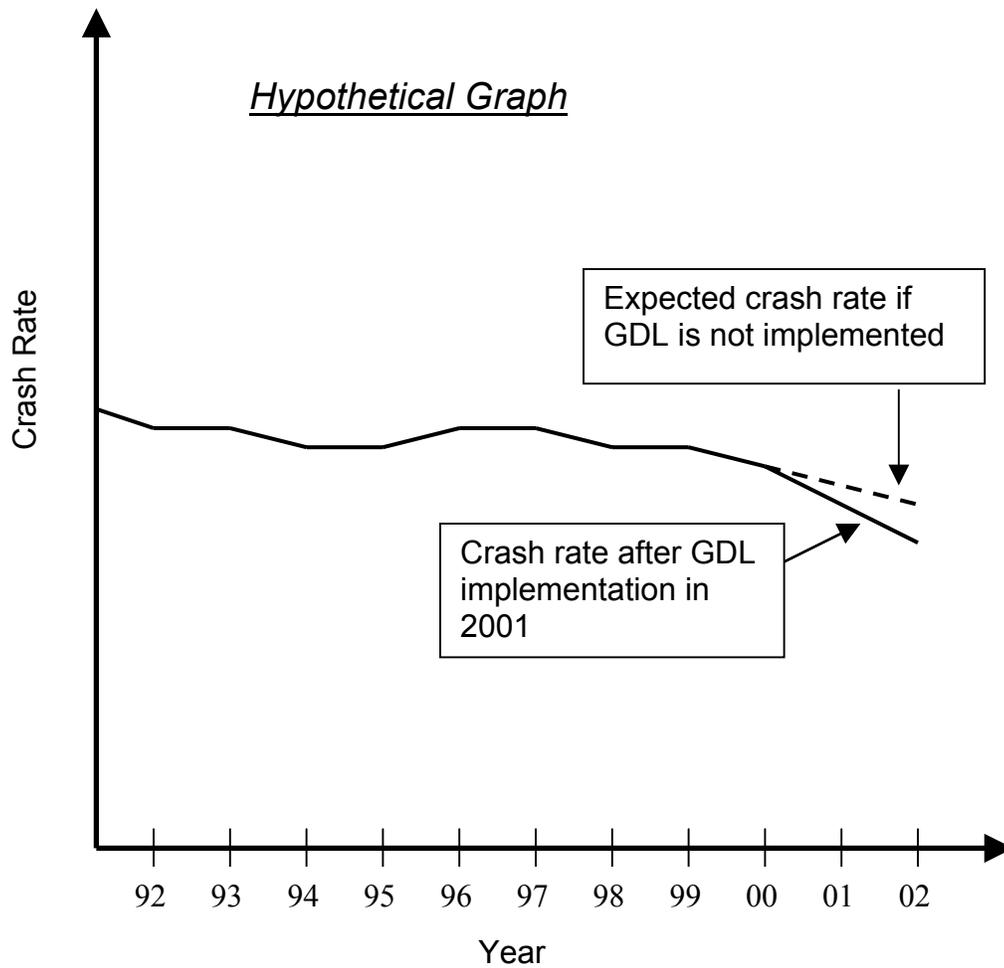


Figure 1. Hypothetical graph to illustrate Interrupted Time Series analysis

#### 4. CHARACTERISTICS OF CRASHES AND VIOLATIONS IN NEW JERSEY

In order to study the effectiveness of the GDL program in Phase 2, it is important to understand the historical data that are available, including their limitations. It is also important to understand the characteristics of the crashes and violations before the implementation of GDL, so that changes due to GDL can be identified in Phase 2. This section will discuss the characteristics of crashes and violations in New Jersey for drivers in different age groups. As discussed in a previous section, NJDOT crash data from 1993 through 1995, and 1998 through 2000, were utilized for the analysis. The focus of the analysis was the data from 1998 to 2000<sup>11</sup>.

In addition to the crash data, violation and suspension data from NJDMV for 1996 through 2000, were utilized. Following is a discussion of the approach used and an overview of the results.

##### Analysis of Crash Data

Nine data sets were made available to the study team, each representing a year's record of crashes from police reports, from 1991 to 2000. Crash data from 1991 and 1992 were incomplete, missing either or both "property damage only" (PDO) accidents or accidents on certain road systems. With regard to the 1997 data, it was reported that some accidents had been entered more than once, and the research team decided that including this data may lead to misleading results. Thus, the crash records for six years, 1993 to 1995 and 1998 to 2000, were analyzed. Table 1 shows the number (and percentage) of crashes by severity for 1993 to 1995 and 1998 to 2000. The statistics indicate that the number of crashes has increased, although this is primarily due to the increase in PDO crashes: the percentage of injury crashes has decreased. However, since, crash data from 1996 and 1997 are not included, it is difficult to identify a trend.

Table 1. Number of crashes by severity from 1993-1995 and 1998-2000

Crash Year	Severity of Crash						TOTAL Crashes
	Fatal Crashes		Injury Crashes		PDO Crashes		
	Count	%	Count	%	Count	%	
1993	721	0.33%	81,429	36.99%	137,984	62.68%	220,134
1994	691	0.30%	82,079	35.87%	146,050	63.83%	228,820
1995	697	0.31%	80,479	35.76%	143,819	63.92%	224,995
1998	970	0.36%	73,389	27.29%	194,543	72.35%	268,902
1999	710	0.26%	69,986	25.38%	205,059	74.36%	275,755
2000	1,310	0.43%	79,150	26.17%	221,964	73.39%	302,424

<sup>11</sup> Although crash data from New York State were also obtained for the last 10 years, they could not be analyzed due to time restrictions. However, they will be used in Phase 2 when comparisons are made between pre-GDL and post-GDL data in New Jersey.

The latest crash report form used by police officers in New Jersey is available in a website maintained by the National Highway Traffic Safety Administration<sup>12</sup>. Appendix C shows the variables that were extracted by NJDOT for 1998, 1999, and 2000.

### Data Manipulation

The 1993-1995 crash data base included the age of the driver as one of the variables. In the 1998-2000 crash data, the age of the driver had to be calculated using the date of birth and the date of the crash<sup>13</sup>. The following discussion illustrates the procedure used to calculate the age of the driver in SPSS.

The calculation was done in two steps: (1) calculate the difference between the year of the crash and the year of birth, and (2) calculate the age of the driver depending on the month and day of the crash and the month and day of birth. Details are given below.

Let us first define the following variables:

cr\_m – Month of crash

cr\_d – Day of crash

cr\_y – Year of crash

d\_crash - Number of days from January 1<sup>st</sup> until the day of crash in the crash year  
(calculated using functions XDATE.JDAY and DATE.MDY in SPSS)

dob\_m – Month of birth of the driver (could be the first driver or the second driver)

dob\_d – Day of birth of the driver (could be the first driver or the second driver)

dob\_y – Year of birth of the driver (could be the first driver or the second driver)

d\_birth - Number of days from January 1<sup>st</sup> until the day of the birth in the year of birth  
(again, this could be for the first driver or the second driver in the record)  
(calculated using functions XDATE.JDAY and DATE.MDY in SPSS)

yrdiff – difference between year of the crash and the year of birth

#### *Calculation of Age:*

*Step1*  $yrdiff = cr\_y - dob\_y$

*Step2* If  $d\_crash < d\_birth$ , then:  $age = yrdiff - 1$

If  $d\_crash \geq d\_birth$ , then:  $age = yrdiff$

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<sup>12</sup> See <http://www.nhtsa.dot.gov/people/perform/trafrecords/crash2002/Pages/state/nj/NJ.htm>

<sup>13</sup> The date of the crash was not coded in a consistent format in the 1998-2000 data. This led to some delays in calculating the age of the driver. Most the dates were coded in 6 columns, 8 columns, or 10 columns. The year of the crash was sometimes coded in 4 columns, some in 2 columns. In some records, the month, day, and year were separated by / or -. In other records, there were no separators. To deal with this situation, a query was run in MS ACCESS using a function called IIF and separators were introduced between the month, day, and the year. This data was then exported to SPSS, which was used for most of the subsequent analysis.

In addition to this, there are other important differences between the 1993-1995 and the 1998-2000 data. During 1993-1995, crash data for each year were recorded in the form of four files that could be linked together based on the control number of a particular accident: accident master file, vehicle master file, occupant master file, and driver master file. Each accident has a unique control number and one accident master record; however, it may have more than one vehicle record, more than one occupant record, and more than one driver record, depending on the number of vehicles, occupants, and drivers involved in the accident. To extract the necessary variables from these records, each file was imported into separate tables in MS ACCESS. These tables were then joined together based on the control number using an ACCESS feature called 'Relationship'. Following this, the necessary variables were extracted using a Select Query. The results of the Query were exported to SPSS for further analysis.

During 1998-2000, all the crash data were recorded in one file. Each accident had a unique control number and at least one record (or page) of data. If the number of vehicles exceeded two, then further information was recorded in a second record and so on. Some of the information recorded pertained only to that particular record and not the accident. For example, three variables: 'Total Killed', 'Total Injured, and 'No. Vehicles' were provided only for the particular record. In order to find the total killed, total injured, and total number of vehicles, for each accident, a function called 'Aggregate' within SPSS was used.

For some of the variables analyzed below, categories were grouped. For example, under "lighting conditions", all "dark" categories were aggregated. This was done when the numbers of crashes for an age-category were small and the age-related patterns for all the grouped categories were similar.

## Results

### *Driver involvements*

Figure 2 shows the total number of driver involvements<sup>14</sup> starting from driver age 15 until driver age 100, for 1998 to 2000 and 1993 to 1995. The number of involvements increases from age 15 until age 17, which is associated with the largest number of involvements. The involvements then start to decrease until the early 20's. From the early 20's until the mid and late thirties, the number of involvements seems to stay the same. Starting the late 30's, the number of involvements again starts decreasing. For the younger age groups, the number of crash involvements during 1998-2000 is higher than 1993-1995 probably due to an increase in the population of drivers in the younger age groups. Other contributing reasons might be the increasing trends over time of both licensing rates and vehicle miles traveled per person and the effect of the economy on driving; in the period 1993 to 1995, New Jersey was recovering from a recession, while the economy was very strong from 1998 to 2000.

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<sup>14</sup> Driver involvements represent the total number of drivers involved in crashes. Figure includes crash involvements of all drivers involved in New Jersey accidents including out-of-state drivers.

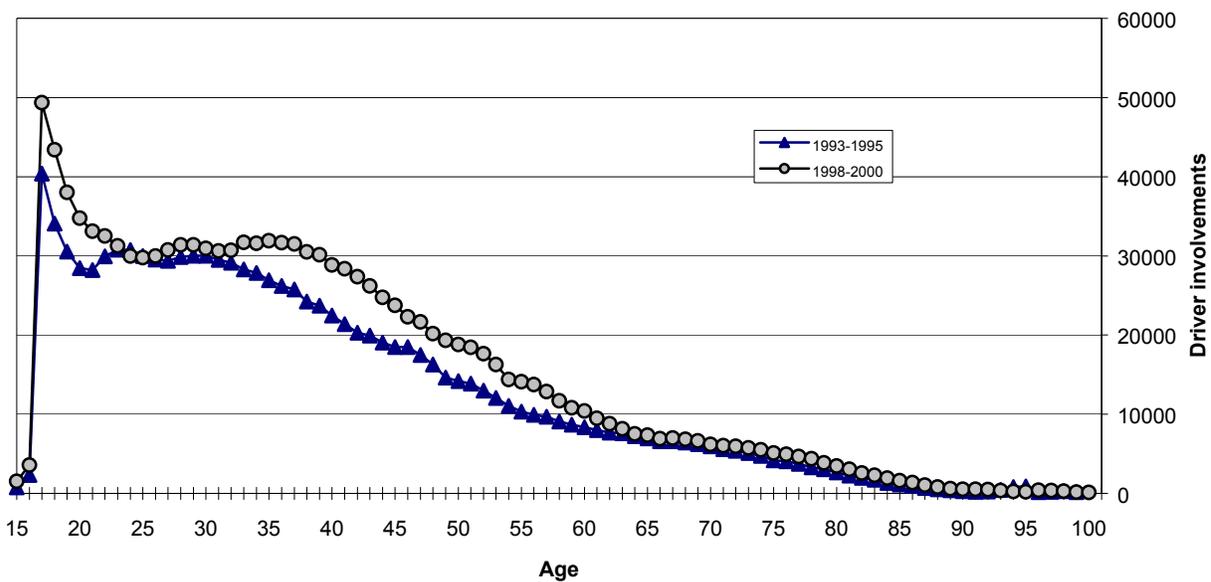


Figure 2. Crash Involvements by Age (1993-1995 and 1998-2000)

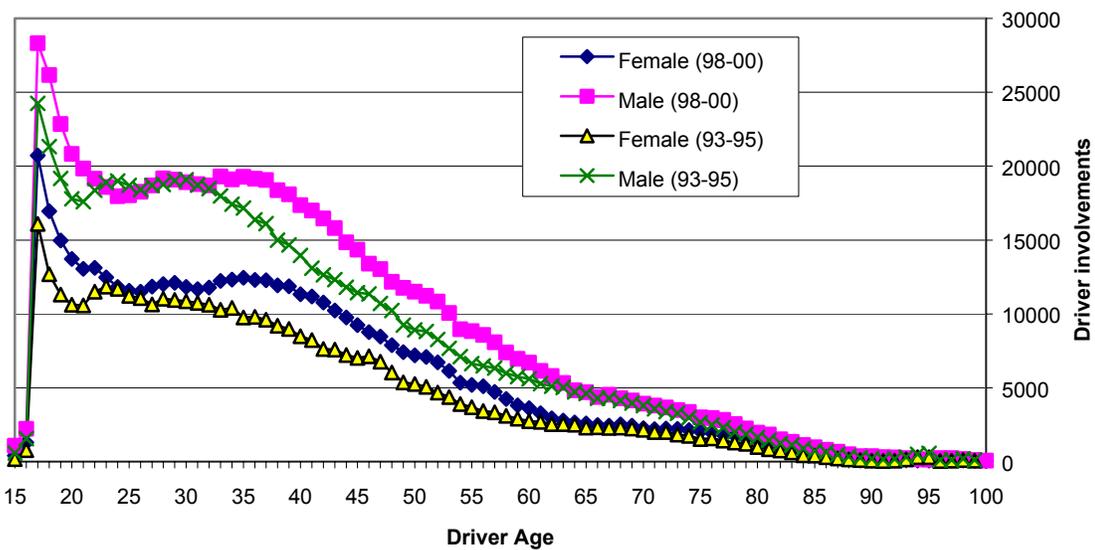


Figure 3. Crash Involvements by Age and Gender (1993-1995 and 1998-2000)

Figure 3 shows the relationship between driver involvements and age for male and female drivers for 1993-1995 and 1998-2000. Although male drivers are involved in substantially more crashes than female drivers, the relationship between driver age and frequency of driver involvements seems to be similar for male and female drivers. Considering 17 year old drivers, females were associated with 42% of crash involvements from 1993 to 1995 and 40% from 1998 to 2000, compared to 39% to 44% reported in previous studies (see Appendix A).

Figure 4 shows the relationship between driver involvements and age for New Jersey drivers in 1998, 1999, and 2000. Comparing figures 2 and 4, the relationship between driver involvements and age is similar regardless of whether all drivers are included or only New Jersey drivers are included. Hence, further analysis focuses on all drivers who were involved in crashes in New Jersey.

In order to be able to separate the anticipated decrease in crash involvements among 17 (and perhaps 18) year olds due to the enactment of GDL in New Jersey from other trends in crash involvements, data for the six years were plotted so as to show any trends. Figure 5 shows crash involvements for 16, 17, and 18 year olds from 1993 to 2000, with a gap for 1996 and 1997. The average number of involvements for the 45 to 54 year old group was also included as a control. While there is an increase in involvements from 1993 to 2000 for all age groups, it is difficult to identify a trend given the few data points and the difference from before the 1996-97 gap to after. A possible explanation for the small decrease in crash involvements in 1999 followed by the large increase in 2000 for the 17 and 18 year olds might be the awareness of safety among teens in the earlier year due to publicity around the GDL bill followed by a surge in licensure among teens in 2000 trying to beat the January 1, 2001 implementation of GDL. However, this would not explain the similar, although smaller increase in 2000 for the middle age drivers.

Figure 6 shows crash involvement rates (involvements per 10,000 population) for the same age groups<sup>15</sup>. Controlling for changes in population does not change the pattern significantly. As noted earlier, the overall increase in crash involvements and crash involvement rates may be due to increases in the rate of licensure or increased VMT per driver either as part of the general trend or in response to economic changes.

To study the seasonal patterns in crashes, the average number of crashes per day was calculated for every month in 1998, 1999, and 2000 for 16, 17, 18, and 45-54 year old drivers (see Figure 7). The figure seems to indicate a gradual increasing trend in the number of crash involvements in the last three years. Overall, May, June, and December seem to be associated with more crash involvements than the other months. These months could be expected to have more crashes because of more driving during the holidays. October also has a larger than average number of crashes for 1998 and 1999, but not for 2000; there may be weather related reasons for some of these peaks. The seasonal pattern seems quite similar for all the age groups shown in the graph.

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<sup>15</sup> New Jersey population data by single ages were not available for 2000 at the time of writing.

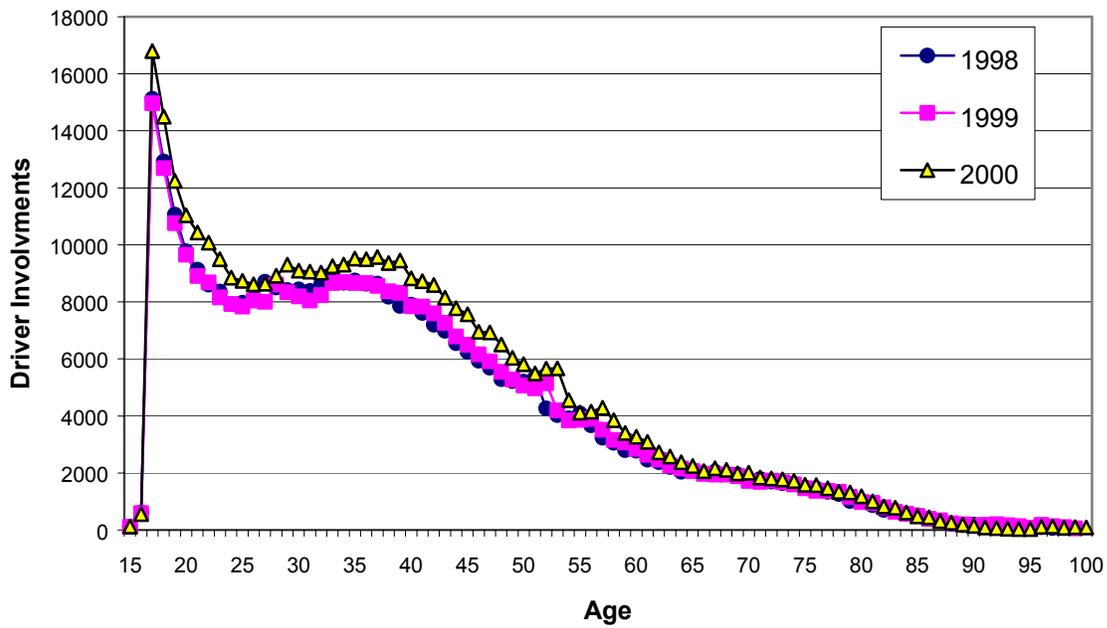


Figure 4. Crash Involvements by Age (New Jersey Drivers only)

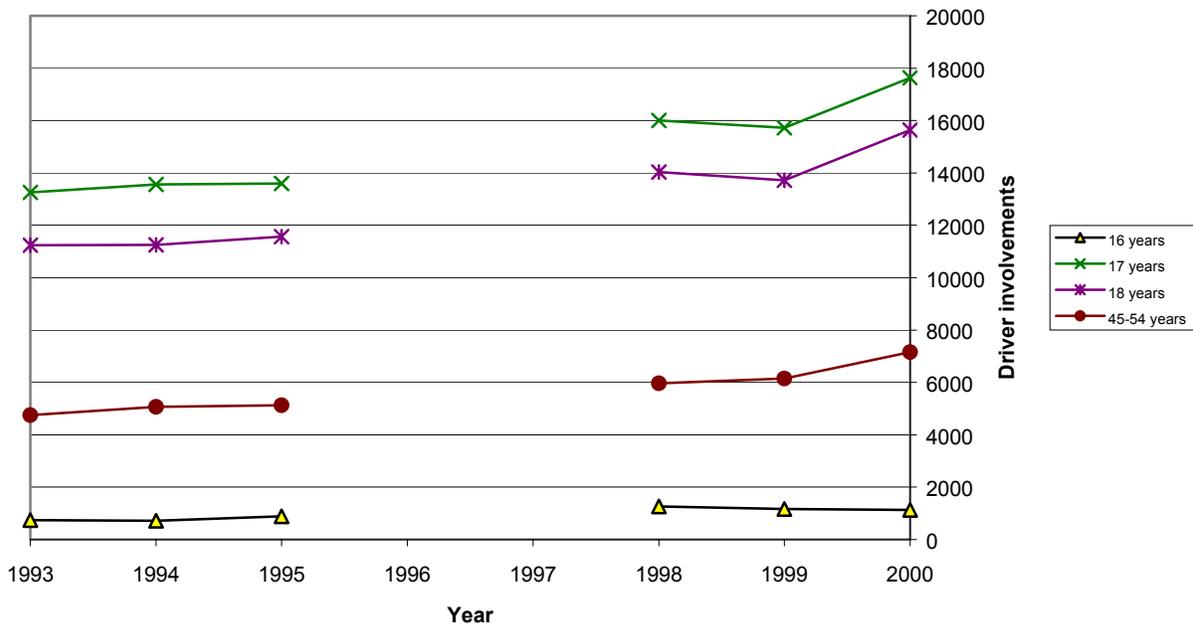


Figure 5. Trends in Driver Involvements: 1993-1995 and 1998-2000

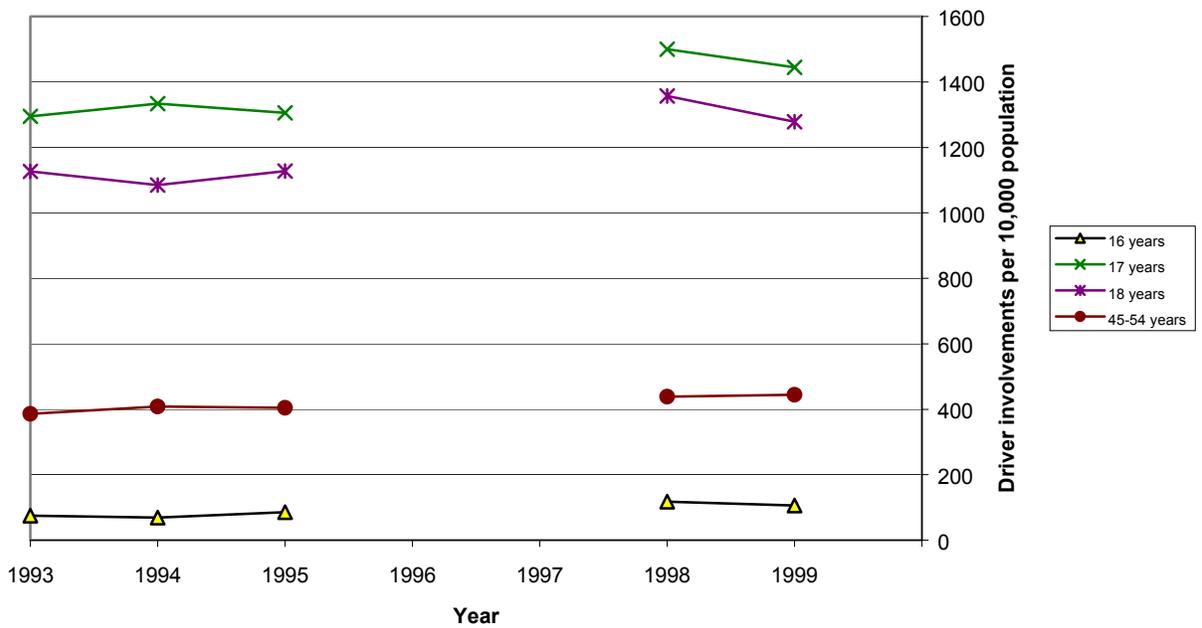


Figure 6. Trends in Involvement Rates (1993-1995 and 1998-1999)

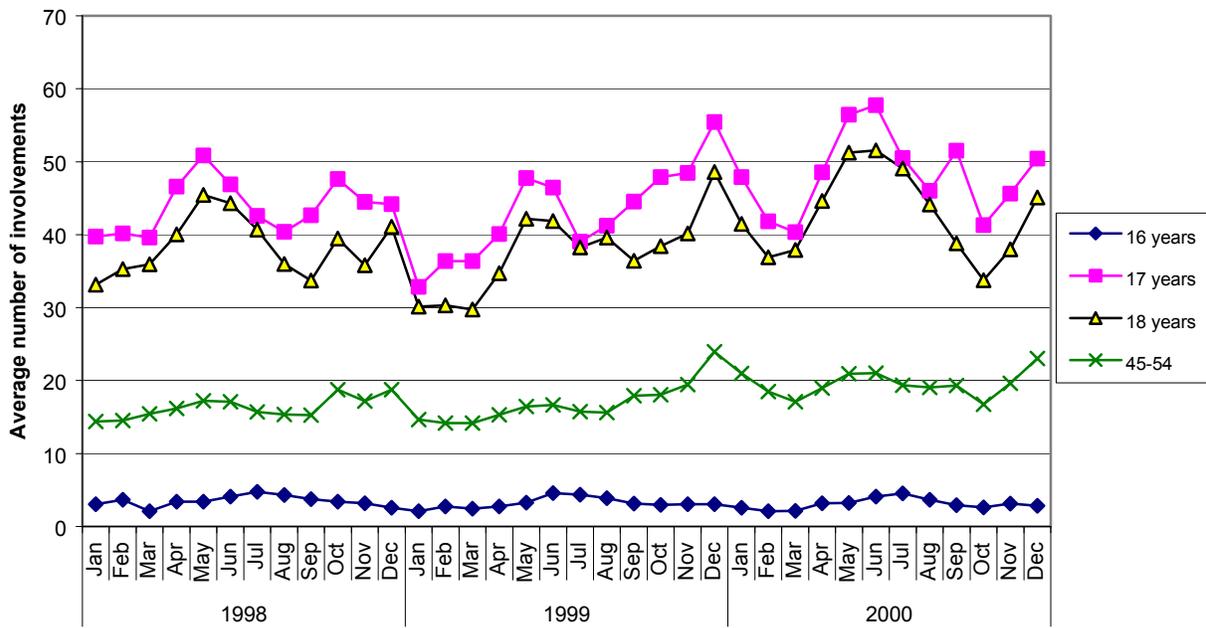


Figure 7. Average Number of Involvements per day in Each Month (1998-2000)

### *Driver Involvement Rate*

Although the figures show that young drivers have more crash involvements than middle aged and older drivers, it is necessary to consider exposure, in order to compare the crash propensity of these drivers. The only measure of exposure that was available to the research team was population<sup>16</sup>. The ratio of involvements to population is defined as the involvement rate. Involvement rates were calculated for each age from '15' to '85 and over' for 1998 and 1999<sup>17</sup>.

Figure 8 shows the relationship between involvement rate (per 10,000 people) and age. The figure indicates that 17-year-old drivers have the highest involvement rate. After age 17, involvement rates show a continuing decline with age.

### *Driver Age and Other Crash Variables*

Following the analysis of age and driver involvements and involvement rates, the characteristics of crashes were studied by conducting cross tabulations between driver age and variables related to the crash and the driver. The analyses focused primarily on the 1998-2000 data. For these analyses, age of the driver was divided into the following categories<sup>18</sup>: 15, 16, 17, 18, 19, 20-24, 25-34, 35-44, 45-54, 55-59, 60-64, 70-74, 75-59, 80-84, and 85-89<sup>19</sup>. The results are discussed below.

### *Lighting Condition*

Figure 9 shows the relationship between driver age and the percentage of crash involvements associated with different lighting conditions. In the figure, 'dark' represents a combination of three categories: dark with street lights on, dark with street lights off, and dark with no street lights. As expected most of the crashes occur during daylight. Teenagers have a higher percentage of their crash involvements during dark conditions, possibly indicating a lack of experience in dealing with dark conditions. 18-year-old drivers have the second highest percentage of involvements during dark conditions. With increase in age, a lower percentage of crashes occur during dark conditions. There is also some anecdotal evidence to indicate that as drivers get older (say, above 55), they tend to reduce their driving after dark.<sup>(74)</sup>

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<sup>16</sup> As discussed in a previous section, there are other measures of exposure, e.g., number of licensed drivers, number of miles driven. New Jersey does not have a historical record of number of licensed drivers by age. In addition, number of miles driven by age is also not available at the State level.

<sup>17</sup> Estimated population data were obtained from the Census Bureau for July 1 of every year. When this report was written, population data were not available by age for 2000.

<sup>18</sup> Residents of New Jersey were not allowed to get a driving permit at age 15. Hence, the results for age 15 may represent drivers who are driving illegally or out-of-state drivers.

<sup>19</sup> There were very few crashes for drivers 90 and older and were excluded for most of the analysis.

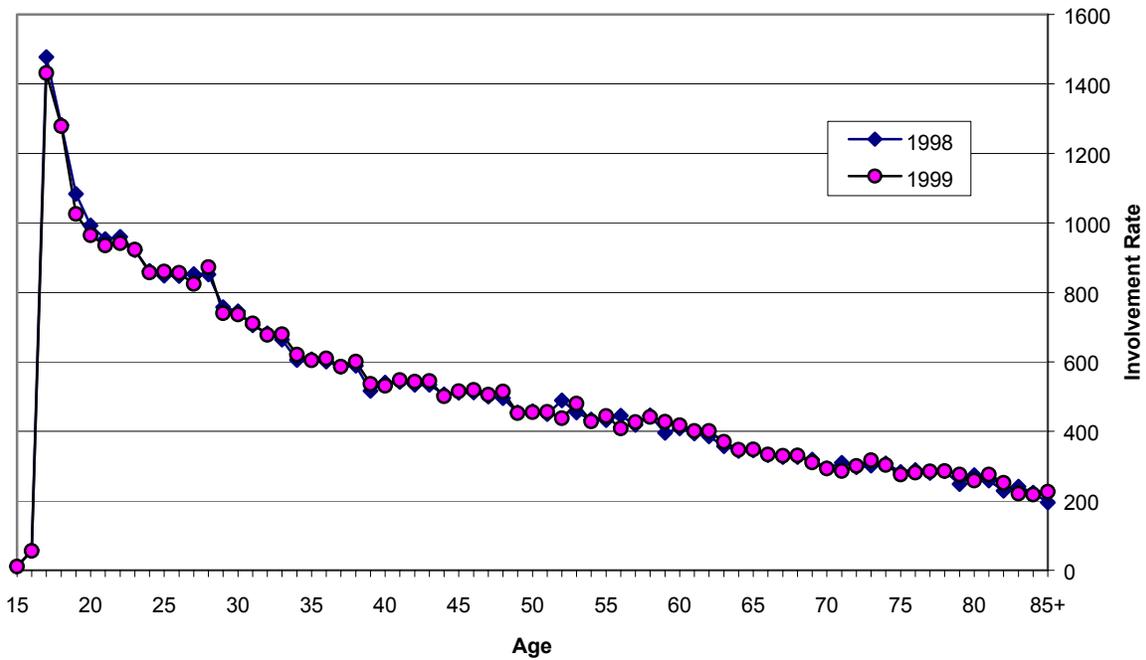


Figure 8. Involvement Rate by Age (per 10,000 people)

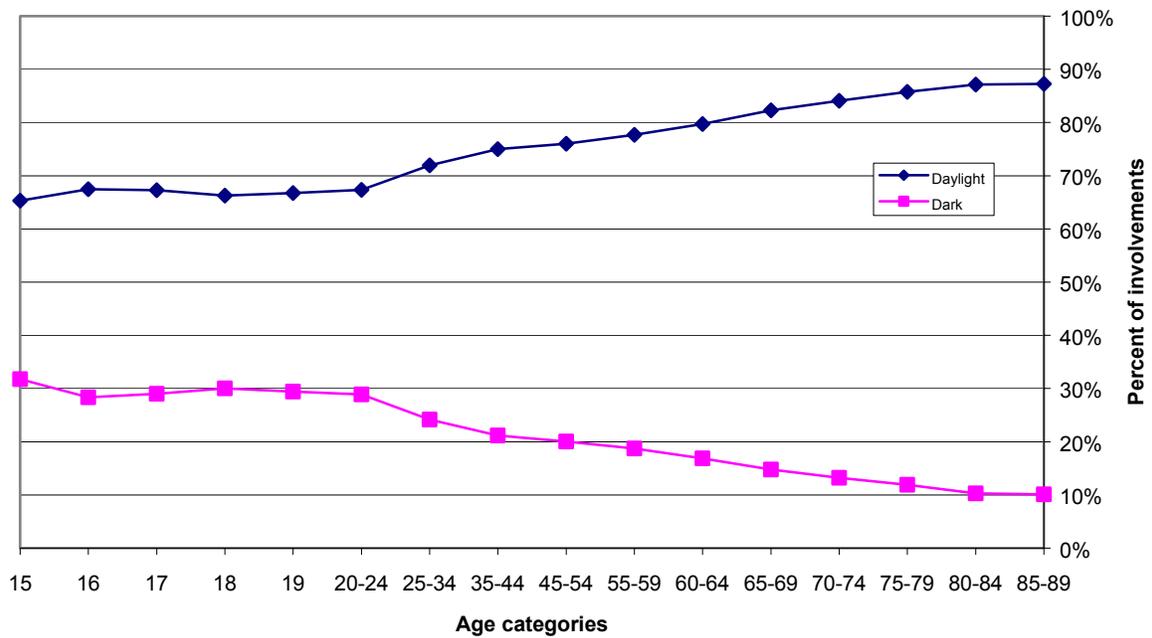


Figure 9. Driver Age and Lighting

## Weather

Figure 10 shows the relationship between driver age and percentage of involvements associated with different weather conditions. In the figure, bad weather includes rain, snow, and fog. As age increases from 15 to 17, there is an increase in the percentage of involvements during bad weather. This may be due to the limited exposure of 15 and 16 year old drivers to bad weather conditions. After age 17, there is a decrease in the percentage of involvements during bad weather conditions, suggesting that as drivers mature, they learn how to drive safely under bad weather conditions<sup>20</sup>.

## Surface Condition

Figure 11 shows the relationship between driver age and percentage of involvements associated with surface condition of the road. Road surface condition is divided into two categories: dry, and wet/snowy/icy. Results from this figure are consistent with those from figure 10, indicating that as drivers become older they learn how to deal with adverse driving conditions.

## Road Character

Road character refers to the geometric alignment of the road and whether any horizontal / vertical curves were present at the crash location. Figure 12 shows the percentage of involvements associated with road character. In the graph, 'curve' includes three conditions: curve and level, curve and grade, and curve and hillcrest. As expected, most crash involvements occur when a road is straight and level. 15 and 16 year old drivers have a relatively low percentage of their involvements when a road has a curve. Curves are more common in hilly and mountainous areas, and it is possible that 15 and 16 year olds who probably have a learner's permit and are under supervision do not drive often under these conditions. After the age of 17, increase in age (and experience) leads to a reduction in the percentage of crashes that occur on curved roads.

## Road System

Figure 13 shows the relationship between driver age and percentage of involvements associated with different types of roads. In the figure, State/Interstate include Interstate highways, State highways, and highways managed by State/Interstate authorities; local refers to municipal roads and private property; county refers to county roads. Young drivers have fewer crashes in high-speed State/Interstate roads and more crashes on local roads, probably because they do more of their driving on local roads. As driver age increases (until say age 55), there is an increase in the percentages of crash

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<sup>20</sup> Also, New Jersey residents first start driving without supervision at age 17.

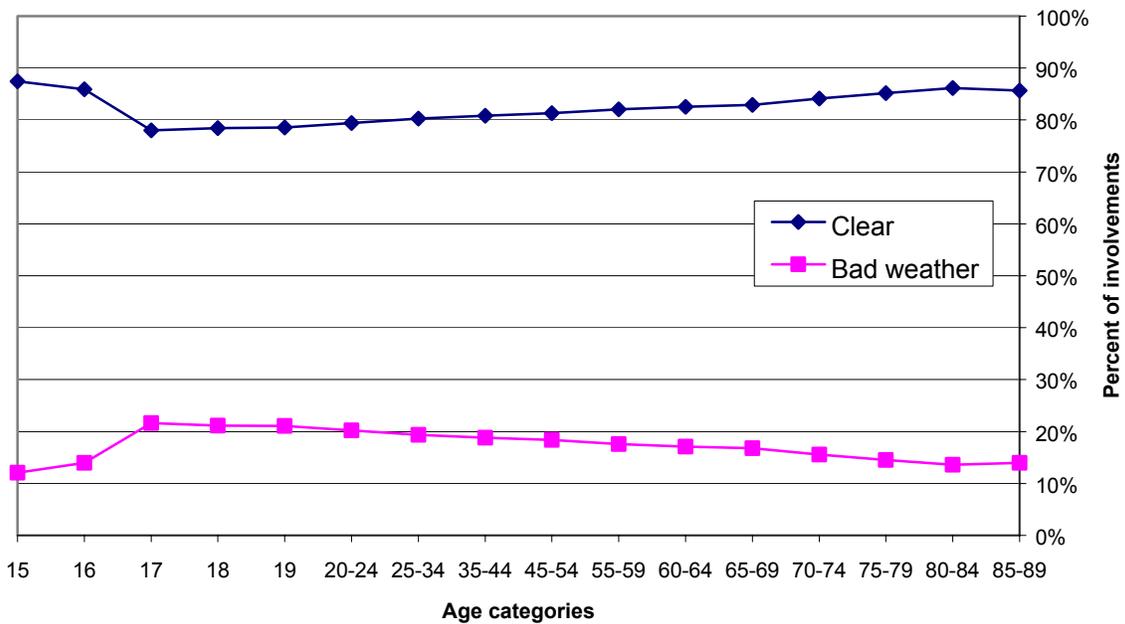


Figure 10. Age and Weather

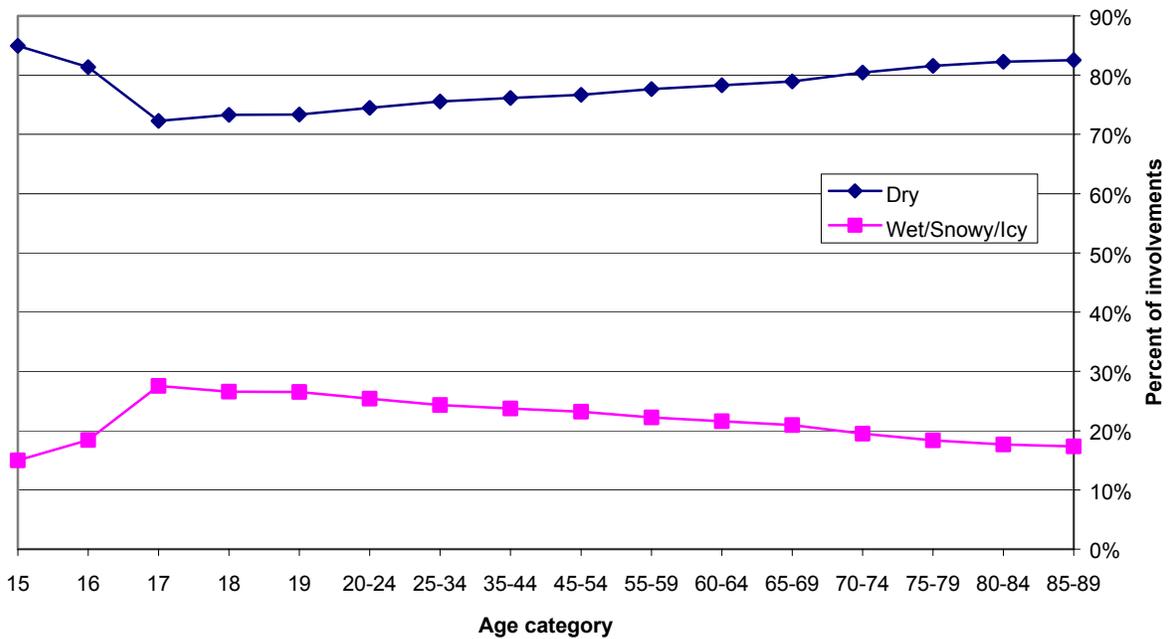


Figure 11. Age and Road Surface Condition

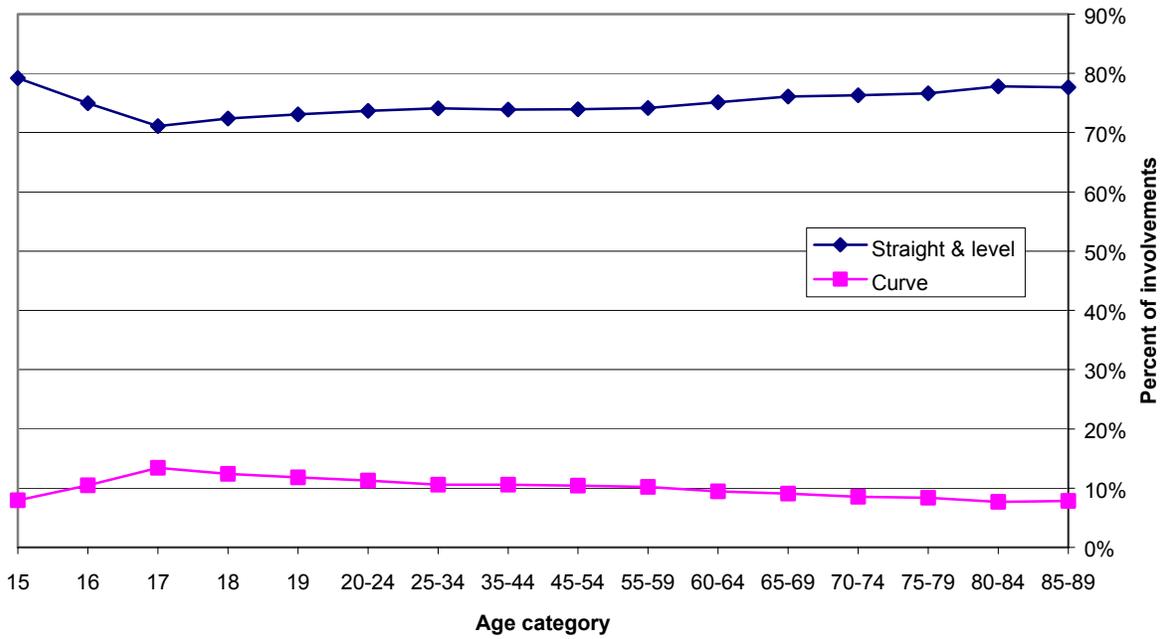


Figure 12. Age and Road Character

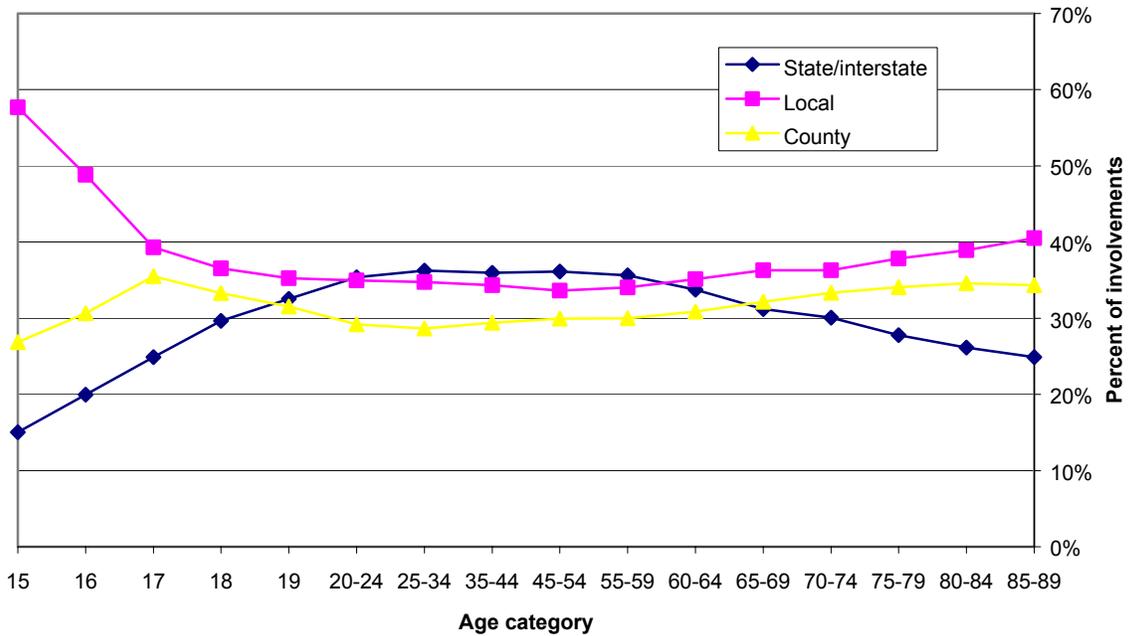


Figure 13. Age and Road System

involvements on high-speed roads and a decrease in crashes on local roads. Older drivers are more involved in crashes on local roads similar to the young drivers. It is not clear if this is because older drivers avoid freeways or that they have problems in navigating local roads. According to Lerner and Ratte,<sup>(75)</sup> “there is widespread belief that older drivers as a group avoid freeways”, although the extensive research conducted by these authors did not support or reject this hypothesis. Their study found “no objective data on the freeway travel of older drivers”.

## Severity

Based on the information given in the crash reports, crashes were classified into fatal, injury, and property damage only (PDO) crashes depending on the number of people injured and killed in a crash. If at least one person was killed, that crash was classified as a fatal crash. If no person was killed and at least one person was injured, the crash was classified as an injury crash. If no one was killed or injured, the crash was classified as a PDO.

Figure 14 shows the relationship between age and the percentage of involvements in fatal crashes. Within the younger age groups, 15 and 16 year old drivers have a relatively high percentage of their involvements in fatal crashes, perhaps due to speeding and reckless driving. Older drivers also have a high percentage of their involvements in fatal crashes probably due to their frailty.

Figure 15 shows the percentage of involvements in fatal and injury crashes for different age groups. Again, the percentage is high for 15 and 16 year old drivers. More than 50% of crash involvements involving 15-year-old drivers result in an injury or fatality. Similarly, approximately 40% of crash involvements involving 16-year-old drivers result in a fatality or injury.

## Time of Day

Figure 16 shows the percentage of involvements by time of day for different age groups. The following observations can be made from this graph:

- Compared to middle aged and older drivers, younger drivers have a higher percentage of their involvements between midnight and 5:00 a.m., although there seems to be large fluctuations within the younger driver age group.
- The percentage of involvements between 7:00 and 10:00 a.m. (i.e., during the morning peak period) is relatively high between driver ages 20 and 64, which represents the majority of the working people.
- 15 and 16 year old drivers seem to have a relatively high percentage of their involvements from 4:00 to 7:00 p.m. (i.e., evening peak). This is probably because most of their recreational trips made by these drivers could be during this after school period.

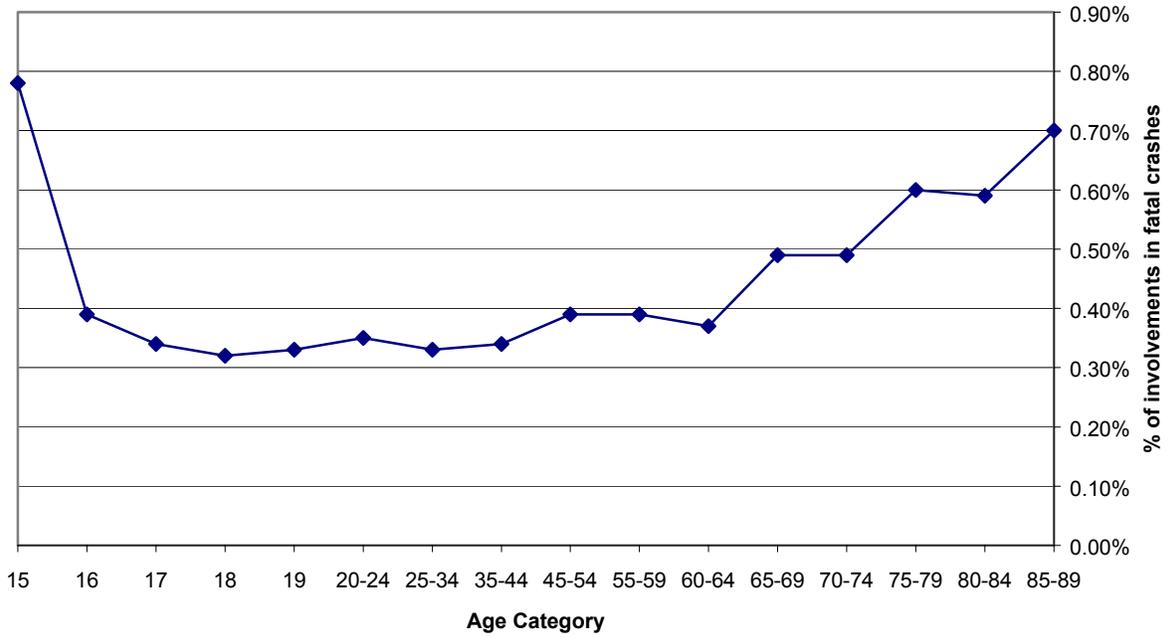


Figure 14. Percentage of Involvements in Fatal Crashes

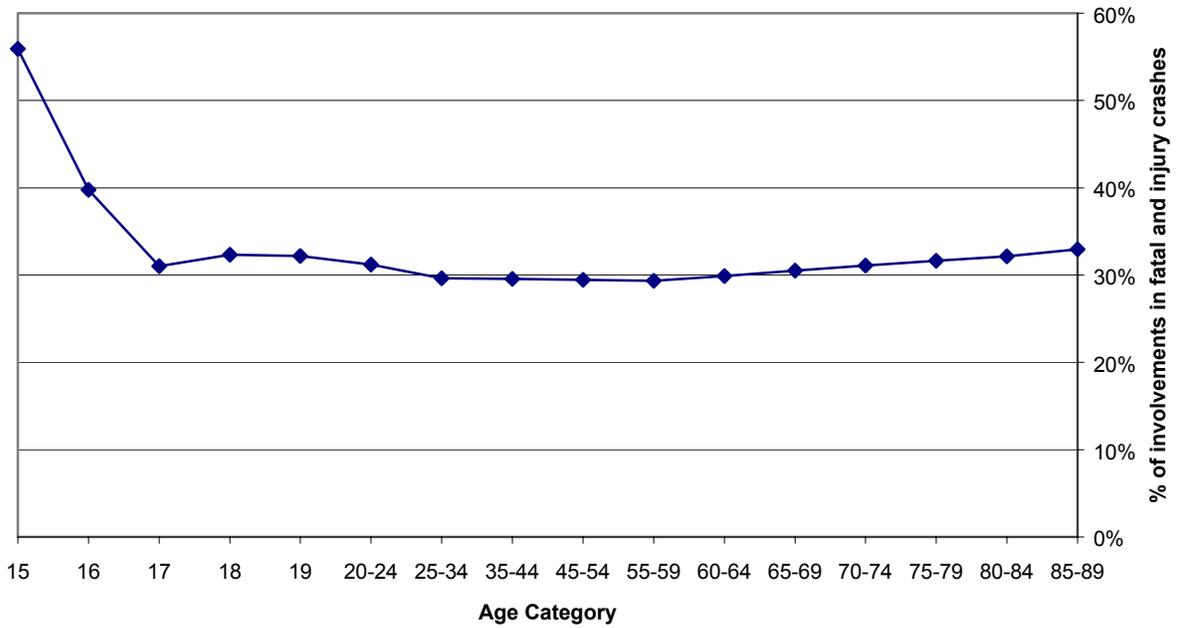


Figure 15. Percentage of Involvements in Fatal and Injury Crashes

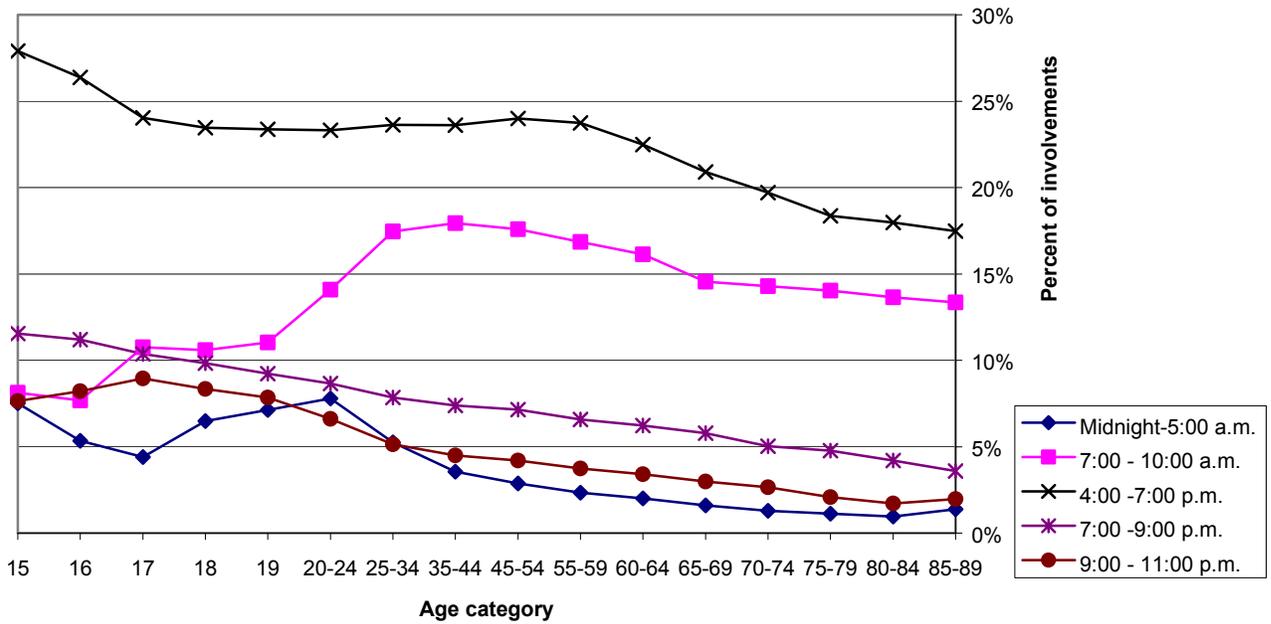


Figure 16. Percentage of Involvements by Time of Day

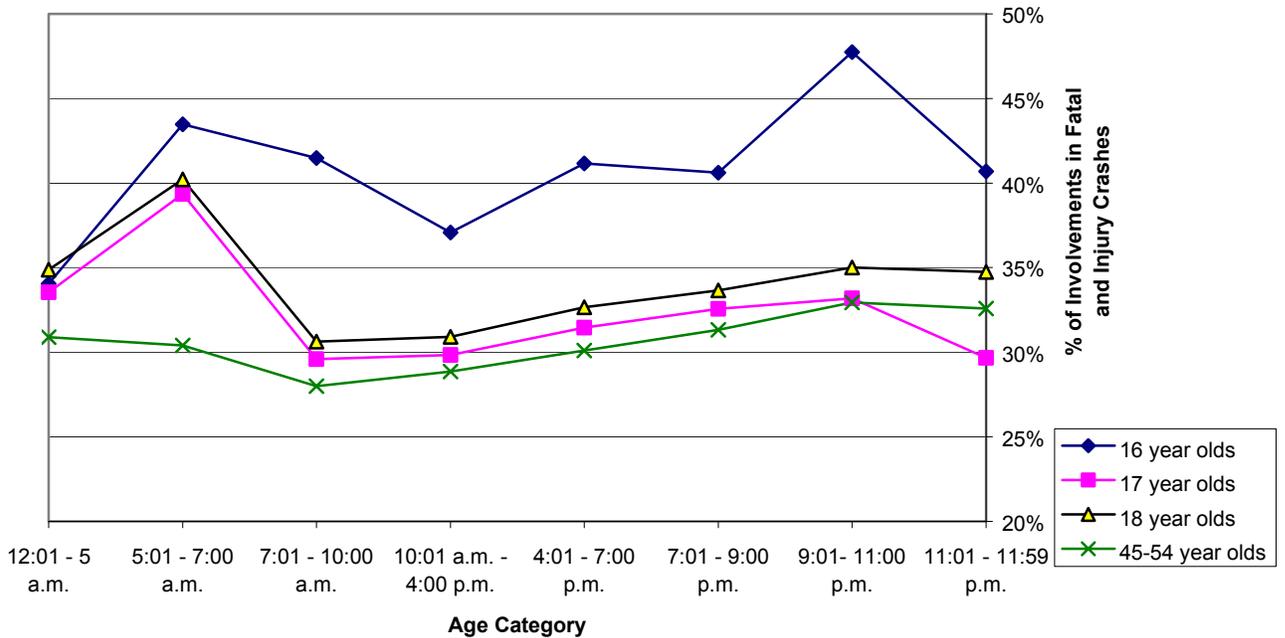


Figure 17. Percentage of Involvements in Fatal and Injury Crashes by Time of Day

- Looking at the late evening time periods 7:00 to 9:00 p.m. and 9:00 to 11:00 p.m., the younger drivers have a higher percentage of their crashes compared to middle aged and older drivers. This supports the argument made by Foss<sup>(10)</sup> that nighttime curfews should start earlier than midnight to be effective in reducing young driver crashes.

### Time of Day and Severity

Figure 17 was developed to study if certain times of the day are associated with more severe crashes for the younger age groups. This figure shows the percentage of involvements in fatal and injury crashes for 16, 17, 18, and 45-54 year old drivers. A crash involving a 16 year old driver between 9:01 to 11:00 p.m. seems more likely to be a fatal or injury crash than in other time periods. In addition, for crashes involving 16-18 year old age groups, the 5:01 a.m. to 7:00 a.m. time period is associated with a relatively high likelihood of resulting in a fatality or injury. These results are again consistent with Foss<sup>(10)</sup> indicating that lawmakers should study the possibility of extending the curfew of the younger drivers to late evenings and early mornings.

### Traffic Control

The crash report provides information about the traffic control system encountered by the driver when the crash occurred. This information is coded for both intersection and mid-block crashes. Figure 18 shows the percentage of involvements by type of traffic control for different age groups. 15 and 16 year old drivers are involved in a high percentage of crashes where no control was present. This could be explained by arguing that either most of their driving is done on local streets or that these crashes happened at mid-block locations that were coded as 'no control' or this may reflect that greater judgment is needed where this is no control. Similarly, younger drivers are involved in relatively few crashes when they encountered a traffic signal.

Looking at the crashes when stop signs are encountered, both younger and older drivers are involved in a higher percentage of their crashes compared to middle aged drivers. The higher value for older drivers is consistent with previous work.<sup>(46)</sup> To be effective in negotiating stop signs, drivers should be able to judge gaps and the speed of cross traffic. It is possible that older drivers have difficulties with this. On the other hand, younger drivers could make mistakes at stop-controlled locations due to overconfidence and impatience.

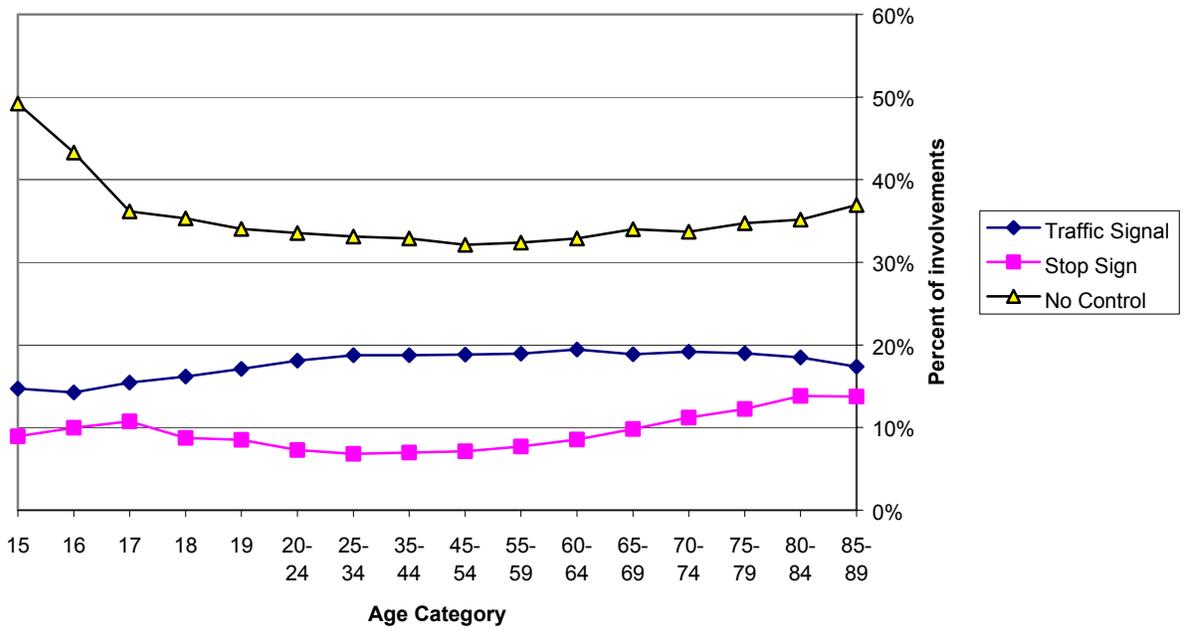


Figure 18. Percentage of Involvements by Type of Traffic Control

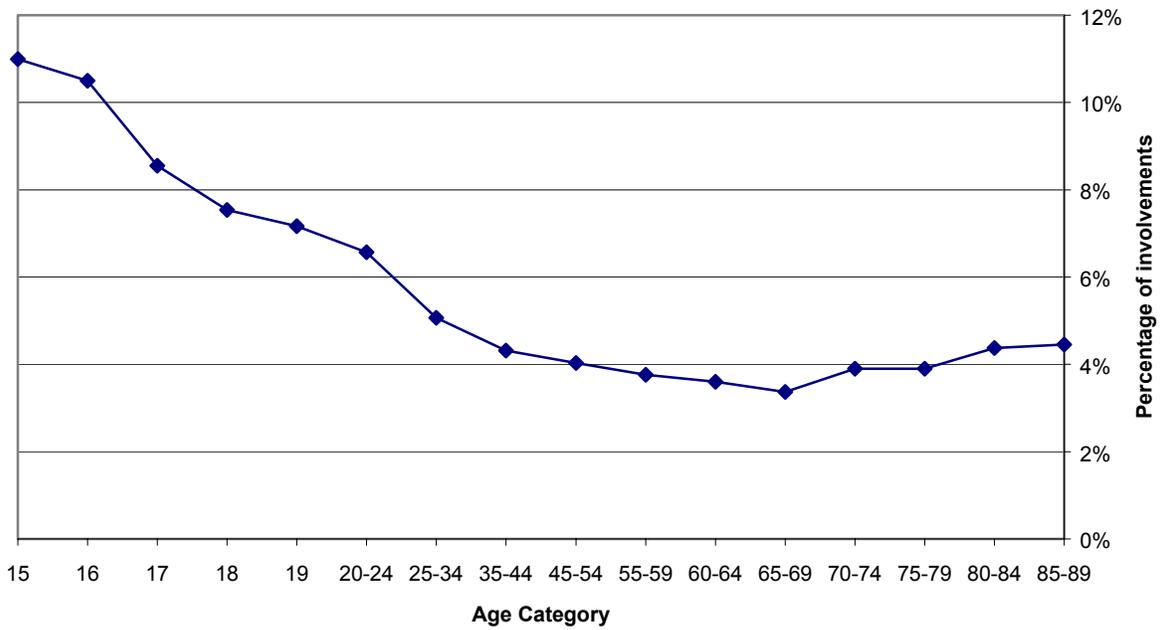


Figure 19. Percentage of Involvements That Were 'Non-collision' or 'Collision with a Fixed Object'

## First Event in a Crash

The crash report includes information about the sequence of events during the crash. Thirty-five types of events are coded. Up to four different events are coded for each vehicle involved in the crash. In the crash report, the events are grouped into non-collision (e.g., overturn, jackknife, and ran off road), collision with fixed object (e.g., bridge rail, tree, and ditch), and collision with non-fixed object (e.g., animals, pedestrians, and other motor vehicles). Here, only the first event in the sequence is discussed. For this analysis, non-collisions and collisions with fixed objects have been combined.

Figure 19 shows the percentage of involvements that were non-collisions or collisions with fixed objects for different age groups. Although these represent a relatively small percentage (less than 15%) of all crashes, there seem to be significant differences between young drivers and other age groups, i.e., young drivers are over-represented in these types of crashes. One could argue that these crashes usually happen when the driver loses control of the vehicle probably due to reckless driving or inexperience in dealing with difficult driving conditions. These results are consistent with previous research that indicates that crashes involving teenage drivers are more frequently single vehicle crashes.<sup>(2,3)</sup>

## Vehicle Action

The crash report includes information about the maneuver undertaken by the vehicle just before the crash, e.g., going straight, turning left, turning right, changing lanes, making a U turn, parking, and merging. Figure 20 shows the percentage of involvements for different age groups associated with selected maneuvers. Approximately half the crash involvements are associated with the vehicle going straight. The percentage of involvements during left turns is relatively high for younger and older age groups. Previous research has shown that older drivers have difficulties in judging speeds of oncoming vehicles as they are trying to yield to these vehicles while making a left turn.<sup>(53)</sup> Young drivers could have problems with left turns due to inexperience, impatience, or overconfidence.

Younger and older drivers also seem to be slightly over-represented in right turn and backing crashes. It is possible that right turns create similar problems as left turns for older drivers especially when they are made at stop controlled intersections or when a right-turn-on-red is attempted. It is possible that young drivers are slightly over-represented in backing crashes due to lack of proper training and experience. Older drivers may have difficulties in backing vehicles safely due to poor vision and other physical limitations.

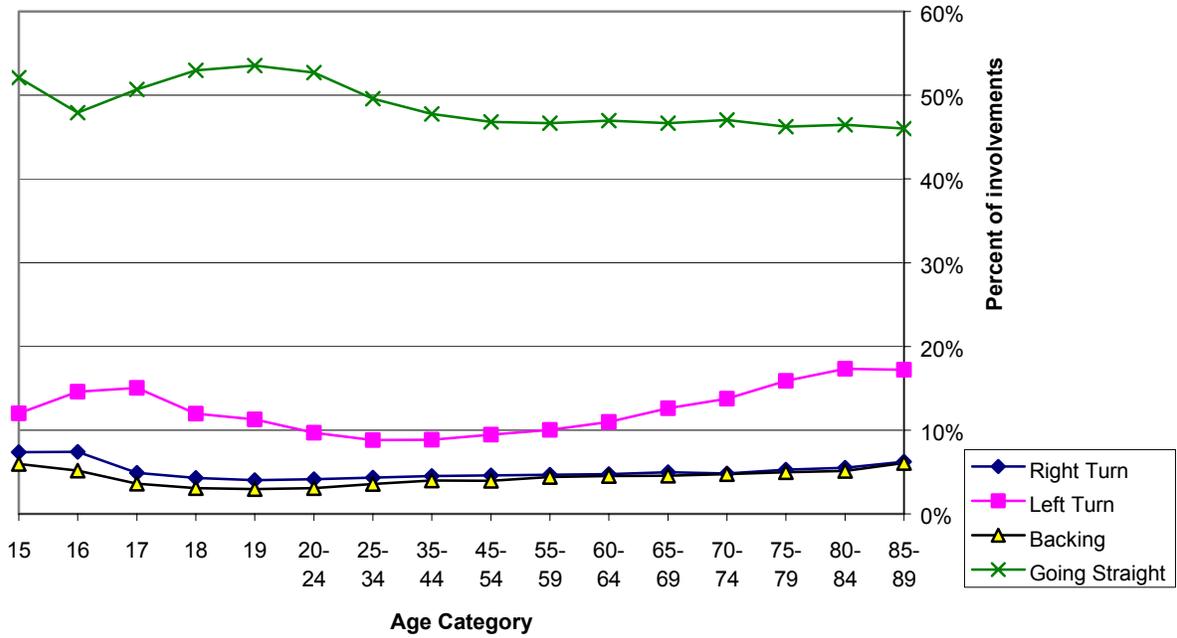


Figure 20. Percentage of Involvements by Vehicle Action

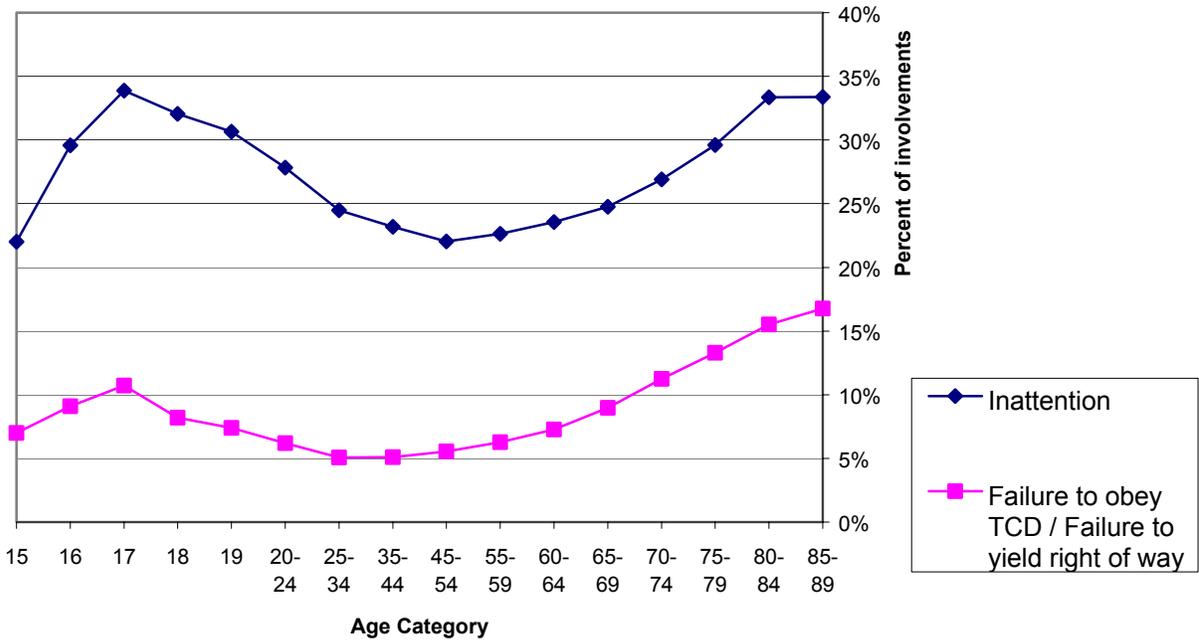


Figure 21. Percentage of Involvements Associated with Contributing Circumstances: Inattention and Failure to Yield/Obey TCD

## Contributing Circumstances

The police officer includes information about contributing circumstances associated with each vehicle that was involved in a crash. Since this is based on the judgment of the police officer, one has to be cautious in interpreting the results. The results for this variable are illustrated in two separate figures. Figure 21 looks at 'inattention' and 'failure to obey traffic control device (TCD) / failure to yield', two common contributing circumstances, that are coded by police officers. Both young drivers (specifically, 17 year old drivers) and older drivers seem to be charged with inattention or failure to obey TCD / failure to yield, more often than middle-aged drivers. Previous research has shown that older drivers have difficulties when they have to yield to other traffic.<sup>(46)</sup> Young drivers may make mistakes under these conditions due to inexperience, impatience, and overconfidence.

Figure 22 looks at four other contributing circumstances: 'following too closely', 'unsafe speed', 'improper turning', and 'backing unsafely.'<sup>21</sup> Younger drivers have a much higher chance of being charged with 'unsafe speed' compared to middle aged and older drivers. Older teenagers have a slightly higher chance of being charged with 'following too closely' compared to older drivers. Young and older drivers have a higher chance of being charged with 'improper turning' and 'backing unsafely', compared to middle aged and older drivers, consistent with the earlier discussion.

## At-Fault Drivers and Innocent Victims

The information coded by the police officer in the contributing factor variable can be used to determine full / partial responsibility by a particular driver for a crash. In New Jersey, the police officer can code 26 different contributing factors including 'none' and 'other'. These factors can be divided into: (i) driver errors and (ii) other contributing circumstances that were not related to the driver. If driver error was involved, that particular driver was considered at least partly at-fault. If driver error was not involved, the driver was considered an innocent victim. All crashes including single vehicle crashes were considered in this analysis. The following shows how the 26 contributing factors were grouped into 'at-fault' and 'innocent victim' categories:

### Driver Error (at-fault):

- Unsafe Speed
- Driver Inattention
- Failed to Obey Traffic Control Device
- Failed to Yield Right of Way to Vehicle/Pedestrian
- Improper Lane Change
- Improper Use of Turn Signals/Failure to Signal
- Improper Turning
- Following Too Closely

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<sup>21</sup> Figures 4.20 and 4.21 are drawn to a different scale. Readers should exercise caution in comparing them.

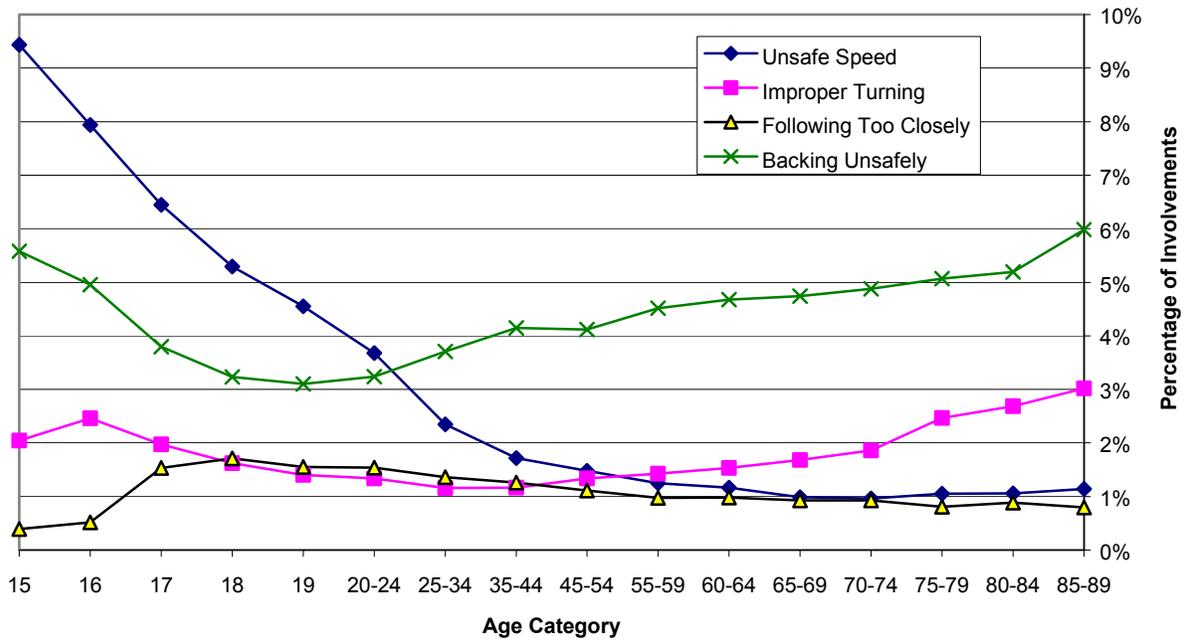


Figure 22. Percentage of Involvements Associated with Other Contributing Circumstances

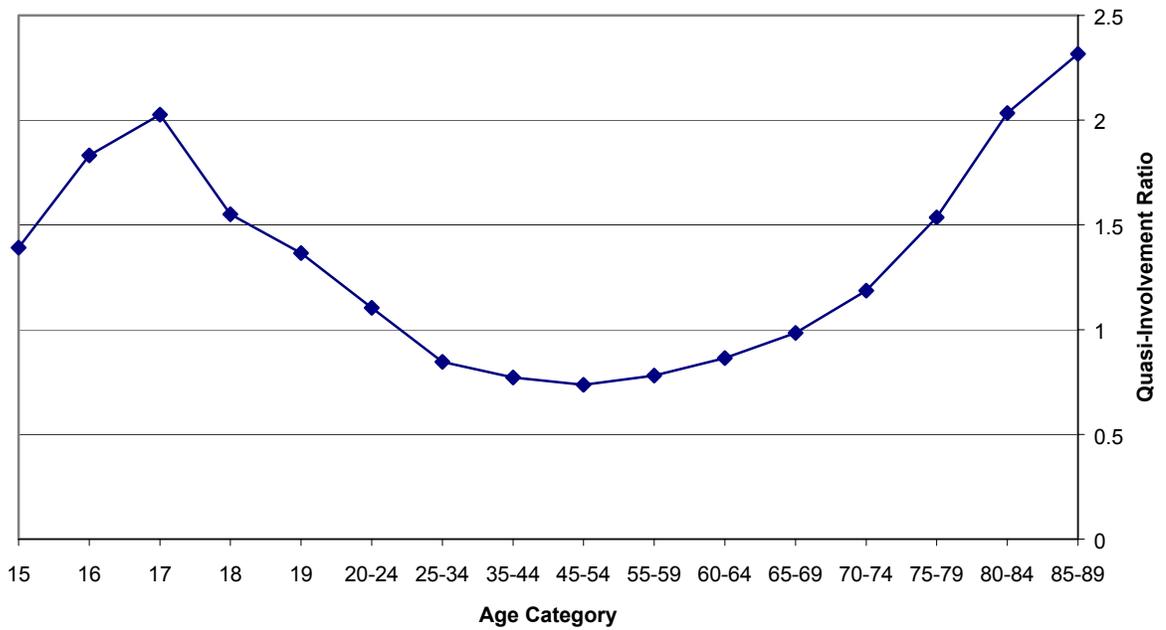


Figure 23. Quasi-Involvement Ratio

- Backing Unsafely
- Dazzling, Improper, or No Lights
- Wrong Way, One Way Road
- Improper Parking
- Failure to Keep Right

Other Contributing Circumstances (innocent victim):

- Pedestrian's / Bicyclist's Actions
- Vehicle Defect
- Animal's Action
- Defective Shoulder
- View / Obstruction / Limited
- Water Puddles
- Obstruction / Debris on the Road
- Improper / Inadequate Lane Marking
- Other Roadway Defects
- Traffic Control Device Defective / Missing
- None

For each age group, the number of involvements where a driver was at-fault was divided by the number of involvements where a driver was an innocent victim. This ratio can be called as a quasi-involvement ratio, since it is similar to the involvement ratio that was discussed earlier in Section 2. A high value of this ratio indicates that a particular age group is more often at-fault more than other age groups.

Figure 23 shows the quasi-involvement ratio for different age groups. The quasi-involvement ratio is highest for the young and old drivers consistent with previous studies that used induced exposure methods.<sup>(46)</sup> This indicates that the younger and older drivers are more often at-fault compared to middle aged drivers.

### **Analysis of Violation and Suspension Data**

The New Jersey Department of Motor Vehicles records more than 1600 different types of events including violations and suspension orders given to individual drivers. After a review of these types of events, 228 types of events relevant to the project were extracted for analysis (see Appendix D). These included primarily 58 different types of suspension orders and 154 types of violations. The 58 different types of suspension orders were grouped into the following 10 categories:

- Speeding or exceeding speed limitations
- Fatality related
- Unqualified due to physical or medical conditions
- Probationary driver program – fail to complete or points
- Persistent violator

Operating / driving under the influence  
Left scene of accident – injury  
Left scene of accident – PDO / other  
Unlicensed  
Probationary driver and improvement program

The 154 different types of violations were grouped into the following 20 categories:

Operating / driving under the influence  
Unlicensed  
Equipment / vehicle related defects  
Struck animal  
Failure to yield  
Failure to observe / obey traffic control device  
Reckless driving or racing  
Following too closely  
Careless driving  
Left scene of accident – death  
Left scene of accident – injury  
Left scene of accident – PDO/other  
Improper crossing – railroad grade crossing  
Speeding or exceeding speed limitations  
Failure to notify – seizure  
Regular / special learners permit non-compliance  
Unsafe driver  
Operated at slow speed / blocked traffic  
Driving after underage drinking  
Failure to wear seat belt

Data were extracted for drivers age 16 through 21 and drivers 40 and older from 1996 to 2000.

### Violation and Suspension Rates

Figures 24 through 27 show violation and suspension rates<sup>22</sup> (per 10,000 people) calculated by dividing the number of violations (and suspensions) by the population in that age group, and multiplying the result by 10,000. For drivers 17-21, the violation rate is between 2000 and 3500 violations per year per 10,000 people. In this group, 18-year-old drivers have the highest rate and 17 year olds have the lowest rate. Since, data on number of licensed drivers or miles driven are not available, it is difficult to infer whether these numbers reflect driver behavior or just exposure. 16-year-old drivers have much lower violation rates compared to other teenagers. For the middle aged and older drivers, the 40-54 age group has the highest violation rates.

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<sup>22</sup> Readers should note that these results include only those driving related violations and suspensions that were selected by the research team.

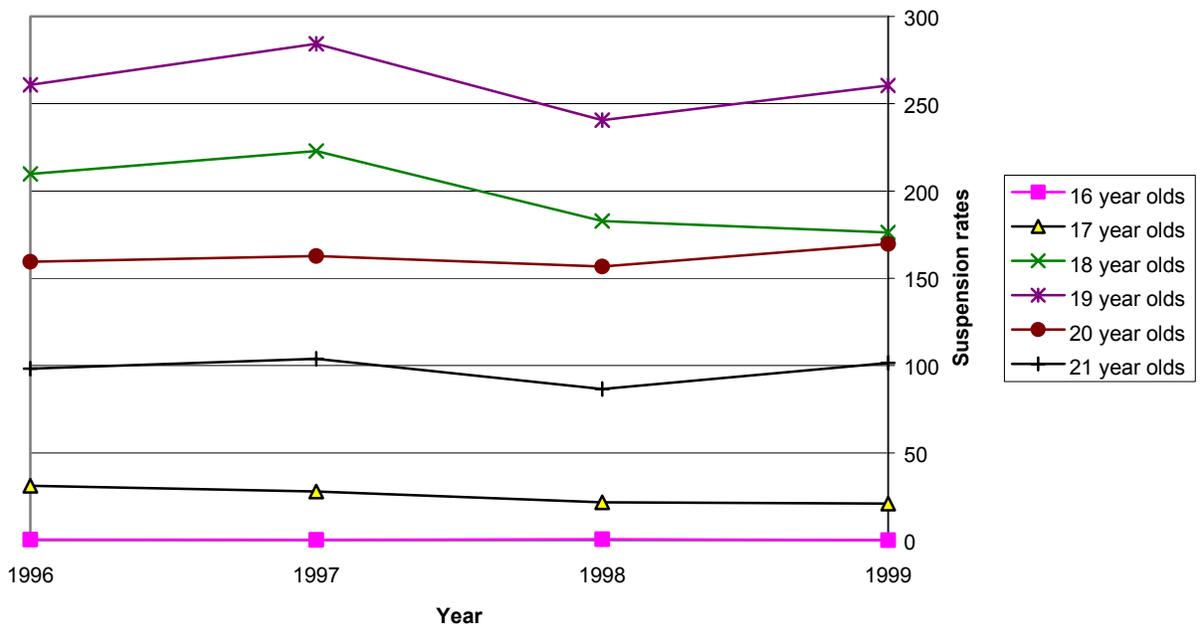


Figure 24. Suspension Rates for 16-21 Year Old Drivers (per 10,000 People)

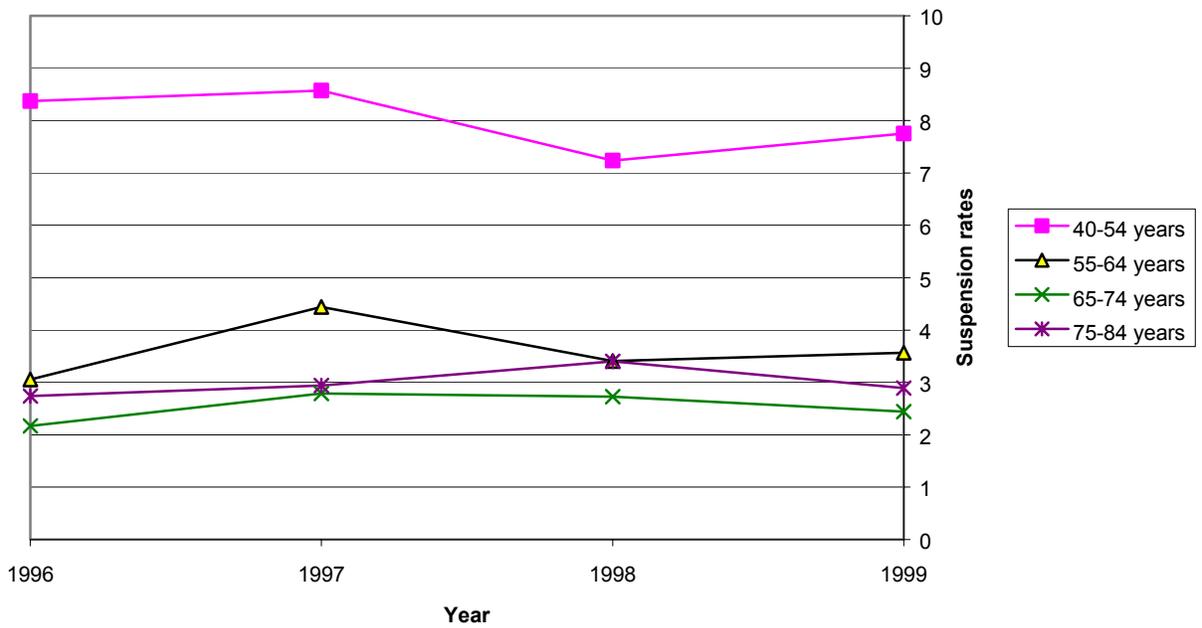


Figure 25. Suspension Rates for 40-84 Year Old Drivers (per 10,000 People)

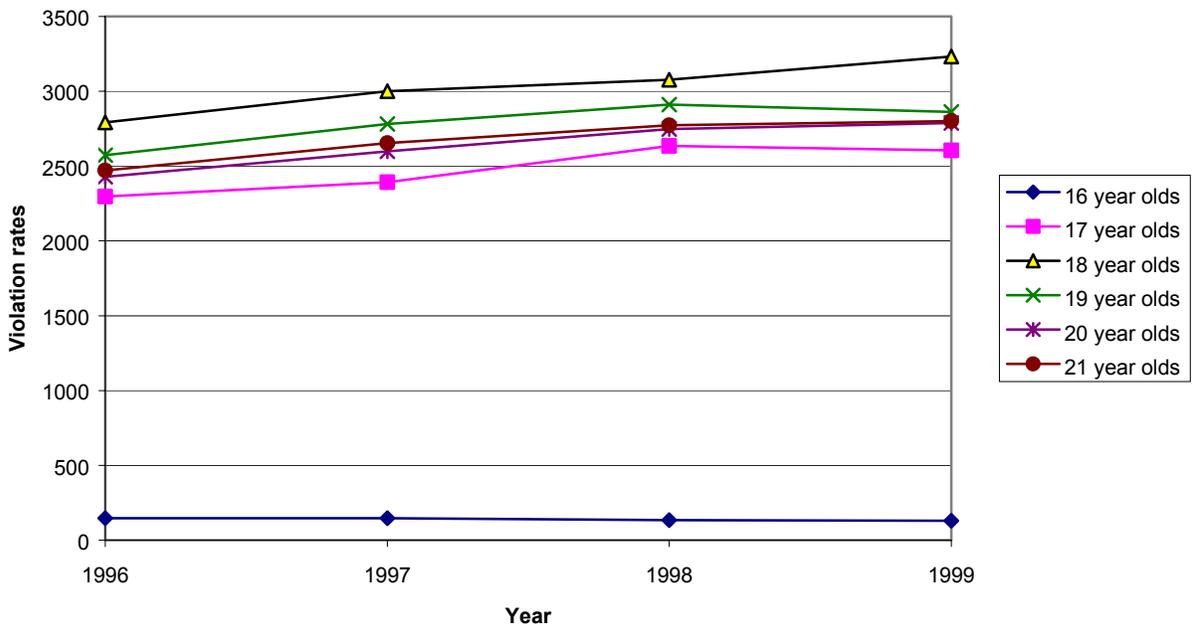


Figure 26. Violation Rates for 16-21 Year Old Drivers (per 10,000 People)

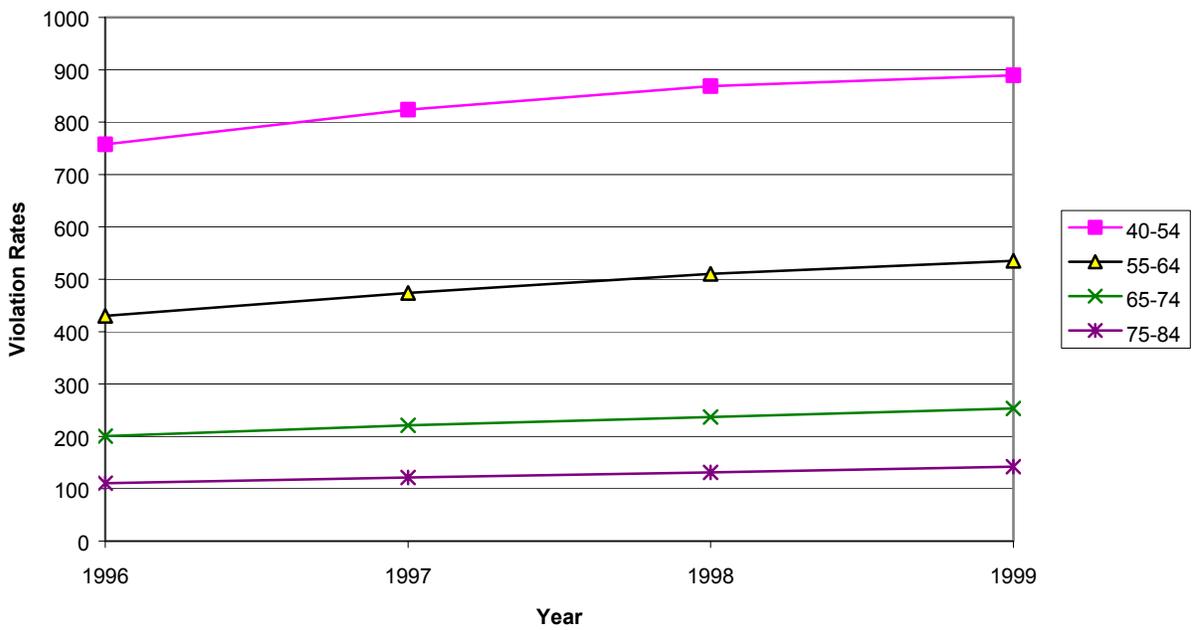


Figure 27. Violation Rates for 40-84 Year Old Drivers (per 10,000 People)

Looking at suspension rates, 19 year old drivers have the highest suspension rates, and 16 and 17 year old drivers have the lowest suspension rates. Among middle aged and older drivers, the 40-54 age group has the highest suspension rate, probably due to the greater number of miles driven by this age group.<sup>(54)</sup>

### Type of Violation and Suspension

Figure 28 and 29 show the relationship between age and percentage by type of suspension order. The following can be observed from the figure:

- Older drivers (shown in Figure 29) are suspended more often for being 'unqualified due to medical or physical conditions'. This is to be expected.
- Younger drivers are issued a suspension order more often than middle aged and older drivers for accumulating too many points or failing to complete the probationary driver program. Again, this is not surprising.
- Drivers in the 40-54 age group seem to have the highest percentage of suspension orders due to being a 'persistent violator'. Among other factors, it is possible that this is primarily a function of the amount of driving.

Figures 30 and 31 show the relationship between age and percentage by type of violation. The figure indicates the following:

- Speeding or exceeding speed limitations is the most common type of violation. Drivers 18-12 have the highest values.
- Older drivers, and to a lesser extent young drivers have a relatively high percentage of 'careless driving' violations.
- Older drivers have a higher percentage of violations due to 'failure to yield / failure to obey TCD', consistent with the results obtained from the analysis of the crash data.

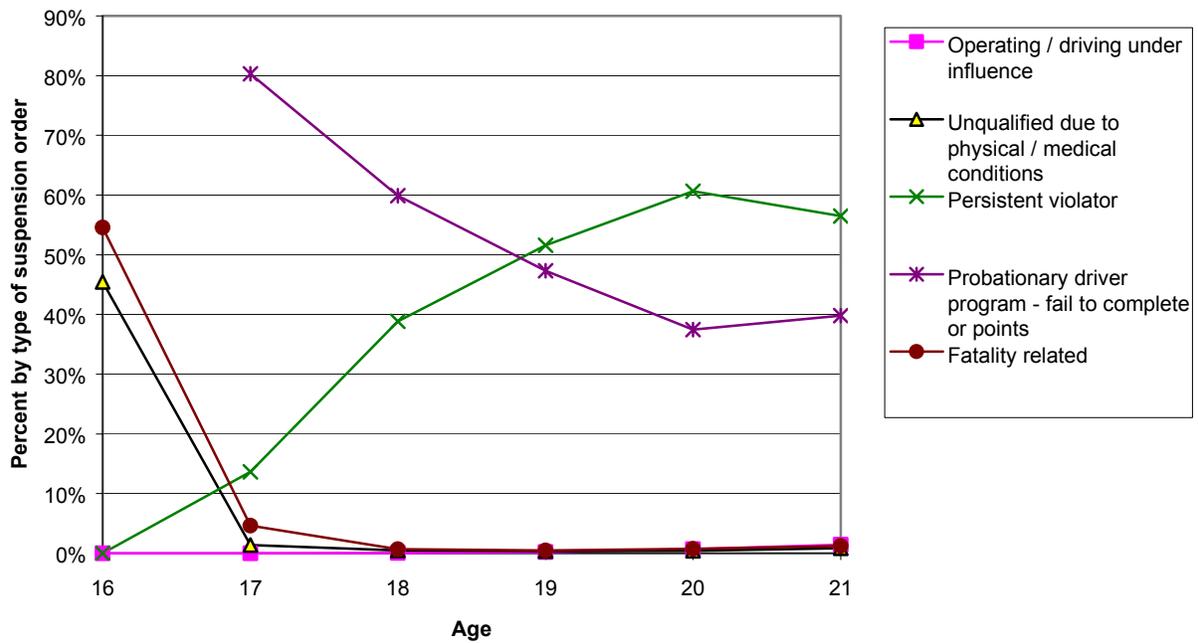


Figure 28. Percentage of Suspensions by Type (16-21 Year Old Drivers)

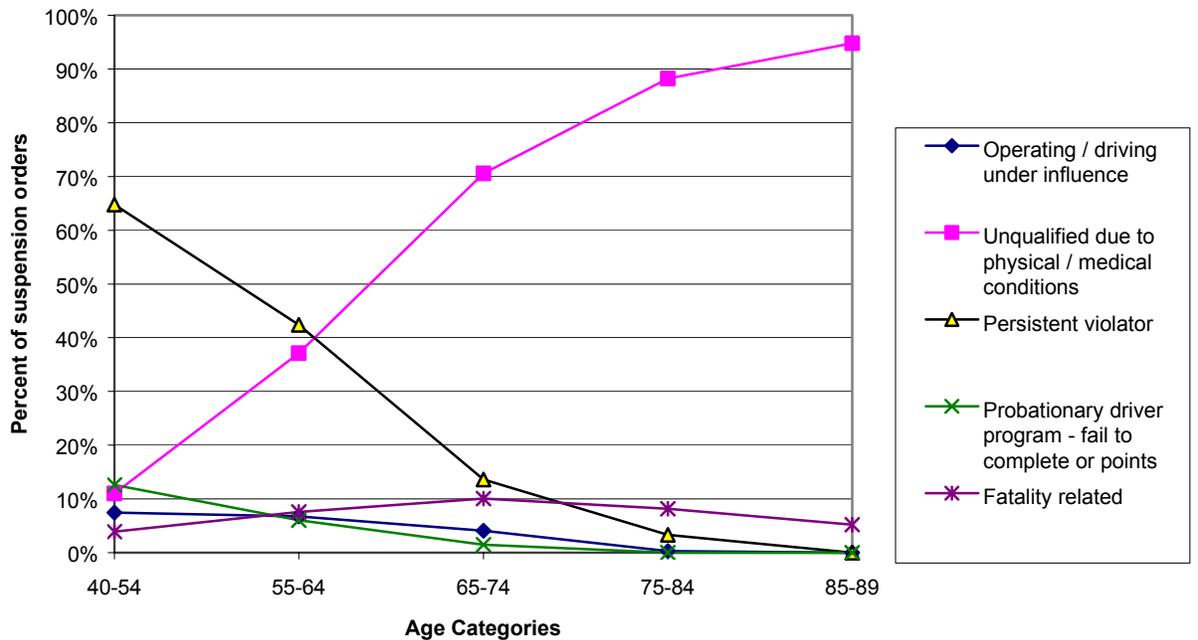


Figure 29. Percentage of Suspensions by Type (45-89 Year Old Drivers)

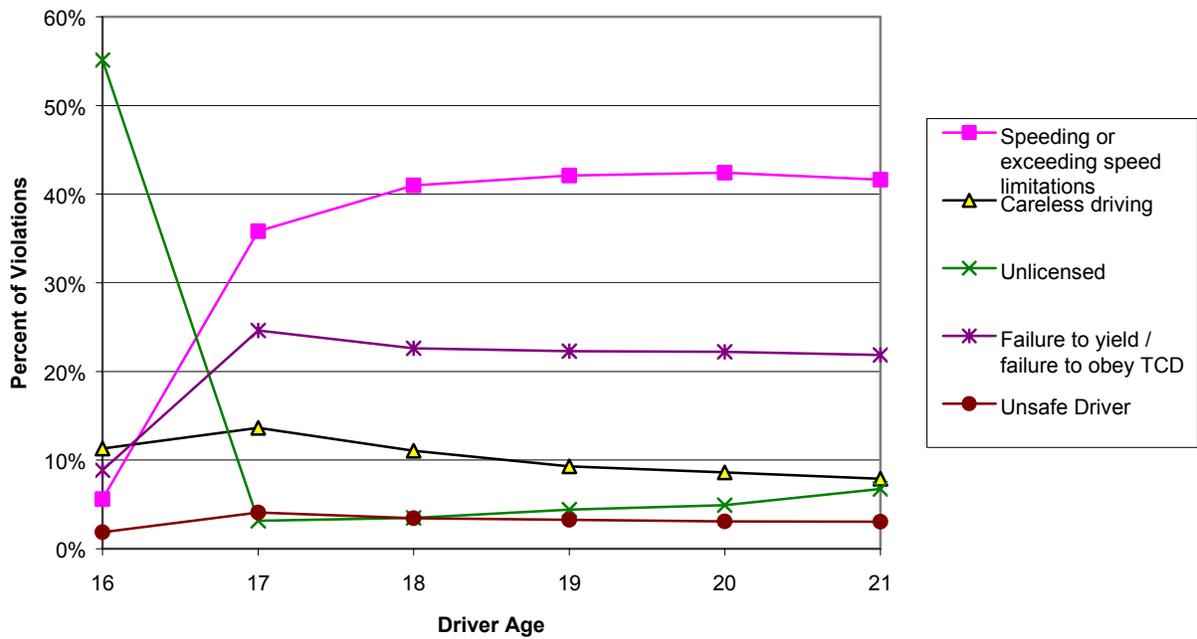


Figure 30. Percentage of Violations by Type (16-21 Year Old Drivers)

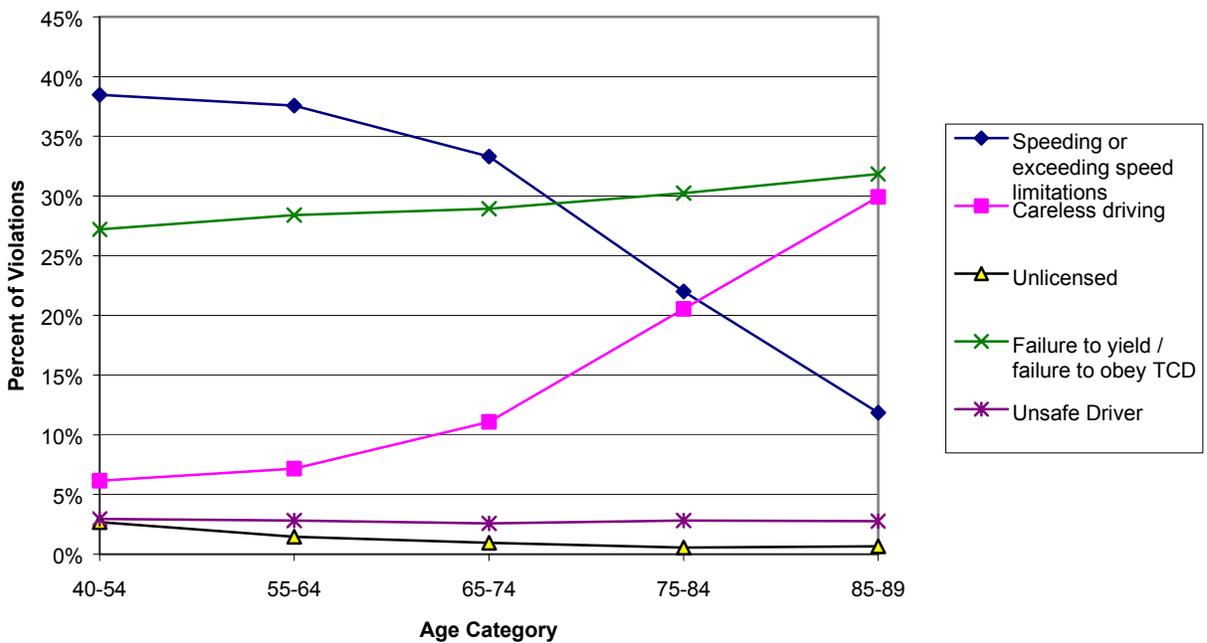


Figure 31. Percentage of Violations by Type (40-89 Year Old Drivers)

## 5. SUMMARY AND CONCLUSIONS

The evidence that young, novice drivers have high crash rates, putting themselves, their passengers, and others who share the road at risk, is overwhelming. Previous research indicates that the teenage drivers are over represented in particular types of accidents including single vehicle crashes, crashes at night and weekends, and crashes with several passengers present.

Thirty four states plus the District of Columbia have responded by passing GDL programs incorporating one or more measures which extend the period over which the beginning driver learns or gains experience driving, ensures supervision during the learning period, restricts or bans driving late at night, limits teenage drivers, or other. Thirteen GDL programs, including ten in the United States, have been evaluated in the literature; all have reported positive outcomes in reducing crashes of novice drivers.

Teenage drivers in New Jersey show the same high crash involvements as they do in other states. In fact, for the period 1998 to 2000, the numbers of involvements for 17, 18, and 19 year olds are higher than those for any other age, despite the likelihood that drivers of these three ages probably drive less than other ages.

The following are the crash characteristics that most distinguish either the 17 year old or 17, 18 and 19 year old drivers from older cohorts:

- Higher percentage of crashes occur after dark
- More crashes occur on local roads
- Lower percent of crashes are fatal compared to older drivers, but higher percent are fatal or injury crashes than for the middle aged driver
- Lower percent occur during the period of the AM commute peak, but higher percent of fatal and injury crashes occur during early morning from 5:00 to 7:00 a.m.
- Much higher percent of crashes are single vehicle crashes
- For 17 year olds, higher percent of left-turn crashes than middle aged drivers (but not mature drivers)
- Higher percent of crashes due to inattention than middle aged driver
- Higher percent of crashes due to failure to obey TCD/ failure to yield than middle aged driver
- Much higher percent of crashes due to unsafe speed
- Lower percent of crashes due to backing unsafely
- Higher likelihood of being at fault (based on the quasi-involvement ratio) than middle aged drivers
- Much higher rate of suspensions
- Much higher rate of violations
- Higher percent of violations due to speeding
- Higher percent of violations due to careless driving than for middle aged driver

The GDL program that New Jersey has enacted has two components that may affect specific characteristics of teenage crash involvements other than the hope for overall reduction. Those components are the restrictions on teenage passengers and the midnight to 5 a.m. curfew. The nature of the crash data, particularly the 1998 to 2000 data, does not allow the analysis of crashes by number of passengers, but crashes by time of day were analyzed. The percent of crash involvements of 17 and 18 year olds that occurred between midnight and 5 a.m. is lower than any other time period, not surprisingly given that they probably driver less than the other periods. The literature reports a higher crash per mile rate for this period, but the data for calculating this rate for New Jersey are not available. However, it should also be noted that the percent of fatal and injury accidents that occur in the midnight to 5 a.m. period is higher for the 17 and 18 year olds than for any other period except (curiously) 5 a.m. to 7 a.m.

## APPENDIX A

### Driver Behavior and Safety Characteristics of Teenage and Novice Drivers: A Literature Review

Teenage drivers (ages 16-19) are among the least safe of any age group. They constitute a smaller portion of the population than those in the 35-44 yr age group, yet they were involved in more total accidents (560,000 vs. 540,000).<sup>(55)</sup> Doherty et al.,<sup>(56)</sup> found that, while 16-19 year olds also had the lowest travel distances among any group aged 16-59; they are over-represented in accidents. While the young driver group is responsible for 4.9% of total travel, they are involved in 13.7% of all accidents.

The actual risk faced by teenage drivers can be measured as multiples of the risks to other age groups. In the US, there were 3.0 fatal involvements<sup>23</sup> per 100 million vehicle miles of travel (VMT) in 1990. Teenagers (16-19) have a higher rate than any other group except drivers over 70 (See Figure 32). Compared to other age groups, not only do teens have three times the risk of being involved in a fatal accident, they are also at 3.3 times more risk for injury accidents.<sup>(57)</sup> Although this study provided only aggregate data for the 16-19 year old age group, other sources indicate the much larger involvement rate among 16-year olds, a common age for teenagers to start driving.

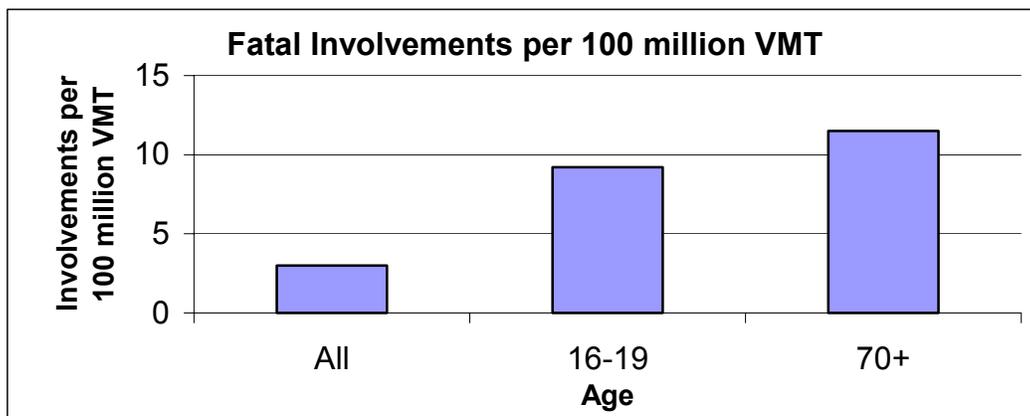


Figure 32. Fatal involvement rates for different age groups in 1990.

Between 1982 and 1998, there was a 2% decrease in adult fatalities, and a 27% decrease in youth (ages 15-20) fatalities.<sup>(1)</sup> During the same period in which crash rates for most drivers, including teenagers 17 and older have been slowly decreasing, rates for 16-year-old drivers have increased.

Data from the Fatality Analysis Reporting System<sup>(55)</sup> shows that the death rate for 16-yr old drivers has increased from 19 to 35 per 100,000 licensed drivers from 1975 to 1998 (see Figure 33). The death rate for 17-19 olds, steadily decreasing from 1975 to 1996,

<sup>23</sup> An accident involving 2 vehicles would qualify as 2 involvements

had been higher than that for 16-yr olds up to 1984. The rate was calculated per 100,000 people in the particular age groups and controls for the fact that the teenage population had declined up until the early 1992. Hence, while the high fatality rates were not caused by increasing number of teenagers, the fact that the teenage population is now increasing suggests that more deaths will occur if there are no changes in fatality rates.<sup>(58)</sup>

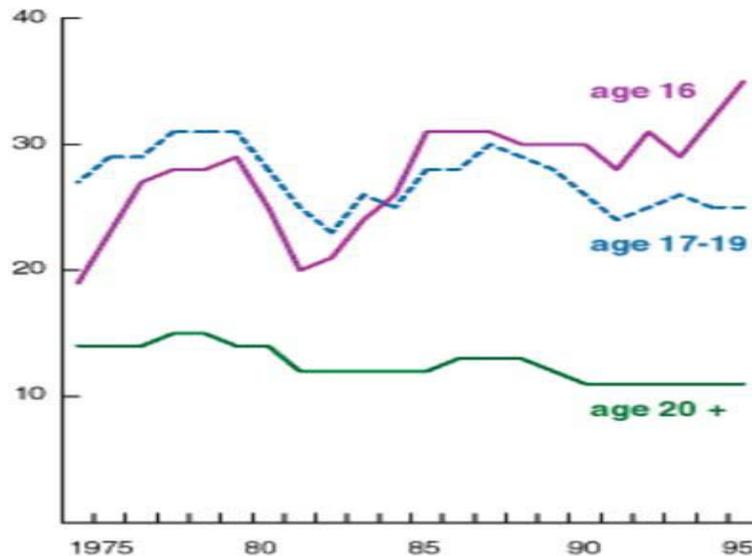


Figure 33. Fatalities per 100,000 licensed drivers for different age groups between 1975-1998.

## Reasons for Higher Risk

### Immaturity and Inexperience

Young men have been observed to engage in risky activities more than other groups. These include: driving closer to the car in front, pulling out of an intersection with less gap and ignoring traffic signs.<sup>(59)</sup> Speeding is another area of concern. Among all 16-yr old drivers involved in fatal accidents, 36% were reportedly speeding or going too fast for road conditions. By comparison, 20-49 year old drivers involved in fatal accidents were speeding only 22% of the time.<sup>(60)</sup>

Arnett et al.<sup>(61)</sup> conducted a study of 139 novice drivers at a small suburban high school. Almost 80% reported driving over 80 MPH at least once over the course of a year. Almost half of the respondents admitted to driving 20 MPH over the speed limit regularly (more than 10 times in one year). Males were more likely than females to have raced another car (59% v. 36%) or to have passed in a no-passing zone (62% v. 39%). Accident rates were found to decrease over the 2<sup>nd</sup> and 3<sup>rd</sup> years of driving for speeds under 70 kph. However, over the same period there was no significant decrease in

accidents at speeds over 70 kph. In addition, only non-alcohol related accident rates decreased over the 3-year period.

Emotions were found to be a somewhat reliable predictor of the driver's tendency to speed. Of teenagers who described themselves as being "angry" at a given time, 68% were driving 10 MPH over the speed limit. Of those who were excited or sad, almost half drove 10 MPH above the speed limit and half drove 10 MPH below the speed limit. Those who expressed themselves as "stressed", "happy", "tired", or "neutral", were seen to be predominantly driving 10 MPH below the speed limit.<sup>(61)</sup>

The driving behavior of 15-year olds is analyzed less often than that of older teens. Williams et al.<sup>(62)</sup> analyzed crash data for 15-yr olds in 33 states. It was found that most 15-yr old drivers either were not permit holders or were driving in violation of the terms of the state's permit. Previous work by the same authors in 1985 featured high school students surveyed in seven states. While 66% of permit holders drove less than 10 miles per week, 29% drove 10-50 miles, and 5% drove more than 50 miles per week. Among licensed drivers (typically aged 16, as opposed to 15-yr old permit holders), 44% reported driving more than 50 miles per week.

The data above shows that 15-yr olds are less likely to accumulate miles in their vehicles than 16-year olds. However, they have higher accident rates in high-risk situations.<sup>(62)</sup> Unlicensed 15-year olds were at greater risk for an accident while engaged in nighttime driving, and they were more likely to be involved in single vehicle accidents. They were also associated with high vehicle occupancy more than 16-yr olds. These factors are discussed further below.

Novices were also found to be at relatively higher risk when they were occasional drivers, as non-owners and non-principal operators. Even occasional drivers' accident rates decreased with accumulated experience. Another high-risk group are those who were driving to their place of work. Their travel is more stressful, with imposed time constraints, leading to more aggressive driving.<sup>(63)</sup>

Gregersen and Bjurulf<sup>(64)</sup> present an analysis of novice drivers' accident involvement in which they conclude that experience is of greater importance than age-related factors, except for 15-year old drivers, who displayed much more immature driving behavior than 16-yr olds. They also studied the issue of beginners adopting bad habits (such as speeding and ignoring traffic signs), and reinforcing these behaviors while gaining experience. However, with lower observed accident rates at older ages, they concluded that the gain in experience offset the reinforcement of bad habits.

A study of novice drivers and accident rates in British Columbia also explored the issue of age versus lack of experience.<sup>(63)</sup> The findings show that 16-18 year olds have significantly different accident experience from the older age group of 19-21 year olds. The former have had less travel time, and therefore, less experience, than the latter. The findings distinguish between culpable and non-culpable accidents, and show that there are more culpable accidents per novice driver in the first year than in the second

or third years. In addition, the reduction in accident rates is highest in the first year. The rates of non-culpable accidents are relatively constant over the first three years, suggesting that the chances of “being hit” do not decrease with more experience. This suggests that the observed higher crash rates are caused primarily by culpable novices. A similar trend is observed when comparing novice drivers to the entire population, not just those in their first three years of driving.

### Culpability of Teen Drivers

Drivers aged 16-19 have the highest percentage of single vehicle crashes: 23% for 16-yr olds, and 16% for 20-24 yr olds. Moreover, they are more likely to be involved in single vehicle fatal accidents: 44% of all fatal crashes by 16-yr old drivers were single-vehicle; the comparable figure for 20-24 yr olds was 35%.<sup>(65)</sup>

As mentioned above, not only is it important to distinguish between teens and the rest of the population, it is equally important to distinguish between 16-yr olds (1<sup>st</sup> year drivers in most cases), and older teens. Fatal crashes involving 16-year olds differ from those involving older teen drivers. Analysis of 1993 crash data showed that the former group was more likely to have single vehicle crashes (23% for 16-yr olds v. 20% for 17 and 18 yr olds). In most cases, single vehicle crashes suggest culpability on the part of the driver. Younger teens were also more likely to be the culpable party in multiple vehicle crashes, and they were more likely to be involved with cases of speeding and high vehicle occupancy.<sup>(65)</sup>

Ulmer et al.<sup>(65)</sup> focused on the events that indicated user culpability. For 16-year-old drivers, 12% of vehicles involved in crashes went off the edge of the road; 18% traveled into another vehicle’s lane; encroachment into another vehicle’s lane at an intersection was noted 23 % of the time.

Another report on the causes of fatal crashes shows that driver error is involved in 80% of 16-yr olds’ fatal accidents. A 5% decrease occurs for 17-yr olds, and 20-49-yr old driver’s accidents feature driver error only 62% of the time. Similar trends were observed for speeding and high-vehicle occupancy as risk factors for accidents.<sup>(66)</sup>

### Nighttime and Weekend Driving

The teenage driver death rate was 1.24 deaths per 10 million trips between the hours of 6 AM and 10 PM (Figure 34). For the two hours before midnight, that rate increased to 3.26, and further almost five-fold to 14.2 between the hours of 12AM and 6 AM.<sup>(11)</sup> Another study conducted by Doherty et al.<sup>(56)</sup> showed an increase in fatal accident involvement rate of 350% for the hours of 8PM to 4:59 AM, among drivers 20-59 years old. The study also showed an increase in fatality rate of almost eight times for 20-24 females driving in those hours.

The study by Massie et al.<sup>(57)</sup> explained the increased crash rate by the reduced visibility, fatigue, and higher probability of alcohol use. The accident involvement rate is

3 to 5 times higher at night than in the day for younger drivers. The difference is most pronounced for the 16 through 19 and 20 through 24 age groups. Males were at more than twice as much risk at night for fatal accidents, but the difference was less pronounced for injury accidents.<sup>(57)</sup>

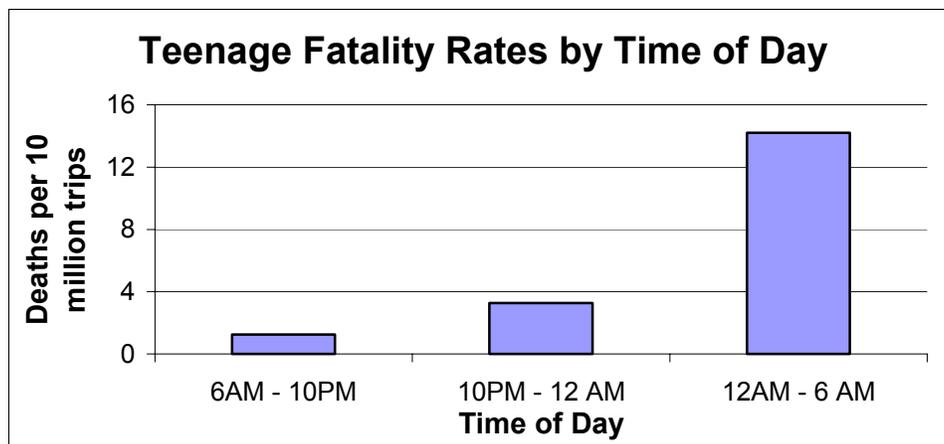


Figure 34. Teenage fatality rates by time of day

A study conducted by Doherty et al.<sup>(56)</sup> in Ontario found that late-night curfews on young drivers reduced total driving by four percent, but fatal accident involvements among beginning drivers decreased by 24 percent. Total accident involvements for beginning drivers decreased by 10 percent. Table 2 shows the accident involvements for different age groups at different times in the day. The same study also looked at the trip purposes for drivers on the road from midnight to 4:59 AM. Note that the late night rate for 25-59 year olds increases more than three times over the day rate, compared to a less than two times increase for 16-19 year olds. Despite this increase, the younger age group still averages 2.3 times more accidents than the 25-49 year old age group in the hours after midnight. For 16-19 year old drivers, over 82% of nighttime trips were for recreational or social purposes. Less than 12% of their trips were to school or work.

Table 2. The effect of nighttime driving on different age groups.

Total Accidents per million kms of travel			
Age Group	Time of Day		Increase
	8:00 PM-11:59 PM	12:00 AM - 4:59 AM	
16-19	23.4	42.3	1.81
20-24	7.9	13.8	1.75
25-59	5.1	18.5	3.63

Young novice drivers were found to be at greater risk in both nighttime hours and on weekends, however, it was found that most novice drivers who undertake nighttime

driving are older beginners, beyond the drinking age. Teenagers, by comparison, were found to drive most often during after-school, evening hours.<sup>(63)</sup> NHTSA<sup>(67)</sup> reports that the crash rate for weekends is twice that for weekdays. During 1998, a youth death was recorded in a traffic crash at an average of once an hour on weekends, and once every two hours on weekdays.

### Effect of Passengers

A vehicle with a teen driver and teenage passengers is at much higher risk than one with the young driver alone. The relative risk of driver death increases with the number of passengers for young drivers per 10 million trips.<sup>(11)</sup> For 16-yr old drivers with one passenger, the risk was 2.76 deaths per 10 million trips. That increased to 3.69 for those with 2 passengers, and 5.61 for 3 or more passengers. 17 year old drivers had lower death rates overall than their 16 year old counterparts, but the relationship was still established between risk and vehicle occupancy (See Figure 35). Among single passenger drivers, the death rate was 2.18, increasing to 4.52 for 17 year old drivers with 3 or more passengers.

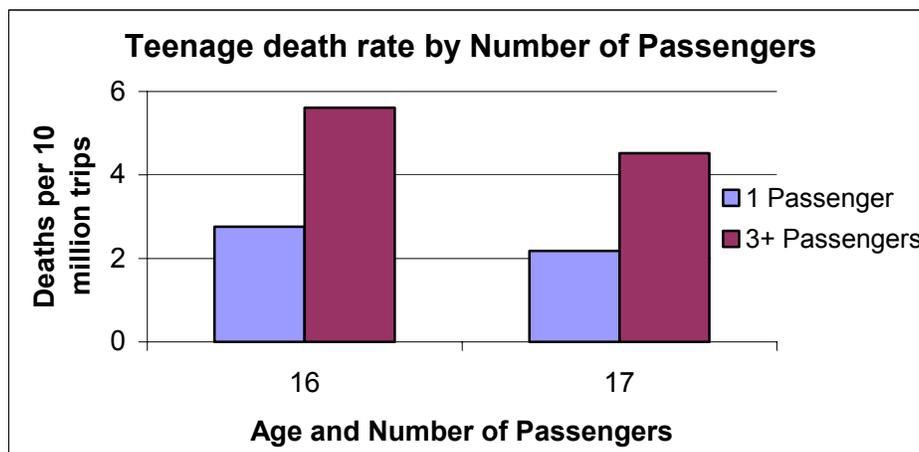


Figure 35. Relationship between teenage death rate and the number of passengers

Male teenage drivers aged 16 and 17 were almost three times as likely as female teenage drivers to be involved in a fatal accident when traveling with two or more passengers: 9.08 deaths per 10 million trips, vs. 3.31 for 16 year olds, and 6.92 vs. 2.28 for 17-year-old drivers.

By comparison, no increase in risk was observed for drivers aged 30-59 with passengers. In fact, the unaccompanied driver was found to be at a greater risk in that age group, in stark contrast to teenage drivers' risk characteristics: 0.68 deaths per 10 million trips for drivers with no passengers vs. 0.42 for drivers with two passengers.

While passengers traveling with 30-59 year old drivers reduce their propensity for crashes, for younger drivers (16-24), the percentage of teen-culpable crashes increases. The effect is most obvious for 16-19 year olds. In Preusser's study<sup>(3)</sup> of

accident data, 86% of 16-19 year old drivers with passengers were at-fault, compared to 81% of lone drivers.

A study by Aldridge et al.<sup>(67)</sup> found that the relative accident involvement ratio (RAIR), measuring the ratio between the percent of males at-fault in single-vehicle accidents to the percent at-fault in multiple-vehicle accidents, was found to be almost half for drivers traveling with either a child or an adult, compared to those traveling with peers. In addition, it was found that about half of all alcohol-related fatally injured teenage drivers had one or more passengers in the car, and 90 percent of those passengers were within 25 percent of the driver's age.<sup>(67)</sup> Another study indicated that teenage drivers (age 16-17) traveling with only passengers under 20 were at four times more risk than those in the same age group who were traveling alone, while those with non-peer passengers were at less risk.<sup>(68)</sup> All these findings indicate that teenagers traveling with their peers are more likely to take risks.

Motor vehicle related risks equally affect the teen driver and the peer passenger. Sixty-two percent of teen passenger deaths involved passengers in vehicles driven by teens.<sup>(66)</sup> About 54% of the crash-related deaths among teenagers in 1998 were drivers; the other 46% were teen passengers.

### Alcohol

One-third of all young adult (15-20 yrs of age) motor vehicle fatalities involve alcohol. However, from 1982 to 1997, the number of alcohol-related youth deaths decreased by almost 59%. There are fewer alcohol-related fatalities for both low BAC (0.01-0.09) and high BAC (0.10).<sup>(67)</sup> Half of all youth fatalities on weekends were alcohol-related, while 28% of those on weekdays involved alcohol.

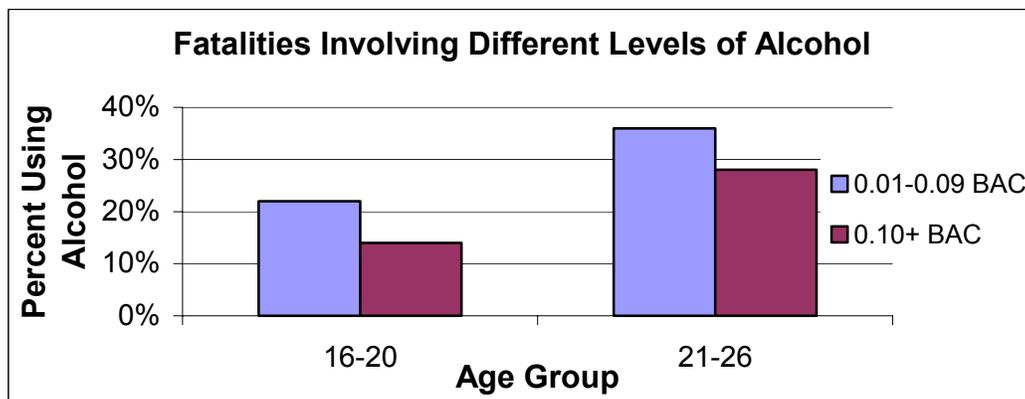


Figure 36. Percentage of fatalities related to alcohol (for two age groups).

At either BACs of 0.01-0.09 or .010 and above, there were lower percentages of young drivers aged 16-20 involved in fatal accidents than 21-44 yr old drivers. 22% of drivers aged 16-20 involved in fatal accidents had BAC's of 0.01+, compared to a 36%

involvement among 21-26 yr olds, and 26% for 35-44 year olds (see Figure 36).<sup>(55)</sup> However, in absolute numbers, more 18-yr olds died in low BAC (.01-.09) alcohol-related crashes than any other age.<sup>(67)</sup>

### Drinking Patterns

In a 1999 survey, one-third of high school students reported riding with a drunk driver in the past 30 days, and 13 percent reported to have driven themselves after drinking. Almost 25% of seniors in a suburban high school studied by Arnett et al.<sup>(61)</sup> admitted to having driven while intoxicated at least once during the past year. This proportion was the same for males and females.

Kulick and Rosenberg<sup>(69)</sup> studied 116 university students at a midwestern university to analyze driving after drinking among young drivers. Despite the legal drinking age of 21, males on average were found to have experimented with alcohol for the first time at the age of 15.3. Females on average were found to have started at an average age of 16.2. Males also claimed to be driving after drinking three or more beers on nine occasions over the past year, while females averaged 8.2 events of that type over that time (See Figure 37).

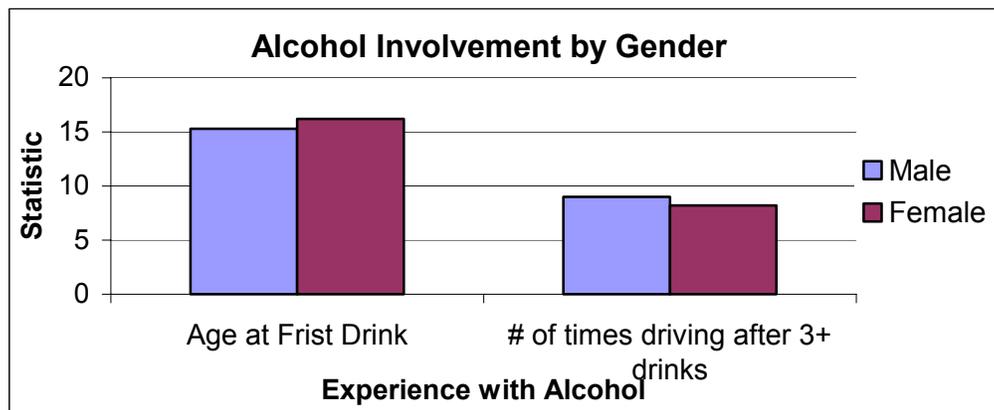


Figure 37. Teenage involvement with alcohol by age and gender

The most common coping methods for not being detected were: driving slowly, driving more cautiously or following laws more diligently. A small portion chose to take roads with lower traffic volumes to improve their chances of not being detected. However, a significant portion of the participants studied claimed to take no measure to prevent getting caught. Nevertheless, this is a minority in comparison to those who practiced drinking and driving and subsequently tried to conceal the act. The fact that teens were experimenting with different ways to cover up their drinking prior to driving demonstrates that the drivers see the penalty of enforcement as a hindrance, instead of recognizing its safety benefits.<sup>(69)</sup>

## Seat Belt Use

Among young (aged 15 to 20) motor vehicle occupant fatalities, only about 30% were using safety devices (seat belt or motorcycle helmet).<sup>(70)</sup> Belt use among teens was observed to be highest among 16-yr olds (49%), and lower for 15-yr old drivers (44%) and for older drivers (down to 39% among 19-yr olds).<sup>(68)</sup>

A study conducted in Houston found that teens use seat belts less frequently than adults (57% v. 71%). Cities with secondary belt enforcement laws (Yazoo City, Mississippi) had lower overall belt use among adults (28%), yet it was still lower among teens (20%) (See Figure 38). The study also showed that travel purpose affected rates of belt use. In cases where the trip purpose was to go to church, teen belt use was 65%, compared to 37% for trips to recreational areas. Females used belts more often than males.<sup>(12)</sup>

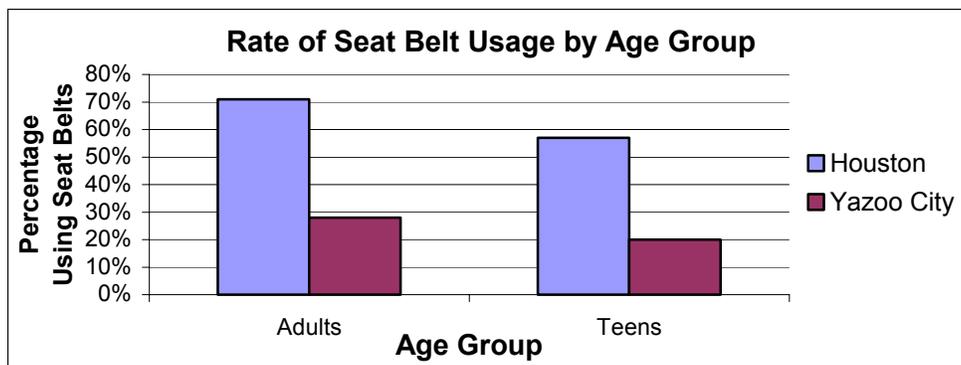


Figure 38. Teen drivers do not buckle up as much as their adult counterparts.

## Gender Differences

A study of the rate of licensure at age 16 shows females to be licensed at the same rate as males.<sup>(71)</sup> The same study found that female drivers make more errors with control aspects when taking a driving test than male drivers. Although men drive more than women and have a higher accident involvement rate in fatal injuries, females have a higher rate of injury accidents, especially during the teen years.<sup>(57)</sup> Ferguson et al.<sup>(50)</sup> suggest that females begin the licensing stage with less on-the-road driving experience than males.

An analysis by Ulmer et al.<sup>(65)</sup> of FARS and GES crash data showed that 16-year-old female drivers comprised a greater portion of crashes at their age than older drivers (44% of 16-yr olds v. 39% of 18-yr olds, for all crashes, and 34% v. 26%, respectively, for fatal crashes). A report from the Insurance Institute for Highway Safety confirms that female drivers at the age of 16 were involved in 35% of fatal crashes in their age group. Furthermore, it showed that females aged 17 to 19 were involved in 29% of all

accidents in that age group, and females between 20 and 49 comprised 30% of the crashes in their age group (See Figure 39).<sup>(66)</sup>

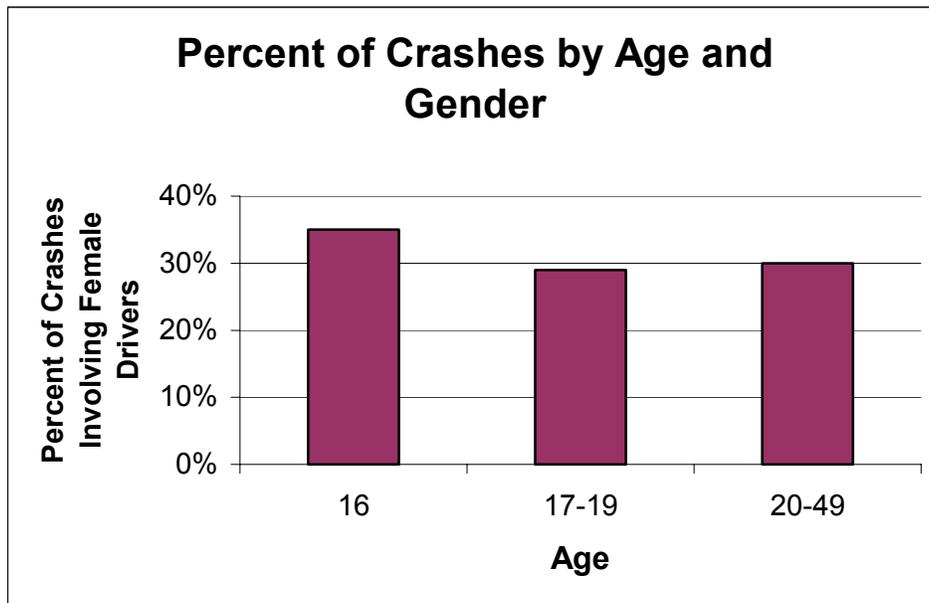


Figure 39. Percent of crashes involving female drivers.

Driver fatal accident involvement rates among 16-yr old females (per 100,000 licensed drivers) reached a 20-yr low in the early 90's ('91-'92) (15 per 100,000), but have been increasing since that time and are higher than they were 20 years ago.<sup>(55)</sup> Among 10-17 yr old passengers and drivers, the death rates for males were 1.3-1.7 times higher than for females. For 18 and 19 year olds, the ratio of male to female fatal crash rates was 2.1-2.5, with males at more risk. At these older teen years, risk generally decreases, so if males are found to have higher relative risk rates, it indicates that the risk rate of females decreases more rapidly after the age of 16.

A study conducted on teens in New Zealand found that male and females have generally the same attitudes toward drinking and driving. However, only 30% of the females studied were drivers, as compared to 56% of the males.<sup>(57)</sup> Because of this reason, females are often seen as being at risk from alcohol not as drivers but as passengers of drunk drivers. For example, none of the females studied were open to the idea of driving themselves after drinking, although 15% had driven home with a drunken friend, another 13% traveled with a friends' parent, and 22% went with a drinking boyfriend.

Harre<sup>(59)</sup> found driving speeds were lower for female drivers than those of male drivers, and females were observed to comply with restricted license conditions more frequently. Although the male and female participants of the study expressed similar attitudes, variations were observed in actual driving observations.

Wylie<sup>(72)</sup> conducted a study on young (15-24 yrs old) female drivers in New Zealand, and found that the distance traveled by females was 43% of the distance traveled by males. This was despite the fact that the licensure rate for the young female population had increased from 50% in 1976 to 56% in 1990. Females over 25 had accident rates of 25 % of their male counterparts. The accident rate for females over 25 was approximately two-thirds of the accident rate for females aged 15-24. The accident rate for males over 25 was approximately 50% of the accident rates of males below 25. Similar ratios were observed for drivers of the same age groups.

### Teen's Driving Records in Relation to Parents' Records

A study in North Carolina indicated that the driving records of young drivers (age 18-21) in the first few years of licensure are related to the driving records of their parents. Teens whose parents had three or more recorded crashes were 22 percent more likely to crash at least once, compared to teens whose parents had no crashes.<sup>(73)</sup> They were also 38 percent more likely to have a recorded violation themselves. For each crash on the parents' record, the teen would be 7 percent more likely to have an additional crash and 13 percent more likely to have an additional violation. For each violation on the parents' record, the corresponding increased likelihood of a teen crash or violation is 3 percent. Males were more likely than females to have received a recorded violation (20% vs. 10%), or to have been involved in a recorded crash (24% vs. 20%) given similar parental driving records.<sup>(66)</sup>

### Vehicles Driven by Teenagers

Although teenage drivers are at more risk, the safety afforded by newer cars is a low priority among parents when selecting a vehicle for teen drivers. Instead, teens in four northeastern states were found to be driving older and smaller vehicles.<sup>(12)</sup> The relative accident involvement ratios were higher for those with new (less than 3 years old) or very old (>10-yr old) cars.

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## **APPENDIX C**

### **Variables extracted from 1998-2000 NJDOT Crash Data**

### 1998-2000 Crash Data

Data Description	From	To	Len	Field No.
Accident Year (YY)	X	2	2	
Accident ID (page 1)	X	8	6	
Accident Suffix (added pages)	X	9	1	
blank		11	2	
Date of Collision (mmddyy )	X	21	10	46
Time (hhmm)	X	25	4	48
County/Municipality Code	X	29	4	49
Total Killed	X	31	2	50
Total Injured	X	33	2	51
Posted Speed	X	35	2	86
Pedestrian Maneuver		37	2	1
Traffic Controls Veh1	X	39	2	2
Traffic Controls Veh2	X	41	2	3
Road System	X	43	2	4
Road Character	X	45	2	5
Road Surface Type	X	47	2	6
Road Surface Condition	X	49	2	7
Weather	X	51	2	8
Vehicle Type Veh1	X	53	2	11
Vehicle Type Veh2	X	55	2	12
Road Divided By		57	2	15
Road Under Construction		59	2	16
Apparent Contributing Circumstances Veh1	X	61	2	28
Apparent Contributing Circumstances Veh2	X	63	2	29
Light Condition	X	65	2	34
Physical Status Driver Veh1	X	67	2	35
Physical Status Driver Veh2	X	69	2	36
Pre-Accident Vehicle Action Veh1	X	71	2	38
Pre-Accident Vehicle Action Veh2	X	73	2	39
Sequence of Events 1 Veh1		75	2	40a
Sequence of Events 2 Veh1		77	2	40b
Sequence of Events 3 Veh1		79	2	40c
Sequence of Events 4 Veh1		81	2	40d
Sequence of Events 1 Veh2		83	2	41a
Sequence of Events 2 Veh2		85	2	41b
Sequence of Events 3 Veh2		87	2	41c
Sequence of Events 4 Veh2		89	2	41d
Collision Type	X	91	2	42
No. Vehicles Involved this page	X	93	2	122
VictimA - Which Vehicle Occupied		95	2	17a
VictimA - Physical Condition		97	2	19a
VictimA - Age		100	3	21a
VictimA - Sex		101	1	22a
VictimA - Safety Equipment Used		103	2	26a
VictimB - Which Vehicle Occupied		105	2	17b
VictimB - Physical Condition		107	2	19b
VictimB - Age		110	3	21b
VictimB - Sex		111	1	22b
VictimB - Safety Equipment Used		113	2	26b
VictimC - Which Vehicle Occupied		115	2	17c
VictimC - Physical Condition		117	2	19c

VictimC - Age		120	3	21c
VictimC - Sex		121	1	22c
VictimC – Safety Equipment Used		123	2	26c
VictimD - Which Vehicle Occupied		125	2	17d
VictimD - Physical Condition		127	2	19d
VictimD - Age		130	3	21d
VictimD - Sex		131	1	22d
VictimD – Safety Equipment Used		133	2	26d
VictimE - Which Vehicle Occupied		135	2	17e
VictimE - Physical Condition		137	2	19e
VictimE - Age		140	3	21e
VictimE - Sex		141	1	22e
VictimE – Safety Equipment Used		143	2	26e
Driver1 – State of License	X	145	2	71
Driver1 – DOB (mmddyy )	X	155	10	72
Driver1 – Sex	X	156	1	74
Driver1 – Alcohol Test Given	X	157	1	108a
Driver1 – Alcohol Test Type	X	159	2	108b
Driver1 – Alcohol Test Results	X	161	2	108c
Driver2 – State of License	X	163	2	94
Driver2 – DOB (mmddyy )	X	173	10	95
Driver2 – Sex	X	174	1	97
Driver2 – Alcohol Test Given	X	175	1	108d
Driver2 – Alcohol Test Type	X	177	2	108e
Driver2 – Alcohol Test Results	X	179	2	108f
Charge (operator 1)		209	30	116
Charge (operator 2)		239	30	117

NOTES:

1. Accident Suffix represents added pages to the Accident ID (page 1 of the Accident Report) where suffix A = page 2, B = page 3, etc.
2. Data such as Total Killed, Total Injured, and Number of Vehicles Involved are for the report page only and do not represent totals for the entire accident. To arrive at total for these items for each accident all pages of the accident must be summed.
3. Accident Day of Week was inadvertently omitted from the database by the vendor. This, however, can be computed using a date function available in most software products.

## **APPENDIX D**

**Events (violations and suspensions) extracted from NJDMV's driver history records**

<b>EVT TYP</b>	<b>EVT RESP</b>	<b>EVT ID</b>	<b>EVT DESCRIPTION</b>	<b>CODES</b>	<b>CODES DESCRIPTION</b>
A	CIS	POLC	INVOLVED IN ACCIDENT-POLICE REPORT	1	INVOLVED IN ACCIDENT-POLICE REPORT
E	RSU	EYES	DRIV REEXAM-VISION-ASSIGN/SCHEDULE	30	Reexamination
E	RSU	MAP3	DRV REEXAM-MED PNL-ASSIGN/SCHEDULE	30	Reexamination
E	RSU	MDAP	DRV REEXAM-MED PNL-ASSIGN/SCHEDULE	30	Reexamination
E	RSU	PHYS	DRIV REEXAM-PHYS-ASSIGN/SCHEDULE	30	Reexamination
K	MFR	CBIR	MEDICAL INTERVAL REPORTING-LICENSE	31	Medical interval reporting
K	MFR	DBIR	MEDICAL INTERVAL REPORTING-LICENSE	31	Medical interval reporting
K	MFR	GBIR	MEDICAL INTERVAL REPORTING-LICENSE	31	Medical interval reporting
K	MFR	HBIR	MEDICAL INTERVAL REPORTING-LICENSE	31	Medical interval reporting
K	MFR	MBIR	MEDICAL INTERVAL REPORTING-LICENSE	31	Medical interval reporting
K	MFR	NBIR	MEDICAL INTERVAL REPORTING-LICENSE	31	Medical interval reporting
K	MFR	SBIR	MEDICAL INTERVAL REPORTING-LICENSE	31	Medical interval reporting
K	MFR	ZBIR	MEDICAL INTERVAL REPORTING-LICENSE	31	Medical interval reporting
O	CRT	SPED	SPEEDING	7	Speeding or exceeding speed limitations
O	DMV	PRDP	PERMANENT REVOCATION NJ DRIV PRIVS	3	PERMANENT REVOCATION NJ DRIV PRIVS
O	FAR	EFTL	FATAL ACCIDENT-EMERGENT	29	Fatality related
O	FAR	FCSC	FATAL ORD:FAIL TO COMPLY SETTLE/CONF	29	Fatality related
O	FAR	FFTL	FATAL ACCIDENT-FOREIGN STATE	29	Fatality related
O	FAR	NFTL	FATAL ACCIDENT-NON EMERGENT	29	Fatality related
O	FAR	SIAE	SERIOUS INJURY ACCIDENT: EMERGENT	30	Serious injury - emergency
O	MFR	BLKO	PHYSICALLY UNQUALIFIED-BLACKOUTS	17	Unqualified due to physical or medical conditions
O	MFR	CARD	PHYSICALLY UNQUALIFIED-CARDIOVASCUL	17	Unqualified due to physical or medical conditions
O	MFR	CBMU	MED UNQUALIFIED TO DRIVE-LICENSE	17	Unqualified due to physical or medical conditions
O	MFR	CHMU	MED UNQUALIFIED TO DRIVE-HAZMAT	17	Unqualified due to physical or medical conditions
O	MFR	CNVC	SUSPEND DRI PRIV-CONVULSIVE DISORDE	17	Unqualified due to physical or medical conditions
O	MFR	CONV	PHYSICALLY UNQUALIFIED-CONVULSIVE	17	Unqualified due to physical or medical conditions
O	MFR	CPMU	MED UNQUALIFIED TO DRIVE-PASS	17	Unqualified due to physical or medical conditions
O	MFR	DBMU	MED UNQUALIFIED TO DRIVE-LICENSE	17	Unqualified due to physical or medical conditions
O	MFR	DHMU	MED UNQUALIFIED TO DRIVE-HAZMAT	17	Unqualified due to physical or medical conditions
O	MFR	DIAB	PHYSICALLY UNQUALIFIED-DIABETES	17	Unqualified due to physical or medical conditions
O	MFR	DPMU	MED UNQUALIFIED TO DRIVE-PASS	17	Unqualified due to physical or medical conditions
O	MFR	EYES	PHYSICALLY UNQUALIFIED VISION DEFIC	17	Unqualified due to physical or medical conditions
O	MFR	GBMU	MED UNQUALIFIED TO DRIVE-LICENSE	17	Unqualified due to physical or medical conditions

O	MFR	GHMU	MED UNQUALIFIED TO DRIVE-HAZMAT	17	Unqualified due to physical or medical conditions
O	MFR	GPMU	MED UNQUALIFIED TO DRIVE-PASS	17	Unqualified due to physical or medical conditions
O	MFR	HBMU	MED UNQUALIFIED TO DRIVE-LICENSE	17	Unqualified due to physical or medical conditions
O	MFR	HHMU	MED UNQUALIFIED TO DRIVE-HAZMAT	17	Unqualified due to physical or medical conditions
O	MFR	HOSP	PHYS UNQUAL-STATE HOSPITAL REPORT	17	Unqualified due to physical or medical conditions
O	MFR	HPMU	MED UNQUALIFIED TO DRIVE-PASS	17	Unqualified due to physical or medical conditions
O	MFR	MBMU	MED UNQUALIFIED TO DRIVE-LICENSE	17	Unqualified due to physical or medical conditions
O	MFR	MEOD	PHYS UNQUAL-MED EXAM OTHER DEFECTS	17	Unqualified due to physical or medical conditions
O	MFR	MHMU	MED UNQUALIFIED TO DRIVE-HAZMAT	17	Unqualified due to physical or medical conditions
O	MFR	MNTL	PHY UNQUAL MENTAL/NERVOUS DISABILIT	17	Unqualified due to physical or medical conditions
O	MFR	MPMU	MED UNQUALIFIED TO DRIVE-PASS	17	Unqualified due to physical or medical conditions
O	MFR	NBMU	MED UNQUALIFIED TO DRIVE-LICENSE	17	Unqualified due to physical or medical conditions
O	MFR	NEUR	PHYSICALLY UNQUALIFIED-NEUROLOGIC	17	Unqualified due to physical or medical conditions
O	MFR	NHMU	MED UNQUALIFIED TO DRIVE-HAZMAT	17	Unqualified due to physical or medical conditions
O	MFR	NPMU	MED UNQUALIFIED TO DRIVE-PASS	17	Unqualified due to physical or medical conditions
O	MFR	SBMU	MED UNQUALIFIED TO DRIVE-LICENSE	17	Unqualified due to physical or medical conditions
O	MFR	SENL	PHYSICALLY UNQUALIFIED SENILITY	17	Unqualified due to physical or medical conditions
O	MFR	SHMU	MED UNQUALIFIED TO DRIVE-HAZMAT	17	Unqualified due to physical or medical conditions
O	MFR	SPMU	MED UNQUALIFIED TO DRIVE-PASS	17	Unqualified due to physical or medical conditions
O	MFR	STRK	PHYSICALLY UNQUALIFIED-STROKE	17	Unqualified due to physical or medical conditions
O	MFR	ZBMU	MED UNQUALIFIED TO DRIVE-LICENSE	17	Unqualified due to physical or medical conditions
O	MFR	ZHMU	MED UNQUALIFIED TO DRIVE-HAZMAT	17	Unqualified due to physical or medical conditions
O	MFR	ZPMU	MED UNQUALIFIED TO DRIVE-PASS	17	Unqualified due to physical or medical conditions
O	PDP	FCPC	FAIL TO COMPLETE PROB DRIVER PROGRA	28	Probationary driver program - fail to complete OR points
O	PDP	FCPD	FAIL TO COMPLETE PROB DRIVER PROGRA	28	Probationary driver program - fail to complete OR points
O	PDP	PTPD	POINT SYSTEM-PROB DRIVER PROGRAM	28	Probationary driver program - fail to complete OR points
O	PDP	PVPD	PERSISTENT VIOLATOR	27	PERSISTENT VIOLATOR
O	SUS	CCDS	O/S UNDER INFL CONTRL DANG SUB/CMV	12	Operating / driving under influence
O	SUS	CSDD	DRIV UNDER INFLUENCE-COMPACT STATE	12	Operating / driving under influence
O	SUS	H113	O/S OPER UNDER INFLUENCE-HAZ/MATERI	12	Operating / driving under influence
O	SUS	H29A	O/S LEAVE SCENE ACCD-PERSNL INJ/HZM	10	Leave scene of accident - injury
O	SUS	H29B	O/S LEAVE SCENE ACCD-PROP DAM/HAZMA	11	Leave scene of accident - PDO/other
O	SUS	H29D	O/S LEAVE SCENE ACC UNAT PROP/HAZMA	11	Leave scene of accident - PDO/other
O	SUS	H450	O/S OPER UNDER INFLUENCE-HAZARD MAT	12	Operating / driving under influence

O	SUS	HCDS	O/S UND INFL CONTRL DANG SUB/HAZMAT	12 Operating / driving under influence
O	SUS	OSDD	DRIV UNDER INFLUENCE-NONCOMP STATE	12 Operating / driving under influence
O	SUS	OSLS	DRIVER LIC SUSPD-NONCOMPACT STATE	18 Unlicensed
O	SUS	PVPS	PERSISTENT VIOLATOR	27 Persistent violator
P	DIP	PROG	DRI IMPROV PROG ASSIGN/SCHEDULE	39 Prob driver and improv
P	PDP	PROG	PROB DRIVER PROG ASSIGN/SCHEDULE	39 Prob driver and improv
V	EXT	010B	UNDER INFLNC CONTRLLD DANGRS SUBST	212 Operating / driving under influence
V	EXT	0310	UNLICENSED DRIVER	218 Unlicensed
V	EXT	0343	EQUIPMENT VIOLATION:MVS REGULATIONS	219 Equipment / vehicle related defects
V	EXT	0344	UNSAFE VEHICLE	219 Equipment / vehicle related defects
V	EXT	0347	OPERATE VEHICLE WITHOUT LIGHTS	219 Equipment / vehicle related defects
V	EXT	0348	IMPROPER VISIBILITY/LIGHTS	219 Equipment / vehicle related defects
V	EXT	0349	VEHIC NOT EQUIPD W/APPRVD HEADLAMPS	219 Equipment / vehicle related defects
V	EXT	0353	SPOT LAMPS PRHIBITED	219 Equipment / vehicle related defects
V	EXT	0354	SPEC RESTRICTIONS-LAMPS/WARN LIGHTS	219 Equipment / vehicle related defects
V	EXT	035C	VEHICLE WITH IMPROPER LIGHT COLOR	219 Equipment / vehicle related defects
V	EXT	0361	LAMPS AND REFLECTORS REQUIRED	219 Equipment / vehicle related defects
V	EXT	0366	MAINTENANCE OF LAMPS	219 Equipment / vehicle related defects
V	EXT	0370	IMPROPER MUFFLER	219 Equipment / vehicle related defects
V	EXT	0372	DRIVE/MOVE MTR VEH W/UNSAFE TIRES	219 Equipment / vehicle related defects
V	EXT	0374	WINDSHIELD/WINDOWS OBSTRUCTED	219 Equipment / vehicle related defects
V	EXT	0375	SAFETY GLASS/BROKEN OR DISTORTED	219 Equipment / vehicle related defects
V	EXT	0376	DANGEROUS EXHAUST GASES	219 Equipment / vehicle related defects
V	EXT	0377	SELLING/USING-UNAPPROVED EQUIPMENT	219 Equipment / vehicle related defects
V	EXT	0380	IMPROPER OR NOT EQUIP APPROVED TIRE	219 Equipment / vehicle related defects
V	EXT	0422	STRIKE ANIMAL WITH CAR	301 Strike animal
V	EXT	0435	FAIL ALLOW PEDESTRIAN COMPLETE CROS	220 Failure to yield
V	EXT	0436	FAILURE YIELD RT WAY TO PEDESTRIAN	220 Failure to yield
V	EXT	0440	IMPROPER PASSING OF STREET CAR	206 Other - Driving related violations or suspensions
V	EXT	0441	DRIVING THROUGH SAFETY ZONE PROHIBI	206 Other - Driving related violations or suspensions
V	EXT	0450	OPERATE UNDER INFLUENCE LIQ/DRUGS	212 Operating / driving under influence
V	EXT	0452	RACING ON HIGHWAY	214 Reckless driving or Racing
V	EXT	0455	IMPROPER ACT STEEP GRADES OR CURVES	206 Other - Driving related violations or suspensions
V	EXT	0456	DELAYING TRAFFIC	206 Other - Driving related violations or suspensions

V	EXT	0457	FAILURE TO COMPLY POLICE INSTRUCTIO	206 Other - Driving related violations or suspensions
V	EXT	0458	DRI VEH W VIEW SIDE/REAR OBSTRUCTED	219 Equipment / vehicle related defects
V	EXT	0466	IMPROPER EXIT DRIVE, ALLEY OR GARAG	206 Other - Driving related violations or suspensions
V	EXT	0467	OBSTRUCTING PASSAGE OF OTHER VEHICL	206 Other - Driving related violations or suspensions
V	EXT	0471	IMPROPER DRIVING ON SIDEWALK	206 Other - Driving related violations or suspensions
V	EXT	0480	DISREGARD OFFICER DIRECTING TRAFFIC	206 Other - Driving related violations or suspensions
V	EXT	0481	FAIL TO OBSERVE TRAFF CNTRL DEVICE	221 Failure to observe / obey traffic control device
V	EXT	0482	FAILURE TO KEEP RIGHT	206 Other - Driving related violations or suspensions
V	EXT	0483	FAILURE TO KEEP RIGHT-INTERSECTION	206 Other - Driving related violations or suspensions
V	EXT	0484	FAIL TO PASS RIGHT PROC IN OPPOS DI	206 Other - Driving related violations or suspensions
V	EXT	0485	IMPROPER PASSING	206 Other - Driving related violations or suspensions
V	EXT	0486	IMPROPER PASS/CROSS NO PASS LINE	206 Other - Driving related violations or suspensions
V	EXT	0487	FAIL TO GIVE WAY TO OVERTAKING VEHI	206 Other - Driving related violations or suspensions
V	EXT	0488	IMPROPER OPER-HWYS W/MARKED LANES	206 Other - Driving related violations or suspensions
V	EXT	0489	FOLLOWING TOO CLOSELY	213 Following too closely
V	EXT	0490	FAILURE TO YIELD RIGHT OF WAY	220 Failure to yield
V	EXT	0491	FAILURE YIELD TO EMERGENCY VEHICLES	220 Failure to yield
V	EXT	0492	FAIL STOP/YIELD TO EMERGENCY VEHICL	220 Failure to yield
V	EXT	0493	FAILURE TO YIELD TO PROCESSION	220 Failure to yield
V	EXT	0496	RECKLESS DRIVING	214 Reckless driving or Racing
V	EXT	0497	CARELESS DRIVING	208 Careless driving
V	EXT	05C1	RACING ON HIGHWAY	214 Reckless driving or Racing
V	EXT	1151	LEAVE SCENE ACDT - DEATH	222 LEAVE SCENE ACDT - DEATH
V	EXT	120B	UNDER INFLUENCE OF NARCOTIC DRUG	212 Operating / driving under influence
V	EXT	1271	IMPROPER CROSSING RAILROAD GRADE	224 Improper crossing - railroad grade crossing
V	EXT	1272	FAILURE COMPLY WITH SIGNAL ON BRIDG	221 Failure to observe / obey traffic control device
V	EXT	1281	PASSING STOPPED SCHOOL BUS	206 Other - Driving related violations or suspensions
V	EXT	1284	NO STOP/IMPROPER PASSG DESSERT TRK	206 Other - Driving related violations or suspensions
V	EXT	129A	LEAVE SCENE ACCDNT-PERSONAL INJURY	210 Leave scene of accident - injury
V	EXT	129B	LEAVE SCENE ACCDNT-PROPERTY DAMAGE	211 Leave scene of accident - PDO/other
V	EXT	129D	LEAVE SCENE ACCDNT-UNATTENDED PROP	211 Leave scene of accident - PDO/other
V	EXT	12A2	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	12A4	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	12A5	SPEEDING	207 Speeding or exceeding speed limitations

V	EXT	12B2	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	12B4	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	12B5	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	12C2	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	2910	MOVING AGAINST TRAFFIC TPK/PKWY/EXW	206 Other - Driving related violations or suspensions
V	EXT	2920	ILLEGAL USE OF MEDIAL STRIP	206 Other - Driving related violations or suspensions
V	EXT	2940	USE OF IMPROPER LANE	206 Other - Driving related violations or suspensions
V	EXT	2950	U TURN PROHIBITED	206 Other - Driving related violations or suspensions
V	EXT	2962	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	2964	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	2965	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	3105	FAIL TO NOTIFY DMV/SEIZURE DISORDER	302 Fail to notify - seizure
V	EXT	3130	REGULAR LEARNER PERMIT NONCOMPLIANC	223 Regular / special learner's permit non-compliance
V	EXT	3132	SPECIAL LEARNER PERMIT NONCOMPLIANC	223 Regular / special learner's permit non-compliance
V	EXT	3261	OPERATE UNDER INFLUENCE LIQ/DRUGS	212 Operating / driving under influence
V	EXT	3262	CARELESS DRIVING	208 Careless driving
V	EXT	4100	SPEEDING ACROSS SIDEWALK	207 Speeding or exceeding speed limitations
V	EXT	4102	SPEEDING BY A PHYSICIAN	207 Speeding or exceeding speed limitations
V	EXT	4105	IMPR OPER AT INTERSECT TRAF SIGNAL	221 Failure to observe / obey traffic control device
V	EXT	4115	IMPROPER TURN TRAFFIC CONTROL SIGNA	221 Failure to observe / obey traffic control device
V	EXT	4116	IMPROPER TURN GREEN ARROW TRAF CNTR	221 Failure to observe / obey traffic control device
V	EXT	4117	FAILURE OBSERVE PEDESTRIAN INTERVAL	221 Failure to observe / obey traffic control device
V	EXT	4119	FAILURE STOP FLASHING RED SIGNAL	221 Failure to observe / obey traffic control device
V	EXT	4122	FAILURE TO STOP FOR POLICE WHISTLE	206 Other - Driving related violations or suspensions
V	EXT	4123	IMPROPER RIGHT AND LEFT TURNS	206 Other - Driving related violations or suspensions
V	EXT	4124	IMPROPER TURN MARKED COURSE	206 Other - Driving related violations or suspensions
V	EXT	4125	U TURN PROHIBITED	206 Other - Driving related violations or suspensions
V	EXT	4126	FAILURE TO GIVE PROPER SIGNAL	206 Other - Driving related violations or suspensions
V	EXT	4127	ILLEGAL BACKING/TURNING IN STREET	206 Other - Driving related violations or suspensions
V	EXT	4128	FAILURE TO STOP AT RAILROAD CROSSIN	221 Failure to observe / obey traffic control device
V	EXT	4129	FAIL TO OBEY TRAFFIC CONTROL DEV	221 Failure to observe / obey traffic control device
V	EXT	4144	DISREGARD OF STOP SIGN REGULATIONS	221 Failure to observe / obey traffic control device
V	EXT	4145	FAIL YIELD LINE VEHICLES THROUGH ST	220 Failure to yield
V	EXT	4215	FAILURE TO OBEY DIRECTIONAL SIGNALS	221 Failure to observe / obey traffic control device

V	EXT	436A	FAILURE YIELD RIGHT WAY TO DRIVER	220 Failure to yield
V	EXT	4371	FAILURE TO YIELD TO BLIND PERSON	220 Failure to yield
V	EXT	4661	IMPROPER ENTERING OR LEAVING HIGHWA	206 Other - Driving related violations or suspensions
V	EXT	4662	AVOIDING A TRAFFIC CONTROL SIGNAL	221 Failure to observe / obey traffic control device
V	EXT	4821	IMPROPER USE OF DIVIDED HIGHWAY	206 Other - Driving related violations or suspensions
V	EXT	4851	WRONG WAY ON ONE WAY STREET	206 Other - Driving related violations or suspensions
V	EXT	4901	FAILURE TO USE PROPER ENTRANCE/EXIT	206 Other - Driving related violations or suspensions
V	EXT	4971	OPERATE AT SLOW SPEED/BLOCK TRAFFIC	205 Operate at slow speed / block traffic
V	EXT	4972	UNSAFE DRIVER	303 Unsafe driver
V	EXT	4982	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	4984	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	4985	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	4992	EXCEEDING SPEED LIMITATIONS	207 Speeding or exceeding speed limitations
V	EXT	5014	DRIVING AFTER UNDERAGE DRINKING	225 Driving after under age drinking
V	EXT	762F	FAILURE TO WEAR SEAT BELT	226 Failure to wear seat belt
V	EXT	8113	FAIL TO OBSERVE TRAFF CNTRL DEVICE	221 Failure to observe / obey traffic control device
V	EXT	8122	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	8124	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	8125	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	815A	FAILURE TO KEEP RIGHT	206 Other - Driving related violations or suspensions
V	EXT	815B	IMPROPER PASSING	206 Other - Driving related violations or suspensions
V	EXT	819A	ILLEGAL ENTRY ONTO THE PARKWAY	206 Other - Driving related violations or suspensions
V	EXT	9122	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	9124	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	9125	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	913C	FAIL TO OBEY TRAFFIC CNTRL DEVICE	221 Failure to observe / obey traffic control device
V	EXT	9140	TPK-UNIFORM DIRECTION TRAFFIC	206 Other - Driving related violations or suspensions
V	EXT	914A	MOVING AGAINST TRAFFIC	206 Other - Driving related violations or suspensions
V	EXT	914B	USE OF IMPROPER LANE	206 Other - Driving related violations or suspensions
V	EXT	9813	RETARDING TRAFFIC	206 Other - Driving related violations or suspensions
V	EXT	9814	MOVING AGAINST TRAFFIC TPK/PKWY/EXW	206 Other - Driving related violations or suspensions
V	EXT	9815	IMPROPER PASSING	206 Other - Driving related violations or suspensions
V	EXT	9816	U TURN PROHIBITED	206 Other - Driving related violations or suspensions
V	EXT	9817	ILLEGAL USE OF MEDIAL STRIP	206 Other - Driving related violations or suspensions

V	EXT	9915	U TURN PROHIBITED	206 Other - Driving related violations or suspensions
V	EXT	9917	ILLEGAL USE OF MEDIAL STRIP	206 Other - Driving related violations or suspensions
V	EXT	A011	OPERATE AT SLOW SPEED/BLOCK TRAFFIC	205 Operate at slow speed / block traffic
V	EXT	A112	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	A114	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	A115	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	A222	ILLEGAL BACKING OR TURNING IN STREE	206 Other - Driving related violations or suspensions
V	EXT	A223	IMPROPER PASSING	206 Other - Driving related violations or suspensions
V	EXT	A224	IMPROPER USE OF DIVIDED HIGHWAY	206 Other - Driving related violations or suspensions
V	EXT	A225	ILLEGAL USE OF MEDIAL STRIP	206 Other - Driving related violations or suspensions
V	EXT	A227	FAILURE TO USE PROPER ENTRANCE/EXIT	206 Other - Driving related violations or suspensions
V	EXT	H113	OPER UNDER INFL LIQ/DRUGS-HAZ/MAT	212 Operating / driving under influence
V	EXT	H29A	LEAVE SCENE ACCD-PERSNL INJUR/HAZMA	210 Leave scene of accident - injury
V	EXT	H29B	LEAVE SCENE ACCD-PROP DAMAGE/HAZMAT	211 Leave scene of accident - PDO/other
V	EXT	H29D	LEAVE SCENE ACCID UNAT PROP/HAZMAT	211 Leave scene of accident - PDO/other
V	EXT	H450	OPER UNDER INFLUENCE/HAZARD MATERIA	212 Operating / driving under influence
V	EXT	HCDS	UNDER INFLU CONTRL DANG SUB/HAZMAT	212 Operating / driving under influence
V	EXT	IBTG	ILLEGAL BACKING/TURNING IN STREET	206 Other - Driving related violations or suspensions
V	EXT	IUEE	FAILURE TO USE PROPER ENTRANCE/EXIT	207 Speeding or exceeding speed limitations
V	EXT	IUMS	ILLEGAL USE OF MEDIAL STRIPS	206 Other - Driving related violations or suspensions
V	EXT	MVLO	OTHER VIOLATIONS-LOCAL ORDINANCES	206 Other - Driving related violations or suspensions
V	EXT	SPED	SPEEDING	207 Speeding or exceeding speed limitations
V	EXT	SSBT	OPERATE AT SLOW SPEED/BLOCK TRAFFIC	205 Operate at slow speed / block traffic
V	EXT	UTRN	U TURN PROHIBITED	206 Other - Driving related violations or suspensions