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An Investigation of Patterns of Adolescent Driving Behaviors Resulting in Fatal Crashes and Their Implications on Policy

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Abstract

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by

Cheryl M. Leonard, MPA

MPA, Master of Public Administration, East Carolina University, 1991

BS, Bachelor of Science, North Carolina State University, 1979

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

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Abstract

The purpose of this quantitative study was to investigate whether there is a statistical relationship between accident-related factors including use of drugs or alcohol, speeding, driver distractions, gender, driver drowsiness, practice of dysfunctional driving maneuvers, and use of occupant protection devices, and fatal vehicle crashes among young teen drivers. Secondary archival data from 84 North Carolina crashes occurring between 2009 and 2013 and involving young teen drivers between the ages of 15 and 18 years were obtained from North Carolina Department of Motor Vehicles Form 349 crash reports. These data were analyzed using chi-square tests for goodness-of-fit, chi-square tests for independence, and z-tests for proportions. The study found statistically significant associations between gender (p <.019), speeding (p < .001), practice of dysfunctional driving maneuvers (p < .001), and non-use of occupant protection devices (p < .001) and teen crash fatalities. The implications of this study for positive social change include recommendations to the State of North Carolina to enact legislative action related to driver education for new drivers, with the anticipated result of reducing traffic fatalities when a teenage driver is involved in an accident. In order to counteract deadly dysfunctional driving maneuvers on the part of young teen drivers, it was recommended that State driver education curricula be expanded to include exposure to more real world, on-the-road supervised driving experience conducted under more varied conditions and that high school driver education facilities be upgraded to include skid pads for student driving practice. Further research relating to the supervised implementation and verification of the requirement of the 50 hours of adult-supervised driving experience for Graduated Driver Licensure was also recommended.

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Dedication

To my faith and family who have provided me the foundation to accomplish my dreams. To my devoted parents, Mother and Daddy, who with all of their love, patience, support, and encouragement has made all my dreams come true.

To my loving sister and brother, Debbie and Frank, who have remained steadfast in reminding me anything and everything is possible. Thank you for pushing me beyond my limits and most importantly sharing in all aspects of my life. With all my love and respect.

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To all my friends and colleagues who have remained steadfast in their support and encouragement in helping me to accomplish my goals.

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Chapter 1: Introduction to the Study

Background

Teen driving habits have become a deadly phenomenon for all drivers across the United States. Motor vehicle crashes have been the leading cause of death in adolescents in the past decade (Centers for Disease Control & Prevention [CDC], 2014). In 2012, approximately 200 people were killed in crashes involving drivers between the ages of 15 and 19 years of age in North Carolina (North Carolina Department of Health and Human Services, 2011). Over the past 7 years, North Carolina crashes involving teen drivers claimed approximately 1,400 lives (North Carolina Department of Health and Human Services, 2011). Since the year 2000, nearly 81,000 people have been killed in U.S. vehicle crashes involving teen drivers; less experienced drivers may be a factor in crashes like these (Masten, Foss, & Marshall, 2011). Dysfunctional and distracting teen driving behaviors, as they impact road safety on the highway, will continue to pose risks not only for the teens themselves, but also for other drivers sharing the roads with them. Risk factors for not just this age group, but various age groups, include using alcohol and drugs, exceeding the speed limit, and failing to use seatbelts.

This study can provide information on this at-risk age group of drivers, because I

- Focused attention on young teen drivers specifically involved in fatal crashes
- Employed raw data extracted directly from on-the-scene accident reports.

This information can inform educational programs directed toward young teen drivers as well as legislation relevant to licensure of drivers in this age group. These

results may provide information on failures of past policy on the part of legislators, administrators, and educators.

Distracted driving is a problem among drivers of all ages and experience levels, but especially for teens due to the combined effects of inexperience, immaturity, peer influences, and use of portable electronic devices (Bingham, 2014a, 2014b; Buckley, Chapman, & Sheehan, 2014; Durbin, McGehee, Fisher, & McCartt, 2014; Romer, Lee, McDonald, & Winston, 2014). The National Traffic Database (NTD) contained data which indicated performing any secondary task (ie., dialing or reaching for a cell phone, texting, reaching for an object, glancing at a roadside object, and eating) was linked with a significantly heightened risk of crash or near crash among young novice drivers (Klauer, Guo, Simons-Morton, Ouimet, Lee, & Dingus, 2013). Furthermore, the prevalence of high-risk, attention diverting behavior increased over time for the young drivers, but not for experienced adult drivers (Klauer et al., 2013). After a decline in fatalities from 1999 to 2005, fatalities from distracted driving increased by 28% from 2005 to 2008 (Wilson & Stimpson, 2010). The increase in texting has been implicated in this phenomenon, but texting is but one of several distractions affecting teen driving. In this study, I focused on a group of drivers who were unique in two ways: (a) their young age and relative lack of driving experience and (b) their involvement in fatal accidents. The study can contribute information to the literature and practice because the data analyzed were extracted directly from the responding officers' accident reports, rather than from summary statistics.

I utilized McConnell's (2010) model of policy success or failure as the framework for my study. According to McConnell (2010), the spectrum of success/failure in

program implementation encompasses numerous aspects of meeting program objectives, identifying program objectives reflecting chronic failures, and re-evaluating a program in which program objectives were characterized by mixed results (p. 354).McConnell (2010) views program success and failure as a spectrum informed by three realms of policy.

Problem Statement

In order to improve education that impacts young teen drivers, parents, and teachers, as well as to put into place more effective policies and legislation for the reduction of traffic fatalities in this age group, it would be helpful to know what factors, or combinations of factors, are associated with traffic fatalities involving young teen drivers. This information would also be helpful in evaluating the success or failure of past educational, legislative, and public policy efforts.

Determining the root of poor teen driving requires viewing driving from the perspectives of various stakeholders as well as teen habits themselves. Driver education programs, the motor vehicle legislation laws, parental guidance to address teen driving habits, and general societal opinions regarding teen driving behaviors have all impacted the problem of highway fatalities among teenage drivers (Bates, Watson, & King, 2006). Teen driving patterns can be identified by a number of markers that may include talking on a cell phone, texting, sending or reading a message while driving, falling asleep while driving, driving without a seatbelt, driving with passengers who do not wear a seatbelt, exceeding the posted speed limit, exhibiting careless and reckless driving that endangers persons and property, driving while impaired, and driving in opposition to the GDL's requirements (Williams, 2012).

The training afforded to teens in driver education programs, the legislative attention directed to the enforcement of driving laws, the available societal resources allocated addressing teen driving habits, as well as parental concerns, all have not thwarted the problem of teen driver fatalities North Carolina highways. Although students are being trained in driver safety by law enforcement, educators, parents/guardians, and society, these adolescents have exhibited risky behaviors and attitudes that appear to negatively impact them when behind the wheel, resulting in a number of crashes and injuries on the roadways (North Carolina Department of Health and Human Services, 2011). Researchers have focused on issues related to teen driving and have found that risky behaviors of teens have infiltrated driving culture.

Due to a lack of data regarding who is responsible for educating teens about correct driving skills, parents, schools, and law enforcement personnel have been at odds on how to end the increase in the death toll. As teenage drivers continue to lose their lives by exhibiting risky behaviors, the NHTSA (Compton & Ellison-Potter, 2008) suggested public education as a solution that may decrease the number of injuries and crashes. A beginning teen driver has been required to adhere to the North Carolina Graduated Driver's License (GDL) requirement (Motor Vehicles, 2002). Furthermore, the North Carolina Graduated Driver's License Law (Motor Vehicles, 2002) identified the levels for which license eligibility is specified, as well as those involved in the training of the young driver. The Governor's Highway Safety Association (as cited in Masten et al., 2011) showed that teen driver fatality is on the rise among 16- to 17-year-old drivers. A rise in teen driver fatality requires a close examination of current Graduated Driver's

License Law to determine what role the law can play in providing a solution to the problem of teen driver fatalities.

Direct access to crash report data from accidents involving teen fatalities should allow a more detailed investigation of these predictive factors than has been hitherto possible or previously reported in the literature. The results of this study should add to previous studies to improve education for teenage drivers, especially for the young teen drivers in the target population for the study, as well as inform legislative decisions regarding teen licensure and driver education. This research involving empirical findings related to teen crash fatalities was interpreted within the theoretical framework of policy success or failure (e.g., McConnell, 2010). Scholars have previously described risky behavior patterns among teenagers between 15- and 19-years-old (Blackman & Abrams, 2008; Craig & McDowell, 2013; Darnell & Dennis, 2008; Hanson, 2008; Males, 2007); however, there have been few studies on patterns of crash data related to highway teen fatalities. In addition, minimal literature has been related to legislative and educational policy addressing these issues.

The findings of this study can provide information for developing and implementing policies and practices aimed at reducing injuries and fatalities among teen drivers. The findings of this study may prove beneficial to teens, parents, educators, legislators, law enforcement officials, health officials, and the general public as the disproportionate incidence of fatalities among teen drivers and their passengers is a public health problem.

Purpose of the Study

The purpose of the study was to empirically investigate factors, and patterns among these factors, associated with traffic fatalities involving young teen drivers and to apply these findings to the evaluation of the success or failure of past educational, legislative, and public policy efforts to reduce the number of these fatalities. The sole dependent variable of the study was the frequency (count, or proportion) of fatal accident cases associated with particular independent variables or combinations of independent variables. The key independent variables were the following:

- Teen driver gender
- Factors reported by the North Carolina State Highway Patrol trooper investigating the accident to be "contributing circumstances" of the accident. These reported contributing circumstances included evidence of alcohol and drug use, use of distracting portable electronic devices (e.g., cell phone use, texting), excessive speed, not using of seatbelts, sleepiness or drowsiness on the part of the driver, and improper maneuvers.

Research Questions

Based primarily on the findings of available research involving teen drivers (i.e., those under 20 years of age) and secondarily on research involving older, adult drivers, the following research questions pertaining to young teen drivers (defined as those from 15.50 to 17.99 years of age) were formulated:

1. What is the association between dysfunctional teen driving behaviors and traffic fatalities among young teen drivers?

2. What is the association between driver gender and selected dysfunctional driver behaviors?

Research Hypotheses

Based upon the research questions, the following research hypotheses were formulated:

- There will be an association between dysfunctional teen driving behaviors and traffic fatalities among young teen drivers.
- There will be an association between driver gender and selected dysfunctional driver behaviors.

The dysfunctional teen driving behaviors hypothesized to be associated with fatalities among young teen drivers were the reported involvement of one of the following: alcohol; drugs; distractions involving the use of electronic devices (e.g., texting); evidence of speeding; sleepiness or drowsiness; and inappropriate driving maneuvers including crossing the center line, overcorrecting, erratic operation of the vehicle, or the non-use of seat belts. The dysfunctional teen driving behaviors hypothesized to be associated with driver gender were the reported involvement of speeding, alcohol use, and inappropriate driving maneuvers.

Theoretical Conceptual Framework

The framework for this study consisted of four perspectives:

- Legislative policy success or failure (e.g., McConnell, 2010)
- Adolescent cognitive and emotional development
- Educational policy success or failure

- Epidemiological and other types of empirical statistical studies of the driving behavior and involvement in traffic fatalities of teenage drivers.

Legislative Policy Success or Failure

The failure and success of policy can be best understood as a spectrum instead of distinct extremes. McConnell (2010) developed a taxonomy of policy successes, failures, and the gray areas in between; McConnell enumerated the following three realms of policy: processes, programs, and politics. McConnell also identified the following spectrum of policy success or failure: "success, resilient success, conflicted success, precarious success, and failure" (p. 345). The results of this study were examined and discussed within this analytic framework, which will be described in greater detail in Chapter 2.

Adolescent Cognitive and Emotional Development Perspective

Potentially risky behavior, such as driving a car, can be affected by the level of maturity of the driver, even in adult drivers. This maturity level is affected by factors of cognitive and emotional development of the teenage driver. These factors will be discussed in detail in Chapter 2.

Educational Policy Success or Failure

Millions of dollars have been invested in driver education; the evaluation of the success of these programs is mixed. McConnell (2010) characterized these as "conflicted success" (p. 345).

Epidemiological and Other Types of Empirical Statistical Studies

A host of epidemiological and other types of empirical statistical studies of the driving behavior and involvement in traffic fatalities of teenage drivers have been

conducted. Although some of these studies had only a tenuous theoretical basis, they were important in identifying critical risk factors associated with teenage traffic fatalities.

Nature of the Study

This was a nonexperimental, archival study designed to empirically investigate factors, and the patterns among these factors, associated with fatal vehicle crashes involving young teen drivers. The data were extracted from North Carolina Division of Motor Vehicles Crash Reports (DMV Form 349). Data records from 84 fatal crashes involving young teenage drivers, aged from 15.50 to 17.99 years of age, occurring between the years 2009 and 2013, were analyzed. The data from the DMV form 349 consisted of the counts, percentages, and proportions of driver demographic characteristics and factors associated with the accident. Therefore, the data were analyzed using chi-square tests and one-sample Z tests for proportions, which according to Everett (1992) and Marasculio and McSweeney (1977), are appropriate for categorical data of this type. Because data on the variables consisted of counts and proportions, a quantitative study was the most appropriate method to be used to investigate these questions. The independent variables of interest in this study were

- Dysfunctional teen driving behaviors
- Driver gender

There were no covariates employed in the study.

As this was an archival study involving extraction of these secondary data from a publically available secondary data source, the study did not have to meet the requirements of internal validity of an experimental or quasi-experimental study.

The major threat to external validity that pertained to this study centered on the potentially inappropriate generalization of the results to another population or context (Bracht & Glass, 1968). The results of this study could reasonably be generalized to the following:

- Similarly aged teen drivers residing in other states (especially those located in the southeastern United States) who have been involved in fatal vehicle crashes
- States with data recording instruments that are similar in content to the NC DMV Form 349 employed in this study.

As the variables of the gender of the driver or evidence for the involvement of alcohol or drugs were measured by direct observation, hypothetical constructs and intervening variables were not included in the analytic model. Hence, considerations of construct validity were not relevant.

There were two potential problems that could affect the validity of the findings:

- Misidentification of the party causing the accident. In a fatal accident involving two vehicles, it is possible that the cause of the accident was misattributed to the teen driver rather than the other driver who was actually at fault.
- Misattribution by the reporting officer of causative factors associated with the accident (e.g., the involvement of alcohol, drugs, distracting factors), all of which were explanatory variables in this study.

The results of autopsies, toxicological tests, or other additional forensic procedures would more than likely be protected by privacy laws; therefore, it would have been difficult to

evaluate the extent of these potential threats to validity. The content of DMV Form 349 is admissible as evidence in North Carolina courts without the reporting officer's presence at the court proceedings.

Definition of Selected Terms

The following definitions were included to clarify their use in this study.

Crashes: Crashes indicate incidents resulting in fatalities and tracked from 2009 through 2013 (Model Minimum Uniform Crash Criteria [MMUCC] Guidelines, 2012).

DMV Form 349 Crash Report: The collision report form used by all law enforcement agencies in North Carolina for the reporting of motor vehicles crashes to the North Carolina Department of Transportation Division of Motor Vehicles (DMV, 2014).

Fatal injury: Any injury that results in death within 12 months after the crash (MMUCC Guidelines, 2012).

Fatal injury crash: Any motor vehicle or other road vehicle crashes that result in fatal injuries to one or more persons (MMUCC Guidelines, 2012).

Law enforcement personnel: The officer who investigated the accident involving the teen driver (MMUCC Guidelines, 2012).

North Carolina Graduated Driver's Licensure (NCGDL): NCGDL is a comprehensive licensing program for teen drivers to prepare and enhance their driving skills (see Figure 1 for detailed explanation of the full system as implemented in North Carolina).

Parental guidance: The influence of the parents/or parent on the teenage driver.

Risky behaviors: These are behaviors exhibited by adolescents while driving which may include, but are not limited to, texting while driving, using alcohol or

chemical impairing drugs while driving, driving while not wearing a seat belt, and speeding (Foss & Goodwin, 2014).

School administration: The influence provided by a teacher, guidance counselor, driver education instructor, or principal.

Young teen driver: The term is used in this study, to indicate a person aged 15.5 to 17.99 years of age, who could drive a vehicle.

Assumptions

This section of Chapter 1 provides assumptions upon which the study depended in order to address the research questions and stay within the established bounds of the research. The secondary data source for the study was DMV Form 349. Data from DMV Form 349 are admissible as evidence in North Carolina courts without the presence of the officer who completed the report at the court proceedings. Therefore, as archival data from DMV Form 349 has legal standing in the State of North Carolina, it served as a credible data source for this study. It was assumed that the law enforcement officer responding to the fatal crash accurately reported the facts related to the accident on form DMV Form 349. This is a necessary assumption, as these reported facts constitute the data that was used in this study. According to the chi-square tests for goodness-of-fit and independence, the observations are statistically independent of each other (Marascuilo & McSweeney, 1977). This assumption should be met. In the Z test for single proportions, it is assumed that a random sample of observations has been drawn from a specified population (Glass & Stanley, 1970, p. 322). Because the sample in this study was the entire population, this assumption can be relaxed.

Scope, Delimitations, and Limitations

The scope for the study was limited to fatal vehicle crashes involving teen drivers aged 15.50 to 17.99 that occurred in North Carolina between 2009 and 2013, the latest years for which complete data were readily available. An increasing number of teenagers have been injured or killed on roadways in North Carolina (Centers for Disease Control & Prevention, 2014). In 2012, approximately 200 people were killed in crashes involving drivers between the ages of 15 and 19 years of age in North Carolina. Due to standardized, state-mandated curriculum in the educational system, the age group 15.50 to 17.99 was a best fit for this type of study as an analysis to determine future public policy and educational curriculum. Teens 18 or older were excluded due to the increased possibilities of exposure to driving skills related to employment (ie., job-related responsibilities, driving military vehicles).

The delimitation may exist on the DMV Form 349 in reference to the comments provided by law enforcement officers based on assessment of the scene of the crash.

The limitations of this study included the following: (a) generalization of the results of the study findings, (b) the time required for data collection, and (c) potential bias in the results due to my experience and expertise. This last potential limitation, however, is also a potential strength in that my expertise should enhance the interpretation of the results from the study.

The ethical issues relating to biases, power relationships, conflicts of interest, and the use of incentives for participation in the study did not apply because archival research was conducted.

Significance of the Study

Because the data recorded on DMV Form 349 Crash Report can serve as evidence regarding a traffic accident in a North Carolina court without the presence of the officer completing the form, it included a detailed description of the accident. Consequently, the use of the data from DMV Form 349 permitted a more detailed picture of teen vehicle fatalities and the factors, and combination of factors, involved than has heretofore been available.

The results of this study could influence policy and practice as it may lead parents/guardians, school officials, and law enforcement personnel to provide the necessary education and support to teen drivers. In this study, I addressed a theoretical framework of perspective policy as it related to legislation for the prerequisite for a teen to obtain a driver's license. The study may provide data to reinforce the need for more supervised on-the-road experience. Secondly, may provide information relevant to the proposed legislative to eliminate publically funded driver education programs in North Carolina schools. This information may provide reform on educational programs directed toward young teen drivers, as well as legislation relevant to licensure of drivers in this age group. Parents/guardians, school institutions, and law enforcement agencies may be prompted to change policies regarding the education of teens in the early stages of driving practice. This could ultimately reduce crashes among teen drivers. The study may provide suggested improvements in the system for training teen drivers while maintaining the current and accepted North Carolina law and driving curriculum. This study may, therefore, provide a positive social change and save lives.

Summary

The purpose of the study was to investigate factors, and patterns among these factors, associated with fatal vehicle crashes involving young teen drivers. Direct access to crash report data from accidents involving teen fatalities allowed a more detailed investigation of these predictive factors and their patterns. The results of this study added to those from previous studies to improve education for teenage drivers (especially for young teen drivers in the target population of the study) and to inform legislative decisions regarding teen licensure and driver education. The findings provided information on the success or failure of public policies with regard to legislation and education associated with teen driving.

The literature review in Chapter 2 is an examination of current studies referencing the theoretical framework as it related to the causes of vehicular crashes resulting in teen fatalities. Chapter 3 provides a discussion of the methodology used in conducting the study including a discussion of the sample and target populations, archival data sources, and statistical techniques to be employed. In Chapter, I 4 present the findings, and Chapter 5 provides a summation, conclusion, and possible recommendations based upon the analyses of the archival data examined.

Chapter 2: Literature Review

Introduction

According to scholars, there is a disproportionate number of crashes involving young drivers and passengers. According to the Centers for Disease Control and Prevention (2010), roughly 2,650 adolescents (aged 16 to 19) were killed in motor vehicle crashes across the United States in 2011, and nearly 292,000 were treated in emergency departments (EDs) for injuries incurred in road accidents. These figures translate into seven teens dying each day as a result of motor vehicle crashes-- the leading cause of death for this age group.

Driver education programs focused on teaching young people basic driving skills and safe driving practices have been the traditional mode of training for teens. However, researchers have challenged the notion that these programs are effective in decreasing crash rates among adolescent drivers (Compton & Ellison-Potter, 2008). In the face of ineffective programs designed to curb teenage accidents, more accurate information is needed in North Carolina in order to develop better programs and improve existing ones. Compton and Ellison-Potter stated in a report to Congress that "Teens do not get into crashes because they are uninformed about the basic rules of the road or safe driving practices; rather, studies show they are involved in crashes as a result of inexperience and risk-taking" (p. 6). These results suggest the following policy failures: driver education has been well-meaning and potentially useful as it is and/or it has not addressed the real issue of risky driving behavior. In addition, risky behavior (e.g. talking on cell phones) has not been legislatively addressed on the part of risky behavior (Motor Vehicles, 2002).

Compton and Ellison-Potter (2008) failed to address driver education in isolation. Driver education was discussed along with laws, sanctions, and GDL as strategies for reducing crashes among teen drivers (Compton & Ellison-Potter, 2008). However, according to the Oregon Traffic Safety Education Association (OTSEA) board of directors, the NHTSA's (as cited in Hanson, 2008) depiction of driver education was inaccurate and outmoded. Furthermore, the OTSEA accused the NHTSA of unfairly dismissing an Oregon study documenting the effectiveness of driver education in decreasing crash severity and frequency, and citation frequency and severity, for students completing the program (Compton & Ellison-Potter, 2008). The NHTSA seemed to downplay the absence of research investigating how driver education performs in conjunction with GDL legislation (Compton & Ellison-Potter, 2008).

The CDC (2010, 2014) advocated for the implementation of GDL programs as a strategy for reducing teen driver crashes. Since the publication of the NHTSA (Compton & Ellison-Potter, 2008) report, all 50 states and the District of Columbia have adopted GDL programs (CDC, 2014). The most comprehensive programs were associated with 38% decreases in fatal crashes and 40% decreases in injury crashes among 16-year-old drivers (author, year). The programs vary from state to state, with those differences generally reducing crashes for 15-year-old to 17-year-old drivers (Masten et al., 2011, McCartt, Tech, Fields, Braitman, & Hellinga, 2010).

North Carolina, the site of this study, was one of the first states to adopt a GDL system (Goodwin, Foss, Margolis, & Waller, 2010). Early adopters, North Carolina and Michigan, experienced reductions of 23% and 25% in crash rates among 16-year-olds (author, year). The implementation of GDL programs has played a role in reducing

crashes among 16-year olds across the United States. In studies from the United States, Canada, and New Zealand, scholars have reported positive effects on young driver safety as a result of GDL legislation (Brar & Rickard, 2013). California implemented a modified driver licensing program as early as 1983, adding legislative enhancements in 1998; the Michigan and North Carolina GDL programs originated in 1997 (Brar & Rickard, 2013; Janke, Masten, McKenzie, Gebers, & Kelsey, 2003). In the United States, the number of fatal crashes among 16-year-olds decreased over a decade, from a high of 33 per 100,000 in 1996 to 19 per 100,000 in 2005 (Goodwin et al., 2010). From 2000 to 2010, deaths among 16-year-old drivers declined by nearly two-thirds (64%), along with declines of more than half in 17-year-old driver deaths (55%) and 25% for drivers over age 17 (Governors Highway Safety Association, 2013). While the reduction in crashes among teen drivers is salutatory, it was hypothesized that these programs have not sufficiently addressed the issue of risky teen driving behaviors.

Under a comprehensive 3-stage GDL program (learner's permit, intermediate or provisional license, full licensure), 16-year-old drivers have possessed provisional licenses that carry restrictions, such as limits on nighttime driving and the number of peer passengers, in addition to a full ban on alcohol and portable electronic devices (Compton & Ellison-Potter, 2008). However, the positive impact of GDL laws on 16-year-old drivers was not extended to 18- and 19-year-olds with full licensure (Brar & Rickard, 2013; Masten et al., 2011; McCartt et al., 2010). Masten et al. (2011) found an increase in fatal crashes among 18-year old drivers when compared to 15.50- to 17.9-year-olds. Less experience driving independently under GDL laws has been a potential factor in teen

driving fatalities, although the precise circumstances of the fatal crashes need further study.

Research about teen driver fatalities supports the urgency of intervention for this young population. There has been an increase in motor vehicle fatalities among 16- and 17-year-old drivers (GHSA, 2013; Williams, 2012). The Governor Highway Safety Association (GHSA, 2013) disclosed an increase in the number of deaths for teens of those ages during the first half of 2012. The NHTSA (Compton & Ellison-Potter, 2008) projected an overall increase in driver fatalities of 8%, but the increase for young drivers surpassed projections. Among 16-year-old drivers, deaths have risen from 86 to 107 for an increase of 24%; deaths also increased from 113 to 116 for 17-year-olds, an increase of 15%, producing a cumulative increase of 19% for 16- and 17-year-olds (author, year). However, North Carolina was one of the states to experience a decline in fatalities among 16- and 17-year-olds: from 17 fatalities in the first 6 months of 2011 to nine in the first 6 months of 2012, for a decrease of 8% (Williams, 2012). There was a decline from 2010, when nineteen 16- and 17-year-old drivers died in motor vehicle crashes, along with 16 similarly-aged passengers and three 15-year-olds (North Carolina Department of Human Services, 2011). This variation in fatalities from year to year supports further study of the causes of teen driver fatalities.

Several factors may explain the disparities in the number of teen driving fatalities. According to Williams (2012), the benefits of GDL laws may have reached a plateau, as the states have had these laws for several years, and the initially rapid pace of strengthening them has tapered off. Williams also suggested that teens may be driving more as the U.S. economy improves, thereby exposing them to more motor vehicle risks.

While acknowledging that any increase in teen driver deaths is discouraging, Williams also pointed out that teen traffic fatalities are still historically low. Nevertheless, more intensive effort is needed to reduce teen driver crashes.

Literature Search Strategy

Academic Search Premier, MasterFILE Premier, and Business Source Premier were used as part of EBSCO service to access literature relevant to the study. State, federal, and international databases accessed were related to teen drivers, fatalities, distracted driving, cell phones, and adolescent development. Keywords that guided research included fatal crashes, driving while intoxicated, speeding, gender, feedback, and simulation. Keywords added to later searches included secondary task, parenting, peer influence and risk awareness.

Laws enacted in 2002 relevant to graduate driver licensure guided the search parameters to include literature from 2002 to the present day. The time period was narrowed to 2010 to reflect changes as new research emerged from agencies and organizations like the Centers for Disease Control and the National Highway Safety Administration.

Understanding Teen Drivers

GDL legislation has not been a panacea for reducing teen crashes. Hanson (2008) noted that driver education focuses on raising risk awareness, which was lacking in the conventional model. Risk awareness has been a central point of most interventions for young drivers in the United States and other countries (Falk, 2009; Fisher, 2008; King, Vidourek, Love, Wegley, & Alles-White, 2008; Poulter & McKenna, 2010; Pradhan,

Pollatsek, Knodler, & Fisher, 2009; Shahar, Elharar, & Danino, 2008). Adolescents have learned the technical aspects of handling a vehicle; however, they need experience in a variety of driving situations , guidance in using judgment, and assistance with making prudent decisions behind the wheel (Brar & Rickard, 2013; DMV Center, 2012; Goodwin et al., 2010; Janke et al., 2003). Teens know how to perform the act of driving due to their driver training programs, but few can use that knowledge under high stress situations. Understanding their driving experiences can lead to determining ways to prevent the habits that cause fatal crashes.

Previous research has pointed to the habits that are most likely to cause a teen to crash. The CDC (2014) identified eight major circumstances of teen driver crashes: driver inexperience, driving with peer passengers, nighttime driving, not using seat belts, distracted driving, drowsy driving, reckless driving, and impaired driving. In North Carolina, speed was the primary factor in most teen driver deaths; speed and impairment were the main circumstances of crashes killing teen passengers (NCDHHS, 2011). Speeding has been the main cause of collisions for drivers of all ages (Brar & Rickard, 2013). As such, legislation and driver education could be amended to address these issues and reduce teen driving fatalities.

The word immaturity has been used to describe teen drivers and can be applied to an array of factors affecting their driving, including inaccurate risk perception, overestimating their driving proficiency, and taking risks (Janke et al., 2003). Teen drivers also tend to overestimate their multitasking ability (Carter, Bingham, Zakrajsek, Shope, & Sayer, 2014). In reality, teens have been less capable of multitasking than adults (Chiu, 2014). Quick reflexes and ease of learning contribute to this illusory sense

of self-confidence (Goodwin et al., 2010). Teens who have been apprehensive at first tend to gain confidence in their driving; however, many teens accurately assess their driving ability, including those who are poor drivers (Chiu, 2014). Nevertheless, many teens not only inaccurately perceived risk, but also their inexperience.

Driver inexperience has been a common feature of teen drivers. U.S. teens have not consistently viewed themselves as inexperienced drivers and do not interpret the meaning of experience in the same way as adults (Ginsburg, Winston, Senserrick, Garcia-Espana, Kinsman, Quistberg, Ross, & Elliott, 2008; Young Driver Research Initiative Team, 2009). Neural and psychosocial development during adolescence has made teen drivers vulnerable to driver distraction and risk-taking, with peer influence playing a role (American Academy of Pediatrics [AAP], 2006; Bingham, 2014a, 2014b; Brar & Rickard, 2013; Floyd-Bann & Van Tassel, 2006; Janke et al., 2003; Reyna & Farley, 2006; Romer et al., 2014). Due to these social, environmental, and psychological factors, teens may require a very specialized method for becoming a safe driver.

Driver distraction has also been recognized as a hazard for teens. The *Journal of Adolescent Health* devoted an entire supplement to the topic of adolescent driver distraction. Intended to make the topic relevant to both researchers and practitioners, the supplement addressed young driver distraction from a variety of perspectives. According to Bingham (2014a, 2014b), the recent upsurge of interest in driver distraction has been fueled by media attention to hazardous driving relevant to texting or talking on cell phones. However, cell phone use has been only one of many sources of driver distraction linked closely with teen driving fatalities. Highlighting the adolescent stage of development, Romer et al. (2014) focused on adolescent brain development and driver

inexperience. Social influences and risk-taking were explored in studies of neural responses (Falk, Cascio, O'Donnell, Carp, Tinney, Bingham, & Simons-Morton, 2014) and peer and parent influences on risk perception (Carter et al., 2014). This insight into the psychological development of teens as related to risk-taking indicates that distracted driving is more than just an education or legislative problem.

Technology may be a source of driver distraction, but it can also be used to capture the reactions of drivers under simulated and natural conditions. The effects of driving with peers were examined in a study of young male drivers' visual scanning while alone and with a male peer (Pradhan, Bingham, Simons-Morton, Ouimet, & Shope, 2014), in two naturalistic studies of distracted driving behaviors by novice and more experienced teenage drivers (Foss & Goodwin, 2014), and the crash risk of glancing off-road by newly licensed young drivers (Simons-Morton, Guo, Klauer, Ehsani, & Pradhan, 2014). Falk et al. (2014) and Pradhan et al. (2014) both made use of driving simulation technology, which is also used for driver training (Carney, McGehee, Lee, Reyes, & Raby, 2010; De Winter et al., 2009; Fisher, 2008; Pradhan et al., 2009). Simulation technology can offer further study of the habits of teens while driving, demystifying what may or may not happen when they drive.

Parental supervision has been a key feature of GDL, and most parents are dedicated to helping their teens drive safely. Foss and Goodwin (2014) used data from a naturalistic study of 50 North Carolina families who were recruited when the adolescents first applied for a learner's permit. One parent from each family was interviewed 10 times the first year the student was learning to drive (Goodwin et al., 2010). Knowledge of adolescent brain development by parents has been an important, though often

neglected, component of an educational program (DMV Center, 2012). Parents, however supportive and however proficient they are as drivers, typically lack knowledge about brain development specific to helping teens acquire the judgment and decision-making skills needed to drive independently under varied and unpredictable conditions.

The last two articles in the supplement were geared toward efforts to reduce the prevalence of adolescent driver distraction. Ehsani, Bingham, Ionides, and Childers (2014) investigated Michigan's laws prohibiting text messaging and the impact on motor vehicle crashes among drivers of all ages. However, it is clear that laws have been ineffective without the massive public awareness campaigns credited with reducing crashes involving lack of seat belt use and drunk driving. Finally, Buckley et al. (2014) recommended strategies for reducing distracted driving and, more generally, inducing positive behavior change in adolescent drivers. Explicitly and implicitly, researchers have highlighted the need for a multifaceted approach to improving teen driver safety involving families, schools, health care providers, public officials, and the teens themselves, whose input is essential for targeting programs effectively (Ginsburg et al., 2008; YDRI Team, 2009). Collaboration between these parties is crucial to gaining a complete picture of the typical teen driver.

The peer group plays a role in understanding distracted driving and risk-taking by young drivers. Erikson (1950/1993) recognized adolescence as a unique stage of development in which young people strive to build a sense of personal identity; parents' influence wanes as the peer group takes precedence. Absent from Erikson's psychosocial model was knowledge of adolescent brain development, which medical professionals can now access through neuroimaging technologies. Knowledge of brain development has

enhanced understanding of risk-taking and judgment in adolescent drivers (Floyd-Bann & Van Tassel, 2006; Shope, 2010). The framework for this study was centered on the role of neural development in the behavior of adolescent drivers and generally covered adolescent development in relation to risk-taking and decision making.

This quantitative study consisted of analyses of crash reports involving teen drivers in North Carolina The purpose of this study was to investigate the relationships between dysfunctional teen driving behaviors and the patterns among these behaviors, associated with fatal vehicle crashes involving young teen drivers. The findings of this study may provide information for developing and implementing policies and practices aimed at reducing injuries and fatalities among teen drivers. The findings of this study may prove beneficial to teens, parents, educators, legislators, law enforcement officials, health officials, and the general public at large, as the disproportionate incidence of fatalities among teen drivers and their passengers is a public health problem.

Theoretical Framework

The framework for this study consisted of four perspectives:

- Policy success or failure (e.g., McConnell, 2010)
- Adolescent cognitive and emotional development
- Policy success or failure
- Epidemiological and other types of empirical statistical studies of the driving behavior and involvement in traffic fatalities of teenage drivers.

The Policy Success or Failure Framework

Because policy permeates nearly every aspect of daily life, the phenomenon of teen driving can best be understood through a comprehensive analysis of policies related

to teen driving. McConnell (2010) developed a taxonomy of policy successes, failures, and the gray areas in between, enumerating the following three realms of policy: processes, programs, and politics. The most relevant of McConnell's realms for this study was the realm of programs; McConnell develops a definition of successful policy based on Rose's (as cited in McConnell, 2010) definition of programs as "what governments do" (p. 350). McConnell discussed two ways of defining policy:

- The rationalist/foundationalist/scientific tradition that defines success as a fact amenable to observation
- The constructivist/discursive tradition that emphasizes the importance of interpretation and meaning, which implies that success is in the eye of the beholder and depends upon the perceiver's beliefs and values (pp. 350-351).

Defining success as related to policies requires a close look at the goal of the policy and what is achieved as a result of the policy. McConnell (2010) advocated for a pragmatic synthesis of these traditions, defining success partly in terms of goal achievement and partly in terms of the value of successful achievement of the goal to the perceiver. McConnell synthesized both traditions in the following definition of policy success: "a policy is successful if it achieves the goals that proponents set out to achieve and attracts no criticism of any significance and/or support is virtually universal" (p. 351). As such, applying this concept to policy means that the outcome and reaction to the policy is significant to determining policy success.

McConnell (2010) identified the following spectrum of success/failure in program implementation:

- Program success: The program implementation was in line with planned objectives.
- Resilient success: Implementation objectives were broadly achieved.
- Conflicted success: The implementation produced mixed results.
- Precarious success: Only minor progress was made; chronic failures were evident.
- Program failure: There was a failure to implement the program as it was envisioned (p. 354).

The results of program implementation should be examined and discussed within this analytic policy framework of researchers.

A provisional examination of these legislative influences is essential to understanding management success or failure as well as policy success or failure. Stark (2011) studied whether legislative influences help or hinder the making of a policy. The legislature's policy-making may or may not shed light on certain issues affecting Stark's three major areas: the influence of pre-event planning, the impact on the performance of state-led crisis responses, or the shaping of the ways in which those responding are judged. McConnell (2011) has instead identified public policy by the processes, decisions and the policlinics aligned by government; these three areas are not mutually exclusive (McConnell, 2011, p. 67). Teen driving may easily be influenced by legislators and policy makers, as it has become a state-led crisis.

A policy success/failure framework has allowed for perspective in approaching the successes and failures of proposed initiatives to reduce teen deaths. McConnell (2011) has provided a unique and clear framework for legislators and other policy makers to

review the perspectives of information received and evaluate the issue of teen driving. More specifically, McConnell has examined complex policy/political outcomes, and between these extremes, found that the success of a policy may depend on the number of lives saved and how the targeted group is affected (McConnell, 2011). Therefore, a policy evaluation and its impact of the reduction of teen fatalities would help determine the success of current policies affecting teen drivers.

Policy Knowledge and Policy Failure

Just as policy successes can be viewed through a certain set of lenses, policy failure can be studied using the concept of blame. Howlett (2012) has examined policy learning and its effect on policy success and failure. As policy literature has focused on policy learning, researchers such as Howlett have concluded that a struggle is evident when pulling together studies of policy learning into a process, which can then be used to frame a problem and thus can result in a policy's success. The failure of policies, however, can be attributed to the different political, programmatic, and process activities of government (McConnell, 2010). In alignment with Hood's (2010) conception of 'blame-avoidance,' both researchers, McConnell (2010) and Hood have noted the blame-game is a precursor to how policies are actually developed. A key policymaker is motivated by his or her own agenda, thus decision-making behavior can be linked to the development of policies and the political aspect of policy making, as well as the discussion of the policy's content and how the policy solidifies into a success (Howlett, 2012). Statistical data and technical information has been necessary to prevent blame, but they both have allowed the decision makers to negotiate policy and minimize the political agenda processes. (Howlett, 2012). Therefore, each level of policy development has relied on the

other level to grow a policy's success and not breed a failure. Howlett has identified the following stages through the lens of failure in his *Common Policy Process Failures by Stage of the Policy Cycle*:

- Agenda setting - overreaching governments establishing or agreeing to establish overburdened or unattainable policy agendas.
- Policy formulation - attempting to deal with problems without investigating or researching problem causes and identifying the probable effects of policy alternatives
- Decision-making - failing to decide on a policy within a reasonable period of time or distorting its intent through bargaining and log-rolling
- Policy implementation - failing to deal with implementation problems including lack of resources, principle–agent problems, oversight failures, and others
- Policy evaluation - lack of learning due to lack of, ineffective, or inappropriate policy monitoring and/or feedback processes and structures (p. 547).

The accepted policy process has been to review legislative history and implement logic to provide strategies for the development of a successful policy; research collected during the policy process is more reflective of individuals rather than groups or organizations that typically change or create policies. According to Weible, Heikkila, deLeon, and Sabatier (2012), understanding and influencing the policy process has been critical to collecting data and information, and processing the legislation accordingly. Weible et al, (2012) has further noted it is an individual who places himself or herself in a position to make a difference. The individual, not the group, can develop strategies to

learn about the issue, take the time to learn about involved stakeholders, and address the issue over an extended period of time, which results in developing policy for the long term. Moreover, for some individuals, the emphasis on deep knowledge may come when they are deeply involved in the issue, as happens when individuals are engaged in policy change; teenage driving behavior is only one area that could result in policy change due to the current legislative environment and the strong feelings about teens behind the wheel.

The successes of policies are discussed widely in political contexts. Practitioners and academia contribute to frameworks that justify policy success, noted Marsh and McConnell (2009). As much as the literature has focused on policy failure or success, the basis of the framework reflects the evaluation of process success, programmatic success and political success. Marsh and McConnell have further complicated the uniqueness of determining policy success: "We then move on to raise a series of what we term complexity issues in relation to success for whom; variations across time, space and culture; and methodological issues." Thus, determining success of a policy is complicated by the presence of individuals, but is also constrained by other factors as well.

Adolescent Cognitive and Emotional Development Perspective

It is generally accepted that potentially risky behavior, such as driving a car, can be affected by the level of maturity of the driver -- even in adult drivers. This maturity level is, in turn, affected by factors of cognitive and emotional development of the teenage driver. Adolescence is aptly described as a transitional stage, in which a young person strives to cultivate an adult identity independent from parents (Erikson,1950/1993). Li,

Simons-Morton, and Hingson (2013) have described adolescence as "a time of increased sensation seeking and risk behavior" especially because "during this transition, learning to drive and obtaining a license are major rites of passage for entering adulthood" (p. e71). Paradoxically, adolescents desire to be independent as they yearn for social acceptance and are heavily influenced by peers (Curry, Mirman, Kallan, Winston, & Durbin, 2012; Falk et al., 2014; Floyd-Bann & Van Tassel, 2006). Young males may be especially susceptible to peer pressure, which plays an important role in deliberate risk behavior, such as speeding, as well as unintentional risk behavior, such as looking away from the road to interact with peer passengers. Driving with other teens is an extensively documented risk factor for crashes (CDC, 2010, 2014). Gender and adolescent social development may be key factors in teen fatalities; this knowledge could affect the education curriculum for learning drivers. This important rite of passage has demanded adult responsibilities because the impact of unsafe driving impacts those teens, their passengers, and other drivers.

One look at the brain can help explain the difference between adult and teen behaviors. Neuroimaging studies have provided objective evidence of differences in cognitive processing between adolescents and adults (Floyd-Bann & Van Tassel, 2006). The research team that designed the 2006 National Young Driver Survey (NYDS) clearly understood that though teens navigate adult responsibility, they are not adults; researchers used input from teens to develop this national survey (Ginsburg et al., 2008; YDRI Team, 2009). These differences in brain development and structure decisively impact problem solving, judgment, decision making, and weighing risks and rewards; all of these qualities are crucial to the development of safe driving habits.

Changes in the brain during adolescence may explain teen inclinations toward risky behaviors. A key phenomenon documented by neuroimaging is the "plasticity" of the human brain, which actually increases during adolescence (Floyd-Bann & Van Tassel, 2006). Brain cell production declines in a process called myelination, whereby the neurons are coated by a type of electrically conductive matter in order to generate faster connections between synapses. Floyd-Bann and Van Tassel (2006) have likened this occurrence to a "turbo-charge effect in the brain," which may be particularly apt for describing an age group with high energy that is inclined toward risk-taking and sensation seeking (p. 9). The changes taking place in the brain are especially visible in MRIs and cell biopsies of the frontal lobe.

The brain continues to impact behavior related to risk well into early adulthood. The prefrontal cortex is the area of the brain involved in planning, impulse control, and executive decision making (AAP, 2006). MRI evidence has demonstrated that this area does not completely mature until the mid-20s. Interestingly, this question appeared on a survey of Connecticut parents whose children were learning to drive (DMV Center, 2012). Brain development was the only specific risk factor included on the survey. Most parents were unacquainted with brain research before the survey, but upon learning the late age at which the brain fully develops, the overwhelming majority deemed it an important factor in driver safety.

Hormones during adolescence can change the way sensory information is received. Changes also occur in the brain in relation to sensory processing (Floyd-Bann & Van Tassel, 2006). Neurotransmitters, the hormones responsible for regulating neural activity, are in a state of flux during adolescence. Neurotransmitters include dopamine, GABA,

and serotonin, which all influence how information is processed and interpreted; these are particularly relevant to adolescent driving due to their association with perceptions of risk and reward. For teens high in sensation seeking, which peaks during adolescence, the drive for new and exciting experiences overrides consideration of potentially harmful consequences (Romer et al., 2014).

Despite being closely related, impulsivity differs from sensation seeking in that it is marked by a deficit in attention. Romer et al. (2014) noted that both impulsivity and sensation seeking have gained attention in relation to teen driving and brain development. Adolescence is also a time of increased impulsivity (Romer et al., 2014). Attention Deficit Hyperactivity Disorder (ADHD), characterized by impulsivity and attention problems, is an extreme manifestation of these two phenomena. When sensation seeking is separated from impulsivity, impulsivity seems to be more closely related to risky behavior, although both sensation seeking and impulsivity can be especially hazardous to teen drivers with poor situation perception.

Of all age groups, adolescents have the highest risk for crashes resulting from drowsy driving. Fluctuating levels of the neurotransmitters dopamine and serotonin are also related to changes in sleep patterns (Floyd-Bann & Tassel, 2006). Adolescents are wired to go to sleep and wake up later than younger children; they also require more sleep but do not get enough sleep. Drowsiness is a serious cause of inattention to the road in teen drivers, and this effect is exacerbated by inexperience and distractibility (Romer et al., 2014). A combination of factors contributing to drowsiness include developmental changes that increase the need for sleep, alterations in sleep patterns that decrease nighttime sleep or lead to disruptions in circadian rhythms, and lifestyle factors, such as

the combined effects of academic demands, extracurricular activities, employment, and socialization with friends (Compton & Ellison-Potter, 2008). Alcohol and drug use per se increase crash risk, but adolescents are especially sensitive to their effects and most are probably not aware of how alcohol interacts with sleepiness to cause further impairment.

In differentiating adolescents from adults, it has been equally important to recognize the myriad individual differences in development, attitudes, and behavior, as well as subgroup differences. Studies consistently find male drivers more prone to risk-taking than their female peers. Furthermore, the presence of a male passenger heightens the risk for speeding, distracted driving, and allowing shorter headway, also known as tailgating (CDC, 2014; Falk et al., 2014; Pradhan et al., 2014; Romer et al., 2014). In 2011, motor vehicle fatality rates for male drivers and passengers aged 16 to 19 was almost double the rate for young females (CDC, 2014). Subgroups of adolescents are especially predisposed to sensation seeking and engage in multiple risk behaviors (Marcotte, Bekman, Meyer, & Brown, 2012; Olsen, Shults, & Eaton, 2013). This could help strategically target safe driving awareness campaigns and educational interventions to vulnerable populations.

Naturalistic studies have discovered varied levels of crash risk in novice teen drivers. Participants in the Naturalistic Teenage Driver Study (NTDS) were monitored over 18 months using an array of sophisticated technology while driving (Guo, Simons-Morton, Klauer, Ouimet, Dingus, & Lee, 2013; Ouimet et al., 2014). The study was designed to provide detailed information on crash events and crash risk factors, with attention to changes over time; 42 participants were newly licensed 16-year old Virginia drivers. In examining the patterns of crash and near-crash (CNC) events over time, Guo

et al. (2013) discerned three distinct groups, classified as high-risk, low-risk, and moderate-risk. The mean crash risk for the high-risk group (21.8 CNC per 10kmt) proved to be 10.6 times higher than the low-risk group (2.1) and 2.6 times higher than the moderate-risk group (8.3). Studies typically show a decline in new drivers' CNC rates over time, but that strategy masks the uneven rates at which such declines may occur, which makes the research of Guo et al. (2013) unique. The CNC rate declined only for the moderate-risk group, while the CNC rate was low for the low-risk group; the high-risk group either did not learn from experience or were simply preferred risky driving behavior. There were no personality differences between groups.

The individual variability in crash risk depends upon hormone levels. The teen drivers in the study were tested for cortisol levels while performing a stress-inducing (mathematical) task (Ouimet, Brown, Guo, Klauer, Simons-Morton, Fang, & Lee, 2014). Over the course of the study, participants with higher cortisol levels had lower crash and near-crash rates as well as a quicker decline in both rates over time; this effect held for teens of both genders. Ouimet et al. (2014) noted that associations between cortisol and disruptive and/or risky behavior have been documented in adults, but findings for adolescents have been inconsistent. They have suggested that if cortisol is a neurobiological marker for risky driving, it offers a plausible explanation for the varied responses to general prevention strategies such as GDL programs, public safety awareness campaigns, and parental supervision. According to the researchers, drivers with a neurobiological predisposition to risk-taking might benefit from strategically targeted techniques such as in-vehicle technologies, calling for additional research into the neurobiological underpinnings of driving risk.

Components of behavioral models have included perceptions of risk, benefits, social norms, perceived control or self-efficacy, along with the practice of relevant skills. Reyna and Farley (2006) have observed that the traditional models of behavioral decision making that guide interventions, such as the health belief model and theory of planned behavior, are applicable for some groups of adolescents but not for others. As described by Reyna and Farley, behavior change models have typically emphasized "conscious behavioral intentions and expectations rather than unconscious emotional and cognitive reactions to environmental triggers" (p. 33). A strategy that can overcome these conscious and unconscious systems will require extensive research.

Interventions for teen drivers could best be broken into two models. Reyna and Farley (2006) believe that the traditional models should be effective for teens who are "risky deliberators," defined as those who consciously weigh risks and rewards, provided they can be persuaded that the risks outweigh the benefits or that other benefits are preferable (such as getting excitement from sports rather than speeding). However, as the NTDS revealed, some teens are more predisposed to take risks and may require a more targeted intervention to induce them to change their driving behavior (Guo et al., 2013; Ouimet et al., 2014). In Europe, programs have been developed to retrain these high-risk drivers (Gandolfi, 2009). Legislators in the United States could easily adopt a similar program.

Identification of the issues that influence risky teen driving has been the focus of decades of research. Blachman and Abrams (2008) have highlighted the complicated array of variables related to teen driver behavior: biological, cognitive, emotional, social, peer, parent, community, and policy. Consequently, they have called for the use of

systems science methodologies not only to advance understanding of the problem, but also to implement evidence-based policies and programs. Efforts to reduce teen driving fatalities have included vehicle safety as well as policies and programs such as a GDL system and require ongoing advocacy by professional and consumer groups (Gillan, 2006). Ensuring the alignment of the research with current policy and programs is critical to everyone's safety on the road.

Educational Policy Success or Failure Perspective

Millions of dollars have been invested in driver education; however, the evaluation of the success of these programs is mixed. McConnell (2010) has described it as "conflicted success," which means "the implementation produced mixed results" (p. 354). Research findings related to this perspective are discussed in this section.

Several groups have provided evaluations of current driver education programs. Advocates for Highway and Auto Safety is one of the groups that have lobbied for strict Graduated Driver's Licensure (GDL) programs in all 50 states (Gillan, 2006). According to Hanson (2008), the criticism of driver education in the report to Congress (Compton & Ellison-Potter, 2008) is unwarranted and based on an antiquated conception of driver education. Representatives from the driver education professional community have since collaborated with the NHTSA to devise Novice Teen Driver Education and Training Administrative Standards (2009) to ensure that driver education provides teens with adequate numbers of classroom and practice hours and is also coordinated with state licensing requirements (Novice Teen Driver Education, 2009). Assurance that driver education programs are rooted in methodology has been the primary concern many stakeholders.

Several programs that address risky drivers have empirical support, but they have not been universally implemented and reach a limited number of students. Classroom-based programs have evolved from didactic instruction into multimedia presentations designed to raise risk awareness by making perceptions of risk personally relevant to young drivers (King et al., 2008; Poland, 2012; Poulter & McKenna, 2010). Driver education programs have varied substantially, thus some programs have been more effective than others (Bates, Watson, & King, 2006; Gandolfi, 2009). However, comprehensive reviews of research on driver education programs have concluded that the empirical evidence does not support the effectiveness of driver education programs of any type in reducing crashes among teens that completed the program (Brar & Rickard, 2013). At the same time, most of the studies included in research reviews were conducted before driver education was redesigned to emphasize risk perception and decision making skills.

Driver education programs have varied substantially; evaluation methods have also varied. This lack of standardization has made it challenging to compare the effectiveness of many programs (Gandolfi, 2009). It is also difficult to control for the influence of cultural and environmental factors, which can have a substantial impact on program effectiveness. Gandolfi has noted that it is often possible to discern which components of an individual program are most effective. This information can then be used to guide the design of additional programs, but it has become important that the components are applied to suitably matched program.

A combination of instruction related to skills and critical thinking is the cornerstone of a successful driver education program. Gandolfi (2009) has advocated a driver

education matrix, integrating the motivational and intentional elements of driving with skills-based competency. The matrix is based on a hierarchy going from psychomotor skills to higher order thinking skills. In ascending order the levels are: Vehicle Maneuvering, Mastery of Traffic Situations, Goals and Contexts of Driving, Goals for Life, and Skills for Living. Each level is comprised of a set of knowledge and skills, risk increasing aspects, and self-evaluation. Gandolfi has envisioned a model of driver education that emphasizes these higher order skills. Brar and Rickard (2013) outlined several expert recommendations for improving driver education and training. Ideally, the courses should: (a) aim to reduce risk-taking by raising adolescents' awareness of risk and teaching them to make prudent decisions, (b) include parent-supervised driving practice, (c) be integrated into GDL programs, and (d) employ a multi-stage design with separate courses for early learning and later stages of licensure. Self-reflection and awareness could additionally be used to build these courses.

The rationale for GDL programs has been that crash risk should be decreased by requiring teens to acquire driving experience under low risk conditions before they obtain full licensure. The implementation of GDL programs by all 50 states and the District of Columbia has been viewed as a major step forward to increase safe driving for all teens (CDC, 2014; Poland, 2012). The CDC (2010) has projected that a strong GDL policy in every state has the potential to save 175 lives and prevent roughly 350,000 deaths each year. In view of evidence that 16-year old drivers have the highest crash rates, even after controlling for experience, the graduated licensing system has the support of experts and the general public (Williams, 2008).

Completing statewide driver education courses, including 30 classroom hours and six hours of road practice has become a prerequisite for all new North Carolina drivers under age 18 (Goodwin et al., 2010). Youth are allowed to obtain a learner's permit at 15, but they must be 16 to be eligible for a provisional or restricted license. Obtaining a North Carolina learner's permit has carried the following requirements:

- Teens must be supervised at all times by a parent, grandparent, guardian, or a driver approved by a parent or guardian.
- The supervisor must be a licensed driver with at least five years of licensure.
- During the first six months of the permit, the young driver is restricted to driving between 5AM and 9PM. After six months, he or she may drive with a supervisor at any time of the day.
- Everyone in the vehicle must use seat belts or restraints required by child restraint laws.
- Teens are prohibited from using a cell phone while driving (with the exception of calling a parent or using the phone due to an emergency situation).
- There is no minimum requirement for supervised hours.

Some states have begun to reduce crashes among teen drivers. Initial evaluation data suggested that the implementation of the North Carolina GDL program reduced crashes involving 16-year old drivers by 27%, fatal crashes by 57%, injury crashes by 28%, non-injury crashes by 23%, nighttime crashes by 43%, and daytime crashes by 20%, when minors were in the company of adults (Brar & Rickard, 2013). Further reductions in crashes were reported after the state policy was changed to prohibit teen drivers from carrying more than one passenger under age 21, producing an overall

reduction of 38.5% in the states' crash rate for 16-year old drivers. Recent studies have found the sharpest decrease in crashes involving 15 to 17-year old drivers in states with the strictest GDL programs, which have restricted driving at night and carrying passengers (Masten et al., 2011; McCartt et al., 2010). This effect has been most pronounced for 16-year olds, probably due to the greater time spent in supervised driving (Masten et al., 2011). However, the higher incidence of fatal crashes for 18-year old drivers is troubling. The circumstances are uncertain and warrant further investigation, possibly leading to further changes in licensing policy.

Epidemiological and Other Types of Empirical Statistical Studies

A host of epidemiological and other types of empirical statistical studies of the driving behavior and involvement in traffic fatalities of teenage drivers have been conducted. Some of these studies have only a tenuous theoretical basis, but they are important in that they identify critical risk factors associated with teenage traffic fatalities. Relevant results of these studies are discussed in this section.

The 2006 National Young Driver Survey (NYDS), involving a nationally representative sample of 5,665 students in 9^{th}, 10^{th}, and 11^{th} grades, was designed to gain insight into the perspectives, attitude, and behaviors of adolescent drivers (Ginsburg et al., 2008; YDRI Team, 2009). The NYDS is based on the Teen-Centered Method (TCM), which employs qualitative and quantitative techniques to illuminate how adolescents think and feel. A total of 443 students were involved in the qualitative stages and their responses were used in developing the survey (stage 1) and interpreting the results (stage 4).

The TCM allowed the researchers to gain deeper and more accurate understandings of teen perspectives on driver safety. For example, the students were aware of previously studied hazards such as distractions and substance use, but they were not aware of how these hazards can interact with driver inexperience (Ginsburg et al., 2008). More generally, the students did not seem to fully grasp that a) teen drivers are collectively inexperienced or b) inexperience is significant as a cause of motor vehicle crashes. There seemed to be a degree of cognitive dissonance in the students' responses to questions related to inexperience. While 60% of the students recognized that inexperience is strongly correlated with unsafe driving, only 15% reported being exposed to inexperienced drivers, an improbability in a sample composed entirely of passengers and young drivers classified as inexperienced by experts. According to Ginsburg et al. (2008), an essential step in promoting safety among teen drivers has entailed understanding how youth interpret "experience."

The students provided Ginsberg et al. (2008) and his research team with important insight into the social context of teen drivers' decision-making. Although only 10% of the students believed the presence of peers posed a substantial hazard, they showed nuanced understanding of how teen passengers might raise the risk of a crash; for example, crashes are likely if the teens "dance and sing," are intoxicated, encourage the driver to speed, or "act wild" (Ginsberg, 2008, p. 1400). Nevertheless, these students were less sensitive to the risk presented by cell phone use; only 28% of the students cited it as a significant safety hazard. Driving under the influence was widely recognized as a serious hazard, which is not surprising given the numerous public health campaigns against drunk driving. However, Black students, Latino students, and students with lower grades

were less aware of the risks of intoxicated driving, suggesting a need for more targeted campaigns or interventions. Ultimately, the information gained from the NYDS provided a springboard for future research and further efforts to promote teen driver safety.

Parental Influence

Parenting Style

The NYDS documented the important role parents play in young driver safety. As part of the survey the teens were queried on parenting style (YDRI Team, 2009). Ginsburg, Durbin, Garcia-Esoabam Kalicka, and Winston (2009) reported on the relationship between parenting styles and adolescents' driving behaviors and attitudes. Four parenting styles have been identified and are often assessed in research on the behavior of children and adolescents: authoritative, authoritarian, permissive, and uninvolved. These four parenting styles diverge on the key dimensions of control (rules and monitoring) and warmth/support. Authoritarian parents exercise high levels of control with minimal warmth. Permissive parents display warmth and emotional support but provide minimal control. Uninvolved parents are neither supportive nor controlling. Authoritative parents strive for a balance between control and support, closely monitoring their children while providing warmth and support. Numerous studies have confirmed the positive impact of authoritative parenting on the psychosocial development and behavior of adolescents across sociodemographic backgrounds.

Parenting styles have emerged as a factor in teen driving habits. The data were drawn from the 2006 NYDS, which Ginsburg et al. (2008) utilized in exploring adolescents' perspectives of driving safety. Regarding parenting style, half the parents were characterized as authoritative, 23% as permissive, 19% as uninvolved, and 8% as

authoritarian (Ginsburg et al., 2009). Compared to their peers with uninvolved parents, adolescents with authoritative parents had half the crash risk for the previous year, were 71% less likely to drive under the influence, and were less likely to use a cell phone while driving. Teens with either authoritative or authoritarian parents reported using seat belts almost twice as often as those with uninvolved parents, as well as speeding half as frequently. No significant differences emerged for the effects of uninvolved or permissive parenting. These findings add to the body of research supporting the benefits of authoritative parenting.

The role of parents in fostering safe teen driving hinges upon communication. Ginsburg et al. (2009) noted that monitoring of parenting style is implicit in GDL legislation. They have suggested that the combination of monitoring and support inherent in authoritative parenting may be especially conducive to honest and open dialogue between parents and teens on safe driving. Ginsburg et al. (2009) invoked the American Academy of Pediatrics (2006) policy statement, which has advised pediatricians to work with families to promote safe driving by teens. The AAP has proposed that pediatricians raise parents' and adolescents' awareness of high-risk situations plaguing young drivers, encourage parents to serve as positive role models, and suggest families draw up teen-parent contracts for safe driving. Based on their findings, Ginsburg et al. (2009) has suggested that pediatricians work with parents to help them achieve the balance of monitoring, warmth and control that is most effective for fostering teen driver safety.

Parental Modeling

Only a few studies have examined the nature of the relationship between parents' and teens' driving behavior. Ideally, parents act as positive role models for their teen

children's safe driving (AAP, 2006; Ginsburg et al., 2009). Studies from the United States, Israel, and Brazil have shown an association between parents' and children's driving styles and have demonstrated that parents can be negative as well as positive role models for safe driving. Lahatte and Le Pape (2008) conducted the first such study with French families using data from the MARC (Mobility, Attitude, Risk, Behavior) survey, a longitudinal study based on a representative national sample of drivers between the ages of 18 and 25. In the last wave of the survey, the young adults and their parents completed parallel questionnaires. The findings revealed a significant association between the responses of the young adults and their parents, although Lahatte and Le Pape emphasized that while "parents are clearly a possible influence, the ability of young people to reappropriate what they see and hear should be underestimated" (pp. 632-633). Siblings are another potential influence within the family. Furthermore, the development of a young person's identity as a driver has paralleled adolescent development as the influence of parents wanes over time. In comparing the responses of novice drivers and those with four years or more of experience, the researchers observed that parents' influence gradually diminished. As young drivers gain more experience, they develop their own sense of the driving environment and their mastery of driving.

Parents who were more involved in teaching their children to drive exerted greater influence over their driving style. Although Lahatte and LaPage (2008) reported this finding in the context of comparing the influence of parents versus driving instructors, in light of the findings of Ginsburg et al. (2009), more involved parents may be more influential even if they play a smaller role in direct driving instruction. A notable finding was that daughters were influenced by both parents, but sons were only influenced by

fathers. The young men tended to view their mothers (or women more generally) as excessively cautious drivers. Taking calculated risks was part of a "masculine" sense of identity as a good driver, which helps to explain why young male drivers have taken more risks in the presence of male peer passengers (Falk et al., 2014; Romer et al., 2014). Parental influence does play out as a significant contributor to safe teen driving practices.

Parents' Perspectives

The prolonged learner stage for new teen drivers has been one of the key components of GDL. However, despite the fact that most states have required a learning stage of at least six months, Goodwin et al. (2010) pointed out there is scant understanding of the nature of parental supervision during that time. As part of their year-long naturalistic study of young drivers and their families, Goodwin et al. conducted a series of 10 interviews with a parent from each of the 50 families. According to the research, effectively enlisting parents as mentors and models with the aim of maximizing the benefits of supervised driving practice has entailed gaining insight into parents' approaches to supervision.

Parents employ various levels of involvement in their teen's driver training. Roughly half the parents (54%) were supervising their teen's driving for the first time (Goodwin et al., 2010). Most parents had some plan in mind for supervising the learning experience but only four parents (8%) had received any guidance materials, and the utility of that material was questionable. Ensuring the teen gained a lot of practice before driving was the predominant plan for most parents. However, only one-quarter (24%) of the parents were aware of the importance of introducing a new driver to driving under a wide range of driving conditions. In fact, the parents were quite diligent about creating a

safe driving environment, but gave minimal attention to the cognitive aspects of driving. Seat belt use was virtually universal, distractions were kept to a minimum, and music was absent or barely audible. At the same time, the parents focused on teaching the teen the technical aspects of vehicle handling, but did not take advantage of opportunities to stress the importance of hazard perception, good judgment, and prudent decision-making.

On the positive side, the teens' driving improved quickly and by the eighth week the overwhelming majority (88%) felt comfortable driving, according to parents' reports (Goodwin et al., 2010). The parents' comfort also increased over time; indeed, close to two-thirds (63%) admitted initially feeling nervous, though 12% appeared "very nervous" throughout the full year of supervised driving. Most parents deliberately limited the amount of feedback or instruction they offered due to teens' presumed sensitivity to criticism as well as fear of distracting them. However, as Goodwin et al. observed, parents failed to take advantage of "teachable moments," providing only basic instruction rather than comments that would stimulate critical thinking.

Goodwin et al. (2010) found most parents committed to doing their best in teaching their teen to drive; all parents excelled on some point of supervision but had difficulties with others. Two families, each with two teen children, stood out for the quality of their supervision: one in which the mother was the primary supervisor and in the other the father assumed a supervisory role. In both cases, the parents provided the teens with opportunities to drive under a variety of conditions. They recognized the importance of addressing the teens' anxiety and building their confidence. They were sensitive to the uniqueness of the teen stage of development and they sought to raise the teens' awareness of risk and to encourage critical thinking. To Goodwin et al. (2010), the inattention to

higher order thinking by most parents represents a serious weakness in their supervision and presents a challenge to the development of effective guidance materials. Focus group discussions with adolescents effectively helped the researchers develop the NYDS (Ginsburg et al., 2009). Engaging parents and teens in (separate) focus groups may be a useful strategy for creating materials to aid parents in supervising teens as they learn to drive.

Parent awareness of risks facing teens, as well as laws regarding driving privileges, are considerations for many states when evaluating legislation and education programs. Connecticut's legislative and educational campaigns were spurred by a number of high-profile crashes in 2007 (DMV Center, 2012). The intensive effort to reduce teen driver crashes included interviews with 300 parents and guardians of teens who received learner permits at age 16 (85%) or 17 (15%). The correct responses to questions regarding the driving laws ranged from virtually universal awareness of cell phone restrictions, to only slightly less awareness of who could ride with permit holders (91 %), to less than 10% who were aware of a 48-hour penalty for serious infractions. Most were aware of the 11 p.m. restriction for a restricted license (60%) and only 8% were unaware of a nighttime restriction for permit drivers. The overwhelming majority (85%) of parents considered the state GDL laws effective in decreasing teen crashes and fatalities. Connecticut adopted teen driving legislation in 2008, accompanied by powerful public awareness campaigns (DMV Center, 2012). Teen driver fatalities in the state dropped dramatically, from a high of 11 in 2002 to a single death in 2011. Teen driver crashes of all types declined by 13.8% between 2009 and 2010. Although a 2012 plateau in the number of

teens breaking the teen driver laws indicates a need for additional outreach, safety advocates are consistently satisfied that the laws and educational programs are effective.

Parent knowledge of brain development during adolescences varies. Notably, the only specific risk factor addressed by the Connecticut survey was adolescent brain development, which elicited varied responses. Less than half the parents (42%) were at all familiar with research on brain development and decision making. Queried about the age at which processes of neural decision making fully mature, the most prevalent responses were 21(26%), 25 (21%), 18 (16%), and 20 (11%). Upon learning that the neural processes do not completely mature until the mid-20s, the vast majority (88%) agreed or strongly agreed that brain development was a factor in teens' safe driving, and 90 % indicated all parents should be informed about this relationship. A majority of parents (69%) recognized motor vehicle crashes as the leading cause of teen deaths, and virtually all knew it was one of the top three circumstances (DMV Center, 2012). Clarifying the link between brain development and the high probability of teen car crashes helps tailor the message to parents about driver training.

Roughly one-third of the parents had taken the parent orientation course for driving test eligibility (DMV Center, 2012). Most (87%) agreed that the course should be requisite and 35% felt it should be required even before teens receive a learner permit. Most thought the course was helpful, and those parents who took the course were significantly more knowledgeable regarding brain research and the 11 p.m. nighttime restriction. The overall positive findings suggested that other states would benefit by requiring a parent orientation course. However, at least in terms of the survey question, there has been no indication that the orientation course addressed the issue of parents'

fostering young learners' higher order thinking in making driving decisions as Goodwin et al. (2010) had done. Educating parents about adolescent brain development and decision making would be a useful, if not essential, component of an educational program designed to help parents cultivate teens' critical thinking and decision making skills relevant to safe driving.

Driving Simulation and Technology

Driving simulators have been rapidly gaining popularity as educational and research tools. A major advantage of simulators is their capacity to generate "huge amounts of data" on a person's driving performance (De Winter et al., 2009, p. 138). The many uses of driving simulators in research have included studies involving central nervous system disorders, visual acuity and impairment, age, gender, driving experience, sleep apnea, alertness and fatigue, alcohol consumption, and cell phone use. Simulators have proved especially valuable in comparison studies. In fact, some studies, such as one involving experienced versus inexperienced drivers, found that simulators provide a more accurate portrayal of driving performance, and hence the distinction between groups or conditions, than an actual road assessment. The use of simulators could tailor training to specific subgroups of teens more at risk of crashes.

Driver Training

There is little definitive support for using simulators for driver training. An obvious distinction between practicing with a simulator and practicing on the road has been that driving simulators, "by definition, provide only a representation of reality, not reality itself" (De Winter et al., 2009, p. 138). Matching similar driving to actual road conditions has posed a "technical and psychological challenge" (p. 138). De Winter et al. (2009)

presented a theoretical framework for assessing driver performance, which they utilized for comparing young learners' driving simulator performance with their on-road driving test performance. The framework is built on three key quantifiable factors: speed of task performance, violations, and errors. The data came from the records of 36 different driving schools in the Netherlands and included 804 individuals (54% female, mean age of 19.4 years). De Winter et al. noted that the Netherlands does not allow accompanied on-road practice and the simulators were developed specifically to prepare learners for on-road driving. Thus, the driving students were presumed to be inexperienced with actual or simulated driving at the time they began their training. The critical issue in using simulation for training purposes has been whether the skills gained through simulation can be successfully transferred to the road.

One use of simulation provided a quality assessment of teen driver ability. The findings of the Netherlands study produced significant associations between the learners' simulator performance and driving test results (De Winter et al., 2009). Individuals with fewer steering errors were more likely to pass the test on the first attempt, and those with fewer steering errors, fewer violations, and faster task execution engaged in training for a shorter time. The student drivers' simulator performance provided valuable information regarding their driving test performance, leading De Winter et al. to propose their framework could be used for formative or summative assessment of learner driver proficiency with the aim of improving the effectiveness of driver training. In particular, they have suggested the information could be used to design specialized training programs for student drivers with high violation scores. Such programs would employ techniques to promote self-reflection or self-control, challenge overconfidence, and

change perceptions of risk. This technique might be effective for teens who are especially predisposed toward risky driving (Guo et al., 2013; Ouimet et al., 2014). De Winter et al. concluded that there is sufficient evidence to regard driving simulators as effective complementary training and assessment tools.

Risk Awareness and Perception Training (RAPT) is a PC-based simulation program to instill hazard anticipation in novice drivers through instruction in strategic scanning (Fisher, 2008; Pradhan et al., 2009). There are four versions of RAPT, beginning with plain top-down views (RAPT-1), moving to an occasional still photograph (RAPT-2), to sequences of still photographs (RAPT-3), and ultimately to a low-fidelity driving similar (SIMRAPT). Fisher (2008) presented a series of experiments to examine the effectiveness of RAPT as a training tool for young drivers. The first experiment was designed to assess whether the effects of training apparent in newly licensed drivers immediately following training on a simulator were still present and comparably strong a week later. Experiment two was designed to examine whether the effects of simulator training would generalize to open road driving. Experiment three explored whether results from the field experiment with RAPT-3 were the same as those observed with the simulator. Experiment four compared the effects of training with RAPT-1 and with SIMRAPT. Finally, experiment five targeted attention maintenance, examining whether newly-licensed young drivers spent more time diverting their eyes from the main roadway than older, experienced drivers.

Teens who participate in simulation training are able to gain skills to make judgments about risky driving situations. Experiment 1 using the SIMRAPT confirmed that trained novice drivers were almost twice as likely (51.8%) as untrained novices

(21.8%) to recognize hazards in near-transfer scenarios (situations presented in training) days after training and more accurately than their untrained counterparts in detecting hazards in far-transfer (situations not presented in training) scenarios (53.1% versus 27.1%). For all scenarios, the trained novices in Experiment 2 were nearly twice as likely to recognize potential roadway risks as untrained novices (60.6% versus 31.8%), further confirming the effectiveness of simulator training (Fisher, 2008). Additionally, the trained novices had significantly greater accuracy in perceiving potential hazards in far-transfer scenarios in Experiment 2. Experiment 3 provided further evidence in favor of the simulator training (Fisher, 2008). However, while participants trained with SIMRAPT, they surpassed those trained with RAPT-1; untrained drivers also performed better in this experiment, but it was uncertain whether using SIMRAPT added additional benefits.

The final experiment clearly demonstrated that young novice drivers are more inclined to glance away from the roadway than their older, more experienced counterparts. For the young drivers, 56.7% of the maximum glances lasted more than two seconds, compared to 20% for the older participants (Fisher, 2008). This last experiment underscored the importance of recognizing driver distraction as a serious hazard for teen drivers and their passengers (Bingham, 2014a, 2014b; Buckley et al., 2014; Durbin et al., 2014; Romer et al., 2014). Experiments of this nature can justify the use of simulation in driver education programs.

RAPT-3 can effectively impact the habits of teen drivers during potentially hazardous incidents. Pradhan et al. (2009) continued the research with RAPT, comparing the eye movements of 12 young drivers trained by RAPT-3 with a control group. The

participants were fully licensed drivers between the ages of 18 and 21 who held a driver's license in the United States for a minimum of one year. RAPT-3 depicted nine driving scenarios with built-in risks of colliding with either pedestrians or other vehicles. One set of risks was due to visible entities and the second due to risks obscured from sight until the last moment. Pradhan et al. (2009) found the results especially striking because the training was brief (<1 hour) and involved PC simulation. The RAPT studies have been ongoing and the RAPT simulations appear to be an efficient and effective tool for training young novice drivers.

Event feedback. Studies using technology to produce feedback related to driving has impacted safe driving habits of teens. Carney et al. (2010) followed up a study of teens in rural Iowa with a similar study involving thirty-three 16-year old drivers in suburban Minnesota; all participants had less than five months of unsupervised driving. Each vehicle was equipped with a DriveCam event-triggered video recording system that provided the driver with immediate visual feedback for safety related driving errors. Weekly event reports and videos were given to the young drivers and their parents. The program extended over a 6-week baseline phase through a 40-week intervention divided into 8-week segments; a second 6-week baseline followed for a total of 52 weeks.

Over the course of the program, the number of coachable events decreased by 61%, from an average of 21 per 1,000 miles during the first baseline, to eight per 1,000 miles during the second baseline (Carney et al., 2010). The intervention proved especially useful in decreasing the frequency of improper turns. Data from the second baseline showed that the results seemed to be enduring, although abrupt accelerations increased. According to Carney et al. the technology used in the study both "extends parental

monitoring and inhibits adolescents' tendency to engage in risk behavior," and "helps adolescents learn to recognize roadway hazards" (p. 1105). This type of intervention could be especially helpful to parents who often do not take advantage of teachable moments (Goodwin et al., 2010). This type of technology could assist parents as part of a more comprehension education program aimed at teen drivers.

Social Influences

Visual scanning behavior. Teens have a particular pattern of scanning behavior while driving. Pradhan et al. (2014) observed that while there is evidence that driving with peers increases the probability of crashes among young drivers, especially for adolescent males with male passengers, there is minimal knowledge of how the drivers' scanning behavior might be affected. The researchers noted that in general, young novice drivers tend to scan more narrowly, pay more attention to the vehicle's right and front, look in mirrors more often, and glance at extraneous traffic objects for longer durations than older, more experienced drivers. These behaviors decrease the ability to detect potential hazards, which is reduced even more if the driver glances away from the road to look at passengers.

One study attempted to understand visual scanning habits related to male drivers and passengers. To examine the effects of young male drivers' scanning actions in the presence (or absence) of a peer passenger, Pradhan et al. (2014) focused on 66 male high school students between the ages of 16 and 19 (with a mean age of just under 17 years) who held one of the highest of the three levels of the Michigan driver license. The simulator was a fixed-base, high fidelity Drive Safety driving simulator with three screens in the front of the car and one screen behind the car that projected the road scene.

After being acquainted with the equipment, the participants were randomly assigned to one of two passenger conditions: risk accepting or risk aversive. Each participant drove in both a passenger and a solo condition through a projected urban environment. Smart Eye AB, a remote eye tracking system, was integrated into the driving simulator for the purposes of the study.

All participants completed three surveys: a pre-appointment online survey, a pre-drive survey, and post-drive surveys (Pradhan et al., 2014). The outcome measures were vertical/horizontal gaze variability and the amount of time the drivers glanced off the road. No significant differences were observed in the amount of time the drivers glanced off the road when driving with a peer passenger or alone. However, their horizontal and vertical scanning narrowed significantly when a peer was present. Pradhan et al. (2014) noted no interaction between the driver and passenger which might account for the lack of differences in the time glancing off-road. They proposed that the narrower scanning range in the peer condition might have reflected cognitive overload, which further supports driver education programs that can be tailored to individual students.

Risk-taking personality characteristics produced mixed results. One marked distinction was that participants who were more resistant to peer pressure looked away from the road for less time than other participants (Pradhan et al., 2014), while other participant behaviors appeared inconsistent. The overall findings highlighted the complexity of risk-taking by adolescent drivers, suggesting that cognitive load, susceptibility to peer influences, and perceived peer expectations may all play a role in safe driving. The findings also revealed individual differences, which are important in understanding teens' risky behavior (Guo et al., 2013; Reyna & Farley, 2006).

Neural responses to social cues. Adolescents' sensitivity to peer pressure has been simultaneously implicated in risk-taking and antisocial behavior, and harnessed to promote safety, sobriety, and prosocial behavior. According to Falk et al. (2014) neural measures may be particularly valuable for illuminating the mechanisms that are underpinning adolescents' susceptibility to peer influence. Noting that current knowledge of how these mechanisms may affect adolescents' risk-taking, the researchers examined male adolescents' sensitivity to social exclusion in relation to taking risks while driving because many of the prior studies only focus on social acceptance. Increased brain activity that signifies reward has been linked with risk-taking in the presence of peers. However, no prior research examined how sensitivity to "social pain" or exclusion might affect teens' risk-taking behavior. Heightened neural activity in the anterior insula (AI), subgenual anterior cingulate cortex (subACC), and the dorsal anterior cingulate cortex in adults is thought to signify that the individual may be out of step with the group and thus serve as a cue to return to accepted norms of behavior. For adolescents, particularly young men, risk-taking can be a means of gaining acceptance and preventing the pain of social exclusion, which makes legislation and driver education programs related to passengers so critical to the safety of teen drivers.

One study sought to understand the influence of peer pressure on the decision to take risks among teen drivers. The participants were 36 male adolescents aged 16 and 17 with Level 2 licenses who were part of the larger study of peer influences on young Michigan drivers (Falk et al., 2014). At an initial fMRI (functional magnetic resonance imaging) session, the participants were introduced to two same gender peers, and completed several tasks under neural scanning including the game Cyberball, which

simulates social exclusion. Before the tasks, the participants completed self-report questionnaires assessing susceptibility to peer pressure, resistance to peer influence; after the tasks they recorded the distress they experienced as a result of exclusion (need threat scale). Roughly one week after the fMRI session, the participants engaged in the driving simulator exercise, randomly assigned to conditions. Following a practice session, the participants drove solo in the presence of a male peer whose behavior was manipulated to depict either risk accepting or not risk accepting.

The link between peer pressure and adolescence illuminates the risk-taking behaviors of teen drivers. Underscoring the importance of peer influence during adolescence, "the mere presence of a peer" was sufficient to promote risk-taking even if no acceptance of risk was explicitly conveyed (Falk et al., 2014, p. S27). However, this influence was more powerful when driving with risk accepting passengers. Heightened activity in the brain's social cognitive and social pain systems during exclusion were linked with more risky behavior with a peer passenger after controlling for risk-taking driving solo and the passenger's behavior. Notably, the use of neural imaging not only provided objective evidence of the participants' responses to anticipated rewards or punishment, but also "predicted variance in the behavioral outcome, above and beyond self-report" (p. S27). These findings added to the growing body of research on how adolescent brain development affects behavior, and the documentation of individual differences could be used to guide the development of programs, such as peer led interventions, to promote young driver safety.

Driver Distraction

Distractions while driving affects teen at high rates than other populations of drivers. Driver distraction has been defined as "a specific type of inattention that occurs when drivers avert their attention from the driving task to focus on some other activity" (NHTSA, as cited in Buckley et al., 2014, p. S16). Distracted driving has been a problem among drivers of all ages and experience levels, but it is especially dangerous for teens due to the combined effects of inexperience, immaturity, peer influences, and extensive use of mobile technology (Bingham, 2014a, 2014b; Buckley et al., 2014; Durbin et al., 2014; Romer et al., 2014). Analysis of data from the NTDS revealed that performing secondary tasks (dialing or reaching for a cell phone, texting, reaching for an object, glancing at a roadside object, and eating) was linked with a significantly heightened risk of crash or near crash among young novice drivers (Klauer et al., 2013). Furthermore, the prevalence of high-risk attention-diverting behavior increased over time for the young drivers, but not for experienced adult drivers. After a decline from 1999 to 2005, fatalities from distracted driving increased by 28% from 2005 to 2008 (Wilson & Stimpson, 2010). The sharp increase in texting has been implicated in this phenomenon, but texting has been one of several distractions affecting teen driving that will require a targeted intervention in driver education programs and specific legislation.

Despite widespread recognition of distracted driving as a problem, it has been largely ignored in the quest to reduce young driver crashes. According to Foss and Goodwin (2014), despite the attention to distracted driving among teens, there has been minimal knowledge regarding the nature and prevalence of distracted teen driving or the precise conditions that cause their attention to stray. As part of the ongoing naturalistic

exploration of teen driving in North Carolina, Foss and Goodwin (2014) used DriveCam event recorders installed in the vehicles of 52 high school students (38 beginners and 14 more experienced students) to capture distracted driving behavior. The beginners had been driving unsupervised for less than six months.

Most of the distracted driver behaviors observed were infrequent occurrences (Foss & Goodwin, 2014). The drivers glanced away from the roadway in almost half the video clips for reasons not related to driving but for usually brief durations. There was a considerable degree of individual variation in the frequency of distracted driving actions, in particular for the use of electronic devices. Foss and Goodwin (2014) noted that the pattern in which "a small subset of drivers accounts for a disproportionate share of problems" has been consistently found for numerous problem behaviors, and teen driving is no different in that respect (p. S57). Even with the implementation of evidence-based policies and programs, a proportion of young drivers have still engaged in risky driving behaviors—often in conjunction with other health risk behaviors such as drug and alcohol use—bolstering the argument that strategically targeted interventions are needed to further decrease teen driver crashes.

Two types of behavior, loud conversations and horseplay, stand out as distracting teen drivers. By analyzing auditory and visual data from inside the vehicle, Foss and Goodwin (2014) captured some sense of the "craziness" adolescents are suspected of displaying, especially in the presence of other teens. Although fairly infrequent, they signified "a degree of rowdiness or chaos in the vehicle that could be quite distracting to any driver, regardless of experience or age" (Foss & Goodwin, 2014 p. S57). Indeed, the teens in the NYDS recognized only this type of passenger behavior as distracting

(Ginsburg et al., 2008). Horseplay and loud conversations were more common with multiple passengers in the car and were strongly linked with serious incidents and to a lesser extent, g-force events (Foss & Goodwin, 2014). Cell phone use and other distractions were more prevalent when the driver was alone in the car and only weakly associated with serious incidents or aggressive driving. The various distracting habits that affect teen drivers are a logical beginning point for reducing fatal teen crashes.

Peer Passengers

Passengers pose a serious threat to a teen driver's ability to drive safely. Foss and Goodwin (2014) concluded that the behavior of passengers, which is beyond the driver's control, poses more of a distraction and a hazard to driving than actions under the driver's control, such as cell phone use or grooming. Limiting or prohibiting peer passengers is a feature of the most effective GDL programs (Masten et al., 2011; McCartt et al., 2010). Falk et al. (2014) demonstrated that the presence of peer passengers was sufficient to increase risk behavior by male teen drivers. The NYDS participants had not believed peer passengers present a distraction unless their behavior was overtly ostentatious (Ginsburg et al., 2008).

Research has been scarce on the specific ways peer passengers contribute to teen crashes. According to Curry et al. (2012), encouraging risk and distraction are both ways in which peer passengers can increase teen drivers' crash risk. To examine this issue, the researchers analyzed data from the National Motor Vehicle Crash Causation Survey (NMVCCS), covering 5,470 crashes between July 2005 and December 2007. Included in the NMCCS data were vehicle, driver, and environmental pre-crash conditions, crash scene records, and interviews with the participants. All crashes involved police and

Emergency Medical Service (EMS) responses and thus were classified as "serious crashes." A total of 677 teens were involved in 656 serious crashes. Roughly three-quarters (73%) of the crashes occurred when the teens were driving alone; in crashes where peers were present, 29% of the drivers had more than one peer passenger (Curry et al., 2012). Certain gender differences surfaced; male drivers involved in serious crashes displayed more risk behaviors (speeding, illegal maneuvers) with peer passengers of either gender than while driving solo; speeding was the most common aggressive driving behavior. Young men were also more prone to external distraction (most often glancing at other traffic) as well as to internal distraction when driving with female passengers. For female drivers, the most prevalent cause of crashes was being distracted by passengers; young women rarely drove aggressively or performed illegal maneuvers. This gender difference could assist parents in tailoring feedback and driving practice to these risk factors.

Comparing their findings with other studies, Curry et al. (2012) noted that taken together, the presence of a male passenger increases risk for both male and female teen drivers. However, young men tended to drive more safely with female passengers than when driving alone. At the same time, researchers acknowledged that these patterns are not necessarily consistent with crash data. Indeed, this fact has reinforced the need for technology-based training such as RAPT (Fisher, 2008; Pradhan et al., 2009) and video feedback (Carney et al., 2010). Because most teens drive alone due to heavy legislation limiting passengers in vehicles with teen drivers, this impacts driver education more than legislation.

Social Influence and Risk Perception

Due to interactions with parents and peers, teen drivers often rationalize distracted driving behavior as normal. Carter et al. (2014) explored the influences of both peers and parents on adolescents' distracted driving behavior. They noted that teens are influenced by parenting styles and role modeling (Ginsburg et al., 2009; Goodwin et al., 2010; Lahatte & Le Pape, 2008; YDRI Team, 2009). A survey was conducted with 403 adolescents (aged 16 to 18 years) and their parents (Carter et al., 2014). The overwhelming majority of teens (92%) acknowledged engaging in distracted driving behavior on a regular basis. At the same time, they perceived that their parents and peers engaged in distracted driving behavior more often than they did, which has not been unusual in studies of adolescents' health beliefs (Reyna & Farley, 2006). In the regression model, teens' risk perception, parents' distracted driver behavior, perceived parent distracted driver behavior, and perceived peer distracted driving behavior were all associated with the teens' distracted driver behavior (Carter et al., 2014). Risk perception and parents' distracted driver behavior had a more powerful influence on young men while perceived parental distracted driver behavior was a stronger influence on young women. These types of perceived norms are intrinsic to most behavior change models (Reyna & Farley, 2006). Understanding the complex dynamics of social influences on adolescent driving has been important for designing interventions that build on social relationships with parents and peers.

Mobile Devices

Cell phone use poses a unique hazard due to its presence with other distracting behaviors displayed by teen drivers. Using national data from the CDC's 2011 Youth

Risk Behavior Survey (YRBS), Olsen et al. (2013) investigated the prevalence of texting while driving and its relationship with other risky driving behaviors (inconsistent seat belt use, drinking alcohol while driving, or riding with a driver who had been drinking) among 8,505 high school students aged 16 or older. The survey asked whether respondents had engaged in these behaviors within the last 30 days. Close to half (44.5%) of the students reported texting and driving (Olsen et al., 2013). These students were also more likely than non-texting peer drivers to wear seatbelts inconsistently, drive after drinking alcohol, and ride with a driver who had been drinking; these associations intensified as the frequency of texting while driving increased. Olsen et al. were especially disturbed by the extent of texting and driving by the youngest, least experienced drivers. However, this occurrence may not be surprising, given teens' relative lack of awareness of the hazard of cell phone use, the meaning of inexperience, and the interaction between the two in increasing the risk of crashes (Ginsburg et al., 2008). Olsen et al. noted that while there appear to be no on-road studies assessing actual crash risk presented by texting teen drivers, a study of adult commercial drivers found that texting increased crash risk by 23 times in a group of drivers with far more expertise and experience than young teens. Based on records from the Fatality Analysis Reporting System (FARS) of crashes on U.S. roads from 1999 to 2008, Wilson and Stimpson (2010) concluded that without the volumes of text messaging after 2001, predicted deaths from distracted driving in 2007 would have declined by nearly two-thirds from the actual figure. As such, cell phone use has greatly impacted teen drivers, presenting a new challenge for legislators and educational professionals.

A notable finding was the presence of a subgroup of youth that engages in several risky driving behaviors (Olsen et al., 2013). The researchers suggested that teens in this group may have viewed these behaviors as less dangerous, possibly because they believed these behaviors carry social and emotional rewards that outweigh potential risks. Alternately, they might have believed that engaging in these behaviors only sporadically may protect them from harm. Olsen et al. (2013) concurred with Foss and Goodwin (2014) that certain subgroups of youth warrant specialized interventions for reducing risk behaviors. Parents could use this information to improve driving training and feedback at home.

Cell phone use while driving can be explained through an analysis of neurological development in teens. O'Connor, Whitehill, King, Kernic, Boyle, Bresnahan, & Ebel (2013) examined this issue from the perspective that some individuals are predisposed toward compulsive cell phone use. In a sample of 383 undergraduates, the researchers conducted a psychometric analysis of the Cell Phone Overuse Scale (CPOS) and its association with motor vehicle crashes as well as other risky driving behaviors such as impulsivity and alcohol consumption. All participants were drivers aged 22 or younger. The analysis showed that the CPOS consists of four related factors: anticipation, activity interference, emotional reaction, and problem recognition (O'Connor et al., 2013). Each factor is significantly linked with facets of impulsive behavior, in particular, emotional urgency. No significant relationships emerged between aspects of compulsive cell phone use and sensation seeking or lack of planning. However, higher CPOS scores were linked with a tendency toward problem drinking and higher anxiety regarding interpersonal relationships. The association between interpersonal anxiety and compulsive cell phone

use has suggested that some individuals may answer calls even when driving because they fear rejection if they fail to answer the call. This may have been a similar mechanism to the sensitivity to social exclusion Falk et al. (2014) observed in their neural study of young drivers. As such, teen drivers may require a more extensive educational program to help identify these very subtle, unconscious patterns of thought.

The CPOS was able to explain a clear correlation between cell phone use and teen crashes. After controlling for other factors (gender, driving experience, impulsivity, alcohol use, and relationship styles), the anticipation subscale of the CPOS was significantly linked with a history of motor vehicle crashes (O'Connor et al., 2013). Each increase of one point on the 13-point scale increased the probability of a previous crash by 13%. According to O'Connor et al. (2013), greater anticipation for incoming messages could have led to frequent cell phone checking, which would distract the driver's eyes from the road, or it could have increased cognitive load and decreased processing speed.

Bans on cell phones have been the standard response by many state legislatures concerned about the danger of cell phone use and driving. O'Connor et al. (2013) noted that bans on using cell phones while driving tend to be ineffective, probably due to lax enforcement; North Carolina's cell phone ban produced negligible results. Ehsani et al. (2014) investigated the impact of Michigan's text messaging restriction, instituted in June 2010, on drivers of different age groups as well as across crashes of various degrees of severity. Data on crashes involving drivers between the ages of 16 and 50 showed that contrary to expectations, significant increases in crash rates and upward trends in crashes involving fatality, disabling injury, and non-disabling injury occurred. The only decreases found were for the least serious incidents like crashes with only possible injury and

property damage. Overall effects of crashes were minimal, though it may be promising for teens that the most substantial changes were declines in possible injury and property damage crashes for 17-year old drivers.

Restrictions on cell phone use may not produce significant reductions in teen crashes while driving like driver education programs can. According to Ehsani et al. (2014), it has been difficult to interpret the small increase in the most severe crashes as well as the decline in the least severe crashes without information on driver behavior. The most probable explanation has been that the texting ban did not alter Michigan driver behavior, which is an assumption supported by data from other states. Extensive public awareness campaigns on seatbelt use and drinking while driving have produced dramatic changes in driver behavior. Without a parallel campaign to target texting and driving, plus strict and visible enforcement of laws, a restriction per se is likely to be insufficient to produce strong and significant changes. Event monitoring systems, like Foss and Goodwin (2014) used in their research, are often recommended to make young drivers, especially those who are most risk-prone, aware of specific hazards of distracted driving (Buckley et al., 2014; Olsen et al., 2013). Teens may reap the greater benefit in the long run through an intense study of driving behaviors than through a simply texting ban by law enforcement.

Unlicensed Drivers

Licensing requirements in a variety of countries suggest that failure to obtain a license results in a higher risk of crashes. As a preface to their study exploring the sociodemographic characteristics of unlicensed drivers in Sweden, Hanna, Hasselberg, Laflamme, and Möller (2010) noted that research from Australia, Italy, New Zealand, the

United Kingdom, and the United States has suggested that unlicensed driving by young people is an important safety issue, but one that is largely neglected. Studies from these countries have revealed heightened risk for crashes, injuries, and fatalities among unlicensed drivers, especially teens (Elliott, Ginsburg, & Winston, 2008; Hanna, Hasselberg, Laflamme, & Möller, 2010). In a Swedish study, young unlicensed drivers were disproportionately represented in single-vehicle crashes and crashes involving nighttime driving and driving under the influence of alcohol or drugs (Hanna et al., 2010). In Sweden, however, the legal age for obtaining a license has been 18; in the United States, unlicensed drivers are often under the age of 16. Further study of this phenomenon could impact driver education programs and legislation related to the age requirements of graduated drivers licensure.

Graduated drivers licensure is a relatively new phenomenon; as such, the impact of licensure on teen drivers is a new area of study for researchers. Confirming the claim of Hanna et al. (2010) that unlicensed teen driving is under-examined, Elliott et al. (2008) were unable to find a wealth of U.S. studies, with the most representative sample located in a regional study published in 1985 before the advent of GDL. For their own research into the phenomenon of teen driving, Elliott et al. turned to the 2006 NYDS. The survey included information on the respondents' licensure status and included a section on driver training, behavior, and crash history to be completed only by those who were learning to drive or who were "driving on their own," defined as driving without a learner's permit or any license at least one hour per week. Out of 5,665 students, roughly one in 25 reported some form of unlicensed driving; this group accounted for 4.2% of the total

sample and 5.9% of the 3,605 students who were classified as drivers (Elliott et al., 2008).

Unlicensed drivers share a certain set of traits. In terms of sociodemographic features, the unlicensed drivers were more likely to be Black or Latino, reside in rural or central city communities, and have lower academic grades than their licensed peers; age or gender differences between the two groups were not present. Having or not having a license was not related to ever being involved in a crash as a driver; nevertheless, the unlicensed young drivers were less inclined to use seat belts and more likely to drive under the influence of alcohol or drugs. They were also more likely to drive without a clear purpose, which could be construed as "joy-riding" (Hanna et al., 2010). Although there was no link between licensure and crashes, this information can help understand the motivation to obtain a license.

Several key traits underscore the attainment of a license, even without consideration for risk of crashes. According to Elliott et al. (2008), the comparable crash risk between licensed and unlicensed young drivers could have reflected the overall high crash risk for that age group. Another explanation may lie in the demographic profiles of the young unlicensed drivers. Unlicensed driving has been especially prevalent among teens living in low-income urban areas where license suspensions, especially among minorities, are often due to unpaid fines. The absence of documentation of citizenship or legal residence could have presented a barrier to obtaining a license. Thus, the researchers proposed that unlicensed teen drivers might be a diverse group, encompassing both the high-risk drivers who reflect the cultural stereotype of an unlicensed teen driver, and teenagers who need to drive but who face socioeconomic barriers to obtaining a license.

Several factors contribute to higher crashes rates in several specific groups. The Swedish study included young adults up to age 27 but excluded individuals who had a learner's permit or had a license that had been revoked (Hanna et al., 2010). The researchers used these criteria in order to focus on drivers who did not go through the licensing process, even several years after reaching the legal age for obtaining a license. Examining the circumstances of crashes in this population, Hanna et al. (2010) found that unlicensed drivers involved in crashes tended to be male, suspected of driving impaired, and were more likely involved in crashes in rural areas and with more severe injuries. Some U.S. studies, including one authored by Hanna (2010) and colleagues, have found young, (<16 years) unlicensed, rural male drivers to be involved in disproportionate numbers of fatal crashes (Elliott et al., 2008). Hanna et al. (2010) proposed that certain conditions, such as higher speed limits and long distance driving resulting from a lack of access to public transportation, might have accounted for the high rates of crashes with severe injuries and fatalities by unlicensed rural drivers. Poor road conditions could have been another contributing factor; the hazards of difficult driving conditions are exacerbated for those who have not had appropriate training and may be more predisposed to take risks.

Many youth without driver licenses were assisted in eventually obtaining a license. Elliott et al. (2008) were troubled that less than half of the unlicensed young drivers had attended driver education and nearly one-quarter did not credit anyone as being helpful in teaching them how to drive, implying that they may have been primarily self-taught. Furthermore, unlicensed drivers (7.6%) were three times more likely than their licensed peers (2.4%) to cite a male friend as being most helpful; paradoxically, the presence of a

male passenger may increase risk (Falk et al., 2014; Pradhan et al., 2014; Romer et al., 2014). Half the unlicensed drivers cited a parent as being most helpful compared to two-thirds of the licensed drivers (Elliott et al., 2008). Understanding why young people drive without a license and what barriers they face in obtaining a valid license is an essential step in improving driver safety for this group.

Alcohol and Drug Use

Every state at the time of this study has prohibited individuals under age 21 from driving with any measurable amount of blood alcohol (Shults & Olsen, 2012). With stringent restrictions, the prevalence of drinking and driving among high school students age 16 and younger declined by over half between 1991 and 2001, from 22.3% to 10.3%. However, despite the dramatic drop, drinking and driving has remained a contributing factor to more than 800 teen deaths each year. Enforcement of minimum legal drinking age laws, zero tolerance laws, and GDL systems are all recommended for reducing drinking and driving among teens, but it has been clear that even evidence-based best practices have not been effective for changing the behavior of all youth.

Both drug use and drinking while driving have been prevalent among teen drivers. While drinking and driving among teens has declined, using marijuana and driving has increased (O'Malley & Johnston, 2013). According to the annual Monitoring the Future survey of U.S. high school students, 28% reported driving under the influence of alcohol or drugs or being a passenger in a vehicle with a driver who used drugs or alcohol. This figure represents a decrease from 2001 when it was 32%, probably due to the decline in alcohol consumption; on the contrary, it does not negate the increase in marijuana use. Males were much more likely to drink and drive, but males and females were equally

likely to drive after smoking marijuana. As such, the effects of marijuana use on driving may require an increased awareness of the dangers for teens.

Driving while impaired often occurs in the presence of other risky behaviors while teens drive. In a national study of 11th grade students in the United States, binge drinking, illicit drug use, and risky driving were all independently related to driving while alcohol or drug impaired (DWI) or riding with someone who was alcohol or drug impaired (RWI; Li et al., 2013). Especially troubling is that DWI was more prevalent among young drivers who drove after midnight, drove while drowsy or sleepy, or read or sent text messages or used cell phones while driving. The association between secondary task engagement and DWI and RWI was fully mediated by risky driving, implying that young drivers who perform secondary tasks while driving are likely to engage in other risky driving behaviors. Similarly, Marcotte et al. (2012) found that binge-drinking adolescents more often violated GDL laws (such as driving at night) and performed other risky behaviors such as speeding or using a cell phone. Binge drinkers also had more citations, crashes, and near crashes than non-binge drinkers; speeding was the most common cause of crashes. Marcotte et al. also noted that binge drinking has been linked with neurocognitive deficits and heightened risk-proneness. The findings of Li et al. (2013) and Marcotte et al. have added to the body of research documenting subgroups of adolescents who engage in multiple risk behaviors that increase the risk for road accidents. These youth may need targeted interventions beyond GDL programs.

Empirical Studies of Programs and Interventions

Learner Drivers

As professionals learn more about risk factor related to teen drivers, programs are developed to target the traits specific to teen drivers. You Hold the Key (YHTK) was created by the Hamilton County General Health District in Cincinnati to improve the safety behavior of teen drivers and passengers (King et al., 2008). Delivered in schools, the 10-week comprehensive program combined driver safety education, cooperative learning, student oriented discussions, interactive lessons, peer-led role play, prevention videos, and presentations from experts on safety. The multifaceted, multimedia program used a variety of techniques ranging from trauma slides and crash victims' experiences to presentations by law enforcement and judicial officials, covering a full range of behaviors related to safe driving. To examine the impact of the program, King et al. (2008) surveyed students from three high schools in a pretest, posttest, and six-month follow-up format; a total of 814 students completed all three assessments.

Benefits of the program included significant increases in the probability of wearing seatbelts and requiring passengers to wear seatbelts, refraining from drinking and driving, as well as minimizing distractions while driving (King et al., 2008). The researchers noted that in contrast to traditional driver education, which focused on imparting information, YHTK encompasses knowledge, attitudes, and skills, as well as addresses problem solving and decision making, which is consistent with behavior change models used in health psychology (Reyna & Farley, 2006). King et al. have strongly advocated that schools implement similar comprehensive driver safety programs. Schools could benefit from a program to help students improve reasoning as related to risky behaviors.

Many programs are designed around anecdotal evidence of those who have experienced a fatal crash. Poulter and McKenna (2010) used the theory of planned behavior (TPB) as a framework for examining the effectiveness of Safe Drive Stay Alive (SDSA), an educational program designed to promote safe driving by alerting secondary school students to the serious consequences of risky driving. The interactive program consisted of a video depicting a young driver encouraged by peers to speed through country roads at night and overtake another vehicle, ultimately resulting in a fatal crash. The staged portrayal is juxtaposed with actual testimony by EMTs, bereaved parents, and seriously injured survivors of a fatal road crash relating their personal stories. According to Poulter and McKenna, the dramatic portrayal of a fatal crash combined with the real world experiences of people directly affected has presented a promising alternative to the conventional classroom presentations that have been largely ineffective; YHTK was designed with the same philosophy (King et al., 2008). The Texas-based Shattered Dreams school program has also made use of dramatization, portraying an alcohol-related crash and its consequences, as well as including an assembly in which the players read impact statements from community members whose lives have been affected by alcohol-related crashes (Poland, 2012). Through these programs students can conceive of risk-taking behaviors in more concrete ways.

Two studies relevant to TPB provided data regarding the impact of these programs. In the first experiment, nearly two hundred 15- and 16-year-old students from 12 British secondary schools attended the program and completed three assessments: a pre-intervention, one to two weeks post-intervention, and a 5-month follow-up (Poulter & McKenna, 2010). Positive impact was partial and short-lived; furthermore, the teens

displayed more negative attitudes on items related to driving within legal limits and perceiving that partners or friends disapproved of speeding. On the theory that a between-group design might be better in capturing attitude changes, a second study was conducted with an intervention group of 241 students and a control group of 291 peers. Six additional items were added to the original 13-item questionnaire. Analyses of the two groups' responses revealed a significant positive effect for the students who attended the program (Poulter & McKenna, 2010). This effect was apparent on three of the four items that improved in the within-participant experiment: driving within the speed limit at all times, resisting peer pressure to drive faster, and sticking to the speed limit when holding traffic up. Although Poulter and McKenna described these benefits as genuine positive changes in response to the intervention, they also acknowledged that the effects were small and probably transient. They suggested that future sessions covering new material might be required to produce enduring effects. The TPB had somewhat limited utility, although Poulter and McKenna proposed integrating TPB constructs into future research on interventions.

Licensed Drivers

Abundant evidence from health psychology has illustrated that a brief intervention is often insufficient to produce lasting results, and this effect may be especially relevant to adolescents whose perspectives are continually developing in when exposed to new peer and adult influences, new experiences, and their own internal cognitive and psychosocial development. Some brief interventions that have produced promising results may be more suitable for integration into a more comprehensive program. Falk (2009) examined whether answering a questionnaire might promote safe driving by stimulating

self-reflection. The underlying premise was that answering the questions would induce cognitive awareness of attitudes, which might translate into behavior change.

Awareness of risk factors may be affected through the use of direct questioning. Falk (2009) conducted an experimental study involving young men divided into two experimental groups and a control group. These participants responded to a questionnaire regarding their risky driving behaviors that was designed to capture attitudes toward risky driving. As in the second study of Poulter and McKenna (2010) differences arose between the experimental groups and the control group, but were short-lived (Falk, 2009). At the same time, Falk observed an intriguing effect: all three groups, including the control group, reported safer driving at the follow-up (Falk, 2009). The commonality across all three groups was the questionnaire, leading the researchers to speculate that they observed a question-behavior effect, whereby "simply questioning people about a specific behavior may influence their future attitudes as well as their future behavior" (Falk, 2009, p. 68).

The first study of two, a replication of the research of Falk, involved 142 Swedish young men (ages 18 and 19) who completed the Risky Driving Behaviour scale plus three scales capturing attitudes toward risk-taking while driving, and four scales capturing attitudes toward accidents and injuries in traffic, designed to heighten awareness of the consequences of risky driving (Falk, 2009). The findings replicated the decrease in self-reported risky driving behavior observed by Falk (2009), leading to a second study in which 149 young men, nearly all (95%) 18 years old, were assigned to one of three versions of the original questionnaire: Driving Behavior Only, Attitudes Toward Risk-Taking, or Attitudes Toward Accidents. One month later, all three groups reported

significant decreases in risky driving behavior. Adding questions about attitudes did not significantly enhance this effect. Due to this lack of effect, awareness of behaviors during driver training may improve outcomes related to teen crashes more so than analysis of attitudes.

The studies confirmed the validity of the question-behavior effect (Falk, 2009). However, it is still uncertain how long the benefits would endure beyond the one-month follow-up. Moreover, although the drivers were novices, given that 18 is the legal age for obtaining a driver's license in Sweden, 18 and 19-year olds are more developmentally mature than the high school students obtaining driver licenses in the United States. Whether the question-behavior effect could have produced long-term improvements in U.S. teen drivers could be determined by longitudinal research in which adolescent drivers are surveyed at intervals in the absence of further intervention. If so, this would be a cost-effective method of improving young driver safety.

An Israeli study examined the effectiveness of a training intervention designed to raise risk perception, which might be even more effective for adolescent drivers if integrated into a more comprehensive and targeted program. The 224 participants included one hundred and thirty five 12th grade high school students and 89 adults, all licensed drivers (Rosenbloom Shahar, Elharar, & Danino, 2008). The training (which took place on a specially designed skid track) combined theoretical education on safety equipment and behaviors with practical training on the principles of emergency maneuvering using scenarios depicting loss of control on various surfaces. During the training session the participants watched the professional driver in action and then sat in care with three other trainees and an instructor; each participant was given opportunity to

experience the situation demonstrated. The 4 to 5 hour program ended with a summary by an instructor. According to Rosenbloom et al. (2008), it appeared that the experience left a "strong impression" on the participants (p. 699). The findings supported that assertion, demonstrating significant improvements in risk perception that did not decline at a follow-up two months later. Despite the overall positive impact, the increases in risk perception were stronger for females and adults than for adolescents and males, consistent with an overall pattern (Romer et al., 2014). The consistent differences in driving habits of males and females could affect the type of feedback or driver training strategy a parent may use.

Parents and Teens

Several programs have attempted to assist parents with the responsibility of providing teens practice with driving. Based on protection motivation theory, the Checkpoints program was created to increase parental limits on novice adolescent drivers' independent driving under high risk conditions (Shope, 2010; Zakrajsek, Shope, Ouimet, Wang, & Simons-Morton, 2009). Designed to promote communication between parents and teens by including a parent-teen driving agreement (PTDA), the program includes a video covering the risks of teen driving, driving restrictions, and working with the agreement, which helps families set restrictions on teen driving under specific conditions and covers general rules for teen driving and the consequences of rule violations. In the Michigan pilot study, during the program the educator guided the parent-teen pairs through the first checkpoint (three months), using motivational messages to present Checkpoint Program recommendations and emphasizing the four

risky driving conditions for teens: driving with teen passengers, driving at night, driving in inclement weather, and driving on high speed roads (Zakrajsek et al., 2009).

The pilot study involved 231 parent-teen duos in 27 driver education sessions randomly assigned to either the intervention or the comparison group (Zakrajsek et al., 2009). Comparison group duos received a copy of *Teen Driver: A Family Guide to Driver Safety*. The key findings were that the parents and teens who participated in Checkpoints experienced heightened parent awareness of teen driver risks, were more likely to draw up a PTDA, and more likely to institute restrictions in accordance with Checkpoint Program recommendations. For both the intervention and control groups, parent awareness of teen driving was high at the baseline assessment, which may account for the high PTDA completion rate by parents and teens in the Checkpoints group (80%). At the same time, the restrictions were minimal and there was no program effect for nighttime driving. The results demonstrated the feasibility of presenting the Checkpoints Program in driver education and showed small but positive results.

Drug and Alcohol Awareness

Parents could also benefit from a strategy to teach their teens the risks associated with driving under the influence of drugs or alcohol. Using a control group design, Darnell and Dennis (2008) investigated the impact of the Texas Drug and Alcohol Driving Awareness Program (TDADAP) by comparing the driving records of 5,601 youth (age 15 to 20) who completed the program and 5,945 students who did not. Texas has extremely strict standards for young drivers: any detectable amount of alcohol is illegal for drivers under age 21, and can result in license suspension or other sanctions. Analyses of the driving records of both groups revealed that convictions for the

TDADAP group were lower than expected while convictions for the control group exceeded the expected number. In fact, adjusted for group size, the non-TDADAP group had 53% more convictions than the intervention group. Drunk driving among teens has been down, but is still a serious problem (Shults & Olsen, 2012). Due to the inherent dangers of drinking and driving, teens should still be involved with intensive educational programs designed to enhance knowledge

Summary and Conclusions

Teen drivers are involved in a heavily disproportionate number of motor vehicle crashes (CDC, 2014). Inexperience, immaturity, risk-taking, driver distraction, driving with peer passengers, driving at night and use of mobile devices have all been implicated in the high crash rates. The implementation of GDL policies have produced significant decreases in fatal and serious crashes among the youngest drivers, though there seems to be some reversal of that effect for 18-year olds (Masten et al., 2011). Less experience driving independently may have been a factor; however, the states with the strictest GDL systems have experienced the most substantial decreases in young driver crashes.

Adolescence is a time of heightened risk-taking and sensation seeking. In fact, a young person's brain does not fully mature until the mid-twenties (Floyd-Bann & Van Tassel, 2006). At the unique adolescent stage of development, teen drivers are more susceptible to impulsivity and distraction, and are especially sensitive to peer pressure. Young males in particular are more likely to speed and take other driving risks in the company of a male passenger (Falk et al., 2014; Romer et al., 2014). In general, passengers present a distraction to young inexperienced drivers, which is a persistent

argument in favor of GDL laws. Rowdy passengers may be even more of a hazard to teen drivers than cell phone use and other distractions (Foss & Goodwin, 2014).

For the majority of young drivers, GDL programs, driver education programs that focus on risk awareness and decision making, simulator training, and parent monitoring, which can be enhanced by parent education and parent-teen programs, all have a strong evidence base. At the same time, certain subsets of teens are especially risk prone, engaging in multiple risk behaviors that affect driving (Foss & Goodwin, 2014; Li et al., 2013; Marcotte et al., 2012; Olsen et al., 2013). For this group, educational intervention programs have seemingly had what McConnell (2010) labels "conflicted success." These teens may require strategically targeted interventions to effectively reduce risky driver; teen driver fatalities have dropped substantially since the early 2000s, but they remain the leading cause of death for adolescents.

Chapter 3 provides a discussion of the methodology to be used in conducting the study including a discussion of the sample and target populations, archival data sources, and statistical techniques to be employed.

Chapter 3: Research Methodology

Introduction

The purpose of this study was to investigate the relationships between dysfunctional teen driving behaviors, and the patterns among these behaviors, associated with fatal vehicle crashes involving young teen drivers. The basic data of the study were distributions of cases and counts or proportions of cases falling into particular patterns (i.e., cross tabulations between explanatory variables). A quantitative study was, therefore, the appropriate type of study to investigate these matters. Teen driving patterns can be identified by a number of markers, which may include talking on a cell phone, texting, reading or sending a message while driving, falling asleep while driving, driving without a seatbelt, driving passengers who do not wear a seatbelt, exceeding the posted speed limit, exhibiting careless and reckless driving, endangering persons and property, driving while impaired, and driving in opposition to the GDL's requirements (Williams, 2008).

The findings of this study may provide information for developing and implementing policies and practices aimed at reducing injuries and fatalities among teen drivers. The findings of this study may prove beneficial to teens, parents, educators, legislators, law enforcement officials, health officials, and the general public at large, as the disproportionate incidence of fatalities among teen drivers and their passengers has been a public health problem. The findings of this study can also provide data useful for evaluating the policy success or failure of legislative, administrative, and educational interventions designed to lower accidents and fatalities among young teen drivers.

In this chapter, the study sample, target population, and data collection and analysis methods are described.

Research Design and Rationale

In this quantitative study, I employed a nonexperimental design to analyze pertinent archival data from the North Carolina DMV vehicle crash database. Because the basic data were in the form of counts and proportions of cases, a quantitative study was more appropriate than a qualitative study. An emphasis was placed on examining those accident-related factors that are related to legislative and administrative policy decisions and educational programs targeting teen drivers. These findings can be used to add on to other researcher' findings; provide useful information to legislators, administrators, and educators; and contribute to an examination of the success or failure of previous legislative, administrative, or educational interventions or policies.

The source of data for the study was the archive of North Carolina DMV Form 349. When an accident occurs in North Carolina, the responding law enforcement officer completes a copy of DMV Form 349. Data for the study were extracted from the DMV 349s for fatal crashes involving young teen drivers. The most recent complete data consisted of 84 DMV Form 349s for fatal crashes involving young teen drivers occurring between 2009 and 2013. There was sufficient time and resources for me to extract the needed data from these 84 forms.

The following types of analytic strategies relevant to categorical data were applied:

- Descriptive frequency distributions of the proportion of cases falling into each category of an independent variable or factor

- Chi-square tests of goodness of fit of an observed distribution of counts or proportions against an expected distribution of counts or proportions given the null hypothesis
- Chi-square tests of independence designed to investigate patterns among the independent variables or factors.

Research Questions

The research questions pertaining to young teen drivers (defined as those from 15.5 to 17.99 years of age) that were addressed in this study were:

- What is the association between dysfunctional teen driving behaviors and traffic fatalities among young teen drivers?
- What is the association between driver gender and selected dysfunctional driver behaviors?

Dependent and Independent Variables

The dependent (outcome) variable in the study was the count or proportion of cases observed in a particular category. For example,

- The proportion of cases in which driving in excess of the authorized speed limit was reported
- The count or proportion of cases in each cell of a cross-tabulation table

The independent variables of interest in the study were the following:

- Dysfunctional teen driving behaviors
- The gender of the driver

Research Hypotheses

Based upon the research questions, the following research hypotheses were formulated:

- There will be an association between dysfunctional teen driving behaviors and traffic fatalities among young teen drivers.
- There will be an association between driver gender and selected dysfunctional driver behaviors.

The indicators of dysfunctional teen driving behavior hypothesized to be associated with fatalities among young teen drivers were the reported involvement of the following: alcohol; drugs; distractions involving the use of electronic devices (e.g., texting); evidence of speeding; sleepiness or drowsiness; and inappropriate driving maneuvers including crossing the center line, overcorrecting, erratic operation of the vehicle, and the use of seat belts. The indicators of dysfunctional teen driving behavior hypothesized to be associated with driver gender were the following: the reported involvement of speeding, alcohol use, and inappropriate driving maneuvers.

I employed a quantitative, nonexperimental design to analyze pertinent archival data from the North Carolina DMV vehicle crash database. As discussed by Glass and Stanley (1970), the null-hypothesized value of a proportion does not have to be zero. In order to have a meaningful null-hypothesized value for use in the one-sample hypothesis tests of proportions, the value of 0.05 was selected. This is the value of the proportion posited by the null hypothesis, not the alpha level or probability of a Type I error. Using this null hypothesized point value, the null hypothesis involving the proportion of characteristic X in the population simply states that the proportion of cases in the

population exhibiting characteristic X is less than or equal to 0.05, thereby acknowledging a small probability of the presence of the characteristic (e.g., driving in excess of the authorized speed limit) in the population. The alternative hypothesis, on the other hand, states that the population proportion of characteristic X is greater than 0.05, thereby acknowledging a higher probability of the presence of the characteristic in the population.

The hypotheses associated with the indicators of dysfunctional teen driving behavior are listed below. The 0.05 level of significance was used in these hypothesis tests.

$H_0$1: There will be no difference between the proportion of young male drivers involved in fatal crashes and the proportion of young female drivers involved in fatal crashes.

$H_1$1: The proportion of young male drivers involved in fatal crashes will be greater than the proportion of young female drivers.

$H_0$2: The proportion of fatal crashes involving speeding will be less than or equal to 0.05.

$H_1$2: The proportion of fatal crashes involving speeding will be greater than 0.05.

$H_0$3: The proportion of fatal crashes in which alcohol was reported as a contributing circumstance to the crash will be less than or equal to 0.05.

$H_1$3: The proportion of fatal crashes in which alcohol was reported as a contributing circumstance will be greater than 0.05.

$H_0$4: The proportion of fatal crashes in which a drug other than alcohol was reported as a contributing circumstance will be less than or equal to 0.05.

$H_1$4: The proportion of fatal crashes in which a drug other than alcohol was reported as a contributing circumstance will be greater than 0.05.

$H_0$5: The proportion of fatal crashes in which distraction involving the use of electronic devices was reported as a contributing circumstance will be less than or equal to 0.05.

$H_1$5: The proportion of fatal crashes in which distraction involving the use of electronic devices was reported as a contributing circumstance will be greater than 0.05.

$H_0$6: The proportion of fatal crashes in which drowsiness or sleepiness was reported as a contributing circumstance will be less than or equal to 0.05.

$H_1$6: The proportion of fatal crashes in which drowsiness or sleepiness was reported as a contributing circumstance will be greater than 0.05.

$H_0$7: The proportion of fatal crashes in which the exhibition of dysfunctional driving maneuvers was reported as a contributing circumstance will be less than or equal to 0.05.

$H_1$7: The proportion of fatal crashes in which the exhibition of dysfunctional driving maneuvers was reported as a contributing circumstance will be greater than 0.05.

$H_0$8: The proportion of fatal crashes in which no seat belt was reported as having worn will be less than or equal to 0.05.

$H_1$8: The proportion of fatal crashes in which no seat belt was reported as having been worn will be greater than 0.05.

$H_0$9: There will be no association between gender and reported speeding.

$H_1$9: There will be an association between gender and reported speeding.

$H_0$10: There will be no association between gender and reported use of alcohol.

$H_1$10: There will be an association between gender and reported use of alcohol.

Methodology

Target Population and Sampling Procedure

The target population consisted of 84 fatal vehicle crashes involving 88 teenage drivers of 15.5 to 17.99 years of age that occurred between 2009 and 2013. The sample for the study was a census of the population as it included all 84 crashes.

Statistical Power Analysis

The power of a statistical test is the probability of correctly rejecting the null hypothesis when it is false (Cohen, 1969). The statistical tests employed in this analysis included the following:

- The chi-square test for goodness-of-fit
- The chi-square test for independence
- The one-sample Z test for proportions

The estimates of statistical power of these tests were calculated by using the techniques and tables in Cohen (1969), and they will be summarized in this section. The calculations of these estimates are described in detail in Appendix C. The calculations of statistical power are based upon the traditional alpha level of 0.05. According to Cohen, an estimated level of statistical power of 0.8 or greater is considered appropriate and acceptable.

Using the methods and tables published in Cohen (1969) and the calculations described in Appendix B, I found the following:

- The estimated statistical power for a chi-square test of goodness-of-fit involving two categories and 84 cases was 0.81.

- The estimated statistical power for a chi-square test of independence involving a two by two contingency table and 84 cases was 0.8 (Everett, 1992).
- The estimated statistical power for a one-sample Z test of proportions when the null hypothesized proportion was specified as 0.05 (see discussion above) and the alternative hypothesis proportion was specified as 0.15 (thus, allowing for the test of a difference in proportions of 0.1 or greater) was estimated to be 0.90 for a sample size of 84 cases.

According to the results of these power calculations, a sample size of 84 cases yields sufficient statistical power to detect meaningful effects.

Recruitment, Participation, and Data Collection for an Archival Study

Crash data for fatal crashes involving teenage drivers in the target population as recorded on the North Carolina DMV Form 349 Crash Report was provided through the North Carolina Department of Transportation, DMV. Permission to use the data was granted by the NCDOT for research purposes. I submitted a waiver form developed by Walden University to the DMV to obtain access to the data collection. I properly signed and executed the document for approval by Walden University, and then provided it to the DMV to obtain the crash reports.

The DMV Form 349 is admissible as evidence in North Carolina courts without the reporting officer's presence at the court proceedings. The report provides a detailed description of the accident situation including all of the independent variables of interest in this study. Because of the exhaustive nature of the descriptive data on DMV Form 349,

and its recognized legal status in North Carolina courts, it was the best source of secondary data for this archival study.

Instrumentation

Some of the variables on which information was collected on DMV Form 349 were modeled on those from the Model Minimum Uniform Crash Criteria (MMUCC) of the NHTSA. DMV Form 349 was designed by a committee of transportation administrators (which included me), law enforcement officers, statisticians, and university researchers. The document has been reviewed and, at times, updated based on new legislation developed, such as laws regarding texting while driving. The document is periodically reviewed by a team of law enforcement officers, statisticians, university researchers, and stakeholders involved in health and human services. The DMV Form 349 has been accepted by North Carolina courts as reliable as it was prepared by state-trained and certified law enforcement officers of the North Carolina Department of Justice.

The document is not an attitude survey, personality assessment, or educational assessment. It is filled in only once. Hence, considerations of test/retest reliability, history, maturation, statistical regression to the mean, and other potential threats to internal validity (Campbell & Stanley, 1959) did not apply to this study. DMV Form 349 includes data on a number of different aspects of the accident that are essentially "apples and oranges" (e.g., driver gender, the reported involvement of speeding and alcohol, which have no necessary relationship to each other [as opposed to a collection of Likert – scale items assessing people's attitudes toward gun control]). Hence, estimates of internal consistency were also seen to be nonapplicable.

The hypothesis of associations between the demographic characteristics of teen drivers and the factors associated with the accident were directly tested. There were no hypothetical constructs or intervening variables in the data analytic model. The data on teen driver demographics, as well as factors associated with the accident, were directly observed and reported on DMV Form 349 and were not indicators of latent constructs or variables. Given these three aspects of the study, construct validity was not considered to be an issue in this study.

DMV Form 349 was designed as an information gathering and report form rather than as a predictive instrument. Therefore, no studies of the predictive validity of the form have been conducted.

As data on all of the variables of interest included in the study appear on DMV Form 349, it was believed to be sufficient to answer the research questions posed by this study.

Operationalization of the Variables

The dependent variable in the study was the count or proportion of cases observed in a particular category (ie.,the proportion of cases in which driving in excess of the authorized speed limit was reported or the count or proportion of cases in each cell of a cross-tabulation table). The values of the independent variables were extracted from the following fields of the DMV Form 349 Crash Reports:

- Driver gender: Question 26
- Driving in excess of authorized speed limit: Driver Contributing Circumstance Category No. 6 marked
- Use of alcohol: Question 37: Category 1 marked

- Use of a drug other than alcohol: Driver Contributing Circumstance Category No. 31 marked
- Distraction involving the use of electronic devices: Driver Contributing Circumstance Category No. 35 marked
- Driver drowsiness or sleepiness: Question 35 (Category No. 3 or 4). (Using SPSS, a Boolean Drowsiness/Sleepiness variable was constructed which had a value of 1 if either Category 3 and/or Category 4 is marked on Form 349 and 0 otherwise)
- Exhibition of dysfunctional driving maneuvers (e.g., crossing the center line of the roadway): Driver Contributing Circumstances Category Numbers 11,12,13,14, or 26. (Using SPSS, a Boolean Dysfunctional Driving Maneuvers variable was constructed which had a value of 1 if one or more of the following categories 11,12,13,14, and/or 26 is marked as a contributing circumstance and 0 otherwise)
- Nonuse of seatbelts: Question 27: Category 0 is marked

Data Analysis Plan

The data analysis software used was the latest version of SPSS.

Data Screening

Only accident reports describing fatal vehicle crashes involving a teenage driver between 15.5 and 17.99 years of age that occurred between the years of 2009 and 2013 in the State of North Carolina were included in the sample.

Data Cleaning

The data were extracted from the source documents (DMV Form 349) and entered into an Excel spreadsheet. They were then input into SPSS. Missing data fields for each case were coded on the Excel spreadsheet as "-1." The data values for each variable were examined by using the SPSS Descriptive Procedure which provides information on the following:

- The minimum and maximum value for each variable, which will provide a range check to identify out-of-range and potentially miscoded values, which can then be correctly coded
- The number of missing cases for each variable
- The mean, mode, and standard deviation of the variable

Data Analysis

The results of data analysis began with descriptive statistics summarizing the demographic characteristics of the drivers and the contributing circumstances of the crashes as reported on Form 349. I stopped reviewing here due to time constraints. Please go through the rest of your chapter and look for the patterns I pointed out to you. I will now look at Chapter 4.

The inferential research hypotheses were tested as follows:

$H_1 1$: "The proportion of young male drivers involved in fatal crashes will be greater than the proportion of young female drivers" will be tested using the chi-square test for goodness-of-fit (Cohen, 1969).

The following hypotheses will be tested using the one-sample Z test for proportions (Glass and Stanley, 1970) followed by confidence intervals for the proportions:

$H_1$2: The proportion of fatal crashes involving speeding will be greater than 0.05.

$H_1$3: The proportion of fatal crashes in which alcohol was reported as a contributing circumstance will be greater than 0.05.

$H_1$4: The proportion of fatal crashes in which a drug other than alcohol was reported as a contributing circumstance will be greater than 0.05.

$H_1$5: The proportion of fatal crashes in which distraction involving the use of electronic devices was reported as a contributing circumstance will be greater than 0.05.

$H_1$6: The proportion of fatal crashes in which drowsiness or sleepiness was reported as a contributing circumstance will be greater than 0.05.

$H_1$7: The proportion of fatal crashes in which the exhibition of dysfunctional driving maneuvers was reported as a contributing circumstance will be greater than 0.05.

$H_1$8: The proportion of fatal crashes in which no seat belt was reported as having been worn will be greater than 0.05.

The following hypotheses will be tested using Fisher's exact chi-square test for independence (Marascuilo and McSweeney, 1977), odds ratios and associated confidence intervals will also be calculated for each 2 x 2 contingency table.

$H_1$9: There will be an association between gender and reported speeding.

$H_1$10: There will be an association between gender and reported use of alcohol.

Threats to Validity

External Validity

The major threat to external validity that pertains to this study centers on the potentially inappropriate generalization of the results to another population or context (e.g., Bracht & Glass, 1968). The results of this study could reasonably be generalized to:

- Similar aged teen drivers residing in other states who have been involved in fatal vehicle crashes, and
- Teen drivers in states that collect crash data similar in content to that on the NC DMV Form 349, which was employed in this study.

Threats to Internal Validity

This is an archival study involving extraction of secondary data from a publically available secondary data source. Therefore, the study did not have to meet the requirements of internal validity of an experimental or quasi-experimental study (Campbell & Stanley, 1959).

Threats to Construct Validity

The hypothesis of associations between the demographic characteristics of teen drivers and the factors associated with the accident were directly tested. There were no hypothetical constructs or intervening variables in the data analytic model. The data on teen driver demographics and factors associated with the accident were directly observed and reported on DMV Form 349 and were not indicators of latent constructs or variables. Given these three aspects of the study, construct validity is not considered to be an issue in this study.

Ethical Procedures

The ethical issues relating to biases, power relationships, conflicts of interest, and the use of incentives for participation of the study did not apply because archival research using secondary data from a publically available database was conducted. As such, these data did not need to meet the University's privacy and protection rules.

Ethical approval was sought by the Ethics Review Office of the Vice-President, Research and Associate Provost at Walden University. This was followed by the informed consent process as outlined by the Institutional Review Board (IRB) at Walden University, United States of America. Data was obtained with permission under IRB number 03-16-16-0103590. I completed the National Institute of Health's training on "Protecting Human Research Participants" following the informed consent process, data collection, as described in Chapter 4, began.

Summary

The purpose of the study was to investigate factors, and their patterns, associated with fatal vehicle crashes involving young teen drivers. The basic data of the study, therefore, are distributions of cases and counts or proportions of cases falling into particular patterns to be assessed with frequency distributions of values on individual variables and cross tabulations between pairs of variables. A quantitative study was therefore deemed appropriate for this situation.

The target population consisted of 84 fatal vehicle crashes involving teenage drivers of 15.5 to 17.99 years of age and occurring between 2009 and 2013, the latest period for which complete data were available.

The independent variables included dysfunctional teen driving behaviors and driver gender. Since the study involves counts and proportions the one – sample Z test for proportions, the chi-square test for goodness – of – fit and the chi-square test for independence were considered to be the appropriate statistical procedures for testing the null hypotheses related to each indicator of dysfunctional teen driving behavior.

Chapter 4 presents the results of the data analysis.

Chapter 4: Results

Introduction

The purpose of the study was to investigate factors, and patterns among these factors, associated with fatal vehicle crashes involving young teen drivers. Data on these factors were extracted from North Carolina DMV Form 349. This form was completed by law enforcement officers who responded to North Carolina fatal vehicle crashes that involved young teenage drivers between 15.5 and 17.99 years of age and occurred between 2009 and 2013.

The following research questions for the study were formulated:

1. What was the association between dysfunctional teen driving behaviors and traffic fatalities among young teen drivers?
2. What was the association between driver gender and selected dysfunctional driver behaviors?

It was hypothesized that the following factors would be reported on Form 349 as significant contributing causes to fatal crashes among this group of teen drivers: alcohol use; drug use; distractions involving the use of electronic devices, such as texting, evidence of speeding, driver sleepiness, or drowsiness; inappropriate driving maneuvers; and the absence of use of seat belts. An association between driver gender and the following dysfunctional driving behaviors was also hypothesized: evidence of speeding, alcohol use, and inappropriate driving maneuvers

In this chapter, I discuss the data collection process, the demographic characteristics of the young drivers in sample, and the results of the analyses.

Data Collection

Data on factors hypothesized to be associated with fatal vehicle crashes were extracted with appropriate permission from the North Carolina DMV Form 349, which was completed by law enforcement officers who responded to these fatal vehicle crashes. DMV Form 349 was designed as an information gathering and reporting form rather than as a predictive instrument. Therefore, no studies of the predictive validity of the form were conducted. As data on all of the variables of interest included in the study appear on DMV Form 349, it was believed to be sufficient to answer the research questions posed by this study. The data were provided by the North Carolina DMV.

The sample consisted of Form 349 reports for all fatal crashes occurring between 2009 and 2013 in the state of North Carolina, and involving at least one teenage driver between the ages of 15.5 and 17.99 years of age. The sample was a census of the population of interest. There were 84 crashes, involving a total of 88 teen drivers in the above age group; two of the 84 crashes involved two teen drivers rather than just one.

The demographic profile of the teen drivers in the sample was as follows: 62.5% of the drivers in the sample were males and 37.5% were females. According to the data, 3.4 % of the drivers were 15 years of age, 47.7% were 16, and 48.9% were 17. The average age of the drivers was 16.45 years with a standard deviation of 0.566 years. The ethnic composition of this sample of drivers was 76.4% Non-Hispanic White, 15.7% African American, 5.4% Hispanic, and 1.1% other ethnicity.

Results

In the paragraphs below, the descriptive statistics pertaining to factors hypothesized to be associated with fatal vehicle crashes are discussed. Many of the

factors listed below are coded categories of Items 14 – 16 on DMV Form 349, which allowed the responding officer to assess the scene of the crash and to code up to three contributing circumstances associated with each driver involved in the crash. If a code for a contributing factor appeared on Form 349, the contributing circumstance was coded in the dataset as being present. In Form 349, the responding officer affirmatively codes the presence of a contributing circumstance or factor. If the code for a particular contributing circumstance was not present on the form or if the factor was not checked in response to the question on the form within which the factor appears, I inferred that the contributing circumstance or factor was absent in that case. Table 1 displays each contributing circumstance and the proportion of crashes within which the circumstance was coded on the form as having been present.

Table 1

Contributing Circumstances from Form 349 and Proportion of Fatal Crashes

Code Number	**Contributing Circumstance**	**Proportion of Crashes**
6	Exceeding the authorized speed limit	36.4%
7	Exceeding safe speed for conditions	22.7%
8	Failure to reduce speed	2.3 %
11	Crossing centerline/ Going the wrong way	30.7%
14	Overcorrecting/over-steering	22.7%
28	Erratic vehicle operation	22.7%
35	Driver distraction involving an electronic communication device	0.0%

Exceeding the authorized speed limit was reported on Form 349 to be a contributing circumstance in 32 (36.4%) of the fatal crashes. Exceeding safe speed for conditions was reported to be a contributing circumstance in 20 (22.7%) of the fatal crashes. Failure to reduce speed was reported to be a contributing circumstance in two (2.3%) of the fatal crashes. One or more of these three speed-related contributing circumstances was reported as a contributing factor in 52.3% of the fatal crashes. The reported number of miles per hour (mph) over the authorized speed limit ranged between zero and 85 mph. The average reported excess speed was 12.4 mph with a standard deviation of 1.68 mph.

Crossing centerline/going the wrong way was reported on Form 349 to be a contributing circumstance in 27 (30.7%) of the fatal crashes. Overcorrecting/over-steering was reported to be a contributing circumstance in 20 (22.7%) of the fatal crashes. Erratic vehicle operation was reported to be a contributing circumstance in 20 (22.7%) of the fatal crashes. One or more of these three dysfunctional driving maneuver factors was reported as a contributing cause in 64.1% of the fatal crashes. Driver distraction involving an electronic communication device was not reported as a contributing circumstance in any of the fatal crashes.

Table 2 displays additional accident related factors reported in response to questions on Form 349 and their proportions of occurrence. The description of the topic of the question is a short paraphrase of the full question as listed on Form 349.

Table 2

Additional Factors Reported on Form 349 and Their Proportions of Occurrence

Question Number	Topic of Question	Proportion of Occurrences
37	Alcohol/other drugs suspected	
	Alcohol Suspected	4.5%
	Other Drug Suspected	1.1%
27	Occupant protection *not* used	42.0%
30	Occupant trapped in vehicle	54.5%
35	Driver physical condition	
	Suspected fatigue	0.0%
	Drowsiness/ Falling asleep	0.0%

According to the results of the analysis of the questions related to alcohol and/or drug use (Alcohol/drugs suspected), alcohol use was reported as suspected in only four (4.5%) of the drivers. Similarly, drug use was reported as being suspected in only one (1.1%) of the drivers.

In 37 (42%) of the fatal crashes, the teen driver was reported as not having used an occupant protection device (e.g., shoulder and lap belt). In 48 (54.5%) of the fatal crashes, the teen driver was reported to have been trapped in the vehicle.

In the question regarding the physical condition of the driver, suspected cases of driver fatigue and falling asleep were possible options as contributing circumstances. No incidents of either suspected driver fatigue or falling asleep were reported.

Statistical Tests

The statistical test for the null hypothesis that a population proportion equals zero is the one-sample Z-test for proportions. The one-sample Z-test requires a sample size of

greater than 30, and the only assumption for this test is that the observations are independent of each other (Glass & Stanley, 1970). Likewise, both the chi-square tests for goodness-of-fit and for independence require that the observations be independent of each other (Cohen, 1969). With the exception of only two of the crashes in the sample (each of which involved more than one teen driver), this assumption of the independence of the observations was met.

Research Hypothesis 1 was the following: There will be a higher proportion of young male drivers involved in fatal vehicle crashes than female drivers. In this sample of teen drivers involved in fatal vehicle crashes, 62.5% were males and 37.5% were females. The chi-square test for goodness of fit can be used to test these observed proportions against the null hypothesis of an equal proportion of both genders. This test yielded a chi-square value of 5.5 ($p < 0.019$) indicating a statistically significant deviation from the null hypothesis of equal proportions of male and female drivers in this age group involved in fatal crashes.

Research Hypothesis 2 was the following: The proportion of cases in which excessive speed is reported as a contributing factor will be greater than zero. Excessive speed (i.e., exceeding the authorized speed limit) was reported as a contributing factor in 36.4% of the fatal crashes. This proportion was significantly different from zero ($Z = 107.38$; $p < 0.0001$). The 95% confidence interval for the observed proportion was 0.2631 to 0.4641. Another indicator of use of excessive speed was the contributing circumstance exceeded safe speed for conditions. This contributing circumstance was reported as being present in 56.82% of the fatal crashes. This proportion was also

significantly different from zero ($Z = 168.34$; $p < 0.0001$). The 95% confidence interval for this observed proportion was 0.4647 to 0.6717.

Research Hypothesis 3 was the following: The proportion of cases in which alcohol use is reported as a contributing factor will be greater than zero. Alcohol use was reported as having been suspected as a contributing factor in four (i.e., 4.5%) of the crashes. This proportion significantly differed from zero ($Z = 13.06$; $p < 0.001$). The 95% confidence interval for the observed proportion was 0.0017 to 0.0883, indicating, however, that suspected use of alcohol was not a meaningful contributing factor to fatal crashes in this age group of drivers.

Research Hypothesis 4 was the following: The proportion of cases in which drugs other than alcohol are reported as a contributing factor will be greater than zero. The suspected use of drugs other than alcohol was reported in only one case (i.e., in only 1.1% of the cases). The 95% confidence interval for the observed proportion was -0.0108 to 0.0328, which included 0.0 and, therefore, led to a failure to reject the null hypothesis.

Research Hypothesis 5 was the following: The proportion of cases in which distraction involving the use of electronic devices is reported as a contributing factor will be greater than zero. Driver distraction involving electronic communication devices (e.g., cell phoned, texting) was not reported as a contributing condition in any of the cases. Driver distraction involving other electronic was also not reported as a contributing condition in any of the cases. Consequently, the null hypothesis that the proportion equals zero could not be rejected.

Research Hypothesis 6 was the following: The proportion of cases in which driver drowsiness or sleepiness is reported as a contributing factor will be greater than zero.

Neither suspected driver fatigue nor falling asleep was reported in any of the cases. Consequently, the null hypothesis that the proportion equals zero could not be rejected.

Research Hypothesis 7 was the following: The proportion of cases in which dysfunctional driving maneuvers were reported as contributing factors will be greater than zero. Dysfunctional driving maneuvers (i.e., crossing the centerline/going the wrong way, overcorrection/over steering, or erratic operation of vehicle) were reported as contributing circumstances in a total of 61.4% of the fatal crashes. This proportion was significantly different from zero ($Z = 181.82$; $p < 0.0001$). The 95% confidence interval for the observed proportion was 0.5119 to 0.7153.

Research Hypothesis 8 was the following: Driving in excess of the speed limit as a reported factor in the crash will be related to driver gender. The appropriate statistical test for this hypothesis was the chi-square test for independence between driver gender and the contributing factor of driving in excess of the authorized speed limit. The value of the chi-square test statistic was 2.80 ($p < 0.096$). While this was a marginally significant chi-square value, the null hypothesis of independence between these two variables could not be rejected at the 0.05 level.

Research Hypothesis 9 was the following: Reported alcohol use will be related to the gender of the driver in that males are hypothesized to be more likely to be reported as using alcohol. The appropriate statistical test for this hypothesis was the chi-square test for independence between driver gender and the suspected use of alcohol. Because alcohol was suspected to have been involved in only four of the cases, this hypothesis could not be appropriately tested.

Research Hypothesis 10 was the following: Dysfunctional driving maneuvers as reported contributing circumstances in the crash will be associated with driver gender. The appropriate statistical test for this hypothesis was the chi-square test for independence between driver gender and reported dysfunctional driving maneuvers, which included the following: crossing the centerline/going the wrong way; overcorrected/over-steered; or operation of vehicle in an erratic, reckless, careless, negligent, or aggressive manner. The chi-square statistic for this test was 0.626 ($p <$ 0.429) indicating no significant association between gender and the reported involvement of dysfunctional driving maneuvers in the crashes involving this age group.

Summary

The purpose of the study was to investigate factors, and patterns among these factors, associated with fatal vehicle crashes involving young teen drivers. Data on these factors were extracted from North Carolina DMV Form 349 for the entire population of teenage drivers between 15.5 and 17.99 years of age who were involved in fatal vehicle crashes occurring between 2009 and 2013 in the state of North Carolina. A statistical summary of the findings is presented in Table 3.

Table 3

Summary of Factors/ Circumstances Associated with Vehicle Crashes Involving Young Teen Drivers in Order of Frequency of Reported Occurrence

Factor/Circumstance	**Percentage of Cases**
One or More Dysfunctional Driving Maneuvers Reported	64.1%
Driver Gender	62.5% Males
Occupant Trapped in Vehicle	54.5%
One or More Speed-Related Circumstances Reported	52.3%
Non-use of Occupant Protection (e.g., Seat Belts)	42.0%
Suspected Involvement of Alcohol	4.5%
Suspected Involvement of Drugs Other than Alcohol	1.1%
Driver Sleepiness/Drowsiness	0.0%
Driver Distraction due to use of Communication Devices	0.0%

The following factors were found to be associated with fatal vehicle crashes in this age group of drivers:

- driver gender with male driver casualties approximately twice as prevalent as female casualties,
- speeding,
- dysfunctional driving maneuvers, and
- lack of use of occupant protection devices (e.g., seat and shoulder belts),

Factors hypothesized to be associated with fatal vehicle crashes but which were *not* found to be significantly associated with crashes in this age group were

- driver use of alcohol,
- driver use of drug(s) other than alcohol,

- driver sleepiness or drowsiness, and driver distraction due to use of communication devices (e.g., texting).

Chapter 5: Recommendations

Introduction

The purpose of the study was to investigate factors, and patterns among these factors, associated with fatal vehicle crashes involving young teen drivers. Data on these factors were extracted from North Carolina DMV Form 349, completed by law enforcement officers who responded to fatal vehicle crashes involving young teenage drivers between 15.5 and 17.99 years of age and occurring between 2009 and 2013 in the state of North Carolina. The findings from the study will be used to inform state legislative, educational, and administrative public policy and practices.

Factors that were found to be associated with fatal vehicle crashes in this age group of drivers were the following:

- Driver gender
- Speeding
- Dysfunctional driving maneuvers
- Extent of use of occupant protection devices (e.g., seat and shoulder belts)

Factors hypothesized to be associated with fatal vehicle crashes but which were not found to be significantly associated with crashes in this age group were

- Driver use of alcohol
- Driver use of drug(s) other than alcohol
- Driver sleepiness or drowsiness
- Driver distraction due to use of communication devices (e.g., texting)

Interpretation of the Findings

Neural and psychosocial development during adolescence makes teen drivers vulnerable to driver distraction and risk-taking, with peer influence playing a role in the development of driving habits (American Academy of Pediatrics, 2006; Bingham, 2014a, 2014b; Brar & Rickard, 2013; Floyd-Bann & Van Tassel, 2006; Janke et al., 2003; Reyna & Farley, 2006; Romer et al., 2014). In 2011, motor vehicle fatality rates for male drivers and passengers aged 16 to 19 was almost double the rate for young females (CDC, 2014). A similar ratio of male to female fatalities was found for the drivers in the sample of this study (i.e., 62.5% male to 37.5% female fatalities).

Brar and Rickard (2013) reported that speeding is the main cause of collisions for drivers of all ages. One or more speed-related contributing circumstances was reported as having been present in 52.3% of the fatal crashes in the sample in this study. However, the reported presence of speed-related contributing circumstances was not associated with driver gender.

One or more dysfunctional driving maneuvers was reported as a contributing circumstance in 64.1% of the crashes in the sample. Dysfunctional driving maneuvers included the following: crossing the centerline/going the wrong way; overcorrected/over-steered; or operation of vehicle in an erratic, reckless, careless, negligent, or aggressive manner. However, the reported presence of one or more dysfunctional driving maneuvers was not significantly associated with driver gender in this sample.

Drugs and alcohol also correlate highly with teen crashes. In a national study of 11th grade students in the United States, binge drinking, illicit drug use, and risky driving were all independently related to driving while alcohol or drug impaired (DWI) or riding

with someone who was alcohol or drug impaired (RWI; Li et al., 2013). In the group of drivers in this study, neither alcohol use nor use of drugs other than alcohol was significantly associated with fatal vehicle crashes.

Drowsiness has been a cause of inattention to the road in teen drivers, and this effect is exacerbated by inexperience and distractibility (Romer et al., 2014). Of all age groups, adolescents have had the highest risk for crashes resulting from drowsy driving, due to a combination of factors including developmental changes that increase the need for sleep; alterations in sleep patterns that decrease nighttime sleep or lead to disruptions in circadian rhythms; and lifestyle factors, such as the combined effects of academic demands, extracurricular activities, employment, and socialization with friends (NCSDR/NHTSA, 1998). Driver drowsiness was not reported as a contributing circumstance in any of the crashes in this sample. The lack of drowsiness as a circumstance could reflect the requirement of nighttime restrictions on the GDL.

Failure to wear a seat belt has been a common risky habit of teen drivers, among others. According to Foss and Goodwin (2014), risky behaviors exhibited by adolescents while driving have included texting while driving, using alcohol or chemical impairing drugs while driving, driving while not wearing a seat belt, and speeding. Occupant protection (e.g., seat belts/shoulder belts) was not used in 42% of the cases in this sample.

Scholars have highlighted the hazards of the use of hand-held electronic communication devices while driving, especially by teen drivers. Distracted driving has been a problem among drivers of all ages and experience levels, but especially for teens due to the combined effects of inexperience, immaturity, peer influences, and extensive use of portable electronic devices (Bingham, 2014a, 2014b; Buckley et al., 2014; Durbin

et al., 2014; Romer et al., 2014). The NTD (as cited in Klauer et al., 2013) revealed that performing any secondary task (dialing or reaching for a cell phone, texting, reaching for an object, glancing at a roadside object, and eating) was linked with a significantly heightened risk of crash or near crash among young novice drivers. The prevalence of high risk, attention diverting behavior increased over time for the young drivers, but not for experienced adult drivers. After a decline in fatalities from 1999 to 2005, fatalities from distracted driving increased by 28% from 2005 to 2008 (Wilson & Stimpson, 2010). The increase in texting has been implicated in this phenomenon, but texting is but one of several distractions affecting teen driving. In spite of the hazards of texting and cell phone use, especially among teen drivers, the use of electronic communication devices was not reported as a contributing circumstance in any of the crashes in this study.

For the majority of drivers in this teenage group the laws, the education and the policies impacting teen drivers were successful because teens do not get into fatal crashes. However, there were findings in this study that would suggest changes in legislation and educational policies to further improve the success of these policies. Due to dysfunctional driving maneuvers being among the primary circumstance implicated in teen crashes in this study, changes in policies and education relevant to maneuvering vehicles may have some impact upon reducing teen crashes. Teen drivers are currently required to have parental supervised driving as part of GDL requirement, but Goodwin et al. (2010) found that parents do not provide enough practice in a variety of driving conditions. Goodwin et al. also found that the majority of parents do not provide adequate feedback or redirection for their teens for fear of making them nervous or upset. As such, policies should be re-evaluated to determine how to counteract this phenomenon.

Limitations of the Study

This was a nonexperimental archival study employing data on selected indicators extracted from accident reports recorded on North Carolina DMV Crash Report DMV Form 349, which were provided with permission to me by the North Carolina Department of Transportation. Crash Report DMV Form 349 is completed based upon judgments and observations of the responding law enforcement officer at the scene of the vehicle crash, and then it is forwarded to Raleigh, NC for coding and storage. The data on Form 349 can be used as evidence in a North Carolina court of law without the physical presence of the responding officer in court. As this was an archival study involving secondary data, the design of the study was not concerned with the requirements of internal validity of an experimental or quasi-experimental study.

The major threat to external validity that pertained to this study centered on the potentially inappropriate generalization of the results to another population or context (Bracht & Glass, 1968). The results of this study can be generalized to similarly-aged teen drivers residing in other states (especially those located in the southeastern United States with similar demographic characteristics to those of the state of North Carolina) who have been involved in fatal vehicle crashes and to states with data recording instruments that are similar in content to that of the NC DMV Form 349.

Recommendations

There are a number of recommendations from this study that were based primarily on the findings of the available research involving teen drivers, defined as those from 15.50 to 17.99 years of age. The recommendations were informed by the research findings related to the following two questions:

1. What is the association between dysfunctional teen driving behaviors and traffic fatalities among young teen drivers?
2. What is the association between driver gender and selected dysfunctional driver behaviors?

Stakeholders have made a concerted effort to find a combination of legislation and education that will reduce teen driving fatalities. According to the National Traffic Safety Administration (2016), millions of dollars have been invested in research in regards to teen driving education and enforcement programs over the years. The evaluation of the success of programs is mixed, as McConnell (2010) described the conflicted success of educational policy success or failure. A host of epidemiological and other types of empirical statistical studies of the driving behavior and involvement in traffic fatalities of teenage drivers have been conducted. Although some of these studies have only a tenuous theoretical basis, they are important in identifying risk factors potentially associated with teenage traffic fatalities.

For the vast majority of drivers in this teenage group, the laws and the educational programs may have proven to be successful; however, they have not addressed the full issue of reducing or minimizing the loss of those teens who have been involved into fatal crashes. According to the findings of this study, there are a number of changes in legislation and educational policies and processes that may improve the success of these policies. Over 64% of the crashes in this sample involved dysfunctional driving maneuvers. These crashes, due to dysfunctional driving maneuvers, may have been associated with limited amount of driving experience on the road. As a result, there is the need for more adult supervised on-the-road driving experience.

In order for a teen to fully be able to maneuver a vehicle s/he needs to have additional training, which could be mandated legislatively through publically funded driver education programs in North Public Carolina Schools. Eliminating publically funded driver education programs in North Carolina Schools and allowing only privately owned programs may not allow some teens and their families to afford useful driver education programs. Those less affluent teens waiting till they are 18 and not being exposed to training during the formative years of 15.5 to 18, in which good driving habits can be formed, might put them at a disadvantage in terms of knowledge and on-the-road experience.

An important research question in this regard is to what extent is 50 hours of on-the-road parentally supervised driving experienced actually adhered to.

Other research questions such as the following could also be asked:

- Can teens just beginning their driving career handle a vehicle with increased horsepower?
- Are the vehicles being purchased appropriate for first time drivers with limited experience?
- To what degree does the teen driver's attitudes toward important driving behaviors (e.g., obeying the speed limit, using electronic devices while driving, using seat belts, drinking and driving) resemble those of his/her parent(s) as perceived by the teenager?
- What demographic factors are associated with a teen's desire to become a licensed driver? The answer to this question could help local agencies design specific driver training programs for their specific teen populations, and could

influence the legislative policies with reference to the ways students can obtain a driver's license. Some students may opt not to drive or delay their driving; as they feel they have not had the proper education or parental supervision in driving.

- What is the difference in the accident rates of students who have had formal driver education training versus those who have not had any formal driver education training? The answer to this question would shed light on the effectiveness of educational programs for teens, and may encourage the development of a framework for coaching and mentoring new drivers.
- What is the association between the number of hours of on-the road supervised driving experience and collision outcomes? Such a study would clarify the impact of state law, which currently requires 50 hours of supervised driving experiences prior to obtaining a license. As noted above, the law does not provide a monitoring provision for tracking supervised driving hours with the exception of the adult driver verifying that the 50 hours of supervised driving experience indeed took place. A related recommendation for research would focus on a study to track the extent of the parental mentoring of a teen driver.

Chapman, and Sheehan (2014) built on the existing research to recommend strategies for reducing distracted driving and, more generally, inducing positive behavior change in adolescent drivers. Explicitly and implicitly, the body of research on adolescent drivers highlights the need for a multifaceted approach to improving teen driver safety involving families, schools, health care providers, public officials, and the teens themselves, whose input is essential for targeting programs effectively (Ginsburg et al., 2008; YDRI Team, 2009).

Implications

Positive Social Change

The findings from this study have the potential to effect positive social change as it relates to the impact on the frequency of fatal accidents involving young drivers. This includes legislative policy with respect to state-supported funding of driver education programs, the state-mandated curriculum of driving skills covered in these programs and the legislative requirements for licensure of young drivers.

Factors that were found to be associated with fatal vehicle crashes in this age group of drivers included driver gender, speeding, dysfunctional driving maneuvers, and the lack of the use of occupant protection devices. Other factors that were hypothesized to be associated with fatal vehicle crashes, such as driver use of alcohol, and the use of drugs, sleepy and drowsy drivers, and the use of communication devices were not found to be significantly associated with crashes in this age group.

Recommendations for Change in Practices

A critical finding in this study was that one or more dysfunctional driving maneuvers was reported as a contributing circumstance in 64.1% of the crashes. As a consequence of this finding it was recommended that

- High school driver education programs be enhanced to include more realistic and longer exposure to more varied driving experience for the learner driver
- Driver education including this enhanced training in driving skills be made available to all North Carolina High School students who desire to participate in it
- Attempts be made to more reliably verify whether or not the requirement of 50 hours of adult supervised driving experience has been met

Although some education and support is provided within current policies that affect teen driving, we may consider legislation to reduce the insurance rates at a considerable amount for those teens waiting to obtain a driver's license until they reach the age of 18. This delay will allow more driving opportunities during the formative age of learning to drive. Additionally, the funding practices in place for policies that impact teen drivers will need to be reevaluated to shift funding into preventing crashes to, for instance, improvements in driver training curriculum.

Conclusion

These findings may provide awareness to future researchers as they explore future studies to inform state legislative, educational, and administrative public policy and practices. Social change is vital to decreasing or eliminating teen fatal crashes now and in the future. Discovering why teens exhibit specific behaviors while driving resulting in teen fatal crashes is critical if teens, parents, educators, law enforcement and legislatures are to reduce or stop the teen deaths.

As an officer deals with the aftermath of a fatal crash, whether a death notification is delivered to parents of a teen driver, or if the teen, through their actions, has killed someone in a vehicle crash, the news is devastating and not soon forgotten. The cognitive, physical, behavioral and spiritual effects continue long after the news and event has passed. Therefore, comprehending why teens continue to choose the driving behaviors causing fatal vehicle crashes is vital. There are those who believe it is the responsibility of the law enforcement officer to take the lead in preventing teen crashes. There are those that believe the schools should be responsible in training the teen the way to drive. There are those who believe our legislatures are to make laws that restrict our

teens from exhibiting risky behaviors. There are those who believe the teen behind the wheel is responsible for their actions. Lastly, there are those who believe the parents are responsible for the teen that drives. You, as the reader, may choose one or all of the above for culpability. As a researcher and in my experience while conducting this study, I have found all parties are in part responsible. When each party realizes the part they play in teen fatal crashes, it is then a positive social change can be made

This study was conducted to collect data to explain why fatal teen crashes continue and what teen driver behaviors were reported as contributing circumstances in these crashes, despite parental guidance, educational curriculum, legislative law and enforcement working toward addressing the continued increase in fatal teen crashes. This study led to the discovery of potential gaps in legislative and educational policies and practices relevant to vehicle crashes involving young teen drivers. For example, the findings of this study included the impact of speeding, non-use of seat belts, and dysfunctional maneuvers as factors associated with fatal crashes in this age group of teen drivers. The occurrence of dysfunctional driving may have been associated with the lack of a sufficient number of supervised hours of driving experience and a lack of quality hours in a variety of simulated driving conditions. Another potential gap is a lack of sufficient monitoring by parent and/or guardian of teen driving behavior prior to the attainment of the learners permit. As a result of these gaps, legislative and educational policies relevant to teen drivers must be reevaluated. With years of on the road practice, an individual is provided the experience needed to address possible events which may result in a crash, or worse, a fatal event. It is believed that the results of this study add to

those of previous studies, which address the need for experience among the teenage drivers, especially for the young teen drivers in the target population of this study.

As with any new responsibility, getting students to understand the importance of foundational knowledge and experience related to driving should be at the top of every legislative agenda across the United States. As Americans and drivers on roads across the United States, we owe it to our teen drivers to not only emphasize the importance of the law by following the law, but also by advocating for the education that goes along with safe driving. This truly is a phenomenon upon which their lives, and ours, depend.

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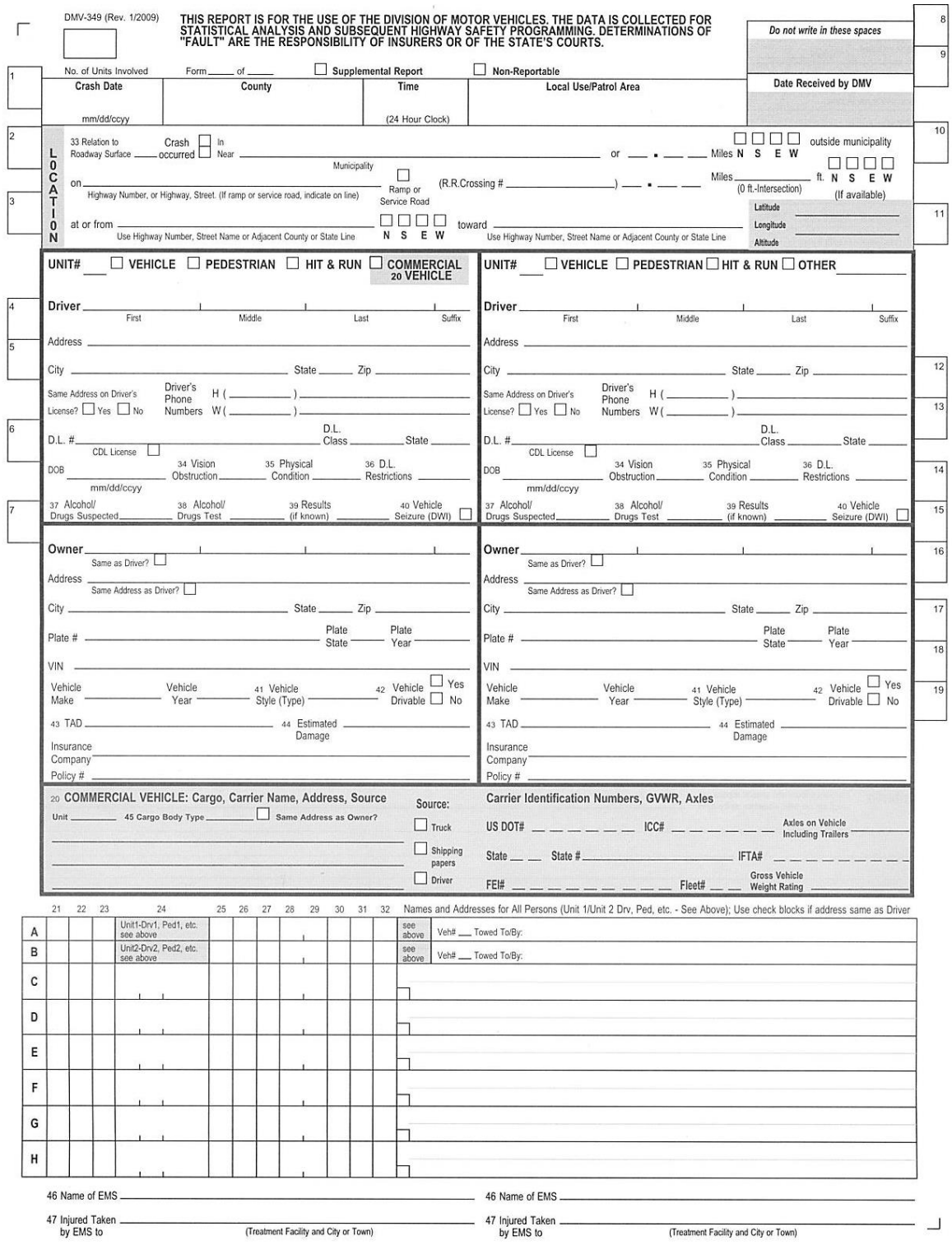
Appendix A: NC Division of Motor Vehicles Form 349 Crash Report



DMV-349 (Rev. 1/2009)

THIS REPORT IS FOR THE USE OF THE DIVISION OF MOTOR VEHICLES. THE DATA IS COLLECTED FOR STATISTICAL ANALYSIS AND SUBSEQUENT HIGHWAY SAFETY PROGRAMMING. DETERMINATIONS OF "FAULT" ARE THE RESPONSIBILITY OF INSURERS OR OF THE STATE'S COURTS.

Do not write in these spaces

Date Received by DMV

No. of Units Involved | Form ___ of ___ | Supplemental Report | Non-Reportable

Crash Date (mm/dd/ccyy) | County | Time (24 Hour Clock) | Local Use/Patrol Area

LOCATION

33 Relation to Roadway Surface | Crash occurred | In | Near | Municipality | or ___ . ___ ___ Miles N S E W outside municipality

on | Highway Number, or Highway, Street. (If ramp or service road, indicate on line) | Ramp or Service Road | (R.R.Crossing # ___) ___ . ___ ___ Miles (0 ft.-Intersection) ___ ft. N S E W (If available)

at or from | Use Highway Number, Street Name or Adjacent County or State Line | N S E W | toward | Use Highway Number, Street Name or Adjacent County or State Line

Latitude | Longitude | Altitude

UNIT# ___ VEHICLE PEDESTRIAN HIT & RUN COMMERCIAL 20 VEHICLE

Driver (First Middle Last Suffix)

Address

City State Zip

Same Address on Driver's License? Yes No | Driver's Phone Numbers H ( ) W ( )

D.L. # CDL License | D.L. Class | State

DOB (mm/dd/ccyy) | 34 Vision Obstruction | 35 Physical Condition | 36 D.L. Restrictions

37 Alcohol/Drugs Suspected | 38 Alcohol/Drugs Test | 39 Results (if known) | 40 Vehicle Seizure (DWI)

Owner | Same as Driver?

Address | Same Address as Driver?

City State Zip

Plate # | Plate State | Plate Year

VIN

Vehicle Make | Vehicle Year | 41 Vehicle Style (Type) | 42 Vehicle Drivable Yes No

43 TAD | 44 Estimated Damage

Insurance Company

Policy #

UNIT# ___ VEHICLE PEDESTRIAN HIT & RUN OTHER ___

Driver (First Middle Last Suffix)

Address

City State Zip

Same Address on Driver's License? Yes No | Driver's Phone Numbers H ( ) W ( )

D.L. # CDL License | D.L. Class | State

DOB (mm/dd/ccyy) | 34 Vision Obstruction | 35 Physical Condition | 36 D.L. Restrictions

37 Alcohol/Drugs Suspected | 38 Alcohol/Drugs Test | 39 Results (if known) | 40 Vehicle Seizure (DWI)

Owner | Same as Driver?

Address | Same Address as Driver?

City State Zip

Plate # | Plate State | Plate Year

VIN

Vehicle Make | Vehicle Year | 41 Vehicle Style (Type) | 42 Vehicle Drivable Yes No

43 TAD | 44 Estimated Damage

Insurance Company

Policy #

20 COMMERCIAL VEHICLE: Cargo, Carrier Name, Address, Source

Unit ___ 45 Cargo Body Type ___ Same Address as Owner?

Source: Truck | Shipping papers | Driver

Carrier Identification Numbers, GVWR, Axles

US DOT# ICC# Axles on Vehicle Including Trailers

State State # IFTA#

FEI# Fleet# Gross Vehicle Weight Rating

	21	22	23	24	25	26	27	28	29	30	31	32	Names and Addresses for All Persons (Unit 1/Unit 2 Drv, Ped, etc. - See Above); Use check blocks if address same as Driver
A				Unit1-Drv1, Ped1, etc. see above									see above Veh# ___ Towed To/By:
B				Unit2-Drv2, Ped2, etc. see above									see above Veh# ___ Towed To/By:
C													
D													
E													
F													
G													
H													

46 Name of EMS

47 Injured Taken by EMS to (Treatment Facility and City or Town)

46 Name of EMS

47 Injured Taken by EMS to (Treatment Facility and City or Town)

48 POINTS OF INITIAL CONTACT (Write in Codes) Unit# __ _____ Unit# __ _____

CRASH SEQUENCE (Unit Level)	Unit# ___	Unit# ___
49 Vehicle Maneuver/Action		
50 Non-Motorist Action		
51 Non-Motorist Location Prior to Impact		
52 **Crash Sequence - First Event for This Unit**		
53 Crash Sequence - Second Event *		
54 Crash Sequence - Third Event *		
55 Crash Sequence - Fourth Event *		
56 **Most Harmful Event for This Unit**		
57 Distance/Direction to Object Struck		
58 Vehicle Underride/Override		
59 Vehicle Defects		

VEHICLE INFO.	Veh.#___	Veh.#___
60 Authorized Speed Limit		
61 Estimate of Original Traveling Speed		
62 Estimate of Speed at Impact		
63 Tire Impressions Before Impact (ft.)		
64 Distance Traveled After Impact (ft.)		
65 Emergency Vehicle Use		
66 Post Crash Fire (if "Yes" check block)	☐	☐
67 School Bus - Contact Vehicle *	☐	☐
68 School Bus - Noncontact Vehicle *	☐	☐

COMMERCIAL VEHICLE: Hazardous Materials Involvement Unit ____

Haz Mat Placard ☐ Yes ☐ No — From Placard indicate:

Hazardous Cargo ☐ Yes ☐ No — 4-digit placard number or name from diamond or box — 1-digit number from bottom of diamond

Released (does not include fuel from fuel tank)

Carrying Haz Mat ☐ Yes ☐ No

ROADWAY INFO.	
69 Road Feature	
70 Road Character	
71 Road Classification	
72 Road Surface Type	
73 Road Configuration	
74 Access Control	
75 Number of Lanes	
76 Traffic Control Type	
77 Traffic Control Open	

WORK ZONE RELATED	
78 Workzone Area	
79 Work Activity	
80 Work Area Marked	
81 Crash Location	

TRAILER INFO.	Unit.#___	Unit.#___
82 Trailer Type		
1st Trailer No. Axles		
Width (inches)		
Length (feet)		
2nd Trailer No. Axles		
Width (inches)		
Length (feet)		

83 Unit.#___ Overwidth Trailer and Overwidth Mobile Home — **Overwidth Permit #** _____

84 DIAGRAM

Indicate North

Unit.#___ was: ☐ Traveling ☐☐☐☐ N S E W on _____ Unit.#___ was: ☐ Traveling ☐☐☐☐ N S E W on _____

85 NARRATIVE (Include pertinent and unusual aspects, which are not listed elsewhere on the form) _____

86 Type/ Owner _____ Owner Address Phone _____ ADDITIONAL PROPERTY DAMAGE State Property? ☐ Estimated Damage $ _____

WITNESSES

Name _____ Address _____ Phone No. (___) _____

Name _____ Address _____ Phone No. (___) _____

TRAFFIC VIOLATION(S)

Name _____ Charge(s) (Citation # optional) _____

Name _____ Charge(s) _____

Officer Name | Officer Number | Department | Date of Report

Appendix B: Calculation of Statistical Power for Hypothesis Tests

As the sample consists of a census, that is, the entire target population, no more cases can be sampled. Therefore, this section will discuss the statistical power possible with a fixed sample size of 84 cases. The alpha level (probability of Type I error) was selected to be the traditional 0.05 – level, which is a generally acceptable level of Type I error in behavioral research (Cohen, 1969) and for which power tables exist in references such as Cohen (1969). Following Cohen's suggestion, a "moderate" effect size of 0.2 was chosen. The estimates of statistical power included in this section are based on tables appearing in Cohen.

For the goodness of fit chi-square statistics, which compare a vector of observed proportions to a vector of expected proportions based upon a null hypothesis (for example, a vector of equal proportions, i.e., H_O: $\pi_1 = \pi_2 = \ldots = \pi_K$) , the effect size (**e**) can be estimated to be (Cohen,1969, p. 214):

$$\mathbf{e} = \Sigma \left[(P_{Obs} - P_{Exp})^2 / P_{Exp} \right]$$

where: P_{Obs} = the observed proportion, and

P_{Exp} = the expected proportion under the null hypothesis,

and the summation is over the K proportions involved in the hypothesis.

With an N of 84 the statistical power associated with the rejection of the null hypothesis, H_O: $\pi_1 = \pi_2$, can be estimated to be 0.81 for an effect size of 0.1 or greater (Cohen, 1969, Table 7.3.15, p. 228).

With an N of 84 the statistical power associated with the rejection of the null hypothesis, H_O: $\pi_1 = \pi_2 = \pi_3$, can be estimated to be 0.72 for an effect size of 0.1 or greater and 0.96 for an effect size of 0.2 or greater (Cohen, 1969, Table 7.3.16, p. 228).

The effect size for chi-square test for independence involving a 2 X 2 contingency table can also be estimated by using the formula for **e** above. With an N of 84 the statistical power associated with the rejection of the null hypothesis of no association between variables can be estimated to be 0.81 for an effect size of 0.1 or greater (Cohen, 1969, Table 7.3.15, p. 228).

In order to estimate the power of a one-sample Z test for a single proportion, a null hypothesized proportion must first be chosen. A null-hypothesized proportion of 0.05 was chosen. Cohen (1969, pp. 197 - 198) has described the following steps for this procedure:

1. Calculate the difference between the arcsine transformation of the proportion posited by the null hypothesis (i.e., 0.05) and the arcsine transformation of the proportion posited by the alternative hypothesis to be use in the power calculation (in this case, 0.15).
2. Multiply this difference by $\sqrt{2}$.
3. Enter Table 6.3.5 (Cohen, 1969, p. 189) with the result of the calculation in Step 2, the chosen alpha level, and the sample size.

Applying these steps, the statistical power associated with detecting a difference of 0.10 (or larger) from the null hypothesized value of 0.05 with an alpha level of 0.05 and a sample size of 84 can be estimated to be 0.9.

The results of these power calculations suggest that an N of 84 cases does indeed yield sufficient statistical power to detect meaningful effects.

Appendix C: North Carolina Graduated Drivers Licensure Law

- License Eligibility and Requirements per North Carolina Law:
- Level 1: Limited Learner’s Permit
- Limited Learner's Permit involves parents, guardians and/or other responsible drivers in the training of young drivers.
- Must be 15 or older, complete driver's education and obtain limited learner's permit.
- For at least 12 months, the Level 1 driver must be supervised by parent, guardian or other approved licensed driver who has been licensed at least five years.
- All people in vehicle driven by Level 1 driver must wear a seat belt, and only the supervisor can ride in the front seat.
- For the first six months, a Level 1 driver may only drive from 5 a.m. to 9 p.m. with his or her supervisor.
- For the second six months, a Level 1 driver may drive at any time with his or her supervisor.
- The Level 1 driver must have no violations during the last six months to graduate to the next level.
- Level 2: Limited Provisional License
- Limited Provisional License protects young drivers during the night time hours when they are most at risk.
- Drivers must be at least 16 years old, but less than 18.
- All passengers must be restrained by seat belt or child safety seat.
- Supervising driver must be seated beside the driver.

- You may drive without supervision from 5 a.m. until 9 p.m. and at any time when driving directly to or from work or any volunteer fire, rescue or EMS (emergency medical service), if you are a member.
- Effective December 1, 2002, a new law (NCGS 20-11(e)(4) was passed regarding the passengers in a motor vehicle. The law applies to limited provisional licenses (Level 2) issued on or after December 1, 2002. The law allows for passengers under 21 in two scenarios:
    - The number of passengers allowed in a motor vehicle under the age of 21 is restricted to ONE when the driver of the vehicle is the holder of the Level 2.
    - If all passengers under the age of 21 are members of the driver's immediate family or member of the same household as the driver there is no under 21 limit.
    - If the supervising driver is in the car, this restriction does not apply.
- Note: Before graduating to Level Three, you must keep this license for at least 6 months and have no convictions of moving violations or seat belt infractions within the preceding six months.
- Level 3: Full Provisional License
- Full Provisional License rewards violation-free driving.
- Unsupervised driving is allowed at any time.
- Level 3 driver is subject to all other conditions of provisional license.
- North Carolina General Statute (2002)

Appendix D: Permissions

CONFIDENTIALITY AGREEMENT

Name of Signer: David B. West, Ph.D.

During the course of my activity in collecting data for this research: "Investigation of Adolescent Driving Patterns Resulting in Fatalities" I will have access to information, which is confidential and should not be disclosed. I acknowledge that the information must remain confidential, and that improper disclosure of confidential information can be damaging to the participant.

By signing this Confidentiality Agreement I acknowledge and agree that:

1. I will not disclose or discuss any confidential information with others, including friends or family.
2. I will not in any way divulge, copy, release, sell, loan, alter or destroy any confidential information except as properly authorized.
3. I will not discuss confidential information where others can overhear the conversation. I understand that it is not acceptable to discuss confidential information even if the participant's name is not used.
4. I will not make any unauthorized transmissions, inquiries, modification or purging of confidential information.
5. I agree that my obligations under this agreement will continue after termination of the job that I will perform.
6. I understand that violation of this agreement will have legal implications.
7. I will only access or use systems or devices I'm officially authorized to access and I will not demonstrate the operation or function of systems or devices to unauthorized individuals.

Signing this document, I acknowledge that I have read the agreement and I agree to comply with all the terms and conditions stated above.

DO Bwest 3-20-15

Signature: **Date:**

DATA USE AGREEMENT

This Data Use Agreement ("Agreement"), effective as of March 15,2015 ("Effective Date"), is entered into by and between Cheryl M. Leonard ("Data Recipient") and North Carolina Department of Transportation/Division of Motor Vehicles ("Data Provider"). The purpose of this Agreement is to provide Data Recipient with access to a Limited Data Set ("LDS") for use in research in accord with laws and regulations of the governing bodies associated with the Data Provider, Data Recipient, and Data Recipient's educational program. In the case of a discrepancy among laws, the agreement shall follow whichever law is more strict.

1. Definitions. Due to the study's affiliation with Laureate, a USA-based company, unless otherwise specified in this Agreement, all capitalized terms used in this Agreement not otherwise defined have the meaning established for purposes of the USA "HIPAA Regulations" and/or "FERPA Regulations" codified in the United States Code of Federal Regulations, as amended from time to time.

2. Preparation of the LDS. Data Provider shall prepare and furnish to Data Recipient a LDS in accord with any applicable laws and regulations of the governing bodies associated with the Data Provider, Data Recipient, and Data Recipient's educational program.

Data Fields in the LDS. No direct identifiers such as names may be included in the Limited Data Set (LDS). In preparing the LDS, Data Provider shall include the data fields specified as follows, which are the minimum necessary to accomplish the research: North Carolina Fatal Crash Reports Involving Drivers Between the Ages of 15 1/2 and Less Than 18 Years Old, For the Reporting Period of January 1, 2009 to December 31, 2013.

3. Responsibilities of Data Recipient. Data Recipient agrees to:

   a. Use or disclose the LDS only as permitted by this Agreement or as required by law;

   b. Use appropriate safeguards to prevent use or disclosure of the LDS other than as permitted by this Agreement or required by law;

   c. Report to Data Provider any use or disclosure of the LDS of which it becomes aware that is not permitted by this Agreement or required by law;

   d. Require any of its subcontractors or agents that receive or have access to the LDS to agree to the same restrictions and conditions on the use and/or disclosure of the LDS that apply to Data Recipient under this Agreement; and

   e. Not use the information in the LDS to identify or contact the individuals who are data subjects.

4. Permitted Uses and Disclosures of the LDS. Data Recipient may use and/or disclose the LDS **for its Research activities only.**

5. Term and Termination.

   a. Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.

   b. Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.

   c. Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.

   d. For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.

   e. Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

6. Miscellaneous.

   a. Change in Law. The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.

   b. Construction of Terms. The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.

   c. No Third Party Beneficiaries. Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.

d. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

e. Headings. The headings and other captions in this Agreement are for convenience and reference only and shall not be used in interpreting, construing or enforcing any of the provisions of this Agreement.

IN WITNESS WHEREOF, each of the undersigned has caused this Agreement to be duly executed in its name and on its behalf.

DATA PROVIDER

Signed: _____

Print Name: James Kevin Lacy

Print Title: State Traffic Engineer

DATA RECIPIENT

Signed: _____

Print Name: Cheryl M. Leonard

Print Title: Student/Researcher

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Cheryl Leonard** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 05/27/2015

Certification Number: 1770501