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Determinants of Usage of Age-Appropriate Child Safety Seats in Connecticut

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MSPH, Southern Connecticut State University, 1989

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

In the United States, motor vehicle crashes are one of the leading causes of unintentional injury death and disability for children ages 1–15 years. Despite local, state, and federal legislative and educational efforts, children continue to be restrained improperly and thus face harm. Identifying behaviors and barriers that place child occupants at risk is crucial for implementing focused, injury-prevention programs and policies. The purpose of this study was to evaluate the effectiveness of Connecticut's child passenger safety law that was strengthened in 2005. This study involved a multifactorial approach to predicting child seat use, guided by Roger's diffusion of innovations as the theoretical framework. The analysis determined if there was a difference in the prevalence of car seat use before as compared to after law implementation and identified variables that best predicted the use of car seats and premature transition to a seat belt. Using Connecticut's Crash Data Repository, a logistic regression analysis indicated that car seat use was 1.3 times more likely post law (OR 0.75; 95% CI: 0.65-0.86) and that in particular, children ages 4, 5, and 6 (combined) were most positively affected by the law (OR 0.67; 95% CI 0.54-0.82). Driver sex, crash time of day, child age, and child seating position were all determined to be significant predictors of whether or not a child was in a child safety seat. Additionally, these variables were also determined to be predictors of early transition to use of a lap/shoulder belt (versus child seat). The social change implication of this study is that identifying predictors of car seat use and early transition helps to formulate and implement injury prevention measures that could in turn help to decrease medical costs, save lives, and prevent injuries.

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Dedication

I am grateful for such an incredible family. First and foremost, I would like to start by thanking my parents for instilling the importance of an education at an early age, the strength and inspiration to persevere despite adversity, and the courage to bring our family to this land of opportunity. Papà, I miss you more than words can say and hope that you can somehow celebrate this great accomplishment with me. Mamma, thank you for being the strong woman that you are and for your unwavering support and encouragement over the years. Ti voglio tanto bene!

I would like to thank my husband Paul for all of his support. Thank you for all your love and words of encouragement and for helping to keep a routine in our home—load after load of laundry, sink after sink of dishes, countless meals, taking the kids to their practices, games, doctor’s appointment, and clothes shopping. This dream would not be a reality without all of your support, love, and encouragement. Ti amo per sempre! You are my ribbon in the sky!

I would like to thank my daughters Cristina, Marcella, Giana, and Daniela for all their support and understanding in my request for the countless hours of silence so that I could focus on completing this project. I hope this project has instilled the importance of education and perseverance upon the four of you. I cannot wait to provide you with my undivided attention, support, and encouragement you all need and deserve to realize your potential and your dreams. I love each of you more than words can say!!

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Ora e' il tempo di festeggiare!!!

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Chapter 1: Introduction to the Study

Introduction

In the United States, motor vehicle crashes (MVCs) cause substantial childhood morbidity and mortality. They are the leading cause of unintentional injury deaths for children ages 5–15 years (Centers for Disease Control and Prevention [CDC], 2014); the second leading cause of unintentional injury death for children ages 1–4 years; and the fourth leading cause for infants (those under the age of 1 year; National Center for Injury Prevention and Control [NCIPC], 2010). In 2011 alone, 650 children ages 12 years and younger died as occupants in MVCs, with a third unrestrained (Ferguson, & Walker, 2013; NCIPC, 2014). Additionally, approximately 148,000 were injured (NCIPC, 2014).

According to the National Highway Safety Traffic Administration (NHTSA, 2014a), during each day in 2012, almost three children under 14 years of age were killed and 462 children were injured while riding in motor vehicles. In unrestrained child fatalities without a car seat or seat belt, a greater percentage of those fatalities occurred in larger vehicle types such as sports utility vehicles (SUV; NHTSA, 2013, 2014a). Whether a child is restrained makes a difference in the likelihood and severity of injury from a MVC. Nearly half of children under the age of 12 years who were found to be unrestrained in a MVC suffered injuries and had hospitalization rates three times as high compared to those children who were restrained (CDC, 2014). In addition to higher hospitalization rates for unrestrained children, those children who were wearing safety restraint devices were 62% less likely to be transported by emergency medical services (EMS) to a medical facility than those children who were not wearing a safety restraints;

thus, a significant reduction in the number of children transported by EMS personnel (Caviness, Jones, DeGuzman, & Shook, 2003).

Placing children in age- and size-appropriate safety restraint systems can reduce serious and fatal injuries by more than 50% (NHTSA, 2014a). From 1975 through 2011, the NHTSA (2014a) estimated that approximately 10,000 lives were saved by child restraints for children under the age of 5 in passenger vehicles with more than 260 young lives saved in the year 2011 alone. An estimated additional 51 lives could have been saved in 2011 if 100% of the children were placed in child safety restraint seats (CSRS; NHTSA, 2014a).

The increase in health care utilization has also been identified in states such as Arizona, where investigators demonstrated that children who were unrestrained had more hospitalization-related costs and had a subsequently substantial effect on the overall health related expenditures (Chan, Reilly, & Telfer, 2006). The increased hospitalizations and health expenditures due to MVCs and unrestrained children can both be decreased greatly solely by ensuring proper use of CSRSs and seat belts.

MVCs disproportionately affect the morbidity and mortality of children. Simply ensuring that children are placed in age- and size-appropriate safety restraints would significantly reduce injury and death rates as well as reduce medical care expenditures. This chapter describes in detail the following sections: background, evolution of vehicle occupant safety, problem statement, purpose of the study, research hypotheses and questions, nature of the study, significance of the study and implications for social change, theoretical framework, definition of terms, assumptions, scope and delimitations, limitations, and summary.

Background

CSRSs are vital in the prevention of injury and death from MVCs. Use of CSRSs reduces the risk of death in passenger cars by as much as 71% for infants and by 54% for toddlers 1–4 years of age (CDC, 2014; NCIPC, 2014; NHTSA, 2014a; Sauber-Schatz & West, 2014). For children 4–7 years of age, the use of booster seats reduces the risk of injury by 45% compared to seat belt use alone (Durbin, 2011a, 2011b; NCIPC, 2014; Sauber-Schatz & West, 2014). However, a recent Safe Kids Worldwide (2014) study found that 70% of parents were unaware of the height recommendations for booster seats—that is, to have children remain in a booster seat until they reach at least 4 feet 9 inches in height (Ferguson, Yang, Green, & Walker, 2014). As a result, 90% of parents transitioned their children to a seat belt before the recommended height was reached (Ferguson et al., 2014). Although having children restrained by a seat belt alone has been shown to be safer than no restraint, they are at greater risk for severe injuries, especially of the abdomen, head, and spinal column (Ferguson et al., 2014). Proper restraining of children in CSRS can prevent serious injuries (Agran, Castillo, & Winn, 1992; Agran, Dunkle, & Winn, 1985; Durbin, Chen, Smith, Elliott, & Winston, 2005; Ferguson, Yang, Green, & Walker, 2013; Glass, Segui-Gomez, & Graham, 2002; Miller, Baig, Hayes, & Elton, 2006; Sauber-Schatz & West, 2014).

CSRS include both rear- and forward-facing car seats as well as booster seats. Child passenger restraint requirements vary based on age, weight, and height. Often, there are three stages: infants (1 year of age and under) use rear-facing infant seats; toddlers (greater than 1 year of age and less than 4 years) use forward-facing child safety seats; and older children (greater than 4 years of age up to 8 years of age) use booster seats. Best practice recommends all children under the age of 2 travel in rear-facing seats in a motor vehicle (Durbin, 2011a). Two types of car seats are available: an infant-only car seat, which is rear facing only, and a convertible car seat, which can be used rear facing or forward facing (Durbin, 2011a). It is recommended that children be kept in a harness system until they weigh at least 60 pounds and are of appropriate age and weight to use a booster seat, usually until the age of 8 or reaching a weight of 80 pounds and reaching approximately 4 feet 9 inches in height (Durbin, 2011a, 2011b). After children have outgrown their booster seats, it is recommended that they continue to sit in the rear of a vehicle restrained with the lap-shoulder seat belt of the vehicle (Durbin, 2011a, 2011b). Multiple studies have shown that children who ride in the front seat of a motor vehicle can be severely injured by air bags (Durbin et al., 2003a, 2005, 2010; Olson, Cummings, & Rivara, 2006; Quinones-Hinojosa, Jun, Manley, Knudson, & Gupta, 2005). Following the car seat manufacturer's instructions for proper installation and height and weight recommendations for the particular seat as well as reviewing the motor vehicle's manual for recommended location of car seat installation can optimize the benefits of the restraint system (NHTSA, 2014).

CSRS use is regulated by law. All 50 states, as well as Puerto Rico and the District of Columbia, have child passenger safety laws (Governor's Highway Safety Association [GHSA], 2014). All require child safety seats for children fitting specific criteria such as age, weight, and height (GHSA, 2014). All states except for Florida and South Dakota require booster seats or other safety devices for children who have outgrown their child safety seats but are still too small to use a vehicle seat (GHSA, 2014). Penalties for not complying with a state's child passenger safety laws vary from monetary fines of $10 to $500, with some states enacting additional penalties such as driver's license points (GHSA, 2014).

Despite these laws and penalties, children continue to be improperly restrained while traveling in motor vehicles (NCIPC, 2014; NHTSA, 2014a; Rogers, Gallo, Saleheen, & Lapidus, 2013; Sauber-Schatz & West, 2014). There are many complexities surrounding the use of CSRS, mainly due to the lack of standardization among the various car and booster seats available on the market. Although the wide array of types of CSRSs promotes increased options for caregivers with children of various ages and sizes, as well as personal preference, it introduces a great potential for human error (Doyle & Levitt, 2010; Rangel, Martin, Brown, Garcia, & Falcone, 2007).

Compounding parental confusion is the lack of consistency and clarity in national child passenger legislation that may unwittingly promote early transitioning from car seats to booster seats or seat belts. The overall rate of misuse for CSRSs is approximately 73% nationally (Decina & Lococo, 2005). Misuse can consist of using the incorrect CSRS recommended for the child's age and weight, installing the car seat wrong, and improperly using a car seat or booster seat as recommended by the law and manufacturers (Durbin, 2011b). Infant seats have the highest proportion of misuse followed by rear-facing convertible seats (Decina & Lococo, 2005). In Connecticut, the proportion is even higher at 80%, a misuse rate of 4 out of every 5 CSRSs (Safe Kids Connecticut, 2013).

Identifying the root cause or reasons for noncompliance can guide public health policy in addressing this issue. These alarming high rates of CSRS misuse both nationally and locally have provoked multiple responses in the form of child passenger safety seat distribution and education programs, communitywide education and enforcement campaigns, and incentive-plus-education programs as well as enactment and changes to child safety legislation (Chang, Ebel, & Rivara, 2002; Pierce, Mundt, Peterson, & Katcher, 2005; Quinlan, Holden, & Kresnow, 2007; Tessier, 2010; Winston, Kallan, Elliott, Xie, & Durbin, 2007).

Evolution of Vehicle Occupant Safety

The evolution of child passenger safety seats, legislation, and advocacy in the United States has had a profound impact on the safety of children who are transported in motor vehicles (Shelness & Charles, 1975). In 1924, President Herbert Hoover convened the first National Conference on Street and Highway Safety to create a uniform set of traffic laws (U.S. Department of Transportation [U.S. DOT], 2014). Ten years later, however, traffic-related deaths continued to increase even as safety countermeasures were being designed and implemented (U.S. DOT, 2014). In the climate of social reform of the 1960s and in response to deaths from MVCs, the Highway Safety Act and the National Traffic and Motor Vehicle Safety Act were passed in 1966 (U.S. DOT, 2014). These acts authorized the federal government to set and regulate standards for motor vehicles and highways, a mechanism necessary for effective injury prevention. Numerous changes in both vehicle and highway design followed this mandate. The primary focus was occupant protection, and child restraints designed for crash protection were then developed in 1968 (U.S. DOT, 2014).

In the late 1960s, public pressure began growing in the United States to improve passenger vehicle safety, with the U.S. Congress passing legislation to make the installation of vehicle seat belts mandatory (Shelness & Charles, 1975). Ralph Nader's 1966 book *Unsafe at Any Speed* helped push matching Highway Safety Acts in 1966 and 1970 that empowered the U.S. DOT to set and regulate federal vehicle safety standards (National PTA & United States, 1986). It was not until 1970, however, that the DOT created the National Highway Traffic Safety Administration (NHTSA) to perform these duties (U.S. DOT, 2014).

In addition to regulating federal standards, the NHTSA also has the task of tracking vehicle safety statistics within the United States for consumer use and safety process improvement. According to their records, 8,325 lives were saved between 1976 and 2006 by child passenger safety (CPS) systems (NHTSA, Children, 2014a). However, motor vehicle accidents remain the number one killer of children over one year of age (NCIPC, 2014).

Over the years, many modifications and adjustments were made to protect adults who drive and ride in vehicles. Automobiles were considered hobbies for the wealthy; therefore, children were rarely considered to be passengers (Tingvall, 1987). However, in the 1930s, it became more common for children to ride as passengers in motor vehicles, and car seats began to be manufactured and sold in 1933 by the Bunny Company

(Shelness & Charles, 1975). Although safety was a factor, the main purpose of these seats was for boosting the child's height and making it easier for the driver to monitor the child (Shelness & Charles, 1975).

The focus was not always on the safety of transporting children, but rather making transporting them easier for the adult vehicle occupant. In 1962, Leonard Rivkin patented the first child car seat in the United States whose sole purpose was protecting the child from injury within a motor vehicle (see Appendix A; US Patent Office, March 5, 1962). Paralleling and closely associated with the evolution of CPS was the general development of vehicle safety. In the early years of vehicle production, safety considerations were strictly at the discretion of the buyer. Different manufacturers' approaches to safety varied widely, and the laws and regulations passed by the local and federal governments did little to standardize these approaches (Hemenway, 2009, p. 13).

In 1971 the first federal child restraint system standard was issued, the Federal Motor Vehicle Safety Standard (FMVSS) 213 (NHTSA, 1999). The purpose of this standard is to "reduce the risk of serious and fatal injury to occupants of passenger cars, multipurpose passenger vehicles, trucks, and buses" (NHTSA, 1999, p. 14). Dr. William Haddon, the first director of the newly created National Highway Safety Bureau, which later became known as the National Highway Traffic Safety Administration, was a strong proponent of a public health approach to injury prevention, shifting efforts from changing individual behavior toward changing the agent (i.e., the car) and the environment (i.e., the roadway; Nader, 1965). Haddon focused on potential vehicle improvements, which led to the creation of federal standards for motor vehicle design and safety equipment. It was not until the late 1960s that a concerted effort from the medical community, the DOT, consumer groups, safety seat manufacturers, and insurance companies demonstrated to the public that CSRS were necessary devices to keep children alive in the event of a MVC (Nader, 1965). While many strides were made at the federal level in regards to occupant safety, it was not until 1978 that the individual states began passing legislation. By 1984, nearly half of the U.S. population under the age of 4 rode in a child safety seat, and all states had legislation requiring the use of CSRS (Nader, 1965).

In 1978, Tennessee became the first state to pass a CPS law that required parents to place their infants in CSRSs that met federal standards (Bae, Anderson, Silver, & Macinko, 2014). This law was the impetus for legislative efforts in other states. In 1981, the passing of a more stringent version of FMVSS 213-80 included rear-facing infant restraints, car beds, and forward facing restraints for children under 50 pounds and frontal crash tests were required as well (NHTSA, 1999). As of 1985, all 50 states including Puerto Rico and the District of Columbia had requirements established for the use of CSRS in motor vehicles as primary laws (Durbin, 2011a; GHSA, 2014).

Advocacy Efforts

Since the 1970s, advocacy efforts regarding CPS have focused on developing better product standards, passing state legislation, and educating parents at the local level using volunteers. Even though advocacy efforts began 40 years ago, they are constantly evolving (Colella, 2009). These advocacy efforts for CPS have brought about the formation of organizations such as Safe Kids, whose primary focus is reducing traffic related injuries (Ferguson & Walker, 2013). It was not until the late 20th century that significant modifications were made to CPS legislation. For instance, it was not until 1990 that automakers were even required to install three-point safety belts in rear outboard seats, which is now the standard (Safety Research & Strategies, Inc, 2009). In 1970, the FMVSS 213 was first passed and has been amended multiple times in the past 15 years, with the largest adaptations in 1996, 1999, and 2005, respectively (Colella, 2009). Although there have been breakthroughs in child safety advocacy efforts, legislative improvements, and assignment of penalties for failing to use CSRS, I have found not studies that evaluate the enforcement of these penalties. There has been a focus on creating laws, but no standardization or focus on what to do if laws are not followed.

Advocacy efforts, while worthy, have created unintended consequences. Current legislation, however, lacks the ability to penalize parents for improper use or selection of inappropriate car restraint systems (Elliott, Kallan, & Durbin, 2009; Elliot, Kallan, Durbin, & Winston, 2006). As safer methods are identified, new legislation continues to be enacted both on a state and federal level in a concerted effort to increase CPS. Two important events occurred in 2002 that had significant effects on CPS in this country: adoption of the lower anchors and tethers for children (LATCH) system and passage of Anton’s Law. LATCH, which was enacted in 2002, is an internationally accepted standard method for attaching child restraints to a vehicle’s rear seat (Durbin, 2011b). All vehicles and car seats manufactured in the United States after September 2002 are required to have this system (Durbin, 2011b). This U.S. FMVSS 225 established requirements for child restraint anchorage systems (NHTSA, 2003).

The second important event that occurred in 2002 was the passage of Public Law 107–318, also known as Anton's Law by the U.S. Congress (NHTSA, 2003). This law was named after a 4-year-old child who died in a rollover MVC after being ejected from the vehicle while sitting in the front passenger seat restrained with a lap/shoulder seat belt (NHTSA, 2003). The belt remained buckled even after the boy was ejected. As a result of her son's death, his mother, Autumn Alexander Skeen, a journalist for the Herald-Republic, researched car safety restraints, in particular the use of booster seats. She pursued the Washington State legislature to pass the country's first mandatory booster seat provision that requires the DOT to track and improve CPS for toddlers and older children (NHTSA, 2003). This law sparked an increase in booster seat use, higher age limits to keep children in car seats in several state laws, as well as new procedures for car seat certification to federal standards (NHTSA, 2003). Anton's Law called on the NHTSA to undertake a number of actions, including:

1. Establishment of performance requirements for child restraints, including booster seats, for children weighing more than 50 pounds (40 pounds was the upper weight limit of Federal Motor Vehicle Safety Standard (FMVSS) 213, which governs child restraints);
2. Examination of situations in which children weighing more than 50 pounds only have access to seating positions with lap belts (a less preferable option than lap/shoulder belts, which offer greater head and upper torso protection than lap belts alone);

3. Development and evaluation of an anthropometric test device that simulates a 10-year-old child for use in testing child restraints in passenger vehicles; and
4. Requiring a lap-and-shoulder belt assembly for each rear-designated seating position to be provided in a passenger motor vehicle with a gross vehicle weight rating of 10,000 pounds or less."

Connecticut Law

Along with evolving federal legislation pertaining to CPS, Connecticut enacted state legislation in 2005 to enhance CPS (Sec. 14-100a) as follows:

1. Children under the age of one year of age and weighing less than 20 pounds must be in a rear-facing seat;
2. Children under seven years of age and weighing less than 60 pounds must ride in a CSRS;
3. After a child exceeds these limits, s/he must be secured in a booster seat with a lap and shoulder belt until they outgrow the booster seat
4. Adult safety belt is permissible for children 7-15 years who weigh greater than 60 pounds." The most stringent version of Connecticut's child passenger safety law was implemented on October 1, 2005. (Seat Safety Belt. Child Restraint System, Ch. 246 Conn. Stat. § 14-100a P.A. 05-58 (1986 & Supp. 2005).

Despite federal and state legislative advancements, Connecticut's children continue to be left without the benefits of a properly secured, age- and weight-appropriate CSRSs, leading to injuries and death and associated medical costs (Safe Kids CT, 2013). Although Connecticut has strengthened its CPS laws, it still falls short when it comes to preventing child injuries and fatalities. Though there is an increased legislation federally and in Connecticut, this is but one prong of a multipronged, effective injury prevention initiative that has significantly improved CPS (Farmer, Howard, Rothman, & Macpherson, 2009). A 2012 study conducted at one of Connecticut's two Level 1 pediatric trauma centers showed that although national, state, and hospital policies require newborns to be transported in a CSRS, considerable misuse exists (Rogers, et al., 2013). The researchers found that 85% of the CSRS were misused; specifically 52% of the errors related to infant positioning in the CSRS and 29% of the devices were improperly attached to the vehicle, thus leading to the child not being properly restrained. (Rogers et al., 2013). Although there are a number of studies that have evaluated the compliance rate of CPS laws, few have evaluated CSRS misuses and state-to-state variation of such laws over time.

Despite these efforts, MVCs continue to be one of the leading causes of unintentional injury and death for children 5–14 years of age (NCIPC, 2014; Sauber-Schatz & West, 2014). Additionally, even with the enactment of both state and federal legislation, children continue to incur injuries in MVCs, resulting in hospitalization, associated medical costs, and even death when not properly restrained in motor vehicles (NCIPC, 2014; Sauber-Schatz & West, 2014). Identifying and addressing variables that can best predict the use of CSRSs can improve the safety of children. This study seeks to close the gap in knowledge of safety advocates to address this public health issue of child injuries and fatalities related to MVCs. While this study is focused specifically on Connecticut's children and CSRS use, the study results may be generalizable nationally.

Problem Statement

Although legislative advances have recognized the importance of the use of child passenger restraints, there continue to be misuse as well as nonuse of CSRSs for those age groups who are legally mandated to use them (NCIPC; Rogers et al., 2013; Safe Kids CT, 2013). Identifying CSRS misuse patterns and gaining a better understanding of these flaws in legislative policies may allow insight into noncompliance of these laws (deliberate or nondeliberate). Closing this gap should be of primary concern and can have significant ramifications in guiding future injury prevention initiatives. This study contributes to the effort of closing this gap by determining if there is a difference in the rate of CSRS use in children 6 years of age and younger who have been involved in a MVC before and after policy implementation. In addition, the study determined variables that best predict the use of CSRS and those that best predict early transition to a seat belt.

Purpose of the Study

The purpose of this study was to evaluate the effectiveness of Connecticut General Statutes § 14-100a, specifically Public Act 05-58, which went into effect October 1, 2005, by evaluating the proportion of children ages 6 years or younger who were in a MVC and who were in a CSRS before and after its implementation. The legislative intent of this statute and similar laws across the country is to decrease the risk of child passenger injuries and death and ensure the appropriate use of child restraint systems (Seat Safety Belt. Child Restraint System, Ch. 246 Conn. Stat. § 14-100a P.A.

05-58 (1986 & Supp. 2005). Thus, the implementation of this statute should demonstrate an increase in the reported number of children ages 6 years or younger who are in a CSRS after a MVC. Identifying and understanding variables that can increase the number of children in CSRS are vital to the implementation of injury prevention interventions that are designed to address this serious public health issue.

Research Hypotheses and Questions

The research questions and hypotheses examined in this study were based on the literature of unintentional injury, impact of health behavior laws (legislative behavioral response), and car safety seat use/misuse rates.

Research Question 1: Is there a difference in the prevalence of CSRS use of children ages 6 years and younger who have been involved in a MVC before and after implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005?

Null Hypothesis 1: There is no difference in the prevalence of CSRS use among children ages 6 years and younger who have been involved in a MVC before and after implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005.

Alternative Hypothesis 1: There will be an increase in the prevalence of CSRS use among children ages 6 years and younger who have been involved in a MVC before and after implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005.

Research Question 2: Which variables best predict the use of CSRS for children ages 6 years and younger who are occupants in a motor vehicle that was involved in a MVC crash?

Null Hypothesis 2: Driver age, driver sex, driver drug and/or alcohol use, driver restraint use, time of day of MVC, and vehicle type do not predict the use of CSRS for children ages 6 years and younger who are occupants in a motor vehicle that was involved in a MVC.

Alternative Hypothesis 2: Some combination of driver age, gender, drug and/or alcohol use, restraint use, time of day of MVC, and vehicle type best predicts the use of CSRS for children ages 6 years and younger who are occupants in a motor vehicle that was involved in a MVC.

Research Question 3: Which variables best predict early transition from a CSRS to a seat belt?

Null Hypothesis 3: Driver age, gender, drug and/or alcohol use, restraint use, time of day of MVC, and vehicle type are not predictors of early transition from a CSRS to a seat belt.

Alternative Hypothesis 3: Some combination of driver age, gender, drug and/or alcohol use, restraint use, time of day of MVC, and vehicle type best predicts early transition from a CSRS to a seat belt.

Theoretical Framework

Diffusion of innovations theory “is the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003, p. 5). It is the process that occurs as individuals adopt a new product, practice, or way of thinking (Rogers, 2003). For the purpose of this study, the diffusion of innovation can be applied to the concept of legislation integration in the local, state, and national community. Diffusion of innovations theory has been used to study a wide range of health behaviors and programs, from diabetes management to smoking cessation (Rogers, 2003). At the organizational level, it may entail starting programs, changing regulations, or altering personnel roles. At a community level, diffusion may involve using the media, advancing policy, or starting initiatives.

There are a number of factors that determine how quickly and to what extent an innovation will be adopted and diffused. Rogers (2003) describes these factors in five steps: knowledge, persuasion, decision, implementation, and confirmation (p. 162). Knowledge is where the person learns about the innovation or "how and why it works" (p. 21)—in this case, knowledge of the enactment of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect 2005. Persuasion is the attitude that the person formulates positive or negative, towards the innovation, again in this case the above stated law (p. 21). Decision is the choice that the person makes to either adapt or not adapt the innovation (p. 21); the decision whether or not to follow the law to place children in age- and weight-appropriate car seats. Implementation is where the innovation is put into practice (p. 21)— the implementation of the actual law. Lastly, confirmation, where the decision where the innovation-decision has been made, but the person implementing the decision looks for approval for the innovation (p. 21). All of these stages are critical to how, when, and if an individual decides to adapt to the proposed innovation (Figure 1).

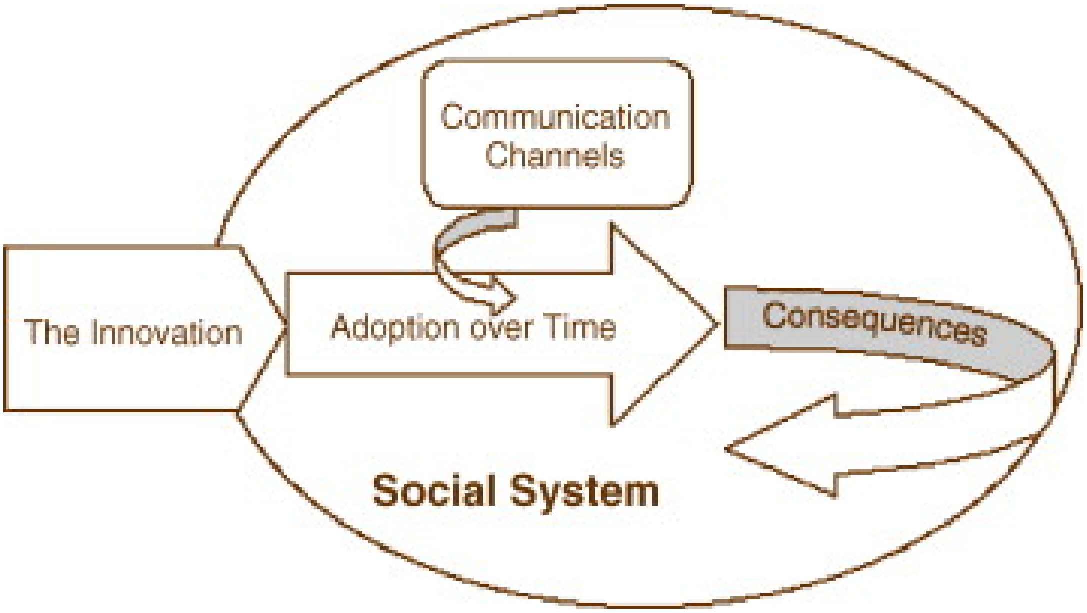

Figure 1. Schematic of diffusion of innovations theory model.

Diffusion of innovations expands the number of people who are exposed to and reached by successful interventions, strengthening their public health impact (Rogers, 2003). The innovation that prevents injury and promotes safety requires a multilevel change process that usually takes place in diverse settings through different scenarios. Effective diffusion of innovation requires the use of both formal and informal communication channels (Rogers, 2003). It also requires a range of strategies to accommodate different communities to facilitate adoption and institutionalization (Rogers, 2003). Strategies or interventions such as education of proper car seat use or providing car seats for those who may not be able to otherwise afford them may facilitate the adoption of the innovation that promotes safety and prevents injury. Individuals who adopt the innovation will move through the decision process at different rates (Rogers, 2003). Rogers described the adoption process as a bell curve: innovators, early adopters, majority adopters, late majority adopters, and laggards.

In this study, the innovation was the implementation of Connecticut's child passenger safety law, Connecticut General Statutes § 14-100a, specifically Public Act (P.A.) 05-58, which mandates that child passengers who have outgrown the height and weight limits of a child safety seat must use a booster seat secured with a lap and shoulder belt until they are at least 6 years of age and greater than 60 pounds (Seat Safety Belt. Child Restraint System, Ch. 246 Conn. Stat. § 14-100a P.A. 05-58 (1986 & Supp. 2005). This legislative change increases the number of children required to be restrained in a child safety seat appropriate for their age and weight. Previous to this change in legislation, child passengers were only required to remain in a car seat or booster seat until age 4 and 40 pounds (Seat Safety Belt. Child Restraint System, Ch. 246 Conn. Stat. § 14-100a P.A. 05-58 (1986 & Supp. 2005). This guideline meant that children were transitioned from a car seat or booster seat, after a shorter period of time, to a vehicle lap/shoulder seat belt or even the possibility of no restraint at all. Determining the characteristics of adults who drive children in motor vehicles and associated factors, including age, gender, driver restraint use, and alcohol/drug use, may shed light on predicting the number of children who will most likely not utilize proper CSRSs. The purpose of this study was to examine the diffusion or spread of Connecticut's child passenger safety legislation and its impact on the use of CSRS. This theory will be discussed in further detail in Chapter 2.

Nature of the Study

MVCs are a major cause of injury and death in children (CDC, 2014; NCIPC, 2014; NHTSA, 2014a). Identifying and addressing variables that contribute to the disregard of CSRS and thus enacted legislation has the potential to save Connecticut's children being placed in harm's way. A cross-sectional design was utilized (a) to determine if Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005 had any effect in the prevalence of CSRS use in children ages 6 years and younger, (b) to determine which variables, if any, best predict the use of CSRS for children ages 6 years and younger who are occupants in a motor vehicle, and (c) to determine which variables, if any, best predict early transition from a CSRS to a seat belt. The independent variables of Connecticut's General Statues § 14-100a, driver's age, driver's sex, driver's drug and/or alcohol use, occupant age, seating position of all occupants, time of day of MVC, and vehicle type were investigated. The dependent variable of seat belt use for children ages 6 and younger was explored to determine the relationship that exists to the aforementioned independent variables.

A descriptive, cross-sectional, retrospective, quantitative study was conducted utilizing the Connecticut Crash Data Repository (CTCDR). The CTCDR contains the MVC police report records for each MVC in which "any person is killed or injured or in which damage to the property of one individual in excess of one thousand dollars is sustained" (Connecticut Department of Transportation [CT DOT], 2015).

Definitions of Key Terms

While there is generally consensus on the key terms used in discussing child passenger safety, the following section will specifically define key terms used in this paper.

Dependent Variable

Occupant protection system use: Safety equipment used in the vehicle at the time of the MVC.

Independent Variables

Case number: Identification number that allows users to access crash information of individual vehicles involved in the same crash.

Cash severity: The severity of the motor vehicle crash

Crash time: Time of day that the motor vehicle crash occurred

Driver age: Age of the driver of the vehicle that the child six years of age or younger was an occupant in.

Driver sex: Gender of the driver of the vehicle involved in the MVC

Drug or alcohol related: Impaired status of the driver of the vehicle with the child 6 years of age or younger.

Early transition:. The placement of a child occupant from an age appropriate car seat to a seat belt (lap/shoulder belt) as determined by Connecticut Law. (NCPSCTP, 2007).

Occupant age: Child passenger occupant age in years.

Occupant sex. Gender of the passenger of the vehicle involved in MVCs.

Seating position. Location in the vehicle for all occupants at the time of the MVC.

Town: Location of the accident.

Vehicle type: The type of vehicle involved in the crash with children ages 6 years and younger.

Types of Child Restraint Systems

Booster seat: A firm seating platform that elevates the child and helps to ensure the vehicle seatbelt fits snug over the shoulders and lower over the child's hips and thighs so that a seatbelt can provide best protection for the child. (NCPSCTP, 2007).

Car bed: An infant restraint system that allows the baby to lie flat, with primary restraint surface being the side of the bed. This type of restraint should only be used by infants who can be discharged from a hospital but may have a medical condition that is aggravated by sitting semi-upright in a regular rear-facing infant restraint system (NCPSCTP, 2007).

Child safety restraint system: A general term for devices designed "to restrain, seat, or position children who weigh 65 pounds or less." These include rear-facing restraints (infant-only and convertible), forward-facing restraints (convertible, child seat, combination seat), car beds, harnesses, and boosters (belt-positioning and shield). The standard specifically excludes vehicle belts (lap or lap-shoulder) from its definition. (NCPSCTP, 2007).

Combination safety seat: A forward-facing car restraint that has a removable harness and can also be used as a belt-positioning booster. For most products, this transition is made when the child reaches 40 pounds (NCPSCTP, 2007).

Convertible safety seat: A car restraint that allows a growing child to stay rear-facing longer because of its higher weight limit capabilities. This type of seat can be used rear-facing for infants up to at least 22 pounds or as much as 35 pounds, and then turned to face forward until the child reaches the product's upper weight limit, usually 40 pounds. Most current convertibles can accommodate children rear-facing up to 40 pounds, thus providing greater safety (NCPSCTP, 2007).

Five-point harness: A car restraint harness that has a webbing strap over each shoulder, one on each side of the pelvis, and one between the legs, with all five coming together at a common buckle. Typically a five-point harness system is used to restrain a child unless the child is of appropriate height and weight to use the vehicle seat belt (NCPSCTP, 2007).

Forward facing child restraint: A restraint that is installed so that the child faces the front of the vehicle. It can consist of a convertible or combination seat (NCPSCTP, 2007).

FMVSS 213: The U.S. Federal Motor Vehicle Safety Standard that establishes requirements for child restraint systems designed for use by children up to 50 pounds in both highway vehicles and aircraft. These requirements cover crash performance, geometry, instructions and labeling, durability, flammability, and product registration (NCPSCTP, 2007).

FMVSS 225: The U.S. Federal Motor Vehicle Safety Standard that establishes requirements for child restraint anchorage systems, also known at LATCH, in highway vehicles. These requirements cover the location and strength of the anchorages for effectively securing child restraints (NCPSCTP, 2007).

Harness: The webbing assembly attached to a car restraint shell or frame that restrains the child in a crash. (NCPSCTP, 2007).

High-back booster seat: A type of booster seat that is used when a car seat lacks head support (NCPSCTP, 2007).

*Innovation***:** The process that occurs as individuals adopt a new product or practice or new way of thinking (Rogers, 2003). For the purpose of this study it is the process of integrating Connecticut’s child passenger safety law into the community.

Intervention: The points at which the innovation is spread out to reach individuals. For the purpose of this study, it is the strategies that will assist in adopting the innovation (Rogers, 2003). For example, educating the community on the proper use of car seats or the availability of car seats to the community for use.

LATCH: An acronym that stands for "Lower Anchors and Tethers for Children" and refers to the child restraint anchorage system specified in FMVSS 225 and corresponding top tethers and lower attachments identified in FMVSS 213. The system includes lower anchorages in the form of rigid bars installed in the vehicle seat bight and flexible (A) or rigid (B) lower attachments on the car restraint that connect to the bars. LATCH has been phased into the vehicle fleet, but all passenger vehicles made from September 2002 must have the system in a certain number of seating positions (NCPSCTP, 2007).

Rear-facing only safety seat: A restraint system that can only be used with the child facing the rear of the vehicle. It is also known as an infant-only seat. Many of these types of seats have two parts- the base which is intended to remain installed in the motor vehicle and the carrier, which allows the caregiver easy removal of the infant while still remaining secured in a restraint system (NCPSCTP, 2007).

Assumptions

The assumptions made in the study include: (a) there is completeness and accuracy of law enforcement documentation of MVCs in their police reports also known as PR-1; (b) all Connecticut drivers are aware and knowledgeable of CT law section 14-100a, specifically Public Act 05-58 that went into effect 2005; and (c) all children have access to an age appropriate CSRS to comply with the law.

Scope and Delimitations

There was minimal threat to the concern of internal validity due to the fact that the data elements that were collected preimplementation of Connecticut's law section 14-100a, specifically Public Act 05-58 that went into effect 2005, are the same data elements that were collected after implementation. There was clear face validity as the same measures were used before as compared to after law implementation. In terms of viewing Connecticut's crash restraint data as a valid measure of car seat use, I believed it to be a valid measure, as car seat use in a MVC is the claims good in general. Since this data source was of individuals involved in a MVC, the external validity had the same potential in this study, except that it was specific to individuals who were more likely to be involved in a MVC. The data source could have potentially excluded those individuals who were extremely safe drivers and those who traveled short distances and were never involved in a MVC. However, that being said, it was most important and certainly possible that not everyone involved in a crash was at fault. Hence, it is possible that even the safest drivers could have been involved in a crash that was not a fault of their own.

Limitations

Identifying and addressing variables that best predict compliance or noncompliance of Connecticut's child passenger safety law has the potential to decrease morbidity and mortality of children who will be transported in motor vehicles. The lack of demographic information that could be obtained from the dataset, such as race of the driver of the vehicle, race of the child occupant, as well as the weight of the child, were limitations to this study. To date, there are no known published studies that report the significant difference between the various types of child restraints, and based on the available dataset, there was no opportunity to differentiate which type of child restraint the child was using at the time of the MVC (e.g., infant or convertible seat versus belt positioning booster seat). Lastly, this study was limited to a single state's database of MVC reports dependent on completeness and accuracy of law enforcement recording of the MVCs as well as accurate coding of the crashes. The lack of documentation of these variables may have prohibited determining whether these were major influencing characteristics in determining proper car seat use and may explain the continued misuse or lack of car seat use.

This newly created electronic database allows for the all of the elements of the police crash reports to be housed in one location, thus making them available for better understanding of MVCs involving children. Understanding driver characteristics and reasoning for not complying with state legislation has the potential to decrease the number of child passenger injuries and fatalities, thus increasing the safety of children transported in motor vehicles.

Significance of the Study and Implication for Social Change

There are many variables that affect the proper use of CSRSs. Although researchers have previously investigated the effectiveness of educational interventions to improve child restraint use and misuse, this study evaluated the effectiveness of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 and the associated factors as it relates to children ages 6 years and younger who were occupants in a motor vehicle that was involved in a crash. Since the enactment of the first child passenger safety law in 1970, there have been widespread efforts to advance CPS. While strides have been made, numerous barriers need to be addressed to ensure that CSRSs are being properly installed, positioned, and utilized. It is evident from the auto industry and the car seat manufacturing industry data that there are sufficient resources that are effective for CPS.

Every 10 years, the CDC (2011) puts forth evidence-based guidelines for national health promotion and disease prevention efforts. The overarching goal of these guidelines is to improve the health of all people in the United States (U.S. HHS, 2014). In 2010, the Healthy People 2020 (2014) was launched consisting of 1,200 objectives categorized into 42 topic areas (U.S. HHS, 2014). One of these public health topic areas is injury prevention and violence control. The goals that are relevant to this research study are

1. Reduce fatal and nonfatal injuries,
2. Reduce motor vehicle crash-related deaths,
3. Reduce nonfatal motor vehicle crash-related injuries,
4. Increase use of safety belts, and
5. Increase age-appropriate vehicle restraint system use in children (U.S. HHS, 2014).

There is no question that MVCs disproportionately affect children who are improperly or not restrained. Only after identifying motives and associated factors that cause adults to be noncompliant with Connecticut legislation can policy makers and injury prevention advocates focus their efforts that begin to address this serious public health issue.

Despite these efforts, the misuse rate of CSRS remains at nearly 73 (CDC, 2014; Decina & Lococo, 2005). This misuse or lack of use of CSRS can result in severe injuries, increased hospitalizations, and fatalities (NHTSA, 2014a). The information and insight derived from this study has the potential to influence decisions on health policy refinement as well as help to focus injury prevention program planning. Determining and addressing variables associated with improper CSRS utilization may help to reduce the increased risk of MVC death and injury, and potentially have significant ramifications and social change effects for the future wellbeing of children who are occupants of a motor vehicle. Ensuring the proper use of an age- and size-appropriate CSRS has the potential to drastically reduce the number of children seriously injured or killed and decrease associated costs.

Summary

Motor vehicle occupant injury is a significant source of morbidity and mortality among children. Identifying variables that may affect parental or caregivers’ use or misuse of child safety seats can substantially reduce injury morbidity and mortality in children less than 6 years of age.

This chapter presented a description of the history of CSRSs and CPS legislation in the United States. This chapter also presented the three research questions and associated null hypotheses and alternative hypotheses for each question as well as study population, data collection procedures, and analysis plan, including the analysis procedures. The subsequent chapters present the literature relevant to this research study, the methods, the results, and the implications of the findings. Chapter 2 discusses the peer-reviewed literature, epidemiological data related to MVCs involving child occupants in the United States, and the search strategies used. Chapter 2 also describes the previous methods and research variables used to examine this issue. Chapter 3 describes in detail the study methods and sampling procedures as well as actions that were implemented to protect study participants and secure the collected data during and after completion of the study. Chapter 4 describes data collection, coding discrepancies, and the study results. Lastly, Chapter 5 describes the interpretation of findings, limitations, recommendations for future research, implications for positive social change, and the conclusion.

Chapter 2: Literature Review

Introduction and Organization of the Review

MVCs continue to be one of the leading causes of unintentional injury deaths for children ages 1–15 years (NCIPC, 2014; NHTSA, 2014a). The purpose of this study was to understand whether legislation influences health behavioral changes and compliance with the law as it relates to CSRS use in Connecticut. This literature review discussed one of the leading causes of unintentional injury deaths—MVCs involving child occupants under the age of 15 in the United States, including the use and misuse of CSRSs. This chapter describes in detail the conceptual model used for the basis of this dissertation as well as search strategies used for literature review. The articles were categorized and divided into the following sections: legislation, health behavior response to legislative regulations, costs, safety seat use, proper use, seating positions in motor vehicles, premature graduation, time of day, misuse, driver demographics' impact on child restraint use, and vehicle type.

Diffusion of Innovations Model and Connecticut's Child Safety Seat Legislation

The diffusion of innovations model has been used in health promotion research for over 40 years (Haider & Kreps, 2004). Rogers's (2003) model describes an innovation as "An idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 12). For Rogers, "a technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (p. 13). For Rogers, adoption is a decision of "full use of an innovation as the best course of action available” and “not to adopt an innovation” is purposeful decision of rejection (p. 17).

Rogers’s model has contributed to the field of public health in the areas of health behavior changes, chronic disease prevention, patient education programs, and its influence on bringing about social change (Haider & Kreps, 2004; Lindbladh et al., 1997; Moseley, 2004; Peeters et al., 2012; Stamatakis et al., 2012; Windsor et al., 2013). The diffusion of innovations model has also had a role in policy adaptation (Makse & Volden, 2011). Makse and Volden ascertained that the individual policies play a role in how fast and how they are adapted. Therefore, they recommended that the nature of each policy be examined individually to determine if previous diffusion efforts were pertinent. Makse and Volden examined the 27 criminal justice policies and attributes that may either enhanced or slow its diffusion. The study concluded that policy attributes play a significant role in the individual policy being adapted and diffused (Makse & Volden, 2011).

Bae et al. (2014) conducted a study that has particular relevance to CPS and CSRSs, and thus I selected it as the model for this dissertation. The study specifically examined the diffusion of child passenger safety laws in the United States over time and the continual changes to the law that states make in response to motor vehicle safety recommendation; states on average made six changes to their respective laws over a 30 year period (Bae et al., 2014). Although CSRSs have been available since the early 1970s, their actual adaption into legislation of all 50 states did not take place until 1986 (Bae et al., 2014).

The spread of the use of evidence-based legislative guidelines can be characterized by comparing the proportion of children ages 6 years or younger who are in a CSRS prior to and after Connecticut General Statutes § 14-100a, specifically Public Act 05-58, which went into effect October 1, 2005. Compliance of the law can be characterized by the proportion of children who are determined to be in an age- and weight-appropriate CSRS (infant rear-facing, forward facing, and booster seat) at the time of a MVC. By evaluating Connecticut's police crash records, safety advocates and legislative officials can further evaluate the effectiveness of the legislation designed to reduce injuries and fatalities that can result from misuse or lack of use of CSRSs and propose the necessary amendments.

The basis for this model is that a majority of the time there are a few individuals who are open to a new idea and will adopt its use (Rogers, 2003). In this case, the new idea was the introduction of Connecticut General Statutes § 14-100a, specifically Public Act 05-58, which went into effect October 1, 2005. As these early adaptors take on the innovation, more and more individuals become open to the new idea that leads to a point or situation at which change occurs. Over time the innovation or idea, in this case the new CPS law, was diffused through the community with more individuals complying with the law, resulting in more children being placed in CSRSs and ultimately better protected from injury and death. Rogers (2003) described the adoption of innovations as a bell shaped curve with five categories: innovators, early adopters, early majority adopters, late majority adopters, and laggards.

Adoption of Connecticut General Statutes § 14-100a, specifically Public Act 05-58, which went into effect October 1, 2005 in this study was described in accordance with Rogers's proposition that if less than 2.5% of children were found to be in CSRSs following a MVC, the spread of this innovation in Connecticut was being done by innovators. The significance of knowing the spread of evidence-based intervention such as evidence-based legislative guidelines and the demographics of the individuals who are the innovators is that it will help identify the strategies needed to further diffuse the innovation within the State of Connecticut. Strategies to encourage and enable the early majority of adopters to implement evidence-based legislative guidelines can be quite different from those to encourage and enable the late majority and laggards (the last 16%) to adopt research-based effective innovations that will ultimately impact the safety and well-being of children in Connecticut communities.

Search Strategies

I performed literature searches via Scopus and Social Science Citation Index as follows: (("*car seat**" OR "*booster seat**") AND (*cost** OR *gender* OR "*driver characteristic**" OR "*vehicle type**" OR (*alcohol* OR "*under the influence*" OR *impaired*) OR (*law** OR *legislation*) OR "*best practice**") AND "*united states*"). Social Science Citation Index yielded 18 results and Scopus revealed 70 results. Next, I searched Academic Search Premier and limited to articles from 2003 to current and academic journals using the following: (("*car seat**" OR "*booster seat**") AND (*cost** OR *gender* OR "*driver characteristic**" OR "*vehicle type**" OR (*alcohol* OR "*under the influence*" OR *impaired*) OR (*law** OR *legislation*) OR "*best practice**") AND "*united states*").

There were 356 results. Next, I searched PubMed with the following categories: "Child Restraint Systems"[Majr] AND ("Cause of Death"[Mesh] OR "Accidents, Traffic"[Mesh] OR "Wounds and Injuries"[Mesh] OR "Costs and Cost Analysis"[Mesh] OR "Child Restraint Systems"[Mesh]) AND ("united states"[MeSH Terms] OR ("united"[All Fields] AND "states"[All Fields]) OR "united states"[All Fields]) AND English[lang], yielding 53 results. Total results from all of the searches were reviewed for relevance and duplicates discarded.

Legislation

MVCs continue to be one of the leading causes of unintentional injury deaths for children ages 1–15 years (NCIPC, 2014; NHTSA, 2014a). Understanding whether legislation influences health behavioral changes and compliance with the law is important. Legislation that strengthens CPS has the potential to decrease the overall number of child passenger injuries and fatalities, which would ultimately increase the safety of child passengers transported in motor vehicles.

The supporting literature demonstrated that proper CSRS and vehicle restraint use reduced injuries and fatalities of children being transported in motor vehicles (Agran, Anderson, & Winn, 2004; Agran, Dunkle, & Winn, 1987; Agran & Hoffman, 2008; Barraco et al., 2010; Caviness et al., 2003; Dellinger, Groff, Mickalide, & Nolan, 2002; Durbin et al., 2003b; Elliott, Kallan & Rice, 2006; Johnston, Rivara, & Soderberg,1994; NHTSA, 2014; Rogers et al., 2013; Thompson et al., 2003; Uherick, Melzer-Lange, & Pierce, 2005). However, children continue to be incorrectly restrained or without the benefit of a CSRS (NHTSA, 2014; Rogers et al., 2013). Both federal and state legislation have attempted to reduce these numbers by the introduction of both primary and secondary seat belt laws in addition to child passenger safety laws. “A primary law allows motorists to be pulled over and cited if noted to be in violation of that law. A secondary law does not allow motorists to be stopped for violating that law but instead mandates the motorists be stopped and cited for another violation before dealing with the one in question”. For example, the driver goes through a stop sign and is talking on his cell phone. In a state where cell phone use is prohibited by a secondary law, the law enforcement official cannot stop the driver unless he has committed the violation of going through a stop sign first before addressing the cell phone use. There are data that illustrate primary laws are more effective in increasing compliance (NHTSA, 2006).

Recent attempts to increase use of child restraints have come in the form of state legislation. All 50 states, Puerto Rico, and the District of Columbia have some form of legislation that requires the use of the restraints by certain groups of children (NCIPC, 2014; GHSA, 2014). The specific points of each law differ for each state, but the basic provisions include: (a) the age of the children affected (usually referring to all children under a specified number of years, e.g., 4 years in Missouri and Tennessee, 3 years in Alabama); (b) type of restraint required (federal standards); (c) the conditions of seating (e.g., if in the front, the child must be in a safety seat; if in back, child must be in safety seat or car seat belt); (d) person responsible for taking action (adult operator); and (e) the level of infraction for violation of the law (e.g., misdemeanor, fine, etc.; GHSA, 2014). Some state laws allow waiving of the fine if the parent can produce a receipt for purchase of the safety device (GHSA, 2014).

Connecticut's Child Passenger Safety Law went into effect October 1, 2005. The law states:

> (1) Any person who transports a child six years of age and under or weighing less than sixty pounds, in a motor vehicle on the highways of this state shall provide and require the child to use a child restraint system approved pursuant to regulations adopted by the Department of Motor Vehicles in accordance with the provisions of chapter 54. Any person who transports a child seven years of age or older and weighing sixty or more pounds, in a motor vehicle on the highways of this state shall either provide or require the child to use an approved child restraint system or require the child to use a seat safety belt. As used in this subsection, "motor vehicle" does not mean a bus having a tonnage rating of one ton or more. Failure to use a child restraint system shall not be considered as contributory negligence nor shall such failure be admissible evidence in any civil action. 2) Any person who transports a child under one year of age or weighing less than twenty pounds in a motor vehicle on the highways of this state shall provide and require the child to ride rear-facing in a child restraint system approved pursuant to regulations that the Department of Motor Vehicles shall adopt in accordance with the provisions of chapter 54. (Seat Safety Belt. Child Restraint System, Ch. 246 Conn. Stat. § 14-100a P.A. 05-58 (1986 & Supp. 2005)

Despite enactment of legislation, child passenger vehicle occupant deaths and injuries continue to occur (NCIPC, 2014; NHTSA, 2014a; GHSA, 2014). According to a May 2013 report from the NHTSA, there were 274 child passengers under the age of 5 who were killed (NCIPC, 2014; NHTSA, 2014a). Seventy-six (30%) were without the benefit of a CSRS. They estimated that in that same year, 263 lives were saved by using restraints (NHTSA, 2014a). It is estimated that if CSRS were used for all those children, 51 additional lives could have been saved (NHTSA, 2014a). In spite of over a decade of legislative efforts, MVCs remain one the major causes of death for children under 12 years of age (NCIPC, 2014). In 2011, more than 650 children ages 12 years and younger died, and another 148,000 injured as occupants in MVCs, 33% without the benefits of a restraint (CDC, 2014; NCIPC, 2014).

Levels of public awareness of a new restraint law correlate with more children being restrained (CDC, 2014). Intensive efforts to publicize the laws via television, for example, result in increased self-reported ownership of safety seats and, in some instances, increases in observed usage (CDC, 2014; National PTA & United States, 1986). Child passenger restraint laws that increase the age that is required for car seat or booster seat use result in more children being restrained (CDC, 2014). There was a documented 17% decrease in death and serious injuries in five states that passed legislation to increase the required age for CSRS use to 7 or 8 years of age (CDC, 2014). In addition, there was a three-fold increase in the number of children who used car seats or booster seats (CDC, 2014). Therefore, evaluating and determining variables that can predict and target specific populations and their behaviors at risk for lower restraint use will be important in implementing future injury prevention interventions and health and legislative policies.

Health Behavior Response to Legislative Regulations

Awareness of laws seems to be an important component of compliance (Gunn, Phillippi, & Cooper, 2007). Studies have found that increased driver knowledge of their state CPS law leads to an increase in booster seat use, thus suggesting that awareness campaigns are effective in improving the desired behavior—use of a CSRS (Gunn, et al., 2007). However, sustaining compliance after implementation of child passenger legislation remains challenging. In a prospective, nonrandomized study, Brixey, Ravindran, and Guse (2010) assessed the effects of the then newly enacted Wisconsin CPS law on the appropriateness of child passenger restraint. Brixey et al. found that there was no significant improvement in the appropriate usage of restraints for children ages 0–7 years before (94%) and after law enactment (94%). Although there was no increase in the use of age- or weight-appropriate car seats, there was an increased use in vehicle seatbelt restraints overall (Brixey et al., 2010).

Additionally, although there was an increase in restraint use, there was also an increase in the rate of premature transition to booster seat use in children, who by law should have been restrained in a rear- or forward-facing car seat given their age, height, and weight (Brixey et al., 2010). There was a significant increase in premature booster seat use in children who should have been restrained in a rear- or forward-facing car seat (10% prelaw, 12% grace period, 20% postfine; $p < 0.0005$). There was no statistically significant change over time in unrestrained children (2.1%, 1.7%, 1.7%, $p = 0.7$, respectively; Brixey et al., 2010). Of note, the study was conducted at a pediatric urban health center and a Women, Infants, and Children (WIC) office in Milwaukee, Wisconsin where 11% of the participants were Hispanic and 80% African American (Brixey et al., 2010). Ninety-two percent of this population received publicly funded health insurance likely indicating low socioeconomic status (Brixey et al., 2010). A follow up 2011 study demonstrated an overall 19% increase in booster use (Brixey, Corden, Guse, & Layde, 2011). The study also concluded that while legislation may affect total booster seat use, it may not improve the proper use of the seat itself, especially in the minority population use (Brixey et al., 2011).

Similarly, Eichelberger, Chouinard, and Jermakian (2012) evaluated the effectiveness of booster seat laws in five states (Missouri, North Carolina, Pennsylvania, Wisconsin, and Wyoming) by comparing injury rates, restraint use, and seating positions 2 years before and 2 years after implementation of the law. Their results showed an increase of nearly threefold in the use of either booster seats or harnessed child restraints, as well as a 5% decrease in the severity of any injury and a 17% decrease in fatality rates in children who sustained fatal or incapacitating injuries (Eichelberger et al., 2012). The researchers also documented a 6% increase in children who rode in the back seat.

Sun, Bauer, and Hardman's (2010) study examined and compared the relationship between the New York state upgraded child restraint law (UCRL-booster seat) implemented in 2005 and the traffic injury rate among 4- to 6-year-old children in New York after the law was passed. The child restraint use rate involving the 4- to 6-year-old group experienced a significantly larger increase from approximately 30% in 2003–2004 to 50% in 2006–2007 (Sun et al., 2010). This comparatively showed a vast improvement considering the 0 to 3-year-old group showed a slower increase rate of 76% to 84% from

2003–2007 (Sun et al., 2010). In conclusion, the UCRL had a significant impact on the 4- to 6-year-old children and their increasing compliance with child vehicle safety measures; however, the UCRL did not have a significant increase in the 0 to 3-year-old children (Sun et al., 2010). This study reports that they are the first to research and compare traffic injury rates for booster seat-aged children before and after implementation of the booster seat law in a single state (before and after effect).

In 2007, a study, examined and quantified the independent contribution of recently enacted booster seat laws in 15 states (East: New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, North Carolina, District of Columbia; Midwest: Ohio, Michigan, Indiana, Illinois; West: California, Nevada, Arizona) on appropriate restraint use by child passengers in motor vehicles (Winston, Kallan, Elliott, Xie, & Durbin, 2007). The study revealed children aged four to seven years of age in states with booster seat law provision were 39% more likely to be reported as appropriately restrained compared with children in other states with no booster seat law (Winston et al., 2007). This study verified a majority of high compliance with the current use of age appropriate restrains among children 4-5 years compared with older children. This study recommends future upgrades to child restraint laws to extend to at least the age of 7 years to maximize the number of children properly restrained for their age.

In 2002, Chang, Ebel, & Rivera studied factors associated with compliance to the booster seat law in the state of Washington. Additionally, factors related to perceived readiness for the law, potential barriers, and other predictors of compliance were also studied. The study included a survey of licensed childcare centers that, by virtue of their role, may need to transport children for medical or recreational purposes. The study revealed 43% of centers had already started preparing for the new law, 48% believed that they would be ready by the time the law passed, and only 70% of respondents were aware of the law and felt comfortable asking staff and parents to use booster seats (Chang, et al. 2002). Transporting centers reported an 18% in childcare centers currently compliant with the future booster seat law (Chang, et al., 2002). Twelve percent of the childcare centers that reported current compliance with the law stopped their field trips for their centers altogether to avoid booster seat responsibilities (Chang, et al., 2002). This study suggests that childcare centers need educational support and assistance to increase knowledge of booster seats benefits. In addition, 91% of the childcare centers stated the need for financial assistance to be in compliance with the law (Chang, et al., 2002). Removing such barriers may improve CSRS use and thus improve the safety of children being transported in motor vehicles.

Costs

Evaluating crash and hospital data to whether mandatory seat belt laws can have a potential effect on hospital charges and reduce medical costs may be beneficial in direct financial support to injury prevention efforts geared towards improving child passenger safety. A savings of $15.3 million to Medicaid per year could be prevented in a ten year time frame, assuming a 92% seat belt usage, including a savings of $91.2 million over ten years, preventing 161 deaths in one year if seat belts were used (Conner, Xiang, & Smith, 2010). Determining the effect of pediatric restraint use on Emergency Medical Services

(EMS) utilization may be another avenue to evaluate costs related to CSRS use or lack of use. From a sample size of 1,580 children, 82.8% (n=1,309) presented wearing some type of restraint (Caviness et al., 2003). There was a 93% EMS transport of children who were not wearing restraints versus an 83.3% EMS transport of children restrained (Caviness et al., 2003). Statistically, this study verified that children wearing safety restraints were 62% less likely to be transported by EMS than those who were not wearing a safety restraint (Caviness et al., 2003). In conclusion, the results indicated the use of safety restraints during MVCs is associated with a significant reduction in the number of children transported by EMS personnel.

In a study funded by the Children's Safety Network Economics and Data Analysis Resource Center, Miller, Zaloshnja, and Hendrie (2006) analyzed the societal return on investment in booster seats in four to seven years olds and in United States laws that require their use. The authors found that with a booster seat law, there was a cost savings of $274 per booster seat, with the average booster seat costing roughly $30. In a net cost per quality-adjusted life year saved, a $1,854 savings per seat and a 9.4 to 1 return on investment were yielded (Miller, et al., 2006), indicating a comprehensive return on investment with booster seat use. In 2005, Corden measured whether booster seats or seat belt use resulted in a reduction of MVC- associated childhood deaths and hospitalizations (Corden, 2005). He found that if there was a 100% compliance with booster seat use in four to seven year olds, 16 deaths and 84 hospitalizations could have been prevented (Corden, 2005). He found that if there was a 100% compliance with seat belt use in eight to 15 year olds, 45 deaths and 206 hospitalizations could have been prevented (Corden, 2005), thus confirming the health and cost benefits of using age-appropriate restraints. Similarly, Pressley and colleagues (2009) found that motor vehicle occupant injuries of three to eight year olds were associated with a lower proportion of injury costs as a result of booster seat legislation. The authors also found that children covered by booster seat legislation were less likely to be hospitalized, thus less likely to incur expenses associated with injuries (Pressley, Trieu, Barlow, & Kendig, 2009).

Human error contributes to unsafe practices that can lead to increased cost, injuries and deaths. Identifying which variables that can best predict these behaviors, as well as enactment and enforcement of policy focused safety initiatives, can be a significant injury prevention tactic, thus potentially decreasing injuries and ultimately saving numerous lives. The body of literature is very limited in this area, calling for further research to be conducted.

Safety Seat Use

In 2011, approximately 148,000 children were injured and 650 died as a result of MVCs (CDC, 2014). Of the children who died, a third was not restrained (CDC, 2014; Sauber-Schatz & West, 2014). Identifying and addressing the variables that best predict safety seat use has the potential to decrease the morbidity and mortality sustained by children as a result of MVCs.

A study undertaking the first comparison of the effectiveness of CSRS and seat belts based on representation samples of all crashes of two to six year olds reported by the police was conducted by Doyle & Levitt (2010). The evidence shown by this study supports that lap and shoulder belts performed roughly as well as CSRS in preventing serious injury for older children, However, CSRS tended to show improvement at reducing less serious injuries for the overall group, including the younger age group (Doyle & Levitt, 2010; Sauber-Schatz & West, 2014). Passengers who utilize lap belts and safety seats showed vast improvement over non-restrained passengers, thus confirming that some type of restraint is better than no restraint (Doyle & Levitt, 2010). Furthermore, it is well established that an appropriate age-adequate restraint system is the safest (Berg et al, 2000; Mannix et al., 2012; Valent, McGwin, Hardin, Johnston, & Rue, 2002; Winston, Durbin, Kallan, & Moll, 2000; Zaloshnja, Miller & Hendrie, 2007; Zaza et al., 2001). Proper restraint use among children between the ages of zero to 11 showed lower risks of injury compared to both unrestrained children and improperly restrained children (Valent et al., 2002). Properly restrained children sustained significant reduction in head, thorax, lower extremities, and mortality risks; however, reductions in risk factors were not significant when comparing improperly restrained children with unrestrained children (Valent et al., 2002).

Furthermore, the effectiveness of CSRS and lap-shoulder belts in rear passenger vehicle seats for two to three year old crash survivors has been also evaluated (Zaloshnja, et al., 2007). It was found that CSRS showed more effective rear seat restraint compared to lap-shoulder safety belts (Zaloshnja, et al., 2007). Children aged two to three years have an 80% lowered risk for injury in CSRS than in safety belts (Zaloshnja, et al., 2007) This study validates and verifies that laws requiring children younger than four to travel in CSRS should continue to be promoted (Zaloshnja, et al., 2007). An evaluation of booster seats versus seat belts alone in reducing the risk of child deaths during MVCs using the Fatality Analysis Reporting System (FARS) demonstrated that children who were traveling unrestrained were 2.8 times more likely to die than those restrained in seatbelts with a booster seat (Rice, Anderson, & Lee, 2009a; Rice, Anderson, & Lee, 2009b). The estimated effectiveness of a seatbelt alone was similar and those unrestrained were 2.6 times more likely to suffer fatal injury than belted children (Rice, et al., 2009a, 2009b).

It is possible that there may be a misclassification of restraint coding among children in this age group because booster seats function with an existing seatbelt system resulting in possible police officer inconsistency in coding of booster seat use. The validity of this study may be questioned due to the above and the fact that FARS does not differentiate between CSRS and booster seats (Rice, et al., 2009a, 2009b).

Children who are properly restrained have a decrease risk of sustaining brain injuries (Muzynski, Yoganandan, Pintar, & Gennarelli, 2005). It was established that proper use of a CSRS significantly decreases the likelihood of a child sustaining a head injury in a MVC (Muzynski et al., 2005). The likelihood of not sustaining a head injury in infants was considerably higher (92.8%) as compared to 15.2% for those infants unrestrained (Muzynski et al., 2005). For those infants who sustained a moderate-to-maximum head injury, a properly used CSRS drastically reduced the incidence of injury from 7% to 0.5% (Muzynski et al., 2005). In 1993, a study of non-fatal childhood MVCs was conducted (Ruta, Beattie, & Narayan, 1993). It was estimated that approximately 24% of head injuries could be prevented by the use of seat restraints (Ruta et al., 1993). Moreover, unrestrained children were 3.1 times as likely to sustain a head injury when compared to restrained children (Ruta et al., 1993). Unrestrained children were about 1.7 times as likely to have multiple diagnoses compared with restrained children (30% vs. 18%) (Ruta et al., 1993). Multiple diagnoses were also more common among children in seatbelts (20%) compared with those in CSRSs (13%) (Ruta et al., 1993).

A separate study conducted in 2004 examined injuries of the back, neck and spinal cord involving different age groups (Zuckerbraun, Morrison, Gaines, Ford, & Hackam, 2004). The study separated participants into two categories based on age. The participants in the 0-8 year age group exhibited a higher rate of traumatic brain injuries (Zuckerbraun, et al., 2004). The specific type of restraint used largely determines the type and severity of the injury. For instance, rear facing CSRSs prevented serious trauma and resulted in fewer head and neck injuries (Zuckerbraun, et al., 2004). Near side impacts posed the greatest risk (78%) in the odds of head injury as compared to frontal crashes. Far side and rear crashes were not associated with significantly increased risk of head injury (Nance et al., 2010). The risk of spinal fractures increase when children are only restrained using a lap belt versus a lap and shoulder belt (Lapner, et al., 2001). A study found that passengers who failed to utilize restraints and became injured exhibited lower Glasgow Coma Scales (Miller, Baig, Hayes, and Elton, 2006. The Glasgow Coma Scale is a standard scale that measures levels of consciousness in a person following a brain injury in which scoring is determined by three factors: amount of eye opening, verbal responsiveness, and motor responsiveness. Head and spinal cord injuries could be reduced in severity if a child is in the proper seating location, properly restrained, and in an age and weight appropriate CSRS (Miller, et al., 2006). Unrestrained child passengers between the ages of four and 15 were several times more likely to suffer a head injury than those who were restrained (Nance et al., 2010). Children four to eight years of age in seat belts were slightly more than twice at risk for a head injury compared to those in a CSRS (including booster seats). They were also approximately at one half the risks compared to those who were unrestrained (Nance et al., 2010). Child passengers seated in the front row of the vehicle showed an elevated but non-significant risk of head injury when compared to those seated in the back row(s), again, demonstrating the need for appropriate restraints (Nance et al., 2010).

As a whole, these studies provide substantial evidence that children who were not restrained in a proper CSRS exhibited more serious injuries than those who were properly restrained (Agran, et al., 1992; Agran, et al., 1985; Glass, et al., 2002; Miller, et al., 2006). However, despite public policies, children continue to be placed in harm's way by parents or caregivers by not being restrained, or not properly placed in an age-appropriate restraint.

Proper Use

A large body of evidence exists surrounding a proven decrease in injuries and fatalities in rear facing CSRSs and booster seats when properly restrained (Glass, et al., 2002; Corden, 2005). It is certain that properly using CSRS and seat belts can save lives, but there are numerous factors that need to be considered to ensure proper CSRS use. These factors can include, but are not limited to, CSRS selection, vehicle seating selection (front seat versus back seat), and seating position (rear passenger side, directly behind driver's seat and middle seat). Despite a significant decrease in the number of children killed in MVCs over the past ten years, it remains as one of the leading causes of injury deaths (Durbin, 2011a). As a result, a panel of experts convened and compiled 2 evidenced-based on child passenger safety that was released in 2011(Durbin, 2011a, 2011b). The policy statement provided five evidence-based recommendations to optimize safety in passenger vehicles for children of all ages:

> "(1) All infants and toddlers should ride in a rear-facing car safety seat until they are 2 years of age or until they reach the highest weight or height allowed by the manufacturer of their CSRS. (2) All children 2 years or older, or those younger than 2 years who have outgrown the rear-facing weight or height limit for their CSRS, should use a forward-facing car safety seat with a harness for as long as possible, up to the highest weight or height allowed by the manufacturer of their CSRS. (3) All children whose weight or height is above the forward-facing limit for their CSRS should use a belt-positioning booster seat until the vehicle lap-and-shoulder seat belt fits properly, typically when they have reached 4 feet 9 inches in height and are between 8 and 12 years of age. (4) When children are old enough and large enough to use the vehicle seat belt alone, they should always use lap-and-shoulder seat belts for optimal protection. (5) All children younger than 13 years should be restrained in the rear seats of vehicles for optimal protection. (Durbin, 2011b, pg. 789-791)

The 2011 American Academy of Pediatrics (AAP) guidelines indicate that restrained children are significantly less likely to sustain serious abdominal trauma than those who are not restrained (Durbin, 2011b). It is recommended that children under the age of two ride rear-facing (Durbin, 2011b). Two types of car seats can be used for this: an infant only carrier, which is used rear facing only, and a convertible seat, which can be used both rear-facing and forward facing. The AAP also recommends that children be kept in a five point harness system until they weigh at least 60 pounds, and use a booster seat until the age of eight and/or reaching a weight of 80 pounds (Durbin, 2011a). Once a child has outgrown a booster seat, the AAP recommends the child continue to sit in the rear of a car (Durbin, 2011a). Multiple studies have shown that children riding in the front seat of a passenger car can be severely injured by air bags (Arbogast, et al., 2003; Arborgast et al., 2005b; Arborgast, et al., 2005a; Arbogast, et al., 2009; Durbin, et al., 2003a; Durbin, et al., 2004; Huseth-Zosel, 2012; Macy, et al., 2013; Quinones-Hinojosa et al., 2005). The recommendations of the AAP are that caregivers should always follow the manufacture height and weight recommendations for their particular seat. A 2004 study showed that suboptimal restraint use resulted in an increase in hollow viscous injuries (Lutz et al., 2003). However, despite these evidenced-based guidelines, children continue to have significant morbidity and mortality risks by not being restrained, or not properly placed in an age-appropriate restraint.

Child safety seat selection and premature graduation

The improper use of CSRS continues despite implementation of CPS laws. A factor to be considered in continued injury from MVCs is the CSRS selection and premature graduation (Winston et al., 2007). When selecting a CSRS it is crucial that one is familiar with the standards as set forth by the American Academy of Pediatrics in order to select both an age and weight appropriate CSRS. Age appropriate CSRSs during a

MVC significantly decrease injuries and death (Tyroch, Kaups, Sue, & O'Donnell-Nicol, 2000). Children who are not properly restrained are twice as likely to be injured (Durbin et al., 2005). Many children are prematurely placed forward facing which puts them at risk for sustaining severe injury in MVCs (Winston et al., 2007). Utilizing age appropriate CSRS decreases the potential for serious injuries by more than half when compared to children who are only restrained by a lap and shoulder belt (Johnston, Rivara, & Soderberg, 1994). Utilization of belt-position boosters had a reduced risk of injury even further to 61% when compared to seatbelts alone in children 4-7 years of age. In children 4 years of age the reduced risk of injury was 56% and in children 6 years of age the reduced risk of injury was 81% when compared to seat belts alone (Durbin et al., 2004). Children who were restrained in a safety seat were 67 percent less likely to suffer fatal injury during severe motor vehicle collisions than were children who were traveling unrestrained (Rice & Anderson, 2009a). CSRSs are highly effective in decreasing the risk of death during severe traffic collisions and generally outperform seat belts (Rice & Anderson, 2009a; Rice & Anderson, 2009b). Thus, parents should be encouraged to place their children in CSRSs in favor of seat belts.

Premature graduation from age and weight appropriate CSRSs leads to increased risk of injury and typically coincides with children being placed in improper seating positions within the vehicle. A study in 2010 by Brixey, Ravindran & Guse found a significant increase in premature booster seat use in children who, by law, should have been restrained in a rear or forward facing seat. This study also found an increase in the percentage of children who were inappropriately restrained with seatbelts. Forward facing CSRSs lower the risk of serious injury by 78% (Arbogast, et al., 2004; Brixey, et al., 2010; 2011). Although there is no significant change in the risk of minor injuries when using seat belt systems, forward facing CSRS decrease the occurrence of injury by 80% and the need for hospitalization by 82% (Arbogast et al., 2004; Doyle & Levitt, 2010; Durbin et al., 2005). Identifying variables that best predict car seat use and targeting injury prevention efforts to those who do not use car seats or misuse car seats can prevent children from being placed in harm's way ultimately leading to injuries, disabilities and death.

Seating Positions in Motor Vehicles

Seating positions in a motor vehicle have large impacts on survival in the event of a MVC (Berg, et al., 2000; Braver, et al., 1998; Durbin et al., 2005; Kallan, Durbin, & Arbogast, 2008; Sahraei, Soudbakhsh, & Digges, 2009). Rear seating positions in particular can improve the chance of survival and minimize the risk of sustaining an injury (Berg, et al., 2000; Braver, et al., 1998; Durbin et al., 2005; Kallan, et al., 2008; Sahraei, et al., 2009). It is recommended that children up to 12 years be restrained in the rear vehicle seat so as to decrease the risk of injury (CDC, 2014). Furthermore, children under the age of three should avoid being placed in the front seat (Berg, et al., 2000; Braver, et al., 1998; Durbin et al., 2005; Kallan, et al., 2008; Sahraei, et al., 2009). One study examined passenger position and risk of death in MVCs using matched cohorts to compare the risk ratio of death from the rear seating position versus death for a front seating position (Smith & Cummings, 2004; Smith & Cummings, 2006). They found that children 0 to 12 years of age did not have a higher risk for death when seated in the back seat and away from the airbags in the front row of the vehicle (Smith & Cummings, 2004, 2006).

Durbin and colleagues (2004) determined characteristics of front row seating of children and discovered that when there was only one child in the vehicle approximately one in three were seated in the front (Durbin et al., 2004). The authors also found that children were also more likely to ride in the front with the driver being male and over the age of 34 (Durbin et al., 2004). To further maximize safety, children should not be seated in the front row of the vehicle until they are at least 13 years of age due to the risk of injury from airbags (Durbin et al., 2003a). Proper seating locations in conjunction with airbag use have the potential to significantly reduce airbag associated injuries (Berg, et al., 2000; Braver, et al., 1998; Durbin et al., 2003a; Durbin et al., 2005; Olson, Cummings, & Rivara, 2006; Sahraei, et al., 2009).

The location of motor vehicle airbags, which are primarily located in the front seats in, is one of the driving factors in determining the seating location of children (Berg, et al., 2000; Braver, et al., 1998; Durbin et al., 2005; Kallan, et al., 2008; Olson, et al., 2006; Sahraei, et al., 2009). As mentioned earlier, the second generation airbags are safer and have resulted in decreased injury with a child sitting in the front seat in cars and minivans but not SUVs (Arbogast et al., 2010). However, expert safety advocates, continue to promote rear seat seating location in the rear from children under the age of 13 years (Durbin et al., 2003a).

One study found that of those children who died as a result of airbag deployment, only less than one percent were restrained properly (Durbin et al., 2003a). Passenger airbags increase the risk of serious injuries in children by twofold (Durbin et al., 2003a). It was determined that in 12.3% of all children involved in a motor vehicle collision sustain injuries from airbag deployment (Durbin, et al., 2003a). While adults benefit from the protection of airbag deployment, studies show children are still at risk for increased injuries due to airbags (Durbin et al., 2003a). Children who were placed in the front seat of a motor vehicle were found to have a risk ratio of 1.8 for facial fractures (Arbogast et al., 2010). A study by Quinones-Hinojosa, et al (2005) found that 97.7% of the children injured or killed by airbag deployment were improperly restrained or completely unrestrained (Quinones-Hinojosa et al, 2005). This same study found that head injuries were the sole cause of death in infants, whereas combinations of injuries were seen in other groups (Quinones-Hinojosa et al, 2005). While airbags can be largely beneficial to adults, it often results in increased injuries, especially head and spinal; the most common injury associated with airbag deployment and improperly restrained children (Quinones-Hinojosa et al, 2005).

A study undertaken to further improve the understanding of the protection offered to rear seat occupants showed that the effectiveness estimates ranged from 5.9% to 82% for different age groups (Shraei, et al., 2009). The results also indicated an overall benefit for occupants sitting in the rear seat compared to the right front passenger seat of all model year vehicles (Shraei, et al., 2009). However, there was a 43.7% reduction in effectiveness for unbelted occupants and a 33.5% reduction for belted occupants in the new model year vehicles (Shraei, et al., 2009). This study considers the protection of the rear seat occupant deserves more attention and assistance from the automotive industry and government agencies to improve safety measure.

In conclusion, the back middle seat is considered to be the safest location in the motor vehicle. Educating and enforcing legislation that ensures children under the age of 12 years are fitted with the correct age and size appropriate restraint, can ultimately improve the chances of a child surviving a serious injury or death as a result of a MVC.

Time of Day

Limited research has shown that driver and their passengers tend to have lower rates of seat belt use during the nighttime hours. In a study of MVCs of teen drivers compared to adult drivers, Irene Chen et al., (2005) examined at the association among child passengers in regards to injury risk, crash time, and restraint use. Teen drivers who drove at night have an increased risk of injury and non-restraint use of their passengers than those teen drivers involved in crashes during the daytime (Chen et al., 2005). Although there is limited data in this area, the need for further research is clear. Having a better understanding of the characteristics of drivers and other variables that may lead to decrease seat belt and car seat use can help safety advocates better target injury prevention programs.

Misuse

It is well established that properly restrained infants and children – either in CSRSs or with seatbelts – are less likely to suffer serious injuries in MVCs than those who are not (Agran, et al., 1992; Agran, et al., 1985; Glass, et al., 2002; Miller, et al., 2002). In fact, compared to children who are properly restrained, those who were not properly restrained are two times more likely to be injured in a MVC, while those who are unrestrained are three times as likely to suffer serious injury (Durbin, 2005).

A 2011 study by found that children between the ages of 4-7 had the highest proportion of inappropriate restraint, as compared to 45.1% who were involved in any MVC and were not appropriately restrained (Schlotthauer et al., 2011). The same study found that the mortality rate increases when children under the age of three are unrestrained or improperly placed in a car seat (Schlotthauer et al., 2011). Children who were restrained in a safety seat were 67% less likely to suffer fatal injury during severe motor vehicle collisions than children who were traveling unrestrained (Rice & Anderson, 2009a; Rice & Anderson, 2009b).

A study found that the rate of abdominal injuries increased when there was misuse of CSRSs (Sweitzer, Rink, Corey, & Goldsmith, 2002). However, there was not a significant difference noted when children between the ages of four and nine were placed in the front or back seat; this may be related to different lap-shoulder seat belt designs (Agran, et al. 1992). Child safety seats showed more effective rear seat restraint compared to the lap-shoulder safety belts for children aged two-three years. Children aged two-three years have an 80% lowered risk for injury in CSRSs than in safety belts (Zaloshnja et al, 2007).

Lap-shoulder belts performed roughly as well as CSRSs in preventing serious injuries for older children (Doyle & Levitt, 2010). A 2002 study found that older children exhibited the lowest Maximum Abbreviated Injury Scale (MAIS) and Injury Severity Scores (ISS), which measures proper restraint, regardless of where they were seated in a motor vehicle (Sweitzer et al. 2002). The Abbreviated Injury Scale is an anatomical-based coding system created by the Association for the Advancement of Automotive Medicine to classify and describe the severity of specific individual injuries with several versions published since the first iteration of 1969 (Sweitzer et al., 2002). The ISS is used to assess trauma severity and correlates with mortality, morbidity and hospitalization time after trauma. Based on these scales, the researchers found that the same pattern of misuse was evident, as observed in the 0-3 year old group, leading to a statistically higher risk of abdominal injuries (Sweitzer et al., 2002). Moreover, the risk of injury for children in this same age group decreases by 78% when they are placed in forward facing child restraint systems and decreases further by 79% when they are in the center rear seat (Arbogast et al 2004). A 2003 study found that 12% of fatalities were caused by misuse of CSRSs (Sherwood, Ferguson, & Crandall 2003). Misuse of CSRS has long been a problem and continues to contribute to injuries and fatalities that have the potential to be reduced and in some cases eliminated.

Driver Demographics and Impact on Child Restraint Use

Identifying and understanding driver demographics and characteristics have the potential to have a significant impact on whether a child is placed or not placed in a CSRS. After reviewing the literature, the demographics found to impact driver’s use of child restraints include: driver’s age, gender, annual household income, race/ethnicity and educational status (Olsen, Cook, Keenan, & Olson, 2010; Winston et al., 2006). Studies also showed that inappropriate restraint usage was more than two times higher in alcohol-related vehicles (34.5%) than in non-alcohol related vehicles (17.1%) (Schlotthauer, et al., 2011). Children in alcohol-related vehicles who were inappropriately restrained had higher proportions of injuries (39.7%) than inappropriately restrained children in non-alcohol-related vehicles in alcohol related crashes (28.1%) and non-alcohol-related crashes (15.7%) (Schlotthauer, et al., 2011). Inappropriate restraint was more than two times higher in alcohol-related vehicles (34.5%) than in non-alcohol related vehicles (17.1%) (Schlotthauer, et al., 2011).Determining and addressing the morbidity and mortality burden that these driver characteristics place on children, can assist public health officials and safety advocates in developing and implementing evidenced-based policies and injury prevention interventions.

Driver age and seatbelt use

Passengers were 70 times more likely to be unbelted if the driver is unbelted (Kim & Kim, 2003). Unbelted occupants are more likely to be younger, male and involved in speed-related crashes in rural areas during nighttime (Kim & Kim, 2003). A study by Olsen et al. (2010) found that child occupants were optimally restrained 57% of the time and seated in the rear seat, 4% were not restrained and 19% were sub-optimally restrained, as well as 27% were sitting in the front passenger seat (Olsen et al., 2010). There was a reported 95% rate of compliance for the drivers who were restrained from the cohort study (Olsen et al., 2010). Children riding with restrained drivers made up 95% of this study’s sample population (Olsen et al., 2010). Furthermore, driver seat belt use is associated with decreased risk of the emergency department evaluation for child passengers in the event of a MVC (Olsen et al., 2010).

A study from Chen and colleagues evaluated teen drivers and the risk of injury to child passengers in motor vehicle crashes (Chen, Elliott, Durbin, & Winston, 2005). Their first aim was to look at the relationship between driver's age (novice teens, older teens, adults) and restraint use, injury risk and front row seating. The second aim sought to evaluate if there was an excess injury risk in teen crashes as compared to adult crashes. The authors found that appropriate restraint for child passengers ages 4-8 years for novice teen drivers was <1%, older teen drivers 4.5%, and adult drivers 23.6% (Chen, et al., 2005). They also found that children less than 13 years of age were more likely to be seated in the front row of the motor vehicle with a novice teen driver 26.8% of the time (Chen et al., 2005). It was also found that passengers of teen drivers have most injury risk with a 43% reduction in odds ratio for novice teen drivers after adjusting for crash severity (OR 1.58, 95% CI 1.14 to 2.19); 24% reduction for older teen drivers (OR 2.15, 95% CI 1.42 to 3.26) (Chen et al., 2005). Their study adjusted for vehicle type, front row seating, restraint status, 19% OR reduction for novice teen drivers (OR 1.37, 95% CI 1.00 to 1.88) and a 13% reduction for older teen drivers (OR 1.74, 95% CI 1.14 to 2.66) (Chen et al., 2005).

In another study, it was found that children were more likely to be seated in the front row of the car if the driver was a male and if the driver was a teenager or over the age of 34 years (Durbin et al., 2004). Teen drivers had the highest proportion of child occupants in the front row seating position (Durbin et al., 2004). It was also noted that front row seating was more common in two row pickup trucks and if the vehicle was not equipped with passenger airbags (Durbin et al., 2004). Older boys were more likely to be seated in the front (Durbin et al., 2004).

Driver socioeconomic status

A 2006 study conducted by the Children's Hospital of Philadelphia focused on identifying parent driver demographic and socioeconomic characteristics associated with the use of sub-optimal restraints for child passengers less than nine years, with emphasis on use of seat belts compared to booster sets for four to eight year old children. Winston and colleagues found suboptimal restraint (use of forward facing CSRS for infants under one or weighing under 20 pounds and any seat belt use for children under nine) most common among children under one and between the ages of four and eight compared to the age group one to three years (Winston et al., 2006). The groups of children less than nine years involved in subpar restraining methods have other risk factors including non-Hispanic black parent drivers, less educated parents, and lower family income (Winston et al., 2006). The highest sub-optimal restraint use was found in the following subgroups: children aged four to eight years, parent drivers 35 years of age and older, parent drivers with less than a high school education, and parent drivers with income below $20,000, or between $39,999 and $40,000 (Winston et al., 2006). Barbara Medoff-Cooper and Lorraine Tulman conducted two focus groups of structured interviews of eight mothers, (one of African American and Latina women and one of white women) to determine car seat use among mothers of children aged three to seven years (Medoff-Cooper & Tulman, 2007). The study group lived near a mid-Atlantic city, had an income of greater than $20,000, and had a high school education (Medoff-Cooper, & Tulman, 2007). All participants associated restraint use with protection from injury and most reported using car seats for their own children (Medoff-Cooper & Tulman, 2007). In addition, the

African American and Latina women reported less frequent use of CSRS than white women, especially with older children in the age group (Medoff-Cooper & Tulman, 2007). This group also experienced more resistance from their children being placed and remaining in their CSRS (Medoff-Cooper & Tulman, 2007).

Driver gender and alcohol use

Voas, Fisher and Trippetts (2002) examined whether differences in two risk factors for crash related injury for children, riding with riding with a drinking driver and failure to use restraints, are related to various driver characteristics such as age, gender, ethnicity and drinking. The analysis of the fatally injured showed women are more likely driving with accompanied children (Voas et al., 2002). However, women with children were most likely to be restrained compared to children traveling with men (Voas et al., 2002). Drivers under the influence of alcohol were less likely to be traveling with children, but if they had children present in the vehicle, they would most likely be unrestrained (Voas et al., 2002).

A large study conducted in Wisconsin found that 2.5% (n=570) of MVCs involving child passengers were a direct result of alcohol (Schlotthauer et al., 2011). Of those alcohol-related crashes, 37.2% (n=212) were passengers in the alcohol related vehicle as well as 10.7% (n=2,400) child passengers injured (Schlotthauer et al., 2011). Of these, 5.9% (n=142) were involved in an alcohol related crash. Inappropriate restraint was more than two times higher in alcohol-related vehicles (34.5%) than in non-alcohol related vehicles (17.1%) (Schlotthauer et al., 2011. Appropriate restraint use varies by age. Those aged four to seven had the highest proportion of inappropriate restraint, as

45.1% were involved in any crash were not appropriately restrained (Schlotthauer et al., 2011). Children in alcohol-related vehicles who were inappropriately restrained had higher proportions of injuries (39.7%) than inappropriately restrained children in non-alcohol-related vehicles in alcohol related crashes (28.1%) and non-alcohol-related crashes (15.7%) (Schlotthauer et al., 2011). A recent study showed that alcohol continues to play a role in child passenger deaths effecting one in five children (Quinlan, Shults, & Rudd, 2014). With little, if any progress in this area, targeted educational and policy efforts can have a substantial impact in the safety and wellbeing of children.

Vehicle Type

According to the NHTSA passenger vehicles make up 90 percent of registered vehicles on the road (NHSTA, 2013). A passenger vehicle is classified as a vehicle weighing less than 10,000 pounds (NHSTA, 2013). Vehicles included in this classification include pickup trucks, vans, SUVs, and other light trucks (NHSTA, 2013). In 2011, passenger vehicles accounted for 96 percent of MVCs reported by law enforcement, (NHSTA, 2013). Of the total number of MVC, roughly five percent resulted in a fatality with almost 4 percent involving a passenger vehicle with a greater percentage of those fatalities occurred in larger vehicle types (i.e. sports utility vehicles (SUV)) (NHSTA, 2013).

It was also noted that when a light truck and another passenger vehicle were involved in a MVC, especially if one vehicle was struck in the side by the front of the other vehicle, the crash was more likely to result in a fatality (NHSTA, 2013). In a study comparing minivans with midsize and large SUVs, Kallan and colleagues found that once a MVC occurred, minivans were more likely to protect child passengers from suffering a non-fatal injury than those children who were passengers in an SUV (Kallan, Arbogast, Elliot, & Durbin, 2009). They also found that SUVs tended to have a higher risk of rolling over in a crash, thus significantly increasing the overall risk of children dying, confirming the results of previous conducted research (Kallan, et al., 2009; Kallan, Arbogast, & Durbin, 2006; Rivara, Cummings, & Mock, 2003). This has become more problematic as families choose to purchase SUVs over the safer minivan (Kallan, et al., 2009). While there is research to support that vehicle type may directly affect child passenger related injuries and death, there is no known study that evaluates vehicle type relationship and the effects of child passenger safety legislation.

Summary

The studies presented in this literature review suggested a strong positive relationship between properly restrained children in CSRSs or safety belts having less serious injuries than children that are unrestrained or improperly restrained in MVCs. The literature established the relationship between motor vehicle crashes involving children legislation, health behavior response to legislative regulations, costs, safety seat use, proper use, seating positions in motor vehicles, premature graduation, time of day, misuse, driver demographics impact on child restraint use, and vehicle type. This chapter also described in detail the conceptual model used for the basis of this dissertation as well as search strategies used for literature review.

Despite laws, children continue to be placed in harm's way by parents or caregivers by not being restrained, or improperly placed in an age-appropriate restraint contributing to morbidity and mortality and established the need for additional research. Understanding variables that predict driver non-compliance of legislation can assist injury prevention and safety advocates in developing evidenced-based strategies to create or support injury prevention interventions, thus potentially decreasing the risk of injury and death of children being transported in motor vehicles. Specifically, no known study utilizing Connecticut's crash records has been performed to evaluate its legislative effects on Connecticut's children's injuries and death. This study sought seeks to fulfill that void in the literature, by evaluating the impact of Connecticut's child passenger safety law on the usage of age appropriate child safety seats.

The next chapter presents detailed information on the methods used in the study. This includes presentation of the research questions and null and alternative hypotheses, independent and dependent variables, data source and database description. Chapter 3 also discusses the research design and the explanation of the statistical tests and analytic methods.

Chapter 3: Methodology

Introduction

This section outlines a methodological approach to utilizing an electronic database for the purpose of determining the effectiveness of Connecticut General Statutes § 14-100a specifically Public Act 05-58, which went into effect October 1, 2005. In an effort to determine the effectiveness of this legislation, the study evaluated: (a) the number of children ages 6 years or younger reported in a child safety seat following a MVC before and after implementation of Connecticut General Statutes §14-100a, (b) which, if any, set of demographic variables (including driver and occupant age, driver and occupant gender, driver drug or alcohol use, driver and occupant restraint use, vehicle type or time of day) best predicted (alone or in tandem) the use of CSRS for motor vehicle occupants age 6 and younger, and (c) which, if any, of the above demographic variables predicted early transition to a seat belt.

The decision to utilize an electronic database in this study was based on the availability to access Connecticut's Uniform Police Accident Report electronic crash repository database, also known as Connecticut Crash Data Repository (CTCDR), as well as my expertise in child passenger safety and injury prevention interventions. This study evaluated the extent to which the law influences restraint use for children as well as explored which factors influence the use of restraints for children after the law was changed. Chapter 3 also outlines the components of the methodological approach including study design, research hypotheses, and data analysis.

Study Design

A descriptive, cross-sectional, retrospective, quantitative study was conducted utilizing the CTCDR. The CTCDR was established in the fall of 2011 and officially launched on April 29, 2013(E. Jackson, personal communications, July 1, 2014). The CTCDR contains roughly 1,531,458 motor vehicle crash records for the State of Connecticut from 1994-2012 with 575 registered users (E. Jackson, personal communications, July 1, 2014).

The study design for research question one explored the prevalence of child restraint use five years before and five years after the law's implementation. The analysis was a simple calculation of the number of children involved in a MVC six years of age and younger that were in a CSRS pre as compared to post implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005.

For research question two, a quantitative research design was conducted for this study as the aim was to determine the relationship between the following independent variables: Connecticut General Statutes §14-100a and driver age, driver sex, driver alcohol or drug use, occupant age, seating position of all vehicle occupants, time of day of crash, vehicle type, and their relationship to child occupant restraint use (dependent variable). For research question three, a quantitative research design was conducted for this study as the aim is to determine the relationship between the following independent variables: Connecticut General Statutes §14-100a and driver age, driver sex, driver alcohol or drug use, occupant age, seating position of all vehicle occupants, time of day of crash, vehicle type, and their relationship to seatbelt use of children six years of age or younger (dependent variable), who by Connecticut law should be in a CSRS. This quantitative analysis of existing data identified the factors influencing the use and misuse of CSRS of Connecticut's children ages six years or less, thus offering assistance to safety and legislative advocates and public health officials to implement evidenced-based injury prevention interventions to address this public health issue. All variables were treated as categorical variables and where possible were recoded into aggregate categories.

A quantitative method was chosen over a qualitative method as variables selected are quantitative in nature such as age and time of day of MVC. The research study was limited to automobiles that are equipped with a safety belt and not suited to transport more than eight individuals (passenger vehicles, SUVs, light weight trucks and minivans). The entire population of interest was analyzed.

The research design for this study was descriptive since "no attempt was made to change behaviors and the measurement will consist of things as they are" (Hopkins, 2000). This study was cross-sectional because one of the purposes of this study was to examine the differences in car seat use among children age six years and younger. By implementing a cross-sectional design, a subset of the population was examined to determine whether there are differences in restraint use at one point in time for all the independent variables.

The prevalence of child passenger restraint use in the CTCDR was computer generated, and subsequently compared pre legislation to post legislation to determine if Connecticut's law had any influence on the behaviors of drivers to place children six years of age or less in a child restraint. This type of design allowed for the quantitative or numerical assignment of values to the independent and dependent variables in order to determine whether there were differences or relationships between the variables. Subsequently, the results for this study were assessed by using one or several statistical analysis measures.

Methods

A retrospective analysis was conducted using the data set of Connecticut's Uniform Police Accident Reports, available through the CTCDR, of all MVCs (fatal and non-fatal). The inclusion criteria were children six years of age and younger who were involved in a MVC, regardless of injury severity or death. The time period of January, 2000 to December, 2010 was studied to allow for adequate evaluation of the five years pre-regulation and five years after implementation of Connecticut's Law Chapter 246 Motor Vehicles- section 14-100a. Public Act No. 05-58, "*AN ACT CONCERNING CHILD RESTRAINT SYSTEMS*" that went into effect October 1, 2005.

In order to effectively evaluate Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005, motor vehicle crashes involving children six years and younger five years prior to the implementation of and five years after implementation was chosen for data analysis. The data used for this study was obtained from the Connecticut Crash Data Repository (CCDR) which is housed in the CTSRC located at the UCONN School of Engineering in Storrs, Connecticut.

Target Population, Setting, and Sample

The target population for this project was motor vehicle occupants, six years of age or younger, who were involved in a MVC. This age range was selected due to the fact that Connecticut's CPS law focuses on this age range. Participants were identified through querying the CTCDR. Sample size and power analyses were calculated using the Raosoft sample size calculator (Raosoft, 2014). A standard significance alpha probability level of 0.05, the standard confidence level of 0.9 and the standard population size of 20,000 was used (given that my *N* was unknown at this time). The minimal sample recommended sample size was 267.

Inclusion and Exclusion Criteria

Inclusion criteria consisted of child occupants age 6 years or younger who were involved in a MVC from 2000-2010 with at least one injury in the vehicle regardless of whether or not the child occupant was injured. All 2005 data was excluded due to the fact that the law went into effect on October 1, 2005 and includes both pre and post legislation data and not reflective of a true change in behavior. Connecticut is fairly unique in that they code restraint use, age, and injury level for all occupants while most states only include data for those injured in the crash (N. Chaudhary, personal communications, 2014). Exclusion criteria included any vehicle occupant greater than 6 years and one day of age, and women pregnant with fetuses of any gestational age whether or not the MVC resulted in emergent delivery of the fetus/child. For the purpose of this study, fetuses not yet born were not considered children and thus not included. Due to the large number of potential subjects for this study, only one child occupant per vehicle involved in the MVC was included in the study. All other multiple child occupants were excluded from the study. The selection was conducted through random choice of the child occupant to avoid any potential biases and the potential to only include a certain age group. According to the Connecticut Department of Transportation Investigator's Guide for Completing the Uniform Police Accident Report Form (1994), there was no required standard for the law enforcement officials to determine and report the order in which a child occupant should be listed on the Uniform Police Accident Report Form, also known as the PR-1(CTDOT, 1994). Thus, selected from the database, the first child occupant listed per vehicle involved in an MVC had the potential to include or eliminate a specific age group, especially if the reports were generated from the same law official or same agency. For example if Officer A always listed the oldest child first, there was the potential for bias and possibly having a higher number of older children in the study and missing the opportunity to evaluate if younger children were transitioned to a seat belt sooner than required by Connecticut law. Due to the fact that the primary dependent variable was the use of restraints, also excluded in this study were any pedestrian or cyclists that may have been struck while outside the vehicle at the time of the MVC, occupant of school buses, motorized caravans, motorcycles or any older make vehicle (e.g. Model-T Ford) that did not have factory manufactured vehicle seatbelts or the ability to secure a CSRS.

Instrumentation and Database

The CTCDR was queried for all available data beginning midnight January 1, 2000 ending midnight December 31, 2010. Data were analyzed with the elimination of all of 2005 data. The 2005 data was excluded due to the fact the law went into effect on October 1, 2005, considering this year included both pre and post law change data, thus considering this a transition year. This timeframe was chosen to allow for sufficient data analysis five years pre-regulation and five years post implementation of Connecticut General Statutes §14-100a.

From January 1, 2000 to December 31, 2010, the timeframe that was used for this study, there were 815,089 MVCs (Table 1) of which roughly 67,797 (14.6%) involved a child six years of age or less involving a total of 89,966 children (E. Jackson, personal communications, July 1, 2014). All personal information in the crash data was removed from the database to protect the identity of those involved (E. Jackson, personal communications, July 1, 2014).

Table 1

Connecticut MVCs That Resulted in Injuries or Fatalities From 2000–2010

	Severity of Crashes		
Year	**Fatality**	**Injury (No fatality)**	**Total**
2000	319	34,447	82,777
2001	290	34,127	83,249
2002	301	31,633	78,673
2003	277	30,947	80,855
2004	280	30,859	81,726
2005	262	29,428	79,532
2006	293	27,366	71,723
2007	269	28,507	113,062
2008	280	26,066	104,187
2009	214	25,737	103,710
2010	299	25,391	101,621
Total			815,089

** Data received from personal communications with Dr. Eric Jackson, Director, Connecticut Transportation Safety Research Center, Connecticut Transportation Institute, UCONN

The CTCDR designed at the University of Connecticut (UCONN) compiles data from agencies in Connecticut that capture police accident report data (CTCDR, 2014 Figure 2 details the CTCDR data flow.

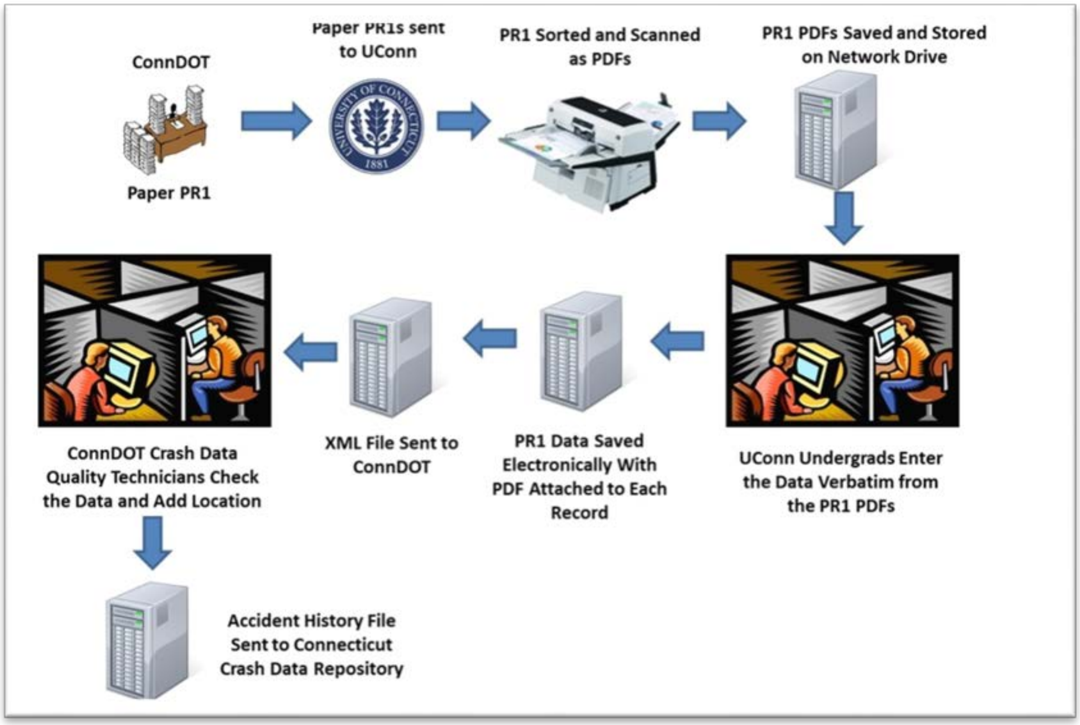

Figure 2. Flowchart of PR-1 data entry into Connecticut Crash Repository Reprinted with permission from Dr. Eric Jackson, Director, Connecticut Transportation Safety Research Center, Connecticut Transportation Institute, UCONN.

The repository provides users on-line access to these data captured from the police accident report, also known as the PR-1 form (Appendix B), along with analysis tools (CTCDR, 2014). The CTCDR is housed in the Connecticut Transportation Safety Research Center (CTSRC) located in the UCONN School of Engineering (CTCDR, 2014). The CTCDR is a web-based tool designed to select crash information collected by state and local police (CTCDR, 2014).

The CTCDR at UCONN School of Engineer's CTSRC houses the electronic police crash records for the State of Connecticut that was used for this study. The CTCDR site runs on three virtual machines. (1) IIS Server (web server)-This virtual machine hosts the web server that is responsible for dispatching web requests to the CTCDR to the JBoss Server. The web server software currently employed is Microsoft Internet Information Services (IIS 6.0) 4, which can be controlled through the IIS Manager application. (2) JBoss Server- This virtual machine hosts the application server that executes the CTCDR application. The web server software currently employed is the JBoss Enterprise Application Platform 4.3.05. (3) MSSQL Server- This virtual machine hosts the CTCDR database. The web server software currently employed is Microsoft SQL Server 2008R as database management system. Important applications for the configuration of the database are the SQL Server Management Studio and the SQL Surface Area Configuration Tool (E. Jackson, personal communication, July 1, 2014).

The CTCDR was set up to allow the general public access to basic crash summary reports without formal registration (E. Jackson, personal communications, July 1, 2014). Utilizing the crash summary tool, users can access what the CTSRC determined to be the most common requested information. Safety advocates, researchers or other high end users that require advance querying of the database need to register on-line and request a formal login user identification and password. Once the request has been granted, the user may access the advanced user data query tool and begin queries tailored to personal preferences and needs. The link to access the dataset and register for a formal login user identification and password can be accessed at http://www.ctcrash.uconn.edu/.

Permission for advance query of the database access was requested and a user name and login was granted.

The CTDOT receives more than 5,000 paper and electronic crash reports each month, containing MVC information such as crash date, crash time, crash severity, location of crash town and street, collision type, driver sex, driver age, whether the crash was alcohol or drug related, injury class (fatal, incapacitating injury that prevents return to normal activity, non-incapacitating evident, possible injury, not injured), occupant seating position, passenger age, protection system used (none, shoulder belt only, lap belt only, should and lap belt, child safety seat, restraint use unknown), airbag status (deployed, not deployed, not applicable, unknown) and ejection status (E. Jackson, personal communications, July 1, 2014). The CTCDR is a query system that allows access to Connecticut's crash data. The structure of the database as a relational database where there is a crash record linked to 1 to N vehicles and each vehicle linked to 1 to *n* people plus data on non-occupants (pedestrians, bikes) linked to the crash. This allows timely, accurate, complete and uniform crash data that can subsequently assist safety advocates, public health and government officials in making more informed policy decisions.

Variables

For research question one the dependent variable was the prevalence of CSRS use after implementation of Connecticut General Statutes § 14-100a. For research question two the independent variables included Connecticut General Statutes §14-100a , driver age, driver sex, driver alcohol or drug use, and age, seating position of all vehicle occupants, time of day of crash, vehicle type, and their relationship to the dependent variable of child occupant restraint use. The independent variables, operational definitions and coding were outlined in Table 2. For research question three, the independent variables included Connecticut General Statutes §14-100a , driver age, driver sex, driver alcohol or drug use, occupant sex and age, seating position of all vehicle occupants, time of day of crash, vehicle type. The dependent variable of seatbelt use for children ages six and younger was explored to determine the relationship that exists to the aforementioned independent variables. Each MVC had a specific case number which was defined as the identification number that allowed this users access crash information of individual vehicles involved in the same crash. The independent and dependent variables that were used for this study are located in Table 2.

Table 2

Dependent and Independent Variables

Variable	**Definition**	**Coding/ Operational Definition**	**Recoding**
Crash Time Independent Variable	Time of day that crash is	Available in 24 hour military time and was not recoded	Was recoded to 6:00am-4:00pm as Day Time 4:01pm-10:00pm as Evening Time 10:01pm-5:59am as Nighttime
Crash Severity Independent Variable	The severity of the crash	Was available as: 1- fatal 2- injured 3- property damage only	Was recoded to include only fatal and injured. Property damage only will not be addressed in this study and therefore excluded. Reports were run separately for injuries and fatal crashes
Driver Sex Independent Variable	Gender of the driver of the vehicle involved in an MVC	1-male 2-female 3-unknown	Was not be recoded
Vehicle Type Independent Variable	Type of vehicle involved in crash with children ages six years or younger	Was available as: 02-Automobile 03-motorcycle 04-moped-motor scooter 05-pedalcycle 06-taxi 07-train	Was recoded to include only automobiles that carry less than eight passengers and will exclude all other categories

(table continues)

		08-emergency vehicle 09-school bus 10-commercial bus 11-motorhome/camper 12-off road vehicle 13- Passenger Van(greater than eight passengers) 14-single unit truck (2-Axle, 4-tire) 15-single unit truck (2-Axle, 6-tire) 16-single unit truck (3 or more Axles) 17-Car-Trailer combination 18- Truck-Trailer Combination 19- Truck Tractor Only 20-Tractor Semi-Trailers 21- Tractor Double Trailers 22-Tractor Triple Trailers 23- Heavy Vehicle (Unclassifiable) 24-Construction/Farm Equipment	The database does not allow for further breakdown of automobile type, therefore for the purposes for this study, automobiles encompasses, passenger cars, light weight pick-up trucks, SUVs and minivans.
Driver Age Independent Variable	Age of the driver of the vehicle that the child six years or younger was an occupant in	Was available in full years increments (e.g. 0, 1, 2, 3, etc.), Less than 12 mos.=0 12 mos. and 1 day but less than 24 mos.=1year 24 mos. and 1 day but less than 36 mos.=2yrs 36 mos. and 1 day but less than 48 mos.=3yrs 48 mos. and 1 day but less than 60 mos.=4 years, etc. up to 110 years	Was recoded into 4 categories 1) 0 years to 21 year olds including 21year olds) 2) 22-35 years 3) 36-54 years 4) 55 years of age and greater
Drug or Alcohol Related Independent Variable	Driver of the vehicle that the child six years or younger was an occupant in impaired status	Was available as: 0-none 1-had been drinking; level less than 0.08 2-intoxicated; drinking level more than 0.08 3-had taken drugs 4-had been drinking and taking drugs 5- intoxicated and had taken drugs	Was recoded to yes or no Yes=any positive result No=zero level
Occupant Age Independent Variable	Child passenger occupant age in years	Was available in full years increments (e.g. 0, 1, 2, 3, etc.), Less than 12 mos.=0 12 mos. and 1 day but less than 24 mos.=1 year 24 mos. and 1 day but less than 36 mos.=2 years 36 mos. and 1 day but less than 48 mos.=3 years 48 mos. and 1 day but less than 60 mos.=4 years, etc. up to 110 years	Was recoded to: Infant=0 years Toddler= 1-3 years School age= 4-6 years
Seating Position Independent Variable	Location in the vehicle for all occupants	01-Front seat left/motorcycle driver 02-Front seat Middle 03-front seat right 04-second seat left 05-second seat middle 06-second seat right	Was recoded to front seat versus back seat and unknown. Further recoding for front versus back seat was as follows:

(table continues)

		07-third row behind driver 08-third row behind front seat middle 09-third row right 10-sleeper section cab (truck) 11-Enclosed passenger or cargo area 12-unenclosed passenger or cargo area 13-traing unit 14-riding on vehicle exterior 15-unknown	Front seat= 01, 02, 03 Back seat=04, 05, 06,07,08,09 Unknown= was excluded from the analysis. Excluded children in cargo area or any location not possible to secure a child restraint
Occupant Protection system used (dependent variable)	Safety equipment in use at the time of the crash	1-none used-vehicle occupant 2-shoulder belt only 3-lap belt only 4-shoulder and lap belt 5-child safety seat 6-helmet/high visibility clothing 7-helmet/no high visibility clothing 8-no helmet/high visibility clothing 9-restraint use unknown	Dependent variable was recoded to yes versus no Yes= use of a child safety seat No=nonuse of a child safety seat The No responses were further recoded N1-none used-vehicle occupant N2-shoulder belt only N3-lap belt only N4-shoulder and lap belt

** Note all data are just for children six years of age and younger involved in MVCs

Data Analysis

After obtaining Institutional Review Board (IRB) approval from Walden University IRB, approval number 11-24-14-0048126, the crash records from an existing electronic database were analyzed for this study. From 2002-2012 there were roughly 988,976 MVC that occurred on Connecticut roadways. Of these, 67,700 MVCs involved a child age six or less. All MVCs involving children six years of age and younger were analyzed. It was possible that some of the children originate from the same vehicle and/or same crash thus, resulted in fewer crashes than child occupants. For those MVCs that had more than one child occupant that met the inclusion criteria (six years of age or younger), only one occupant from that MVC was used in the data analysis. In order to be consistent in the selection, a random selection of the child occupant listed on the data pull was included in the data analysis. For example, vehicle one has three child occupants listed as

Child A, Child B, and Child C. Child A's data might been the one included in the analysis for the first vehicle listed and Child B might have been the one included for the second vehicle listed and so forth.

The sample characteristics were described using standard frequency analysis. All analyses were performed using SAS software, version 9.2 (SAS institute, Cary, NC) and SPSS v19.0 (IBM Corporation). For research question one, the analysis consisted of binary logistic regression examining the proportion of those children ages six and under that were in a CSRS before and after the law change. Specifically a "dummy" variable was used that identified whether the crash occurred during the pre-period or the post period and the analysis examined the prevalence of CSRS use before and after the law (i.e., the question does the pre/post law variable significantly predict dichotomous rate of car seat use was answered). The analysis included year as a covariate to control for any pre-existing trends. Data from 2005 was excluded since the law was enacted on October 1, 2005 and that year would include both pre and post law data and thus not reflective of a true change in behavior.

For research question two and three, a logistic backwards stepwise regression model was performed. This semi-automated process consisted of deleting variables based solely on the t-statistics of their coefficients to build a model (SAS Institute Inc., 1989). As recommended, the regression coefficients are usually estimated using maximum likelihood estimation (SAS Institute Inc., 1989). The backwards elimination involved "starting with all candidate variables, testing the deletion of each variable using a chosen model comparison criterion, deleting the variable (if any) that improved the model the most by being deleted, and this process was repeated until no further improvement was possible" (SAS Institute Inc., 1989). Both SPSS and SAS analysis programs assisted the researcher to determine the best fit model that predicted restraint use by running a backwards stepwise logistic regression. The final product was a model that best predicted proper restraint use given all the variables in Table 2. The variables were treated as categorical and where possible were recoded into aggregate categories as described in table 2 whenever possible. For example: restrained versus not restrained; child safety seat versus no child safety seat; proper use versus not proper use, etc.). The operational definition for proper use was in concert with Connecticut General Statutes § 14-100a, specifically Public Act 05-58, where any child six years of age or less should be restrained in a CSRS while traveling in a motor vehicle. For children restrained with a seatbelt that by law should have been in a CSRS were considered not properly restrained and determined to have been prematurely transitioned. All other codes/operational definitions of variables are located in Table 2. Data with missing variables (e.g. unknown sex, age, etc.) was excluded from the analyses. There was no cleaning and screening procedure done by this researcher. This was an existing dataset that has been cleaned and tested by Connecticut Department of Transportation Highway Safety Office (HSO) prior to being made available for public use. The HSO has a standardized internal process and conducts system checks and balances. If any errors or discrepancies were identified, they would have been rectified either by the HSO (for roadway locations) or with the reporting law enforcement official prior to the data being released to the dataset.

Research Questions

The research questions and hypotheses examined in this study were based on the literature of unintentional injury, impact of health behavior laws (legislative behavioral response), and car safety seat use/misuse rates.

Research Question 1: Is there a difference in the prevalence of CSRS use of children ages 6 years and younger who have been involved in a MVC before and after implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005?

Null Hypothesis 1: There is no difference in the prevalence of CSRS use among children ages 6 years and younger who have been involved in a MVC before and after implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005.

Alternative Hypothesis 1: There will be an increase in the prevalence of CSRS use among children ages 6 years and younger who have been involved in a MVC before and after implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005.

Research Question 2: Which variables best predict the use of CSRS for children ages 6 years and younger who are occupants in a motor vehicle that was involved in a MVC crash?

Null Hypothesis 2: Driver age, driver sex, driver drug and/or alcohol use, driver restraint use, time of day of MVC, and vehicle type do not predict the use of CSRS for children ages 6 years and younger who are occupants in a motor vehicle that was involved in a MVC.

Alternative Hypothesis 2: Some combination of driver age, gender, drug and/or alcohol use, restraint use, time of day of MVC, and vehicle type best predicts the use of CSRS for children ages 6 years and younger who are occupants in a motor vehicle that was involved in a MVC.

Research Question 3: Which variables best predict early transition from a CSRS to a seat belt?

Null Hypothesis 3: Driver age, gender, drug and/or alcohol use, restraint use, time of day of MVC, and vehicle type are not predictors of early transition from a CSRS to a seat belt.

Alternative Hypothesis 3: Some combination of driver age, gender, drug and/or alcohol use, restraint use, time of day of MVC, and vehicle type best predicts early transition from a CSRS to a seat belt.

Limitations to the Study

A limitation to this study was that it may not be generalizable to the general public and may only apply to those individuals more likely to be involved in MVCs. That is, this sample was not randomly selected but limited to those occupants involved in MVCs potentially affecting the external validity of the study. That said, this population was the most important in terms of understanding predictors of restraint use. Another limitation was that data was pulled from one electronic database that was dependent on the accuracy of the MVC documentation of law enforcement officials and data entering of reports from CTDOT personnel. The threat to internal validity was thought to be minimal since the anonymity of subjects was maintained as well as only one subject from each MVC was included in the data analysis. This was done to eliminate the potential for multiple child occupants in the same vehicle with different adaptation to Connecticut state law.

Ethical Protection and Concerns

Prior to conducting the study, the researcher applied and obtained IRB approval number 11-24-14-0048126 from Walden University. The CTCDR was created in the fall of 2011 and officially launched on April 29, 2013 and only contains de-identified information and only allows for querying of de-identified information. All personal information in the CTCDR has been removed to protect the identity of those involved. To gain advance access to the CTCDR users need to register on the welcome page. After clicking on the “register” button, users are prompted to provide their contact information and set their own login and password. Once the user has registered and a password obtained, they were able to login to the CTCDR and immediately begin to use the query tool. The electronic database entries are coded numerically, de-identified by information systems personnel, and assigned a crash ID and case number according to crash date and time before the researcher takes possession of the data. The database entries of the PR-1 are devoid of driver’s name, address, birth date, and licensure information; passenger’s name, address, and birthdate and therefore not available to anyone querying the database. No verbal or physical interaction took place between the researcher and individuals in the database, therefore physical or emotional safety were not an ethical concern. All data were maintained on a secured password protected laptop computer that only the researcher has access to. Data were maintained in accordance with Walden University's IRB approval number 11-24-14-0048126 requirements of five years. After the required waiting period, all data related to this study will be destroyed by the researcher, according to Walden University informational technology protocols.

Summary

Police accident record data from an existing electronic record database of approximately 815,089 motor vehicle crashes of which 67,797 (14.6%) involved a child age six years or less involving a total of 89,966 children was used for this study. The data was compared for the number of children ages six years or younger reported in a child safety seat pre-implementation as to post -implementation of CGS § 14-100a, specifically Public Act 05-58 that went into effect 2005. A test was conducted to evaluate for existing trends prior to finalizing the details of analysis using Chi-Square to compare the prevalence of restraint use between each of the years being included in the study prior to 2005. This was done to determine if there are existing trends or an increase in use of restraints before the law changed followed by a stepwise backwards logistic regression to analyze whether any of the described variables) best predict the use and proper use of CSRS for children ages six years of age and younger who are occupants in a motor vehicle. Dissemination of the results of this study will provide safety advocates, legislators, injury prevention specialists, caregivers and medical personnel the knowledge about this public health issue and may support the development of more programs or result in changes to legislation that will ultimately improve the safety and well-being of children ages six years or younger. Chapter 3 describes in detail the study methods. This discussion includes presentation of the introduction to the study, study design, instrumentation and procedure for recruitment (sampling), independent and dependent variables, research questions, research design and approach, methods, target population/setting/sampling, ethical protection, data analysis and a summary. The query data and data analysis are presented in Chapter 4. Findings and potential implications for policy and practice changes will be presented in Chapter 5.

Chapter 4: Results

Introduction

The purpose of this study was to evaluate the effectiveness of Connecticut's CPS law that was strengthened in 2005. The three research questions sought to be answered by conducting this study were: (1) Is there an association in the prevalence of CSRS use in children ages six years of age and younger who have been involved in a MVC pre as compared to post implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005? (2) Which variables best predict the use of CSRS for children ages six years of age and younger who are occupants in a motor vehicle that was involved in a MVC crash? and, (3) Which variables best predict early transition from a CSRS to a seat belt (i.e. lap/shoulder belt)?

This chapter describes in detail the following sections: Introduction, Data Collection, Results, and Summary. The study was conducted utilizing data from the Connecticut Crash Data Repository (CTCDR). The CTCDR was established in the fall of 2011 and officially launched on April 29, 2013 (E. Jackson, personal communications, July 1, 2014). The CTCDR contains roughly 1,531,458 MVC records for the State of Connecticut from 1994-2012 (E. Jackson, personal communications, July 1, 2014). To date, there are no known studies that have used this database for purposes of evaluating Connecticut CPS legislation.

Data Collection

The CTCDR was queried for all motor vehicle crashes that involved child occupants age six years or younger who were involved in a MVC with at least one occupant injury (i.e., not including a pedestrian or bicyclist being the only injury) in the crash, regardless of whether or not a child occupant was injured. The timeframe queried was from January 1, 2000 to December 31, 2010 to include data five years pre and five years post-implementation of Connecticut's CPS legislation that was upgraded in 2005. There were a total of 36,737 MVC records (including 153 records from fatal crashes) identified to use for this analysis (an additional 54,909 records were excluded because there were no injuries reported in the MVC). Police reporting of restraint use was less accurate for non-injury crashes (as there is minimal investigation) thus the dataset was limited to injury only crashes (E. Jackson, personal communications, December 17, 2014). An *a priori* decision was made to randomly select only one child passenger to be included in the analyses from each vehicle in the dataset that had more than one child occupant to remove some potential biases. For instance, car seat position based on the number of other children in the vehicle and the ages of individuals, who might have more than one child in the vehicle might impact restraint use in a manner that could not be properly examined in this study. Also, in cases of multiple child occupants, the characteristics of the driver used to create variables would be counted multiple times (repeated for each additional child in the car), perhaps exaggerating their influence. This might not have been a problem if people with those characteristics were equally likely to have multiple children, but there may be some characteristics (e.g., age and sex of driver) that might be more highly associated with having multiple children in the vehicle.

Once the full dataset was compiled, a random number was assigned to each line of data (representing a single child occupant in a MVC). The data were then collapsed across multiple instances of a specific vehicle (calculating the number of children under age seven). For cases stemming from the same vehicle all data would be identical except for those pertaining to the child occupant. Data from the child with the largest random number were kept. This resulted in the final dataset containing 21,663 records. Seat belt/child restraint use data were missing for 1,425(6.6%) of the child occupants, resulting in 20,238 with valid data, representing the records in the final dataset used for this study. All analyses were conducted using SPSS version 19 (IBM Corp).

The data distribution across years included a total of 12,230 children pre legislation and 9,433 children post legislation MVC records (21,663 total records) (Table 3). The distribution was fairly equal across all age groups (Table 4). These numbers exclude the 2,111 (107 with missing seat belt/CSRS use) from 2005, the year legislation went into effect and as described in the study design. For the years included in the analyses, 69.7 percent (14,116, not including the 1398 from 2005) were restrained in car seats (Table 5).

Table 3

Motor Vehicle Crash Report Case Distribution by Year

Year	N	Total Percent (%)	N Pre/Post Law
2000	2,706	11.4	
2001	2,572	10.8	
2002	2,465	10.4	Total Counts Pre Law
2003	2,206	9.3	12,230
2004	2,281	9.6	
2005*	2,111	8.9	2,111
2006	1,942	8.2	
2007	1,892	8.0	
2008	1,723	7.2	Total Counts Post Law
2009	1,995	8.4	9,433
2010	1,881	7.9	
Total	2,3774	100.0	

*2005 data is the law transition year; these data were not included in the analyses.

Table 4

*Child Age Distribution**

	Age	Frequency	Percent
Pre Law	Less than 1 year	1,558	12.7
	1year	1,826	14.9
	2 year	1,911	15.6
	3 year	1,794	14.7
	4 year	1,814	14.8
	5 year	1,662	13.6
	6 year	1,665	13.6
	Total	12,230	100.0
Post Law	Less than 1 year	1,355	14.4
	1 year	1,506	16.0
	2 year	1,414	15.0
	3 year	1,378	14.6
	4 year	1,346	14.3
	5 year	1,250	13.3
	6 year	1,184	12.6
	Total	9,433	100.0

*Excludes 2005 data

Table 5

*Restraint Use Distribution by Year***

Year	Child Safety Seat	EARLY TRANSITION Lap Belt Only	Shoulder and Lap Belt	Shoulder Belt Only	All Early Transition	None Used-Vehicle Occupant	Restraint Use Unknown*
2000	1,447	234	724	13	971	96	192
2001	1,407	162	688	15	865	73	227
2002	1,423	167	605	12	784	47	211
2003	1,340	123	539	9	671	46	149
2004	1,440	92	537	10	639	53	149
2005¥	1,398	60	511	6	577	29	107
2006	1,389	33	364	4	401	30	122
2007	1,434	33	311	5	349	23	86
2008	1,311	30	270	5	305	22	85
2009	1,490	29	331	8	368	34	103
2010	1,435	18	299	3	320	25	101
Total	15,514	981	5,179	90	6,250	478	1,532

* Unknown restraint use excluded from analyses
¥ Note: 2005 data was the law transition year; these data were not included in the analyses.
** Early transition and "none used" were coded as non-child safety seat use for Research Q 1

Discrepancies in Coding

There were a few discrepancies in the coding of variables used in the analysis from the plan presented in Chapter 3. Pre and post legislation (General State Statute § 14-100a, specifically Public Act 05-58 that went into effect in 2005) data were only used to answer research question one. It was excluded for questions two and three because the data analyzed only included the 2006-2010 data, the years after the law went into effect. That is, research Questions 2 and 3 examined only post-law data resulting in a single level of the variable. Alcohol/Drug use was not included as a variable because 99.4% of the records were recorded as "None-Indicated/Unknown." Since this was a single code, it could not be separated out further to determine which records differentiated the alcohol/drug variable in those drivers who did not use alcohol/drug, from those drivers for whom the law enforcement official did not determine use. Although the *N* for this variable was small, a cross tabulation showed that for the 50 drivers who were identified as positive for alcohol/drug use, proper CSRS use for the child was 64% compared to 79% for those who were not known to be positive ($\chi^2 = 6.7$, $p < 0.01$).

Vehicle Type was included as a variable; however, the PR-1 form used by law enforcement officials does not specify the individual type of passenger vehicle (i.e. SUV, van, or small truck). Therefore, the level of distinction was between passenger vehicle and commercial vehicles (i.e. bus, 18-Wheeler, large trucks, box trucks and motorcycles). The gender of the vehicle occupant was excluded from the analysis because it was only collected for the pre-law period and not collected for the post-law years for comparison (personal communications E. Jackson, December 17, 2014). That said, authors Braitman, Chaudhary & McCartt (2013) suggest that the sex of children is less important than the sex of the older occupants for studies related to motor vehicle crashes. Occupant age was included as defined in Table 2 in Chapter 3. Seat position was originally included as defined in Chapter 3, but later recoded to "front and back seat" since the *N*'s (716) of the 3rd row seat were relatively few (3%) but also, and perhaps more importantly, because of the potential confound of vehicle type created by breaking out the third row. That is, in every case the passengers seated in a third row would have been in an SUV or van exclusively whereas second row seating could include a passenger car and pickup truck as well. Thus there were 1,247 children seated in the front row (pre law: 931; post law: 316) and 20,096 seated in the second and third rows (pre law: 11,114; post law: 8,982) combined. There were 320 records excluded from this analysis because the seating position was unknown or in a non-valid seating position (e.g. cargo area or driver seat) (pre law: 185; post law: 135) (Table 6).

Table 6

Vehicle Occupant Seating Position Distribution

Seating Position	N	Total Percent (%)
Enclosed Passenger or Cargo Area*	12	0.1
Front Seat/Driver*	11	0.1
Front Seat Middle	83	0.4
Front Seat Right	1,164	5.4
Second Seat Left/ Behind Driver	6,443	29.7
Second Seat Middle	3,834	17.7
Second Seat Right	9,103	42.0
Third Row Left/Behind Driver	288	1.3
Third Row Behind Front Seat Middle	128	0.6
Third Row Right	300	1.4
Unknown*	297	1.4
Total	21,663	100.0

*Data excluded from the analysis

Driver age was included as defined in Table 2 in Chapter 3. Driver sex was included as previously described in Chapter 3 and any unknowns were excluded.

Lastly, time of day was included as defined in Table 2 of Chapter 3. The frequencies for the driver sex variable were 68% female drivers pre law and 68% female drivers post law versus 32% male drivers pre and 31% post law. For the driver age variable, pre law there were 9% in the <22 years , 54% in the 22-35 year, 32% in the 36-54 year and 4.5% in the 55+ years categories with post law frequencies of these age categories being quite similar. The frequencies for the time of day variable were 67% for the day time, 26% evening and 7% nighttime categories with post law frequencies of these age categories also being quite similar with 68% in the daytime, 26% in the evening time and 6% in the nighttime categories (Table 7).

Table 7

Driver Sex, Driver Age and Time of Crash Distribution

			N	Percent
Driver Sex	Pre Law	Female	8,298	67.8
		Male	3,890	31.8
		Missing/Unknown	42	0.3
	Post Law	Female	6,442	68.3
		Male	2,959	31.4
		Missing/Unknown	32	0.3
Driver Age	Pre Law	<22years	1,138	9.3
		22-35 years	6,585	53.8
		36-54 years	3,837	31.7
		55+ years	548	4.5
		Missing/Unknown	122	1.0
	Post Law	<22 years	775	8.2
		22-35 years	5,057	53.6
		36-54 years	3,076	32.6
		55+ years	449	4.8
		Missing/Unknown	76	0.8
Time	Pre Law	Morning 6AM to 4:59 PM	8,229	67.3
		Evening 5PM to 8:59PM	3,206	26.2
		Night 9PM to 5:59AM	795	6.5
	Post Law	Morning 6AM to 4:59 PM	6,423	68.1
		Evening 5PM to 8:59PM	2,411	25.6
		Night 9PM to 5:59AM	599	6.4

Results

This section details the specific analysis results for each individual research question and the acceptance or the rejection of the Null hypothesis.

Research Question 1

Is there an association in the prevalence of CSRS use in children ages six years of age and younger who have been involved in a MVC pre as compared to post implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005? Null Hypothesis: There is no difference in the prevalence of CSRS use in children ages six years of age and younger who have been involved in a MVC pre as compared to post implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005. Alternative Hypothesis: There will be an increase in the prevalence of CSRS use in children ages six years of age and younger who have been involved in a MVC pre as compared to post implementation of Connecticut General Statutes § 14-100a, specifically Public Act 05-58 that went into effect in 2005.

“Proper” use was defined as the child occupant being restrained in a child safety seat. All other codes (i.e., Lap Belt Only, None Used, Shoulder and Lap Belt, and Shoulder Belt Only) were considered non-proper use (see Table 5 for distribution). Another variable “Law” was defined as whether the crash occurred prior to when the law was implemented (pre: 2000-2004; N =12,230) or after the law was implemented (post: 2006-2010, N = 9,433) (Table 3). In order to control for any existing trends (e.g., pre-existing increase in use from year to year before the law was implemented) the variable “year” was also included as a covariate.

Proper Use (or “Use”) was entered into a binary logistic regression with year and the Law (pre/post) entered into the model. Use was considered a categorical variable while year was entered as a continuous variable so as to account for the “2-step” difference between 2004 and 2006 (making it a categorical variable would have made the “steps” between each level the same as any other level). Alpha was set at .05 to determine significance. Despite having clear predications regarding direction of the results, only 2-way probabilities were considered. This was felt to be more conservative and consistent with prior research in the field.

Table 8 depicts the binary logistic regression comparing CSRS use pre to post law. During the pre-legislation period, proper use was 62.4 percent, and it was 79.0 percent in the post-legislation period. The results indicate that even considering any impact of year, restraint use was 1.3 times more likely post-law implementation compared to pre-law (OR 0.75; 95% CI: 0.65-0.86). Indeed there was an overall effect of year as well (OR 1.1; 95% CI: 1.07-1.11). Figure 3 indicates restraint use for each year. The relationship between car seat use and year is such that as year increases, CSRS use increases.

Table 8

Binary Logistic Regression Comparing Child Safety Seat Use Pre to Post Law

					95% C.I.for Odds Ratio	
	χ^2	*p* value	Odds Ratio	B	Lower	Upper
Pre-post Law	15.841	.001	.746	-.294	.645	.862
Year	61.638	.001	1.090	.086	1.067	1.114
Constant	60.701	.001	.000	-171.712		

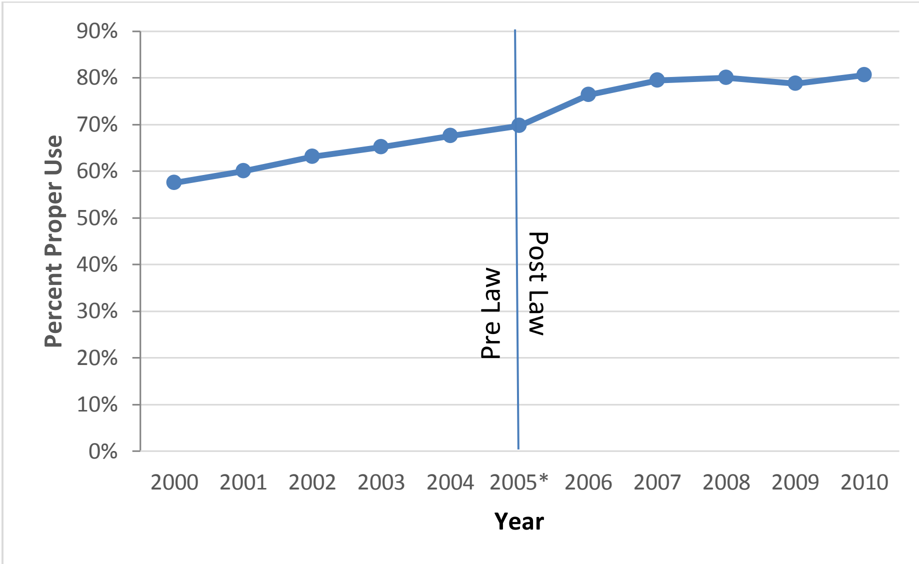

Figure 3. Child safety seat use rates by year (**-Excluded from analysis*)

Figure 3 illustrates that CSRS use was increasing approaching the 2005 implementation of the law. Following law implementation there was an apparent "bump-up" in the percentage of proper car seat use beyond what would have been expected by the trend prior to the law. The same analysis (removing age category of the child occupant) was run separately for each age category of child occupant to examine the effect of the law by individual age (Table 9).

Table 9

Binary Logistic Regression Restraint Use Pre versus Post Law by Age Category

Child Age Category		χ2	*p* value	Odds Ratio	B	95% C.I.for Odds Ratio Lower	Upper
Infant	Pre-post Law	.250	.617	1.208	.189	.575	2.536
	Year	.745	.388	1.051	.050	.939	1.177
	Constant	.703	.402	.000	-96.979		
Toddler	Pre-post Law	.153	.696	1.058	.056	.798	1.403
	Year	28.875	.000	1.120	.113	1.075	1.167
	Constant	28.331	.000	.000	-225.467		
School Age	Pre-post Law	13.937	.000	.666	-.407	.538	.824
	Year	77.454	.000	1.158	.147	1.121	1.197
	Constant	77.232	.000	.000	-294.819		

The results indicated the effect of CSRS was more robust for older children. Specifically, there was no significant difference from pre law to post law in CSRS use rates for children under the age of four. But children ages four, five and six (combined) had 1.5 times higher use in the post law period than the pre law period. Specifically, infants (< 1 yr. of age) showed no significant (*n.s.)* change from pre law (94.1%) to post law (94.7%) (OR 1.2; 95% CI 0.58-2.54)). The toddler age group (ages 1 to 3yrs) also were unaffected by the law going from a CSRS use rate of 82.1 percent in the pre law time period to a use rate of 89.7 percent in the post (OR 1.06; 95%CI 0.80-1.40). However, the school age group was positively affected by the law (OR 0.67; 95% CI 0.54-0.82)

Pre to post law effects by individual child age are displayed in Figure 4. This effect was driven, in part, by a “ceiling” effect for the younger occupants (Figure 4). That is, proper CSRS use of the youngest children was approaching 100 percent before the law took effect. There was little room for improvement of restraint use in children ages 0, 1, and 2 years old. The effect for 3 year olds starts to show an impact of the law while the older children were all under 50 percent CSRS use during the pre-law timeframe and increased significantly in the post-law timeframe with increases of 28 percentages points, 35 percentage points and 28 percentage points respectively across increasing years of age.

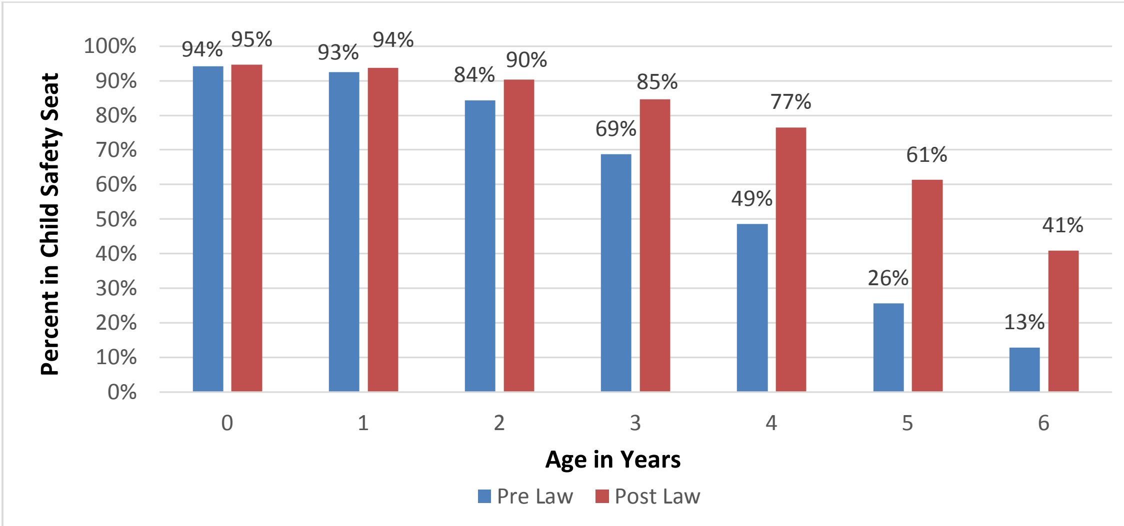

Figure 4. Pre-post law child safety restraint system use

The results indicated that the null hypothesis was rejected. There was a statistically significant increase in CSRS use following implementation of the law. Further analyses explored the extent to which the law led to increased CSRS use by individual year of age (of the child occupants). These results indicated that CSRS use was relatively high for the youngest occupants (<4 years old) and that the law did not lead to a statistically significant increase in child seat use for these ages. However, use for the older children (ages 4, 5 and 6) was impacted by the law change in that CSRS use significantly increased from pre to post law change.

Research Question 2

Which variables best predict the use of CSRS for children ages six years of age and younger who are occupants in a motor vehicle that was involved in a MVC crash? Null Hypothesis: Driver age, driver sex, driver drug and/or alcohol use, driver restraint use, time of day of MVC and vehicle type do not predict the use of CSRS for children ages six years of age and younger who are occupants in a motor vehicle that was involved in a MVC. Alternative Hypothesis: Driver age, driver sex, driver drug and/or alcohol use, driver restraint use, time of day of MVC and vehicle type best predicts the use of CSRS for children ages six years of age and younger who are occupants in a motor vehicle that was involved in a MVC.

For research question 2, a backward stepwise (conditional) binary logistic regression was conducted. The entry probability was 0.05 and removal was 0.1 (the defaults used by SPSS). Alpha was also set at .05 to determine significance.

The 2006 to 2010 data were used for this analysis. That is 9,433 MVC records post implementation of the law. The distribution across time categories for the post law data is described in Table 7. Relatively few children were being driven at night (6.3%) compared to daytime (68.1%) with evening time driving falling between daytime and night (25.6%). Women drove children more than men (68.6% versus 31.4%) (Table 7).

The majority of children were driven by individuals between the ages of 22-35 followed by those ages 36- to 54 (Table 7). Variables were entered into the backward stepwise binary logistic regression (predicting use) (Table 10). The results indicate that all the variables entered into the regression remained in the model. However, despite remaining in the model, the driver age category did not significantly predict CSRS usage. All other variables (Driver Sex, Child Age, Child Seat position and Time of day) all independently predict the likelihood of a child being in a CSRS.

In the multifactor analysis, child age was the independent variable most strongly associated with car seat use (Table 10). Infants (under 1 year of age) were more likely than school-aged children to be placed in car seats (OR 12.6; 95% CI: 9.7-16.4), while toddlers were 5.9 times more likely (95% CI: 5.2-6.7). Female drivers, driving during the day or evening and sitting the child in the back seat were all also independently associated with a higher likelihood of car seat use. The age of the driver was not statistically significantly associated with car seat use after adjusting for the other variables in the model. The results support the notion that all variables belong in the model that describes child safety seats after the law was implemented.

Table 10

Backwards Stepwise Binary Logistic Regression Predicting Car Seat Use

					95% C.I. for Odd Ratio	
Categories	χ^2	*p* value	Odds Ratio	B	Lower	Upper
Child Age Category	948.518	.000				
Infant vs. School-Age	352.180	.000	12.621	2.535	9.685	16.448
Toddler vs. School-Age	745.034	.000	5.884	1.772	5.181	6.683
Driver Age Category	7.332	.062				
0-21yr versus 55yr+	.002	.968	.993	-.007	.720	1.370
22-35yr versus 55yr+	3.414	.065	1.267	.236	.986	1.627
36-54yr versus 55+	1.377	.241	1.164	.152	.903	1.501
Driver Sex Category	8.428	.004	1.197	.180	1.060	1.352
(Female Vs. Male)						
Time of Day Category	26.352	.000				
Daytime vs Night	23.722	.000	1.733	.550	1.389	2.163
Evening vs Night	10.406	.001	1.475	.388	1.165	1.867
Seating Position	143.336	.000	.190	-1.658	.145	.250
(Front Seat vs Back Rows)						
Constant	2.902	.088	.758	-.277		

The younger the child the higher the likelihood of car seat use (Table 11). The analysis showed that 95% of infants less than one year of age were in a child safety seat followed by 90% of toddlers 1-3 years and 60% of school age children ages 4-6 years. There were a total of 79% of children across all these age groups reported to be in a child safety seat as compared to 21% not in a child safety seat (Table 11).

Table 11

Child Safety Seat Use by Child Age Category

		Child Age Category			
		Infant (<1 yr of age)	Toddler (1-3 yr old)	School-Age (4-6yr old)	Total
Not in a Child Safety Seat	N	67	419	1,369	1,855
	%	5.2%	10.3%	39.7%	21.1%
In a Child Safety Seat	N	1,224	3,633	2,079	6,936
	%	94.8%	89.7%	60.3%	78.9%
Total	N	1,291	4,052	3,448	8,791

Younger adults (under 36yr.) tended to have the child occupants in a proper seat more frequent than did older drivers (Table 12). However, the effect of driver age did not reach statistical significance.

Table 12

Child Safety Seat Use by Driver Age Category

		Driver Age Category				
		21yr and under	22-35yr	36-54yr	55yr+	Total
Not in a Child Safety Seat	N	124	891	708	114	1,837
	%	17.0%	18.9%	24.5%	27.1%	21.0%
In a Child Safety Seat	N	606	3,815	2,180	306	6,907
	%	83.0%	81.1%	75.5%	72.9%	79.0%
Total	Count	730	4,706	2,888	420	8,744

Male drivers were 1.2 times less likely to have their child occupants in a child safety seat (77%) than did female drivers (79.8%) (Table 13). This effect was statistically significant ($\chi^2 = 8.43$, $p < .01$).

Table 13

Child Safety Restraint System Use by Vehicle Driver Sex

		Vehicle Operator Sex		
		Male	Female	Total
Not in a Child Safety Seat	N	635	1,218	1,853
	%	23.0%	20.2%	21.1%
In a Child Safety Seat	N	2,126	4,803	6,929
	%	77.0%	79.8%	78.9%
Total	N	2,761	6,021	8,782

Driving later in the day was associated with lower child seat use (Table 14). Drivers traveling during the daytime were 1.7 times more likely to restrain the child occupants (80%) than those driving at night (70.7%). Drivers traveling during the evening were 1.5 times (77.1%) more likely to restrain the child occupant than those driving at night.

Table 14

Child Safety Restraint System Use by Time of Day Category

		Time of Day Category			
		Daytime	Evening	Night	Total
Not in a Child Safety Seat	*N*	1,185	511	159	1,855
	%	19.7%	22.9%	29.3%	21.1%
In a Child Safety Seat	*N*	4,833	1,720	383	6,936
	%	80.3%	77.1%	70.7%	78.9%
Total Count		6,018	2,231	542	8,791

There was a sizable effect of seat position (Table 15). Children were restrained in the front seat only 44 percent of the time but were properly restrained in the back seat 80 percent of the time. In addition, children were 5.3 times less likely in the front seat than the rear seats.

Table 15

Child Safety Restraint System Use by Seat Position

		Seat Position		
		Front Seat	Back Rows	Total
Not in a Child Safety Seat	*N*	160	1,676	1,836
	%	55.9%	19.9%	21.1%
In a Child Safety Seat	*N*	126	6,758	6,884
	%	44.1%	80.1%	78.9%
Total	*N*	286	8,434	8,720

The results indicate that several factors are predictors of child safety seat use in the time period following the law implementation, 2006 to 2010. Specifically driver sex, crash time, child occupant age and child occupant seating position were all significant predictors of whether or not a child was in a child safety seat during the crash. The age of the driver was the only variable entered into the equation for which there was no significant predictive value. That is, the null hypothesis was rejected for all the predictors except driver age.

Research Question 3

Which variables best predict early transition from a CSRS to a seat belt? Null Hypothesis: Driver age, gender, drug and/or alcohol use, restraint use, time of day of MVC and vehicle type do not predict early transition from a CSRS to a seat belt.

Alternative Hypothesis: Some combination of driver age, gender, drug and/or alcohol use, restraint use, time of day of MVC and vehicle type best predicts early transition from a CSRS to a seat belt.

The data from years 2006 through 2010 were also used to address research question 3. An analysis was run to predict children restrained in a lap and/or shoulder belt compared to a child safety seat. For these analyses completely unrestrained individuals (i.e., restraint use was indicated as "none-used") were excluded (Table 5).

The regression indicated that child age was also the factor most strongly associated with early transition to an adult restraint system (lap and/or shoulder belt). Infants were 13.9 times less likely to be transitioned earlier than school-age children (OR 0.72; 95% CI: 0.55-0.10) and toddlers were 6.4 times less likely than school age children (OR 0.16; 95% CI: 0.14-0.18). Seat position was also strongly related to early transition. Children in the front seat were 5.2 times more likely to be in an adult restraint system than children in the back seat (OR 5.2; 95% CI: 3.9-6.8). Men were 1.2 times more likely to transition their child occupants to an adult restraint system than were women (OR 0.84; 95% CI: 0.74-0.95). Time of day also predicted early transition with drivers traveling during the day being 1.5 times less likely to have children in lap/shoulder belts than those driving at night (OR 0.65: 95% CI: 0.52-0.82) and those riding in the evening being in shoulder/lap belts 1.3 times less often than those riding at night (OR 0.75; 95% CI 0.59-0.96).

The results indicated that all the variables except driver age remained in the model (Table 16). The variable of driver age was not significant and does not contribute to the model.

Table 16

Backward Stepwise Logistic Regression Predicting Early Transition

					95% C.I. Odds Ratio	
	χ^2	*p* value	B	Odds Ratio	Lower	Upper
Child Age Category	980.469	.000				
Infant to School-Age	339.772	.000	-2.629	.072	.055	.095
Toddler to School-Age	764.373	.000	-1.855	.156	.137	.178
Driver Sex Category (Female vs Male)	7.345	.007	-.171	.842	.744	.954
Time of Day Category	15.397	.000				
Morning to Night	13.034	.000	-.431	.650	.515	.821
Evening to Night	5.117	.024	-.287	.750	.585	.962
Seating Position (Front Seat vs Back Rows)	131.901	.000	1.639	5.151	3.894	6.814
Constant	.232	.630	-.058	.943		

Infants were least likely to be in a lap/shoulder belt (4.5%) than school-aged children (38.5%) (Table 17). The toddlers were 6.4 times less likely to be in an older person restraint system (9.1%) than were the older school-age children.

Table 17

Car Seat versus Lap/Shoulder Belt by Child Age Category

		Child Age Category			
		Infant <1 yrs. old	Toddler 1- 3 yrs.	School Age 4-6 yrs.	Total
In a Child Safety Seat	*N*	1,224	3,633	2,079	6,936
	%	95.5%	90.9%	61.5%	80.1%
Using a Lap/Shoulder Belt	*N*	58	362	1,303	1,723
	%	4.5%	9.1%	38.5%	19.9%
Total	*N*	1,282	3,995	3,382	8,659

Once again the youngest drivers (less than 36yr) were most likely to keep their children in a child Safety seat than older drivers but the effect was not significant and did not remain as part of the model. The percentages for this variable are shown in Table 18.

Table 18

Car Seat versus Lap/Shoulder Belt by Driver Age Category

		Driver Age Category				
		21yr and under	22-35yr	36-54yr	55yr+	Total
In a Car Seat	*N*	606	3,815	2,180	306	6,907
	%	85.6%	82.2%	76.4%	74.3%	80.2%
In a Lap/Shoulder Belt	*N*	102	824	674	106	1,706
	%	14.4%	17.8%	23.6%	25.7%	19.8%
Total	*N*	708	4,639	2,854	412	8613

Men were more likely than women to restrain child occupants with a lap/shoulder belt (Men: 21.5%; Women: 19.2%) (Table 19).

Table 19

Car Seat versus Lap/Shoulder Belt by Driver Sex Category

		Driver Sex		
		Male	Female	Total
Child Safety Seat	*N*	2,126	4,803	6,929
	%	78.5%	80.8%	80.1%
Lap/Shoulder Belt	*N*	581	1,140	1,721
	%	21.5%	19.2%	19.9%
Total	*N*	2,707	5,943	8,650

Drivers traveling during the day were 1.5 times less likely to have children in lap/shoulder belts (18.7%) than those driving at night (25.5%) (Table 20). Similarly those riding in the evening were in shoulder/lap belts 1.3 times (21.7%) less than those riding at night.

Table 20

Child Safety Seat versus Lap/Shoulder Belt by Time of Day Category

		Time of Day Category			
		Daytime	Evening	Night	Total
Child Safety Seat	*N*	4,833	1,720	383	6,936
	%	81.3%	78.3%	74.5%	80.1%
Lap/Shoulder Belt	*N*	1,114	478	131	1,723
	%	18.7%	21.7%	25.5%	19.9%
Total	Count	5,947	2,198	514	8,659

Finally children riding in the front seat were much more likely to be in a lap/shoulder belt (53.8%) than were children in the rear rows (18.8%). Table 21 provides the percentages for use by seat position.

Table 21

Child Safety Seat versus Lap/Shoulder Belt by Seating Position

(Front Seat vs Back Rows) Category

		Seating Position		
		Front Seat	Back Rows	Total
Child Safety Seat	*N*	126	6,758	6,884
	%	46.2%	81.2%	80.1%
Lap/Shoulder Belt	*N*	147	1,564	1,711
	%	53.8%	18.8%	19.9%
Total	*N*	273	8,322	8,595

The results indicate that several factors are predictors of early use of a lap/shoulder belt (versus child seat) in the time period following the law implementation. Specifically, child occupant age (Table 18), driver sex (Table 19), crash time (Table 20), , and child occupant seating position (Table 21) were all significant predictors of whether a child was in a lap or shoulder belt during the crash. That is, we could reject the null hypothesis for all the predictors except driver age.

Summary

Chapter 4 provided a detailed analysis of Connecticut's 2000-2010 MVC records. The results showed that Connecticut's CPS legislation, which was strengthened in 2005, had a significant effect on CSRS use. In particular, children ages four, five and six had significantly higher safety seat use post legislation. These results also indicated that CSRS use was already relatively high for the youngest occupants (<4 years old) and that the law did not have a statistically significant effect in child seat use for these ages.

This study showed that the younger the child the higher proper car seat use. The analysis also showed that infants and toddlers were more likely to be in car seats than school age children; that adults under the age of 36years tended to place children in a proper seat more frequent than older drivers; male drivers more often tended to not place children in a child seat and driving later in the day was associated with lower child seat use. Chapter 5 reviews potential implications in practice and policy, and considerations for future research.

Chapter 5: Discussion

Introduction

In the United States, MVCs cause substantial childhood morbidity and mortality and remain one of the leading causes of unintentional injury deaths for children ages 115 years (CDC, 2014). Whether or not a child is restrained makes a difference in the likelihood and severity of injury from a MVC. Nearly half of children under the age of 12 years who were found to be unrestrained while experiencing a MVC suffered injuries and had higher hospitalization rates when compared to those children who were restrained (CDC, 2014). Children who were wearing safety restraint devices at the time of a MVC were 62 percent less likely to be transported by emergency medical services (EMS) to a medical facility than children who were not wearing safety restraints (Caviness, et al., 2003). Placing children in age and size appropriate safety restraint systems can reduce serious and fatal injuries by more than 50 percent (NHTSA, Children, 2014a**).**

The goals of this study were to (1) determine if there was an association in the percentage of car seat use in children ages six years and younger who were involved in a MVC pre as compared to post implementation of Connecticut's 2005 car seat law; (2) determine which variables best predicted the use of car seats, and; (3) determine which variables best predicted early transition to a seat belt. The independent variables of interest for this study were crash severity, vehicle type, driver sex, driver age, driver drug or alcohol use, child seating position, child age, and time of day. Using the CTCDR, a logistic regression analysis was used to illicit a model that best predicts car seat use and early transition to a seat belt, having accounted for relevant covariates. Four variables (child age, seating posting, driver sex and time of day) were identified as significant predictors of car seat use and early transition to a seat belt. With these results, targeted interventions can be implemented that will ultimately prevent injuries, save lives, and decrease medical costs.

The study results indicated that there was a statistically significant increase in child safety seat use after the law was strengthened in 2005. Further analyses explored the extent to which the law led to increased child safety seat use by children ages zero to six years, the ages that Connecticut's CPS law pertains to. These results indicated that the youngest child occupants (<4 years old) had the highest child safety seat use both pre and post law and thus, the law did not lead to a statistically significant increase in child safety seat use for these ages. However, the law had a positive impact on child safety seat use for older children (ages 4, 5 and 6). That is, CSRS use significantly increased from pre to post law change for these older children.

The results also indicated that several factors were predictors of child seat use in the time period following the law implementation, 2006 to 2010. Specifically, driver sex, crash time, child occupant age, and child occupant seating position were all significant predictors of whether or not a child was in a child safety seat during a MVC. That is, the younger the child the more likely they were to be placed in car seats; -male drivers, driving during the day or evening and sitting the child in the back seat were all associated with a higher likelihood of car seat use. In contrast, the age of the driver was the only variable that was not statistically significantly associated with car seat use after adjusting for the other variables in the model.

The results also indicated that several factors were predictors of early use of a lap/shoulder belt (versus child safety seat) in the time period following the law implementation. Specifically child occupant age, driver sex, time of day, and child occupant seating position were all significant predictors of whether a child was in a child safety seat versus a lap or shoulder belt during the crash. That is, that younger the child the more likely they would be associated with early transition to an adult restraint system (lap and/or shoulder belt); that children placed in the front seat were more likely to not be in a CSRS; that men were 1.2 times more likely to transition their child occupants to an adult restraint system than were women; and that drivers transporting children in motor vehicles in the daytime were more likely to not have children in CSRS, who by Connecticut state law should have been.

Interpretation of Findings

The results of this study suggest that the impact of Connecticut General Statutes § 14-100a, specifically Public Act 05-58, which went into effect in 2005, is effective in children being placed in CSRS. Increased use of CSRSs had a protective effect on the safety of children transported in motor vehicles. As a result, there were many children that avoided injury and even death because of this law, especially in the four, five and six year old age groups whose usage rates increased 28 percentage points, 35 percentage points, and 28 percentage points, respectively.

As stated in Chapter 2, there is supporting literature demonstrating that use of a proper CSRS can reduce injuries and fatalities of children being transported in motor vehicles (Agran, Anderson, & Winn, 2004; Agran, Dunkle, & Winn, 1987; Agran &

Hoffman, 2008; Barraco et al., 2010; Caviness et al., 2003; Dellinger, Groff, Mickalide, & Nolan, 2002; Durbin et al. 2003b; Elliott, Kallan & Rice, 2006; Johnston, Rivara, & Soderberg,1994; NHTSA, 2014; Rogers et al., 2013; Thompson et al., 2003; Uherick, Melzer-Lange, & Pierce, 2005). In spite of over a decade of legislative efforts, MVCs remain one the major causes of death for children under 12 years of age (NCIPC, 2014). Levels of public awareness of a new restraint law correlate with more children being restrained (CDC, 2014; Gunn, et., 2007; NHTSA, 2006; Brixey, 2010; Sun, 2010). Intensive efforts to publicize the laws via television, for example, result in increased self-reported ownership of child safety seats and, in some instances, increased observed usage (National PTA, & United States, 1986; CDC, 2014). Child passenger restraint laws that increase the age required for car seat or booster seat use result in more children being restrained (CDC, 2014). There was a documented 17 percent decrease in death and serious injuries in five states that passed legislation to increase the required age for CSRS use to seven or eight years of age (CDC, 2014). In addition, there was a three-fold increase in the number of children who used car seats or booster seats (CDC, 2014). This study demonstrated a similar impact, especially in the four, five and six year old age categories. There was a 57 percent increase in CSRS use in four year olds, a 234 percent increase in five year olds, and a 315 percent increase in six year olds.

Also in Chapter 2 was the supporting literature demonstrating that early transition from age and weight appropriate CSRSs leads to increased risk of injury and typically coincides with children being placed in improper seating positions within the vehicle. A study in 2010 by Brixey, Ravindran & Guse found a significant increase in premature booster seat use in children who, by law, should have been restrained in a rear or forward facing seat. The analysis from this study found that children were early transitioned out of safety seats and found an increase in the percentage of children who were inappropriately restrained with seatbelts. Driver sex, crash time, child occupant age, and seating position were all significant predictors of early transition from a CSRS to a lap or shoulder belt and younger adults, were more likely to place children in a proper CSRS than older drivers. The analysis also concluded that while legislation may affect total CSRS use, it may not improve the proper use of the seat itself.

Similar to the literature findings of Brixey, Corden, Guse, & Layde, (2011), the analysis of this study also found that school age children were less likely than younger children to be in a safety seat. In addition, this study contributes to the limited body of literature that shows driving later in the day was associated with lower rates of car seat use. Also, there was a sizable effect of seat position. Children were found to be in a CSRS 80% of the time while seated in the back row and on 44% if seated in the front row. Seating positions in a motor vehicle have large impacts on survival in the event of a MVC (Berg, 2000; Braver, 1998; Durbin et al., 2005; Kallan, 2008; Sahraei, 2009). Rear seating positions in particular can improve the chance of survival and minimize the risk of sustaining an injury (Berg, 2000; Braver, 1998; Durbin et al., 2005; Kallan, 2008; Sahraei, 2009). Now that variables that best predict CSRS in Connecticut’s children have been identified, targeted injury prevention efforts to those who do not use car seats or misuse car seats can prevent children from being placed in harm’s way ultimately leading to injuries, disabilities and death.

The application of Roger's (2003) Diffusion of Innovations model to CSRS use in Connecticut before and after 2005 highlights that this innovation (CSRS use) was indeed communicated further through social channels by strengthening the law in 2005. Although CSRS use was indeed increased for the infant to three-year-old age groups, pre-law usage rates were already high in those groups so the innovation merely spread to more parents/guardians within the laggard group. Findings in the four to six-year-old age groups suggest a more robust impact, with the innovation progressing from the early majority into the late majority group among users in the four and five-year-old age groups (49-77% and 26-61%) and from the early adopters to the early majority among users in the six-year-old age group (13-41%).

While best practices may differ in encouraging early adopters and early majority groups versus the late majority of adopters and laggards to implement an innovation, Connecticut's child passenger safety law clearly increased adoption of CSRS use within all groups of the social system described by Roger. These results provide evidence for increasing law enforcement efforts and penalties for not having a child placed in an appropriate CSRS in Connecticut, which may have a further positive effect on the amount of parents/guardians placing children in these lifesaving injury prevention devices, especially among the four to six-year-old age groups.

Limitations

It is important to note that the data used in this study was a census of MVCs that resulted in injuries. The results from this study may have highlighted a population of drivers with a greater propensity to be involved in a MVC; therefore, the results from this study can be generalizable to similar drivers in Connecticut and throughout the United States.

However, there were some limitations to this study. Identifying and addressing variables that best predict compliance or non-compliance of Connecticut's CPS law can lead to decreased morbidity and mortality of children who are transported in motor vehicles. The use of a secondary database proved to be a limitation in this study. The lack of demographic information that could have been obtained from the data set, such as race of the driver of the vehicle, race of the child occupant, as well as the weight of the child, might have provided further knowledge to best predict car seat use. In particular, the weight of the child would have been helpful in determining if this was a factor in early transitioning to a seat belt, especially if it was a result of the child being too large and not fitting in the CSRS properly. Another variable that was not available and may have proven beneficial was the type of child restraint used, but based on CTCDR currently available, there is no opportunity to differentiate which type of child restraint the child was using or the model at the time of the MVC. For example, infant or convertible seat versus belt positioning booster seat; Graco versus a Britax manufactured seat. This might have provided insight into the ease of use and an opportunity to provide feedback to manufactures as to the fit of the seat into the particular vehicle. Lastly, this study was limited to a single State's database of motor vehicle crash reports dependent on completeness and accuracy of law enforcement recording of the motor vehicle crashes, as well as, accurate coding of the crashes. There was no opportunity to verify the accurateness of the data completed by law enforcement, since it is data was not collected by this researcher and there was no control over what is contained in the dataset. However there was a quality control performed by the CTDOT prior to the data becoming available for public access. The lack of the available of the aforementioned variables may prohibit determining whether these are major influencing characteristics in determining proper car seat use and may explain the continued misuse or lack of car seat use.

Lastly, the use of a secondary electronic database did not allow for data on what motivates caregivers to use or not use child safety restraint systems. For example, whether an individual can afford to purchase a seat; whether they find the seat easy or difficult to use; whether they belief that car seat are beneficial (both personal and religious); and whether they are or are not law abiding citizens may provide further insight into what is a complex public health problem. Understanding driver characteristics and reasoning for not complying with state legislation has the potential to decrease the number of child passenger injuries and fatalities, thus increasing the safety of children transported in motor vehicles. Additionally, understanding the motivators and barriers for parents/guardians to use CSRSs or not would be beneficial as well and could lead to more targeted intervention programs.

Furthermore, there were some unavailable variables, such as type of vehicle, which could have allowed a fuller picture of child safety seat use. These variables could have been useful in predicting child safety seat usage and early transition. For example, it is well established that in child fatalities without a child safety seat or seat belt, a greater percentage of those fatalities occur in larger vehicle types (e.g. sports utility vehicles

(SUV) (NHSTA, 2013; NHTSA, 2014a). Another limitation is that there was an existing increasing trend in CSRS use prior to the law. Including the year as a continuous variable in the regression models should have accounted for the increasing trend and allowed the results to indicate the extent of any additional increase in restraint use as a function of the law. However, there remains an unanswered question about what would have happened to child safety seat use without the law. That is, would child safety seat use have reached the current level on its own, but the law change raised it faster? Or would child safety seat use have plateaued if not for the law? Comparison to an out of state control group (crash data from a neighboring state for example) might be useful to answer this question.

Recommendations

Additional considerations in interpreting the prevalence of CSRS use in the CTCDR would be the inclusion of race and ethnic data (Lee, et al., 2008). In a 2008 study by Lee , et al., among children whose race/ethnicity was known, African American and Hispanic children were at least six times more likely than White Non-Hispanic children to be unrestrained (12% and 14% respectively vs 2%) (Lee, et al., 2008). Black and Hispanic children were 1.5 times more likely to be inappropriately restrained than White Non-Hispanics (47% and 50% respectively verses 34%) (Lee, et al., 2008). Furthermore, unrestrained children were 1.7 times as likely to have multiple diagnoses compared with restrained children (Lee, et al., 2008). While currently not a captured data point, further understanding of cultural/ethnic factors that may contribute to use, misuse or nonuse of CSRS could assist legislators, law enforcement officials and other safety advocates with injury prevention efforts and education.

A recommendation for further research to determine whether legislation influences health behavioral changes and compliance with the law is important. As mentioned above, the addition of a state control group to this or a similar study would serve to further flesh out how much of the increased usage of CSRSs was due to the existing national trend and how much was truly due to the newly enacted law.

Implications for Positive Social Change

This study highlighted areas of legislative policy and child passenger safety practices that need further attention. The results of this study indicated that male drivers transition children from CSRSs to seatbelts faster that female drivers and that older drivers transition children from CSRSs to seatbelts faster than younger drivers. Targeted campaigns educating both of these groups could help to change these dangerous behaviors. Another area of focus should be child occupant seat positioning. A large body of evidence exists demonstrating a proven decrease in injuries and fatalities with rear facing CSRSs and booster seats when children are properly restrained (Corden, 2005; Glass, et al., 2002). Children are safer in the rear seat positions, but, as seen in the results of this study, as they get older, transitioning to a lap/shoulder belt or moving to the front seat is evident and contributes to a double negative effect on their safety (Corden, 2005; Glass, 2002). Proper use of CSRSs and seat belts can certainly save lives, but there are numerous factors that need to be considered to ensure proper CSRS use. These factors include, but are not limited to, education on CSRS selection, vehicle seating selection (front seat versus back seat), and law enforcement to increase compliance (CDC, 2014; NCIPC, 2014; NHTSA, 2014a). Despite a significant decrease in the number of children killed in MVCs over the past ten years, MVCs remain one of the leading causes of injury deaths (Durbin, 2011a).

Implementing educational and enforcement campaigns could be effective injury prevention interventions that would improve the safety of our nation's children. Tailoring these campaigns to educate parents/guardians within various communities would be the logical first step. Further, engaging 4 to 6 year old students through classroom activities may increase requests from children to be properly restrained and positioned and thus allow them to assist in their own safety.

Legislation that strengthens child passenger safety has the potential to decrease the overall number of child passenger injuries and fatalities, which would ultimately increase the safety of child passengers transported in motor vehicles. The positive effect on the safety of children could be even greater if Connecticut's CPS law was expanded to include older children and require booster seat use until age 12. If legislation for this older age group worked the same as the current law, there would be an increase in proper CSRS use (i.e. child positioned in back seat) and potential to save even more children from injury and death.

The social change implication of this study is such that certain targetable variables, such as driver sex and child age, were identified as significant predictors of car seat use and early transition to a seat belt. Using these results to guide program planning, targeted injury prevention efforts could be implemented that would ultimately decrease medical costs, save lives, and prevent injuries.

Conclusion

This study establishes significant predictors of CSRS use and early transition to a seat belt that could lead to targeted interventions and a positive impact on the health and well-being of Connecticut's children. In addition, the study confirms that Connecticut legislation is effective, that is children under the age of 6 are being placed in CSRS at a great rate after the law went into effect; in particular, the four, five and six year olds. Now that predictors of CSRS use have been identified, focused morbidity and mortality prevention efforts can be implemented that will ultimately decrease medical costs, save lives, and prevent injuries. The information and insight derived from this study can influence decisions on health policy refinement as well as focus injury prevention program planning. The results might also set the stage for future successes that might be gained by lobbying for and recommending expansion of Connecticut's General State Statute § 14-100a, specifically Public Act 05-58, which went into effect in 2005. Educating legislators, medical professionals and other safety advocates about the findings of this study and seeking their support to improve legislation would benefit one of our country's most vulnerable populations – children. Addressing variables associated with improper CSRS utilization may help to reduce the increased risk of motor vehicle crash death and injury, and could potentially have significant ramifications and social change effects for the future wellbeing of children who are occupants of a motor vehicle. Ensuring the proper use of an age and size appropriate CSRS has the potential to drastically reduce the number of children seriously injured or killed in MVCs, as well as decrease the associated healthcare and societal costs of these injuries and deaths.

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Appendix A: Infant Seat Patent

Oct. 22, 1963 **L. RIVKIN** **3,107,942**

INFANT'S SEAT

Filed March 5, 1962

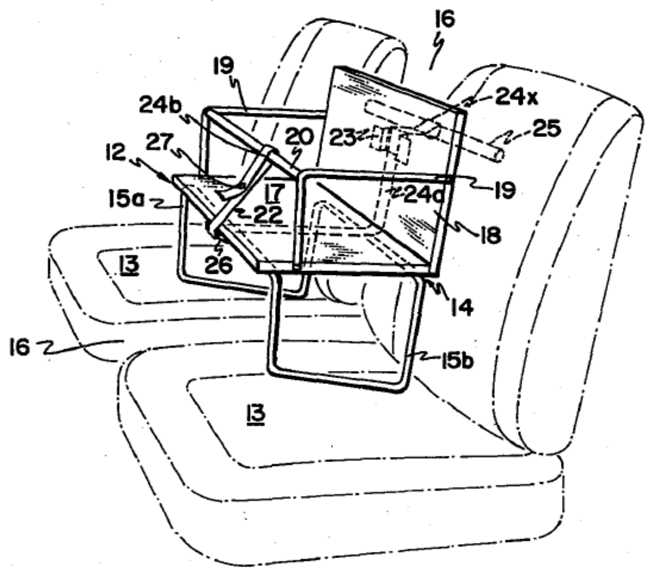

FIG. 1

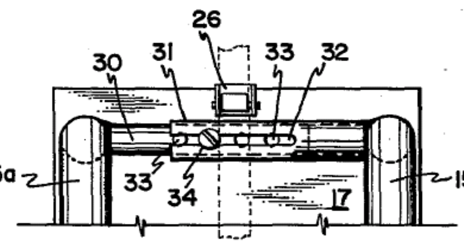

FIG. 3

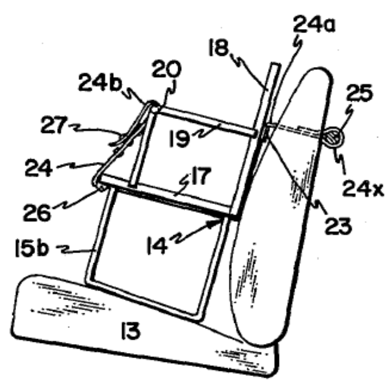

FIG. 2

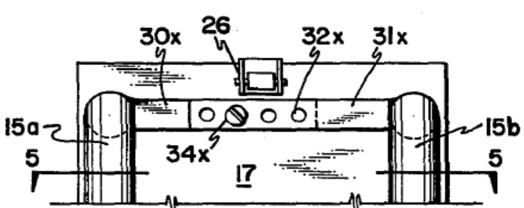

FIG. 4

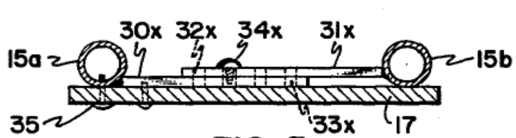

FIG. 5

INVENTOR.
LEONARD RIVKIN
BY

Attorneys

United States Patent Office

3,107,942
Patented Oct. 22, 1963

1

3,107,942

INFANT'S SEAT

Leonard Rivkin, 6260 E. Colfax, Denver, Colo.

Filed Mar. 5, 1962, Ser. No. 177,464
4 Claims. (Cl. 297—254)

This invention relates to demountable infant's seats for use in self-propelled vehicles, particularly automobiles, station wagons and the like.

The infant's seat of my invention is particularly suited for use in vehicles having bucket-type seats or other forms of divided seats having a structural member or open space separating the forward seat portions of adjoining seats. Conventional infant's seats now on the market utilize brackets or hangers which form a part of the back structure of the infant's seat and terminate in elevated portions which overhang or straddle the back of a vehicle seat at its top and thus secure the infant's seat to the vehicle seat. They depend on friction fit for whatever resistance they have to lateral movement, which at best is quite limited.

Accordingly, it is an object of my invention to provide a simple, durable and comfortable infant's seat adapted to be mounted on vehicle seats and which has means for selectively and positively holding it against forward or lateral movement while mounted on such seat.

Another object of my invention is to provide a simple, economical and efficient infant's seat which is adapted to be mounted in straddling relation to adjoining bucket or divided seats of a vehicle and has means for extending or contracting the straddling portions of the infant's seat.

Other objects reside in novel details of construction and novel combinations and arrangements of parts, all of which will be detailed in the course of the following description.

The practice of my invention will be described with reference to the accompanying drawings illustrating typical structural embodiments. In the drawings, in the several views of which like parts bear similar reference numerals:

FIG. 1 is an isometric view of one embodiment of my invention secured in place on adjoining bucket seats of a vehicle with hidden parts of the assembly shown in dash lines;

FIG. 2 is a side elevation of the infant's seat of FIG. 1, showing its elevational relationship to a vehicle seat by which it is supported;

FIG. 3 is a fragmentary bottom plan view illustrating the adjustment features of the base support assembly of the infant's seat shown in FIGS. 1 and 2;

FIG. 4 is another fragmentary bottom plan view of another embodiment of the adjustable base support assembly of my invention; and

FIG. 5 is a fragmentary section of the assembly shown in FIG. 4, taken along the lines 5—5 of FIG. 4.

As shown in FIG. 1, an infant's seat 12 adapted for demountable attachment to adjoining bucket seats 13 of a vehicle has a base support assembly 14, including two leg portions *15a* and *15b* in straddling relation to an open space 16 between the seats 13. The seat structure fastened to and supported by assembly 14 may comprise a seat portion 17, a back portion 18, side arm rests 19 and a retaining bar or member 20 supported by and secured to the forward ends of arm rests 19 at their top portions as by welding.

Seat 12 is securely held in the position shown in FIG. 1 while the vehicle is operating or standing, through the provision of a belt-fastening assembly 22. This assembly includes a guide 23 mounted at the rear of back 18 of seat 12 near its top through which a rear end portion *24a* of a strap 24 extends and holds a rod or bar 25 by a frictional fit with a looped portion *24x* at its rear end. Strap 24 extends forwardly along the undersurface of seat portion 17 and through a clamping member 26 held at the forward end of said undersurface. The forward end portion *24b* of strap 24 carries a series of snap fasteners 27 permitting said end to be looped over retaining member 20 and fastened to provide a leg division for an infant placed in seat 12.

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In the fastening action, bar 25 and associated strap portion *24a* are first inserted through the open space between vehicle seats 13 until the bar is resting in a horizontal position in engagement with the backs of said seats. The forward portion *24b* is then pulled through clamping member 26 until the rearward portion of the strap 24 is taut and bar 25 resists further movement. The clamping member is then actuated to clampingly hold the strap and the forward portion *24b* is suitably looped over retaining member 20 and fastened by snap fasteners 27. This fastening effectively holds seat 12 against forward or lateral shifting until the clamping member 26 is again actuated for seat removal.

As previously noted, seat 12 has an adjustable base support assembly 14 which provides lengthening or shortening the spacing between leg portions *15a* and *15b*. In the embodiment shown in FIG. 1, this adjustment feature will be best understood by reference to FIG. 3. In this arrangement, leg portion *15a* has a fixed connection to seat 17 as by screws or other suitable fastenings (not shown). Lateral tube portions 30 in fixed connection with leg portion *15a* at its opposite ends extend over a major portion of the width of seat 17 and are spaced from the seat to provide clearance for a lateral tube portion 31 in fixed connection with leg portion *15b* which is not attached to seat 17. The outer end of tube portion 31 is slotted for a substantial distance as shown at 32 and is in register with a series of threaded openings 33 in tube 30, and a screw 34 permits the telescoping tube members to be locked in selected positions to vary the distance between leg portions *15a* and *15b*.

FIG. 4 illustrates another embodiment in which the lateral portions *30x* and *31x* are formed of strap material instead of being tubular. Portion *30x* is welded or otherwise fixedly held on leg portion *15a*, both of which are secured to seat 17 as by screws 35 or other suitable fastenings. Openings *33x* in portion *30x* are adapted to be alined with openings *32x* on lateral portion *31x* welded or otherwise secured to leg portion *15b*. When the openings *32x* and *33x* are brought into selective register, a screw *34x* is inserted to lock the leg portions in the selected spacing relation.

The adjustment of the base support permits the leg portions to be spaced a sufficient distance to effectively bridge any space between adjoining seats without danger that a slight lateral shifting will move one of the leg portions into such space and tilt the infant's seat enough to cause possible injury to the occupant. Also, when structure fills the space between adjoining seats, the leg portions can be disposed to contact the sides of such structure and when the strap fastening is drawn, an even more stable support is provided for the infant's seat.

The drawings illustrate tubular and strap or flat shapes as being utilized in the framework of the infant's seat, and preferably these components will be formed of steel or aluminum. However, it should be understood that any suitable materials may be used in the seat framework. The material and shaping of the seat portion 17 and back member 18 may be of any suitable type, but preferably such components will be padded sufficiently to provide maximum comfort for the occupant.

In a preferred arrangement, the adjustable parts will be disposed at the forward and rear ends of the seat to provide greater stability and easier manipulation. However, it will be understood that one such adjustable cross connection will be effective for the intended purpose and will provide a reduction in production cost. The strap 24 may be of any suitable material such as webbing, elastic strip or the like and the clamping member 26 may be of any of the well-known types used with such straps so long as it effectively cinches the infant's seat in its locked position. The provision of the retaining bar 29 is not essential under all conditions and a strap fastening may be substituted if desired. However, the illustrated arrangement is preferable as providing a positive safeguard against the occupant sliding forwardly out of the seat. Changes and modifications may be availed of within the spirit and scope of the invention as defined in the hereunto appended claims.

I claim:

1. As a new article of manufacture, an infant's seat arranged to be mounted in bridging relation to adjoining bucket-type vehicle seats, comprising a supporting base assembly and an upper seat portion, inclusive of a forward retaining bar on the seat portion, and cinching means for securing the infant's seat in bridging relation to said vehicle seats, inclusive of a strap adapted to be held at one end in fixed relation to rear surfaces of the vehicle seats, and having an intermediate portion locked to the supporting base assembly, with a forward portion in looped attachment to said retaining bar for limiting the leg position of an occupant of the seat.

2. As a new article of manufacture, an infant's seat arranged to be mounted in a bridging relation to adjoining bucket-type vehicle seats, comprising a supporting base assembly and an upper seat and back portion, inclusive of a forward retaining bar on the seat portion, and cinching means for securing the infant's seat against forward or lateral movement in bridging relation to said vehicle seats, inclusive of a strap adapted to be held at one end in fixed relation to rear surfaces of the vehicle seats, and having an intermediate portion secured to the back and seat portion and locked beneath the seat portion in taut condition with a forward portion in adjustable looped attachment to said retaining bar for limiting the leg position of an occupant of the seat.

3. As a new article of manufacture, an infant's seat arranged to be mounted in bridging relation to adjoining bucket-type vehicle seats, comprising a supporting base assembly and an upper seat and back portion, inclusive of a forward retaining bar on the seat portion, said base assembly including leg portions of the U-shape, the cross-connecting portions of which incline at the angle of the seat surface by which they are supported so as to maintain the back portion in frictional engagement with the vehicle seats, and cinching means for securing the infant's seat against forward or lateral movement in bridging relation to said vehicle seats, inclusive of a strap adapted to be held at one end in fixed relation to rear surfaces of the vehicle seats, and having an intermediate portion secured to the back and seat portion and locked beneath the seat portion in taut condition with a forward portion in adjustable looped attachment to said retaining bar for limiting the leg position of an occupant of the seat.

4. As a new article of manufacture, an infant's seat arranged to be mounted in bridging relation to adjoining bucket-type vehicle seats, comprising a supporting base assembly and an upper seat and back portion, inclusive of a forward retaining bar on the seat portion, said base assembly including adjustably spaced leg portions of U-shape providing substantially parallel cross-connecting portions supported on the vehicle seat, means for locking the leg portions in selective seat bridging positions, and cinching means for securing the infant's seat against forward or lateral movement in bridging relation to said vehicle seats, inclusive of a strap adapted to be held at one end in fixed relation to rear surfaces of the vehicle seats, and having an intermediate portion secured to the back and seat portion and locked beneath the seat portion in taut condition with a forward portion in adjustable looped attachment to said retaining bar for limiting the leg position of an occupant of the seat.

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Appendix B: Connecticut Uniform Police Accident Report

CONNECTICUT UNIFORM POLICE ACCIDENT REPORT FORM PR-1 Rev. 12/94 ***Please Print or Type***

A. WEATHER CONDITION: 1. No Adverse Condition; 2. Rain; 3. Sleet,Hail; 4. Snow; 5. Fog; 6. Blowing Sand, Soil, Dirt or Snow; 7. Severe Crosswinds; 8. Other; 9. Unknown;

B. ROAD SURFACE CONDITION: 1. Dry; 2. Wet; 3. Snow/Slush; 4. Ice; 5. Sand, Mud, Dirt or Oil; 8. Other; 9. Unknown;

C. LIGHT CONDITION: 1. Daylight; 2. Dark–Not Lighted; 3. Dark–Lighted; 4. Dawn; 5. Dusk; 9. Unknown;

D. ACCIDENT OCCURRED ON: 1. Main Roadway; 2. On Ramp; 3. Off Ramp; 4. H.O.V. Lane; 5. Collector – Distributor Roadway; 6. Service or Rest Area; 7. Weigh Station; 8. Connector;

E. OTHER ROADWAY FEATURE: 1. Int. Public Road; 2. Int. Private Road; 3. Int. Residential Dr.; 4. Int. Commercial Dr.; 5. On Bridge; 6. At RR Xing; 7. At Median X Over; 8. At On Ramp; 9. At Off Ramp 0. None

F. MEDIAN BARRIER PENETRATION: 1. Full; 2. Partial; 3. None; 4. Not Applicable;

G. CONSTRUCTION OR MAINTENANCE RELATED: 1. Yes; 2. No;

VEHICLE #1 **H. VEHICLE TYPE** **VEHICLE #2**

02 Automobile
03 Motorcycle
04 Moped–Motor Scooter
05 Pedalcycle
06 Taxi
07 Train
08 Emergency Vehicle
09 School Bus
10 Commercial Bus
11 Motorhome/Camper
12 Off Road Vehicle
13 Passenger Van
14 Single Unit Truck (2 Axle, 4 Tire)
15 Single Unit Truck (2 Axle, 6 Tire)
16 Single Unit Truck (3 or more Axles)
17 Car-Trailer Combination
18 Truck-Trailer Combination
19 Truck Tractor Only
20 Tractor Semi-Trailer
21 Tractor Double Trailers
22 Tractor Triple Trailers
23 Heavy Vehicle (Unclassifiable)
24 Construction/Farm Equipment
25 Other
26 Unknown

OBJECT #1 **TRAFFIC UNIT #1** **J. OBJECT(S) STRUCK** **TRAFFIC UNIT #2** OBJECT #1

OBJECT #2 OBJECT #2

01 Animal other than Deer
02 Bank, Ledge, Rock (Off Rd.)
03 Bridge Structure
04 Building, House
05 Catch Basin, Manhole
06 Const., Barricade, Barrel
07 Culvert, Endwall
08 Curbing
09 Deer
10 Ditch
11 Fence
12 Fire Hydrant
13 Foreign Object on Pavement
14 Highway Sign, Post, Delineator
15 Illumination Pole
16 Impact Attenuator
17 Jersey Barrier
18 Metal Beam Guide Rail
19 Overhead Sign Support
20 Railroad Appertunance, Track
21 Traffic Control Device
22 Traffic Island
23 Tree
24 Underpass Ceiling
25 Utility Pole
26 Vehicle Off Road
27 Wall
28 Wire Rope Guiderail
29 Other

OBJ.#1 LOC OBJ. #1 LOC
OBJ. #2 LOC OBJ. #2 LOC

TRAFFIC UNIT #1 **K. OBJECT(S) LOCATION** **TRAFFIC UNIT #2**

1 Off Road & Shoulder Ahead
2 In Roadway
3 On Shoulder, Right
4 On Shoulder, Left
5 Off Road & Shoulder, Right
6 Off Road & Shoulder, Left
7 On Median Divider
8 Gore Area, Ramp Nose
9 Over Roadway

L. INVOLVED PERSON IDENTIFIER: 1. Occ. Vehicle #1; 2. Occ. Vehicle #2; P=Pedestrian; W=Witness;

M. INJURY CLASSIFICATION
K: Fatal Injury
A: Incapacitating Injury (Prevents Return to Normal Activity)
B: Non-Incapacitating Evident Injury
C: Possible Injury (Claim of Non-evident Injury)
N: Not Injured

N. SEATING POSITION
01 Front Seat Left/Motorcycle Driver
02 Front Seat Middle
03 Front Seat Right
04 Second Seat Left/Motorcycle Passenger
05 Second Seat Middle
06 Second Seat Right
07 Third Row Behind Driver/Motorcycle Pass.
08 Third Row Behind Front Seat Middle
09 Third Row Right
10 Sleeper Section of Cab (Truck)
11 Enclosed Passenger or Cargo Area
12 Unenclosed Passenger or Cargo Area
13 Trailing Unit
14 Riding on Vehicle Exterior
15 Unknown

P. AIRBAG STATUS
1 Deployed
2 Not Deployed
3 Not Applicable
4 Unknown

Q. EJECTION STATUS
1 Not Applicable
2 Totally Ejected
3 Partially Ejected
4 Trapped
5 Unknown

O. OCCUPANT PROTECTION SYSTEM USE
1 None Used — Vehicle Occupant
2 Shoulder Belt Only
3 Lap Belt Only
4 Shoulder and Lap Belt
5 Child Safety Seat
6 Helmet/High Visibility Clothing
7 Helmet/No High Visibility Clothing
8 No Helmet/High Visibility Clothing
9 Restraint Use Unknown

INSTRUCTIONS FOR COMPLETING SHADED AREAS

Report only that data relative to a QUALIFYING VEHICLE involved in a QUALIFYING ACCIDENT

Definitions:

QUALIFYING VEHICLE

- Any motor vehicle displaying a hazardous material placard, or
- Any motor vehicle equipped for carrying property and having at least two axles and six tires, or
- Any motor vehicle designed to transport more than fifteen persons including the driver.

QUALIFYING ACCIDENT

- Any accident that involves a QUALIFYING VEHICLE and which results in one of the following:
- Fatality to any person, or
- Injury to any person that requires immediate medical treatment away from the accident site, or
- Disablement of any vehicle as a result of damage sustained in the accident

INSTRUCTIONS FOR COMPLETING VEHICLE MANEUVER FIELDS

The vehicle maneuver PREFIX and SUFFIX will be used in combination to describe the intended action of each vehicle prior to the accident.

PREFIX:

The PREFIX describes evasive action taken, if any

SUFFIX:

If EVASIVE ACTION TAKEN, select the code that best describes the condition that required the evasive action

If NO EVASIVE ACTION TAKEN, select the code that best describes the vehicle's action.

EXAMPLES:

Evasive Action Taken

PREFIX	SUFFIX
02 Vehicle slowing for	35 Stopped Vehicle
03 Vehicle stopped for	09 Vehicle turning left from proper lane
04 Vehicle skidded slowing or stopping for	11 Vehicle making "U" turn
05 Vehicle avoiding	08 Vehicle turning right from improper lane

No Evasive Action Taken

PREFIX	SUFFIX
01 None Apply	02 Vehicle negotiating curve
01 None Apply	19 Vehicle changing one lane to exit
01 None Apply	11 Vehicle making "U" turn
01 None Apply	08 Vehicle turning right from improper lane

FORM PR-1 REV. 12/94

R. COLLISION TYPE

01 Turning — Same Direction
02 Turning — Opposite Direction
03 Turning — Intersecting Paths
04 Sideswipe — Same Direction
05 Sideswipe — Opposite Direction
06 Miscellaneous — Non-Collision
07 Overturn
08 Angle
09 Rear-end
10 Head-on
11 Backing
12 Parking
13 Pedestrian
14 Jackknife
15 Fixed Object
16 Moving Object
17 Unknown

TRAFFIC UNIT #1 **S. VEHICLE MANEUVER PREFIX** **TRAFFIC UNIT #2**

1. None Apply; 2. Vehicle Slowing For; 3. Vehicle Stopped For; 4. Vehicle Skidded Slowing or Stopping For; 5. Vehicle Avoiding;

TRAFFIC UNIT #1 **T. VEHICLE MANEUVER SUFFIX** **TRAFFIC UNIT #2**

01 Vehicle Going Straight
02 Vehicle Negotiating Curve
03 Vehicle on Wrong Side of Road
04 Vehicle Passing Same Direction on Left
05 Vehicle Passing Same Direction on Right
06 Vehicle Passing Improperly Parked Vehicle
07 Vehicle Turning Right from Proper Lane
08 Vehicle Turning Right from Improper Lane
09 Vehicle Turning Left from Proper Lane
10 Vehicle Turning Left from Improper Lane
11 Vehicle Making "U" Turn
12 Vehicle Turning Right from Driveway
13 Vehicle Turning Left from Driveway
14 Vehicle Turning Right on Red Light
15 Vehicle Engaged in Parking Maneuver
16 Occupant Exiting or Entering Vehicle
17 Vehicle Skidding in Roadway
18 Vehicle Entering Traffic from Ramp
19 Vehicle Changing One Lane to Exit
20 Vehicle Changing More Than One Lane to Exit
21 Vehicle Changing Lane(s) to Left
22 Vehicle Changing Lane(s) to Right
23 Vehicle Changing More Than One Lane from Entrance
24 Vehicle Backing Along Roadway
25 Vehicle Backing Along Shoulder
26 Vehicle Backing into Roadway
27 Vehicle Backing into Driveway or Side Road
28 Vehicle Being Towed or Pushed
29 Vehicle Traveling on Shoulder
30 Vehicle Engaged in Highway Maintenance
31 Traffic Signal
32 Traffic
33 Traffic Sign
34 Traffic Officer
35 Stopped Vehicle
36 Parking
37 Parked Vehicle
38 Train
39 Bicycle
40 Motorcycle
41 Other
42 Emergency Vehicle
43 Turn Right
44 Turn Left
45 Mechanical Failure
46 Previous Accident
47 Construction or Maintenance Work
48 School Bus
49 Pedestrian in Road
50 Animal in Road
51 Foreign Object in Road
52 Unknown Reason

TRAFFIC UNIT #1 **U. PEDESTRIAN MANEUVER** **TRAFFIC UNIT #2**

01 Directing Traffic
02 Working in Road
03 Playing in Road
04 Not in Road
05 Emergency Personnel
06 Crossing at Intersection With Signal
07 Crossing at Intersection Against Signal
08 Crossing at Unsignalized Intersection
09 Crossing Between Intersections
10 Crossing From Behind Parked Vehicle
11 Entering or Exiting Vehicle
12 Waiting for, Exiting or Entering School Bus
13 Walking or Jogging in Road
14 Other or Unknown

V. CONTRIBUTING FACTOR APPLIES TO: 1. Traffic Unit #1; 2. Traffic Unit #2; 3. Traffic Unit #3; etc.

W. CONTRIBUTING FACTOR (Select one only)

01 Driving on Wrong Side of Road
02 Speed Too Fast for Conditions
03 Violated Traffic Control
04 Under the Influence
05 Failed to Grant Right of Way
06 Improper Passing Maneuver
07 Improper Lane Change
08 Following Too Closely
09 Slippery Surface
10 Driver Lost Control
11 Animal or Foreign Object in Road
12 Fell Asleep
13 Defective Equipment
14 Driver Illness
15 Driver's View Obstructed
16 Unsafe Tires
17 Unsafe Use of Highway by Pedestrian
18 Unsafe Right Turn on Red
19 Driverless Vehicle
20 Insufficient Vertical Clearance
21 Proper Turn Signal Not Displayed
22 Disabled or Illegally Parked Vehicle
23 Abnormal Road Condition
24 Vehicle Without Lights
25 Traffic Signal Not Operating
26 Vehicle Involved in Emergency
27 Entered Roadway in Wrong Direction
28 Roadway Width Restricted
29 Unknown
30 Unsafe Backing
31 Improper Turning Maneuver

DATA ELEMENTS BELOW APPLY ONLY TO VEHICLES SUBJECT TO MOTOR CARRIER REGULATION

VEHICLE #1 **X. DEFECTIVE EQUIPMENT** **VEHICLE #2**

1. Brakes; 2. Tires/Wheels; 3. Steering; 4. Suspension/Frame; 5. Lighting; 6. Other; 7. None; 8. Unknown;

VEHICLE #1 **Y. NUMBER OF AXLES INCLUDING TRAILERS** **VEHICLE #2**

VEHICLE #1 **Z. CARGO BODY TYPE** **VEHICLE #2**

1. Bus; 2. Van/Enclosed Box; 3. Cargo Tank; 4. Flatbed; 5. Dump; 6. Concrete Mixer; 7. Auto Transporter; 8. Garbage/Refuse; 9. Other;

VEHICLE #1 **AA. SEQUENCE OF EVENTS** **VEHICLE #2**

EVENT #1 / EVENT #2 / EVENT #3 / EVENT #4 (Vehicle #1) — EVENT #1 / EVENT #2 / EVENT #3 / EVENT #4 (Vehicle #2)

01 Ran off the Road
02 Jackknife
03 Overturn
04 Downhill Runaway
05 Cargo Loss or Shift
06 Explosion or Fire
07 Separation of Units
08 Collision Involving Pedestrian
09 Collision involving Motor Vehicle in Transport
10 Collision involving Parked Motor Vehicle
11 Collision involving Train
12 Collision involving Pedalcycle
13 Collision involving Animal
14 Collision involving Fixed Object
15 Collision involving Other Object
16 Other