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The effects of primary prevention policies on mortality from motor vehicle crashes among children in the U.S.

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ABSTRACT

Introduction: Every year, 4500 children die in motor-vehicle crashes in the United States, with estimated costs of more than $40,000 and $240 billion in productivity losses. The majority of deaths and injuries are associated with improper use of restraint devices, alcohol, high speeds, and built environments. *Methodology*: This is a retrospective study using U.S. panel data from 1997 through 2005. Data sources included the Fatality Analysis Reporting System, the Insurance Institute for Highway Safety, the U.S. Census Bureau, the Atlas of Presidential Elections, and the U.S. Bureau of Labor Statistics. This study used conditional fixed effects negative binomial regression to analyze the effect of the covariates on mortality by state and year. *Results*: A total of 32,893 children died in motor-vehicle crashes (MVCs). States that allowed fines greater than $50 for lack of restraint use experienced significant reductions in mortality as well as states with laws allowing the use of red light cameras. Graduate licensing programs requiring a minimum age of 16 for the intermediate-level experienced mortality reductions as much as 90% compared with a minimum age of 14. Higher posted speeds were associated with higher mortality rates, particularly on local roads. *Conclusion*: This research focuses on the effects injury prevention laws have on mortality, but not on how effectively these laws are implemented and/or enforced. Results may be useful to policy-makers and public health practitioners involved in injury prevention and public health.

1. Introduction

For more than six centuries, unintentional injuries have been labeled "accidents" and "Acts of God," terms with damaging connotations that assigned fault to supernatural forces out of our control and which could not have been foreseen (Grossman, 2000; Loimer, Driur, & Guarnieri, 1996). This view has only recently been challenged in response to the large body of evidence that identifies factors associated with the events in which unintentional injuries occur (Bergen, Chen, Warner, & Fingerhut, 2008; Crandall, Bhalla, & Madeley, 2002; Dahl, 2004; DiMaggio, Durkin, & Richardson, 2006; Durkin, Laroque, Lubman, & Barlow, 1999; Evans, 2003), although the use of the word has been preserved and remains widely used, even among institutions that work directly on injury prevention (Evans & Stoddard, 2003).

Unintentional injuries are the leading cause of death and disability for Americans younger than 44 years of age regardless of race, socioeconomic status, or gender (Bergen et al., 2008) and the fifth leading cause of death for all ages (CDC, 2014). Among children ages 1 to 19, unintentional injury caused by motor-vehicle crashes is the leading cause of death and the second for children younger than one year (MMWR, 2007). Every day five children die and 568 are injured in motor-vehicle crashes in the U.S. alone (NHTSA, 2006), resulting in a child death rate that is more than two times the rate in Sweden, the United Kingdom, Italy, and the Netherlands and the second highest among all other high-income countries (UNICEF, 2001).

The economic burden associated with medical care and rehabilitation and the years of potential life loss are high, especially considering that the majority of these events are largely preventable (CDC, 2007a; Gielen & Sleet, 2003; Grossman, 2000; Runyan, 1998). The majority of the deaths and injuries associated with motor-vehicle crashes involve improper use or lack of use of protective devices, speed, the use of alcohol, and built environments that promote vehicle performance rather than community safety (Dahl, 2004; Durkin et al., 1999; Eberhardt & Pamuk, 2004; Finkelstein, Corso, & Miller, 2006; Grossman, 2000; Peden et al., 2004).

Some estimates indicate that every year 80,000 to 120,000 children are injured and more than 4500 are killed in motor-vehicle crashes in the United States (Retting, Ferguson, & McCartt, 2003). More than 30% of fatalities occurring among children ages 1 through 4 are a result of inappropriate use of child safety seats (NHTSA, 2006; Zaza, Sleet, Thompson, Sosin, & Bolen, 2001). For every child traffic injury fatality in the United States, there are approximately18 hospitalizations and 233 emergency department visits (Grossman, 2000).

Between 1999 and 2005, there were a total of 78,846 deaths due to unintentional injuries among U.S. children between the ages of 1 and 19. Among all children, those ages 15–19 contribute the largest amount to the overall mortality rate, while rates in all age groups have shown a

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decrease during the last decade (Grossman, 2000). Motor-Vehicle Crashes (MVC) are the leading cause of unintentional injury death among children and adolescents in the United States.

Lifetime economic cost from MVC for children and adolescents totals $50 billion, including medical expenses, and account for 9% of total lifetime costs of injuries and 77% of total productivity losses (CDC, 2001, 2007b; Finkelstein et al., 2006). Total injury costs have been estimated at $17,000 per child and overall lost quality of life at more than $250 billion (Danseco, Miller, & Spicer, 2000). Despite the social and economic costs that result, when compared with other conditions, the distribution of funds to control and/or prevent injuries remains distinctively low (DHHS, 2008; Peden et al., 2004).

Unintentional injuries among children and adolescents represent an important public health challenge and also a neglected one. A child's susceptibility to injury depends on physical characteristics, cognitive abilities and development, dependence level, and patterns of behavior, and these factors may change substantially over time (WHO, 2008). Their injury risk is also influenced by the physical world in which they live and play, their family's socioeconomic status, and also by people they depend on for their safety. Children have limited control over the built environment, which the World Health Organization considers "political vulnerability to injury," (Network WROfEHE, 2004) a situation that can be addressed by taking actions through population-based approaches. Efforts on injury prevention can be more successful in reducing the burden of injury if they are part of more comprehensive injury prevention programs. Childhood injuries are events charged with powerful symbolism; children are unable to protect themselves and depend on adults to provide such protections, demanding our attention and action (Kingdon, 2003).

The objective of this research is to evaluate the effects that primary prevention policies, particularly restraint laws, licensing programs, speed cameras, DUI laws, and environmental modification have had on reducing the mortality risk from motor-vehicle crashes involving young children and adolescents in the United States.

2. Materials and methods

This is a retrospective study focused on panel data from 1997 to 2005 in all 50 states and the District of Columbia, analyzing data that represent not only the variations in fatal motor-vehicle injuries among children, but also any patterns over time. Because health policies that focus on injury prevention and control may take several months to years to influence mortality, available data must allow for these trends to be observable and measurable. Data were collected starting from 1997 because the federal speed limit was increased in 1996 from 55 to 65 mph and so it was expected the data would reflect this change. Data were from the Fatality Analysis Reporting System (FARS), the Insurance Institute for Highway Safety (IHHS), the U.S. Census Bureau, the Atlas of Presidential Elections, and the U.S. Bureau of Labor Statistics.

FARS data include crashes that resulted in the death of a motor-vehicle occupant or a non-motorist within 30 days of the crash. IHHS data include enacted laws from all 50 states related to automated enforcement, seatbelt laws, laws focusing on driving-under-the-influence, laws focused on state licensing programs, and legal speed limits. Population estimates for years prior to 2000 came from the Census annual time series of state civilian population estimates by sex and age; data for 2000 and later came from the Census civilian non-institutionalized population estimates from April 2000 to July 2008. The state unemployment rate was used from 1997 through 2005 to account for the differences in the use of motor vehicles, which has been associated with reductions in motor-vehicle injury. Presidential elections data include state-level voter turnout and gubernatorial election results for each state and year of study.

An unconditional fixed-effects negative binomial regression (NB2) and maximum likelihood estimation was used for the data analysis and goodness-of-fit was evaluated for the model using the Pearson dispersion statistic. The model was adjusted so that the outcome can be interpreted in terms of changes in mortality rates, to account for risk exposure for each state's population, and the natural log of the state population for each year was also added as an offset variable.

3. Results

There were a total of 32,893 fatalities from MVCs for children between the ages of 1 and 18, with an average age of 14 years. From all fatalities, 13% occurred in 1997 compared to 8% in 2005, with an average of 1.5 deaths per crash event. All states have laws that require the use of child safety seats, the use of adult belts, and fines for not using child restraints. Child seats were required, on average, up until 5 years of age and adult belts were permissible restraints by age 12. Red light and speed camera use did not change during the study period, although primary enforcement for child safety seat and seatbelt use increased from 33% to 51% by 2005. All states had laws that allowed license suspensions, which lasted an average of 90 days or less (Table 1).

State legislation for alcohol-related offences remained unchanged throughout the study period, with 94% of states allowing the use of interlock systems and 86% restricting open containers for drivers. All states had consistent licensing program laws in place. On average, states required a child to be at least 15 years old to obtain a learner's permit, maintain it for at least 6 months, and complete 40 h or less of supervised driving before upgrading to an intermediate license. Most states allowed night restrictions for intermediate license holders. Less than half restricted intermediate license holders from driving with young but 81% of states had such restrictions for full license holders (Table 1)

Speeds were the highest for rural interstates registered at 70 miles per hour with estimated travel speeds increasing from 79.13 mph in 1997 to 80.6 mph in 2005. On average, MVC fatalities in 1997 were 13.8 year-old males travelling in rural local roads with high-posted speeds (greater than 75 mph), with no violations charged and where no traffic control devices were available. By 2005, the average age for MVC fatalities had increased to 14.3 years. For 1997 and 2005, the typical fatality was travelling in a passenger car on a two-way undivided highway/road with a valid driver's license, undetermined blood alcohol levels, riding in the front seat with no restraint use. In 1997, the typical model vehicle year was built in the 1990s, whereas by 2005 the typical model year was built in the 2000s.

Results from the parameterized NB2 model with sensitivity analysis are included in Table 2. Significant mortality reductions were found in 1999, 2000, and 2005, with 12, 20, and 11% mortality reductions, respectively.

Significant mortality reduction (6%) was found among states that allowed the use of adult safety belts at older ages and fines of more than $50 (46%). A large mortality reduction (62%) was also observed among states with red-light cameras, as well as a significant mortality increase (62%) among states that allowed speed cameras.

There were large decreases in mortality for minimum ages required for intermediate licenses (of as much as 95%) compared with a minimum age of 14. No significant effects on mortality for states that establish night restriction enforcement for intermediate license holders were found, compared with having no restrictions. In contrast, states where night restrictions for full license holders could be lifted before and after age 18 experienced significant mortality reductions of 80% and 86%, respectively.

Mortality increased 87% in roads with posted speeds of 60 mph and 41% in roads with posted speeds of 65 mph, compared with posted speeds of 55 mph, while higher unemployment translated into a mortality reduction of 16%.

Violations for reckless driving and impairment experienced larger reductions (27% and 31%, respectively) compared with no violations

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