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Child Passengers Killed in Reckless and Alcohol-Related Motor Vehicle Crashes

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Abstract

Introduction—About 20 years ago, concern was raised about the dangers children face when driven by drinking drivers in the United States. During the last decade, the pace of research on this topic subsided. Yet in 2010, every day three children younger than age 15 were killed, and 469 were injured in motor-vehicle crashes.

Method—The aim of this effort is to describe the status of the problem in the United States and suggest lines of research. From the Fatality Analysis Reporting System (FARS), we selected crashes in which a driver aged 21 or older was driving at least one child younger than age 15. We identified crashes that occurred at different times of the day in which the driver was speeding, ran a red light, or was alcohol positive. We described the drivers' demographics and examined how they relate to the different crash types.

Results—We found that, although driving a child seems to protect against the studied forms of risky driving, such protection varies sharply depending upon the drivers' and children's demographics and the crash type. There is no clear reason to explain the drivers' decision to endanger the children they drive. The percent of children killed in speeding-related and red-light running motor-vehicle crashes has remained relatively stable during the last decade. Future research must (a) examine the effectiveness of current child endangerment laws; (b) examine crashes other than fatal; and (c) be more targeted, looking at specific drivers' age and gender, specific children's ages, the time of the crash, and the type of crash.

Keywords

Child endangerment; motor-vehicle crashes; alcohol; speeding; red-light running

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1. Introduction

Among the many categories of impaired driving that have been studied and explored over the years, it is surprising that those where children are the victims have received little attention. Yet, according to the National Highway Traffic Safety Administration (Royal, 2000), an estimated 46 to 102 million drunk-driving trips are made every year with children younger than 15 in the vehicle, and 1 in 20 (5%) drinking drivers had at least one passenger younger than 15 on their most recent drink-driving trip. In 2010, every day three children younger than 15 were killed and 469 were injured in the United States in motor-vehicle crashes (MVCs). Those numbers made MVCs the leading cause of death for children aged 0 to 14 in the country (NHTSA, 2012).

In 1986, Margolis and colleagues (1986) conducted one of the earliest studies examining children in alcohol-related MVCs. In reviewing North Carolina's traffic crash data, they found that alcohol use was associated with 7.9% of the MVCs involving children and accounted for 15.4% of the motor-vehicle-related deaths and 10.4% of the injuries. Most (70.6%) of these deaths were child passengers in which the driver had been drinking. Almost a decade later, Margolis and colleagues (2000) used the Fatality Analysis Reporting System (FARS) dataset (1991–1996) to investigate the association between alcohol use by drivers and mortality of children. They found that 3,310 children had died in those years in an alcohol-related MVC. Of these, 66.3% were being transported by a drinking driver. Around the same time, Quinlan and colleagues (2000) examined characteristics of child passenger deaths and injuries involving drinking drivers using FARS data (1985–1996). They found that 5,555 child passenger deaths involved a drinking driver. Of these deaths, 64% occurred while the child was riding with a drinking driver, and 67% of these drinking drivers were old enough to be the caregiver of the child (i.e., about 42.8% of the children died while being driven by an adult who was drinking). Shults later followed up with the data via the Centers for Disease Control and Prevention (CDC, 2004) to examine FARS data from 1997 to 2002. Consistent with their previous results, they found that 68% of children who died in alcohol-related MVCs were transported by a drinking driver.

Almost a decade passed before further research on child fatality rates in alcohol-related motor-vehicle studies (where the driver transporting them was alcohol positive) reemerged. In 2010, Males et al. reexamined FARS data (and the General Estimates System [GES]) from 1998 to 2007 to update and explore the fatality and injury rates of young passengers involved in fatal crashes whose drivers tested positive for alcohol. His study found that, in alcohol-related MVCs, 2,307 children were killed, 7,088 children were injured, and 2,444 children had no or unknown injuries. However, neither Males nor any other researcher (to our knowledge) has recently examined specifically children who died in an alcohol-related MVC where the driver transporting them was drinking. These studies highlight the concern for young children killed in alcohol-related MVCs, particularly those whose drivers are alcohol positive.

Beyond the injuries and fatalities caused by impaired drivers are those related to reckless and/or aggressive driving. According to a recent AAA report (AAA Foundation for Traffic Safety, 2009), approximately 56% of fatal crashes between 2003 and 2007 were attributed to

aggressive driving, with excess speed being the number one factor (30.7%). Statistics specific to child passengers were not found.

In this study, we (a) update the existing research regarding child fatalities in MVCs, specifically those where the driver was drinking while driving or recklessly driving (as indicated by speeding and red-light infractions) and transporting a child, (b) examine trends, and (c) identify gaps in knowledge and needs for future research. This manuscript is organized as follows. Prevalence rates for fatally injured children by both the children's and drivers' age and gender are examined first. Next, we examine the prevalence of drivers' drinking ($BAC > .00$, $BAC \geq .08$), speeding, or red-light running at the time of the crash by the children's age and gender. Time of day and crash type (single-vehicle, multivehicle crash) are then examined. Subsequently, logistic regression was applied to model the joint contribution of drivers' age, gender, and type of the crash to the likelihood a driver was drinking, speeding, or running a red light at the time of the day, and the likelihood that the child was not restrained. Finally, trends in the observed drivers' behaviors are examined.

2. Materials and Methods

2.1 Data Sources

Data used for these analyses came from the 1982–2011 FARS. Maintained by NHTSA, the FARS is a record system for all police-reported MVCs on public roadways that result in the death of at least one road user within 30 days of the event. FARS provides detailed information about each fatally injured driver's gender, age, and level of alcohol consumption. FARS also contains information about the number of vehicles involved in the crash and about the passengers. The FARS data set provides a large representative source of information that allows us to confidently make inferences at the national level and about the changing trends over time.

Given the extensiveness of the FARS data set, we limited our sample by excluding buses, vans, farm equipment, snowmobiles, and construction vehicles. Only passenger vehicles, minivans, pickups, and sports utility vehicles were kept. We also excluded from the file drivers who were mentally challenged, died while driving from a non-driving condition (e.g., a heart attack), police chases, and nonmoving traffic violations. Although information on race/ethnicity is available in the FARS, this information comes from death certificates (i.e., it is available for fatally injured occupants only) and has only been available since 1999 (Hilton, 2006). Therefore, race/ethnicity was not studied in this effort.

2.2 Measures and Analyses

The variables of interest are described in the following paragraphs.

2.2.1 Age—There is ample evidence that the driver's age influences the likelihood of impaired driving (e.g., Kelley-Baker et al., 2013; Voas, Torres, Romano, & Lacey, 2012), with adolescents and the elderly being at a higher risk of crash than other drivers (e.g., Fell, Fisher, Voas, Blackman, & Tippetts, 2009; Kelley Baker, Falb, Voas, & Lacey, 2003; Peck, Gebers, Voas, & Romano, 2008; Romano, Peck, & Voas, 2012b). Because crash risk for drivers younger than age 21 is highly exacerbated by the presence of other teenagers in the

vehicle (e.g., Romano, Kelley-Baker, & Lacey, 2012a) and to avoid confounding the risks associated with teens driving teens with that of adults driving children (the focus of this study), only drivers aged 21 and older transporting a child (passengers younger than aged 15) were included in this study. To systematize the analyses, the following age categories were examined for drivers: 21–24, 25–29, 30–39, 40–49, 50–59, 60 and older. We hypothesized that drivers are more careful in their driving when driving younger children—who may be seen as more vulnerable in the event of a crash—than when driving older children.

2.2.2 Gender—There is also ample evidence that gender affects the overall likelihood of drinking and driving (e.g., Kelley Baker et al., 2003; Kelley-Baker & Romano, 2010; Romano, Kelley-Baker, & Voas, 2008). The role of the driver's gender in shaping the crash risk of his/her child passenger is suspected (Romano et al., 2012a) but severely understudied. We hypothesized that female drivers would be more protective (take less driving risks) than their male counterparts.

2.2.3 Crash Type and Time of Day—There is also ample evidence that single-vehicle crashes, in particular those at nighttime, are more closely associated with impaired driving than any other crash type (e.g., Voas, Romano, & Peck, 2009; Voas et al., 2012). It would therefore be logical to presume that both the crash type and the time of day would affect (mediate and/or modify) the association between the driver, the children, and drinking and driving. On the other hand, it could be hypothesized that drivers of children have different driving patterns than those in the general population. Such possibilities (which have not been studied yet) are examined in this manuscript. To do so, we examined the following timeframes: 6 a.m. to 9:59 a.m.; 10 a.m. to 4:59 p.m.; 5 p.m. to 7:59 p.m., and 8 p.m. to 5:59 a.m.

2.2.4 Alcohol—The FARS also informs about the drivers' blood alcohol concentration (BAC). Alcohol, however, is tested for only a fraction of the drivers. In 1982, only 54% of the fatally injured drivers were tested, and in 2002, that figure climbed to 65% (Hedlund, Ulmer, & Northrup, 2004). For those with no actual measure available, the FARS provides imputed BAC measures developed using a multiple imputation technique by Subramanian (2002). When the driver was not tested for alcohol, we used the imputed measure. A total of 54.2% of the drivers in our dataset have an imputed BAC.

2.2.5 Risky Driving Behaviors Other than Alcohol—Impaired driving per se is not the only way drivers can endanger children. In this effort, we also examined drivers' speeding and failure to obey a red light. We identified speeding-related crashes as suggested in the FARS Analytic Reference Guide (NHTSA, 2010b, page V-81). As such, the comparison group was established by drivers with a proper "Driving Condition Factor" (until the year 2008) or using the variable SPEEDREL (for 2009 and 2010). Following the suggestions in the FARS guide, we also used the "Driving Condition Factor" code to identify drivers who ran a red-light signal. Use of a restraint was indicated by FARS variables MAN_REST and REST_USE, which were used to indicate if the vehicle occupant (either the drivers or the children) were wearing a safety belt at the time of the crash.

2.2.6. Analyses—We conducted descriptive, bivariate statistics to examine dual associations between the variables of interest and logistic regressions to estimate the joint contribution of the factors of interest to the risky outcomes (e.g., BAC .08, speeding, red-light running, restraint nonuse). Annual prevalence was estimated for trend analyses. The different estimates were compared by looking at point estimates and examining their 95% confidence intervals.

3. Results

From 1982 and 2011, the selected FARS file contained information on 28,377 fatally injured passengers aged 0 to 14 who were killed while riding in the same vehicle as a driver aged 21 or older. Table 1 illustrates the age and gender distribution of children and drivers. A significant percentage of the fatally injured children (almost half, 48%) were 5 years old or younger, a finding that might be telling of the frailty of little children, as well as an indication that too many of these children are not properly restrained when ride in a vehicle. Most (more than 80%) of these children aged 0 to 5 years were driven by drivers younger than age 40 years. Relatively few drivers were 50 years of age or older. These findings seem to relate to the typical age of these children's caretakers. Broadly speaking, as the age of the child increases, so does the age of the driver. However, this was not the case for drivers aged 21 to 24 years. The age of the child driven by a 21- to 24-year-old driver followed a "U-shaped" distribution with similar percentages driving 5 and 6-year-olds and 13- and 14-year-olds. This may suggest siblings or younger caretakers (babysitters, etc.) are driving older children. More than half the drivers were women (55.4%); however, this gender difference varied with the child's age. Although women more frequently drove children aged 10 or younger, men more frequently drove children aged 14 (another finding suggesting the need to further examine this group of young drivers and teenagers).

Table 2 examines the prevalence of children fatally injured in an alcohol-related, speeding, or red-light-running MVC over the 29-year period (1982–2011) examined in this study. Approximately 18% of children were killed by an alcohol-positive (BAC>.00) driver, about 80% of them (14.1% of all children) at BAC .08. Next, about 18% of the children were killed by a speeding driver. The similarity of these figures (BAC>.00, BAC .08, and speeding) suggests a close association between alcohol and speeding, as previously indicated by the literature (e.g., NHTSA, 2004). To explore this possibility, we further examined the database and found that 33% of the BAC .08 drivers were also speeding (about 25% of those who sped were at BAC .08), confirming that alcohol and speeding are related behaviors in this study as well.

Table 3 examines the distribution of fatally injured children by drivers' age and gender, separately by the time of day and the crash type. Because of the observed differences in driving behavior by children's age, we also separated the analyses for children aged 0 to 4 and 12 to 14 years. Most of the children (40.4%) were killed between 10 a.m. and 4:59 p.m.--41.5% of younger children aged 0 to 4 compared with 37.1% of children aged 12 to 14. About 43% of all children killed by a female driver died between 10 a.m. and 4:59 p.m., a proportion significantly higher than that for males (36.9%). This association reverses at

nighttime (8 p.m.–5:59 a.m.), with 30.5% of the crashes with a male driver, but only 19.6% of the crashes in with a female driver.

The proportion of crashes occurring at nighttime (8 p.m.–5:59 p.m.) is significantly larger among crashes in which the child was aged 12 to 14 years (28.6%) than when 0 to 4 years (24.2%). This difference increases notably when the driver is young: 41.7% of crashes in which a 12- to 14-year-old child was transported by a 21- to 24-year-old driver occurred between 8 p.m. and 5:59 p.m., a figure significantly higher than the 26.7% of crashes in which a 21- to 24-year-old driver transported a 0- to 4-year-old child. This finding again points to the different behaviors shown by drivers of young and old children, particularly when the driver is 21 to 24 years old.

Table 4 shows the outcome of the logistic regressions modeling the likelihood a driver was at BAC .08, speeding, running a red light, as well as the likelihood the child passenger was wearing a seat belt. We ran these four regressions separately for cases in which the children were aged 0 to 4 and 12 to 14, yielding the eight models shown in Table 4. After adjusting for all variables in the model, gender (being a male driver) remained a significant contributor to the drivers' drinking and driving (BAC .08), speeding, and non-restrained children. This finding gives some support to our hypothesis that female drivers are more protective (take less driving risks) than their male counterparts. Gender was not a significant factor regarding red-light violations though.

Comparisons between the models for children aged 0 to 4 and 12 to 14 allowed us to test the hypothesis that adults drive more carefully when transporting younger children than when transporting older children. We found some evidence in support to this hypothesis. Compared to drivers aged 30 to 39, younger drivers (aged 21 to 24 or 25 to 29) showed higher odds of being at BAC .08, but only when they were transporting children aged 12 to 14. No such age difference was detected when the children were 0 to 4 years old. The evidence in support for this hypothesis is weaker for crashes that are not alcohol related. Young drivers (aged 21 to 24 or 25 to 29) were also more likely to be found speeding than drivers aged 30 to 39, as well as more likely to have the children they were transporting unbuckled, with this age-based difference occurring regardless of the children's age. On the other hand, drivers aged 21 to 24, 25 to 29, or 30 to 39 did not differ in the likelihood of running a red light, either while transporting younger or older children. Further, we found that drivers aged 60 and older who ran a red light tend to put children aged 0 to 4 at a higher fatality risk than younger red-light violators.

The already-discussed possibility that alcohol contributed to speeding, red-light running, and seat-belt nonuse also was explored by including BAC as an explanatory variable in these models (Table 4). Table 4 shows that alcohol (drivers at BAC .08) was the largest contributor to speeding (OR=2.18 and 3.14, for children being transported who were aged 0 to 4 or 12 to 14, respectively) and to finding unbelted children (OR=1.91 and 1.76, respectively). Interestingly, being at BAC .08 was not a significant contributor to red-light running in this study.

The time of day was a significant contributor to drivers' drinking and driving, with the odds of finding a driver at BAC .08 at nighttime (between 8 p.m. and 5:59 a.m.) being 4.63 and 3.54 higher than the odds between 10 a.m. and 4:59 p.m. for drivers who were transporting a child aged 0 to 4 or 12 to 14, respectively. Single-vehicle crashes were also found to be associated with the likelihood of drivers being at BAC .08. The odds of finding an unbelted child were also higher between 8 p.m. and 5:59 a.m., a finding that to some extent confirms the association between alcohol and children not being buckled. Thus, the pattern for the occurrence of alcohol-related crashes in which at least a child was killed seems to follow that of the general population of alcohol-related crashes, which also tend to occur at nighttime and to be associated with seat-belt nonuse. This finding seems to provide evidence for rejecting our hypothesis that drivers of fatally injured children have different driving patterns than the general population of drivers. That is not the case for speeding-related crashes though. Unlike children killed by drinking drivers (at BAC .08) and/or by not wearing a seat belt (which were more likely to occur between 8 p.m. and 5:59 a.m.), children killed by speeding and red-light-running drivers followed a more uniform time distribution. Furthermore, drivers' speeding was found to be a significant contributor to the deaths of children aged 0 to 4 when it occurred during early daytime (between 6 a.m. and 9:59 a.m.) when most children are transported, than at nighttime, when the most speeding-related fatal crashes occur (NHTSA, 2003).

Tables 1 to 4 show a picture in which BAC .08, speeding, red-light running, and seat-belt nonuse contribute to children's fatalities, albeit not in identical ways. Table 5 examines the evolution of these factors over time by looking at the annual percentage of children aged 0 to 14 who were killed by a BAC .08 driver, a speeding driver, and a red-light-running driver. It also shows the percentage of these children who were belted at the time of the crash. The percentage of BAC .08 drivers decreased significantly between 1982 (20.6%) and 1991 (12.8%), remaining statistically unchanged since then. The prevalence of speeding and red-light running remained statistically unchanged over the period under study (the prevalence of speeding seems to be increasing lately, but such increase is not statistically significant). Finally, the prevalence of red-light running also remained constant across the study period, with a slight decrease in the most recent years (but not statistically).

Perhaps the most striking series coming from Table 5 is that showing the evolution of seat-belt use among children. Only about 6% of all the children killed in 1982 were wearing a seat belt. That prevalence was increasing steadily until the about 63% prevalence registered in 2011. Although increasing, it is nevertheless striking that, even in 2011, about 37% of the children in the file were not properly belted.

4. Discussion

One objective of this study was to assess the prevalence of child passengers killed by drivers (21 years and older) who were alcohol positive, as well as child passengers killed by drivers operating their vehicles recklessly. Decade-old research by Quinlan and colleagues, Margolis and colleagues, and Males motivated our interest. We felt this research was past due to be updated and expanded upon to include not just alcohol-involved fatalities, but also

to introduce reckless driving as a potential crash threat to young passengers. Of particular importance to us were the children killed by their own adult drivers.

Despite applying different approaches, our findings were consistent with those by previous authors. Between 1985 and 1996, Quinlan et al. found 5,555 child passenger deaths involved a drinking driver, yielding an average of 463 deaths per year. Of these, 64% occurred while the child was riding with a drinking driver (of which 67% were aged 21 or older). Thus, Quinlan et al. estimated that approximately 198 children were killed annually while being driven by a drinking adult. Our data, spanning a similar period but with an additional decade (1982–2011), revealed about 18% of the 28,377 children were fatally injured by their own drinking driver aged 21 or older. This averages approximately 177 child deaths annually (over 29 years). Thus, after taking into account the additional restrictiveness of our inclusion criteria (e.g., we excluded children killed while riding in buses or vans) and differences in the BAC imputation methods, an important finding of this effort is that the dangers caused by children being driven by drinking drivers have persisted over time.

This study also began to examine characteristics of the crashes and drivers of these fatally injured young passengers. We began by examining the hypothesis that adults drive more carefully when transporting younger versus older children. We assessed this hypothesis by comparing the crash prevalence in this study with those published in the literature for the general population of drivers. We found some evidence in support of this hypothesis. A 2005 NHTSA report (Liu, Chen, Subramanian, & Utter, 2005) estimated that between 1983 and 2002, between 30% and 37% of all MVC fatalities in the United States were speed related, a much larger prevalence than the 18.5% we found in this study. The observed difference in speeding-related crashes seems to suggest that drivers of children do not tend to speed as often as other drivers do. Regarding alcohol, we found that almost 25% of speeding drivers were at BAC .08. Nevertheless, compared with the contribution to alcohol in about 41% of all the speeding-related fatal crashes (Liu et al., 2005), this figure shows again that drinking and driving (BAC .08) is less prevalent among crashes involving a fatally injured children than among fatal crashes in general.

The evidence involving red-light running is less clear. On one hand, the proportion of drivers of fatally injured children who ran a red light (6.7%) seemed to parallel those reported for the general population of drivers: Porter and England (2000) reported that about 7% of all fatal crashes occurred at signalized intersections. On the other hand, the 6.7% of drivers of fatally injured children who ran a red light in our database is lower than the 10.2% 2000–2009 mean proportion reported by the Federal Highway Administration for the general population of drivers (FHWA, not dated).

A more consistent outcome came from the evaluation of the hypothesis that female drivers are more protective (take less driving risks) than their male counterparts. We found support for this hypothesis among crashes related to alcohol (BAC .08 driver), speeding, and unbelted children. As with the previous hypothesis however, the evidence was not conclusive and varied depending on the type of crash under consideration (gender was not a significant factor regarding red-light violations).

We also examined the hypothesis that drivers of children show driving patterns that differ from those shown by the general population of drivers, which yielded mixed results. We found evidence in support of this hypothesis among speeding crashes. Drivers of children who speed tend to commit that violation at different times than those incurred by the general population of drivers. Most speeding crashes in the United States tend to occur between 6 p.m. and 6 a.m. (NHTSA, 2003). When a child is transported, however, speeding crashes tend to occur during the daytime hours, when children are most likely to be transported. Among alcohol-related crashes, however, we found a pattern of occurrence that tends to mimic those in the general population of drivers: the majority of the drivers of children that were at BAC .08 crashed late at night or early morning, periods that correspond with alcohol-related crash statistics for all BAC .08 drivers.

After examining these hypotheses, one significant conclusion emerges: there is a previously unsuspected lack of homogeneity in the patterns of occurrence of crashes involving a fatally injured child. The patterns of crashes involving children varies notably depending on the age of the driver, the gender of the driver, the age of the child, the time of the crash, and the type of crash. Reasons for such heterogeneity are unclear. Although examining these reasons is beyond the scope of this study, several explanations are possible. We speculate that what motivates drivers to drink and drive (or protects them from drinking and driving) while transporting a child might differ depending, at a minimum, on the factors examined in this effort. Further, it could be speculated that speeding and red-light-running violations differ in the way people perceive them as a risk, resulting in some drivers of children being more prone to avoid some traffic violations than others, with such a difference in risk perception varying depending upon the drivers' age and gender, among other reasons. A detailed examination of this heterogeneity (i.e., with databases and/or models other than those applied to this effort) should be pursued by future research efforts.

A second objective of this effort was to examine the evolution of BAC .08, speeding, red-light running, and seatbelt nonuse crashes over time (BAC .08 is the current limit). Our findings show that, similar to previous analyses, these factors showed dissimilar patterns of evolution. Although the prevalence of speeding and red-light running crashes among the drivers of fatally injured children remained statistically unchanged over time, that for BAC .08 and seat-belt nonuse followed an evolution pattern that mimic those for the general population of drivers (i.e., initial decrease and posterior leveling off for BAC .08 rates, continuous decrease for seat-belt nonuse rates). Although an examination of the reasons for such a divergent pattern goes beyond the scope of this effort, this dissimilar evolution suggests once more the need for more honed research efforts. Also of interest is the unchanged evolution in the rates of speeding and red-light running crashes involving fatally injured children. Such a persistent rate suggests the need to revise the effectiveness of current traffic laws and programs, in particular those specifically aimed to protect children (e.g., child endangerment laws).

Finally, how important is the issue of children being endangered by their drivers? Is it worth the research focus we are proposing? At first glance and compared with other problems affecting our society, 978 young fatal victims a year (177 alcohol related) may appear insignificant. The magnitude of the problem increases, however, when we consider that

these deaths only include children killed by their own drivers who are least 21 years old. The number of victimized children would increase further if we consider those killed and/or injured by the unsafe behavior of other drivers. Further, those figures only consider fatally injured children. The addition of nonfatally injured children should add to the relevancy of the problem. Moreover, being involved in a crash could add trauma to a child even if she/he surfaces from the crash physically unharmed. By examining only those children who were killed by their own adult (aged 21+) driver, we only analyzed a small fraction of the problem. This issue deserves some additional attention by researchers and child advocates, as it could be improved upon.

The need for research goes beyond theoretical reasons and straight into policy making. Although in the United States, a battery of child endangerment laws are currently in place, the effectiveness of these laws to protect the safety of children as passengers has not been examined yet. Over the past few decades, the damage caused by this issue has remained relatively unchanged, suggesting that the implementation of child endangerment laws have been ineffective in alleviating the problem. Our trend analyses showed that the evolution of child fatalities over time merely followed changes in the general population (a progressive increase in seat-belt use and a reduction in BAC .08 crashes until the 1990s, followed by lack of progress). The evidence seems to suggest that the current child endangerment laws are ineffective at curbing the problem. The need to address the effectiveness of these policies is profound: with speeding and other reckless driving behaviors on the rise, the number of child fatalities in these types of crashes may grow worse.

This study is not free of limitations. We were limited to the FARS data set. Important variables, including exposure, were not included as data were not available. Further, these numbers only represent the fatally injured and not those injured nonfatally (that is, those in which the child passenger lived even though injured). Further, safety technology developed and deployed in vehicles may be masking additional crashes where children survived but drivers' behaviors (drinking or driving recklessly) may be the same. Despite these shortcomings, we believe that this effort is significant in that it provides further evidence in support of the need for closer, more detailed research on the way our children are endangered.

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Biographies

Tara Kelley-Baker, a Senior Research Scientist with PIRE, has developed and directed several research projects in the fields of drug and alcohol use/abuse prevention and traffic safety. Her recent projects and interests focus on women and youth and include research on drug use, binge drinking, underage drinking, and issues relevant to impaired driving. Currently, she serves as Co-Principal Investigator on 2013 National Roadside Survey and Drug Crash Risk Study. These major efforts establish the estimated incidence of alcohol- and drugged-impaired driving on our nation's roadways and determine the relative risk contribution of alcohol and drugs on crashes. She is also currently Principal Investigator on an NIAAA study examining child endangerment laws as they relate to aggressive and impaired driving. Recently, she served as Principal Investigator on an evaluation of a teen driving parental responsibility program, as well as a study investigating the feasibility of a teen alcohol interlock program. Her interest in this area includes prevention efforts aimed at reducing the large number of US citizens killed each year in drunk-driving crashes. These studies have contributed to the debate influencing legislative changes concerning drunk-driving laws in our nation.

Eduardo Romano is a Senior Research Scientist at PIRE in Calverton, Maryland. His past work involved estimating the incidence and cost of national and state intentional and unintentional injuries, and the evaluation of Mexican policies aimed to deter binge drinking by young American visitors in Tijuana (Mexico). As a Principal Investigator (PI), he has participated in NIH-funded efforts to evaluate the involvement in crash-risk situations of women and different minority groups, as well in a NHTSA-funded project to study the involvement in traffic violations of recent immigrants to the United States. He is currently the PI in a NIH-funded project looking at estimating alcohol-related and drug-related relative risks and on an OJJDP project to study the impact of alcohol-related laws and policies on teens' impaired driving. Dr. Romano holds a Ph.D. in Agricultural and Applied Economics from the Virginia Polytechnic Institute and State University.

Highlights

- Drivers are less likely to drive recklessly when driving a child.
- The patterns of crashes involving children varies notably depending on the age of the driver, the gender of the driver, the age of the child, the time of the crash, and the type of crash.
- Reasons for such heterogeneity are unclear.
- The number of child fatalities in motor-vehicle crashes has remained stable over the last decade.
- Such stability occurs despite the enactment of laws and policies to deter child endangerment.

Table 1

Number and percentage of fatally injured children (aged 0–14) by drivers' age and gender 1982–2011

Children Age (years)	N	Drivers' age group					Drivers' gender	
		21–24	25–29	30–39	40–49	50–59	60+	Female
<1	2,606	31.2%	27.9%	26.9%	7.9%	3.8%	2.2%	54.8%
1	2,145	29.2%	28.6%	29.2%	7.9%	3.1%	1.9%	55.9%
2	2,196	25.8%	29.9%	29.3%	9.1%	3.5%	2.4%	58.0%
3	2,352	21.9%	29.9%	33.0%	8.4%	3.7%	3.1%	57.1%
4	2,257	18.2%	28.5%	35.7%	10.7%	3.7%	3.1%	59.6%
5	2,079	13.7%	28.7%	38.0%	12.4%	4.2%	3.0%	58.4%
6	1,854	10.2%	26.2%	43.0%	12.7%	4.3%	3.7%	57.2%
7	1,816	6.6%	23.6%	45.6%	14.9%	5.2%	4.0%	57.9%
8	1,801	5.6%	20.9%	45.9%	18.0%	5.3%	4.3%	56.0%
9	1,656	4.9%	16.4%	48.2%	19.0%	6.5%	5.1%	55.8%
10	1,545	4.2%	11.8%	49.2%	22.7%	7.1%	5.0%	54.7%
11	1,502	5.7%	10.2%	46.2%	25.8%	7.1%	5.1%	52.9%
12	1,509	7.0%	7.9%	43.5%	29.1%	7.0%	5.5%	50.5%
13	1,458	10.3%	9.5%	37.7%	28.9%	8.1%	5.6%	49.4%
14	1,601	16.7%	9.2%	33.5%	28.4%	7.4%	4.9%	46.1%
Children's Gender								
Male	14,361	15.5%	22.2%	38.1%	15.4%	5.0%	3.8%	51.7%
Female	13,990	15.4%	21.8%	37.9%	16.1%	5.1%	3.6%	59.1%
All children	28,377	15.4%	22.0%	38.0%	15.8%	5.0%	3.7%	55.4%

N denotes total number of children at each age

Table 2

Fatally injured children (by age and gender). Percentage killed by a BAC>.00, BAC .08, speeding, and red-light violator driver, 1982–2011

Child's Age (years)	N	Drivers' BAC>.00			Drivers' BAC .08			Drivers' Speeding			Drivers' Red Light		
		%	95% LCI	95% UCI	%	95% LCI	95% UCI	%	95% LCI	95% UCI	%	95% LCI	95% UCI
<1	2,606	17.8%	16.3%	19.3%	13.6%	12.3%	14.9%	16.3%	14.9%	17.8%	6.5%	5.6%	7.5%
1	2,145	17.5%	15.9%	19.1%	13.6%	12.1%	15.0%	18.1%	16.4%	19.7%	4.9%	4.0%	5.9%
2	2,196	20.5%	18.8%	22.2%	16.4%	14.8%	17.9%	19.4%	17.8%	21.1%	6.2%	5.2%	7.3%
3	2,352	20.1%	18.5%	21.8%	15.5%	14.1%	17.0%	19.4%	17.8%	21.0%	7.7%	6.6%	8.7%
4	2,257	17.9%	16.3%	19.5%	14.1%	12.7%	15.6%	17.9%	16.3%	19.5%	7.9%	6.8%	9.0%
5	2,079	17.2%	15.6%	18.8%	13.7%	12.2%	15.2%	17.3%	15.7%	18.9%	7.2%	6.1%	8.3%
6	1,854	16.5%	14.8%	18.2%	12.7%	11.2%	14.2%	18.6%	16.9%	20.4%	5.9%	4.9%	7.0%
7	1,816	18.3%	16.5%	20.1%	14.3%	12.7%	15.9%	16.6%	14.9%	18.4%	6.9%	5.8%	8.1%
8	1,801	17.1%	15.4%	18.9%	13.1%	11.5%	14.6%	16.0%	14.3%	17.7%	7.0%	5.8%	8.2%
9	1,656	15.6%	13.8%	17.3%	12.5%	10.9%	14.1%	17.0%	15.2%	18.8%	6.8%	5.6%	8.0%
10	1,545	16.2%	14.3%	18.0%	12.4%	10.8%	14.1%	17.2%	15.3%	19.0%	6.1%	5.0%	7.3%
11	1,502	16.2%	14.3%	18.0%	12.4%	10.7%	14.1%	17.8%	15.8%	19.7%	7.3%	5.9%	8.6%
12	1,509	18.6%	16.6%	20.5%	14.9%	13.1%	16.7%	21.1%	19.0%	23.1%	6.1%	4.9%	7.3%
13	1,458	19.5%	17.5%	21.5%	14.9%	13.1%	16.7%	22.7%	20.5%	24.8%	7.5%	6.2%	8.9%
14	1,601	21.4%	19.4%	23.4%	16.6%	14.8%	18.5%	25.1%	23.0%	27.3%	6.2%	5.1%	7.4%
Child's Gender													
Male	14,361	19.3%	18.6%	19.9%	15.0%	14.4%	15.5%	19.1%	18.5%	19.8%	6.7%	6.2%	7.1%
Female	13,990	16.8%	16.2%	17.5%	13.2%	12.6%	13.7%	18.0%	17.3%	18.6%	6.8%	6.3%	7.2%
All children	28,377	18.1%	17.6%	18.5%	14.1%	13.7%	14.5%	18.5%	18.1%	19.0%	6.7%	6.4%	7.0%

BAC stands for Blood Alcohol Concentration. For each driver condition, “%” indicates percentage of “N”; 96 LCI and 95 UCI denote 95% confidence interval, respectively.

Table 3
Age distribution of fatally injured children and their drivers' age and gender by time of the crash and crash type, 1982–2011

Children's Age	Drivers' Age & Gender	N	Time of the day										Crash Type							
			6 AM–9:59 AM			10 AM–4:59 PM			5 PM–7:59 PM			8 PM–5:59 AM			Single Vehicle			Multivehicle		
			%	95%LCI	95%UCI	%	95%LCI	95%UCI	%	95%LCI	95%UCI	%	95%LCI	95%UCI	%	95%LCI	95%UCI	%	95%LCI	95%UCI
0–4	21–24	2930	16.0%	14.7%	17.4%	38.9%	37.1%	40.6%	18.4%	17.0%	19.8%	26.7%	25.1%	28.3%	6.3%	5.4%	7.2%	93.7%	92.8%	94.6%
	25–29	3347	13.5%	12.4%	14.7%	39.5%	37.8%	41.1%	21.4%	20.0%	22.8%	25.6%	24.1%	27.1%	6.3%	5.5%	7.1%	93.7%	92.9%	94.5%
	30–39	3556	13.4%	12.3%	14.6%	42.7%	41.0%	44.3%	21.1%	19.8%	22.5%	22.8%	21.4%	24.1%	5.9%	5.1%	6.6%	94.1%	93.4%	94.9%
	40–49	1016	15.5%	13.2%	17.7%	43.8%	40.8%	46.9%	18.8%	16.4%	21.2%	21.9%	19.4%	24.5%	7.3%	5.8%	9.1%	92.7%	90.9%	94.2%
	50–59	413	11.9%	8.8%	15.0%	48.9%	44.1%	53.7%	16.7%	13.1%	20.3%	22.5%	18.5%	26.6%	5.6%	3.4%	7.8%	94.4%	92.2%	96.6%
	60+	294	12.6%	8.8%	16.4%	59.2%	53.6%	64.8%	15.6%	11.5%	19.8%	12.6%	8.8%	16.4%	6.5%	3.7%	9.3%	93.5%	90.7%	96.4%
12–14	Male	4964	11.1%	10.2%	12.0%	36.8%	35.5%	38.2%	21.6%	20.5%	22.8%	30.5%	29.2%	31.7%	5.9%	5.3%	6.6%	94.1%	93.4%	94.7%
	Female	6591	16.6%	15.7%	17.5%	45.0%	43.9%	46.3%	18.8%	17.9%	19.7%	19.6%	18.6%	20.5%	6.5%	5.9%	7.1%	93.5%	92.9%	94.1%
	All	11556	14.2%	13.6%	14.9%	41.5%	40.6%	42.4%	20.0%	19.3%	20.8%	24.2%	23.5%	25.0%	6.2%	5.8%	6.7%	93.8%	93.3%	94.2%
	21–24	523	7.3%	5.0%	9.5%	28.5%	24.6%	32.4%	22.6%	19.0%	26.1%	41.7%	37.5%	45.9%	8.2%	5.9%	10.6%	91.8%	89.4%	94.1%
	25–29	404	11.6%	8.5%	14.8%	32.9%	28.3%	37.5%	19.3%	15.5%	23.2%	36.1%	31.5%	40.8%	9.4%	6.6%	12.3%	90.6%	87.8%	93.4%
	30–39	1742	14.1%	12.5%	15.8%	35.2%	33.0%	37.4%	21.7%	19.8%	23.6%	29.0%	26.9%	31.1%	7.7%	6.4%	9.0%	92.3%	91.1%	93.6%
	40–49	1315	13.4%	11.5%	15.2%	40.6%	38.0%	43.3%	20.5%	18.3%	22.6%	25.6%	23.2%	27.9%	9.5%	7.9%	11.1%	90.5%	88.9%	92.1%
	50–59	341	17.0%	13.0%	21.0%	43.7%	38.4%	49.0%	19.9%	15.7%	24.2%	19.4%	15.2%	23.6%	8.8%	5.8%	11.8%	91.2%	88.2%	94.2%
	60+	243	13.2%	8.9%	17.4%	49.0%	42.7%	55.3%	23.9%	18.5%	29.2%	14.0%	9.6%	18.4%	5.8%	2.8%	8.7%	94.2%	91.3%	97.2%
	Male	2348	10.9%	9.6%	12.1%	35.3%	33.4%	37.2%	20.1%	18.5%	21.8%	33.7%	31.8%	35.6%	8.2%	7.1%	9.3%	91.8%	90.7%	92.9%
	Female	2220	15.4%	13.9%	16.9%	39.1%	37.1%	41.1%	22.3%	20.6%	24.1%	23.2%	21.4%	24.9%	8.7%	7.5%	9.8%	91.3%	90.2%	92.5%
	All	4568	13.1%	12.1%	14.1%	37.1%	35.8%	38.6%	21.2%	20.0%	22.4%	28.6%	27.3%	29.9%	8.4%	7.6%	9.2%	91.6%	90.8%	92.4%
All	21–24	4379	14.5%	13.5%	15.5%	37.4%	36.0%	38.8%	19.7%	18.5%	20.9%	28.4%	27.1%	29.7%	6.9%	6.1%	7.6%	93.1%	92.4%	93.9%
	25–29	6245	14.2%	13.3%	15.1%	39.2%	38.0%	40.4%	21.4%	20.4%	22.4%	25.2%	24.1%	26.3%	7.2%	6.6%	7.9%	92.8%	92.2%	93.4%
	30–39	10793	14.2%	13.6%	14.9%	39.7%	38.8%	40.6%	21.8%	21.0%	22.6%	24.2%	23.4%	25.1%	6.5%	6.1%	7.0%	93.5%	93.0%	94.0%
	40–49	4471	14.4%	13.3%	15.4%	41.4%	40.0%	42.8%	20.2%	19.1%	21.4%	24.0%	22.8%	25.3%	8.5%	7.7%	9.4%	91.5%	90.6%	92.3%
	50–59	1433	14.0%	12.2%	15.8%	46.1%	43.5%	48.6%	18.9%	16.9%	20.9%	21.0%	18.9%	23.1%	6.9%	5.6%	8.2%	93.1%	91.8%	94.4%

Children's Age	Drivers' Age & Gender	N	Time of the day												Crash Type											
			6 AM–9:59 AM				10 AM–4:59 PM				5 PM–7:59 PM				8 PM–5:59 AM				Single Vehicle				Multivehicle			
			%	95%LCI	95%UCI		%	95%LCI	95%UCI		%	95%LCI	95%UCI		%	95%LCI	95%UCI		%	95%LCI	95%UCI		%	95%LCI	95%UCI	
	60+	1056	12.4%	10.4%	14.4%	56.1%	53.1%	59.1%	18.2%	15.9%	20.5%	13.4%	11.3%	15.4%	6.6%	5.2%	8.3%	93.4%	91.7%	94.8%						
	Male	12666	11.1%	10.5%	11.6%	36.9%	36.1%	37.8%	21.5%	20.8%	22.2%	30.5%	29.7%	31.3%	6.8%	6.4%	7.3%	93.2%	92.7%	93.6%						
	Female	15710	16.7%	16.2%	17.3%	43.3%	42.5%	44.1%	20.4%	19.7%	21.0%	19.6%	19.0%	20.3%	7.3%	6.9%	7.7%	92.7%	92.3%	93.2%						
	All	28377	14.2%	13.8%	14.6%	40.4%	39.9%	41.0%	20.9%	20.4%	21.4%	24.5%	24.0%	25.0%	7.1%	6.8%	7.4%	92.9%	92.6%	93.2%						

Percent estimates are row percent (i.e., based on “N”). Time of the day denote the hour : minutes in which each time period starts and ends. Children’s age 0–4 and 12–14 denote children who were younger than 5 years old and aged 12–14, respectively. The group “All” includes all children in the study. 95% LCI and 95% UCI denote the lower 95% confidence interval, and the upper 95% confidence interval, respectively

Table 4

Outcome of eight logistic regression models. Odds Ratio (OR) and 95% confidence interval for variables modeling the likelihood a fatally injured child (separately for those aged 0–4 or 12–14) who was driven by a BAC .08 driver, a speeding driver, a red-light-running driver, or who was wearing a seat belt.

	BAC .08				Speeding				Red-Light Running				Children Not Wearing a Seat Belt			
	Model I: ages 0–4		Model II: ages 12–14		Model III: ages 0–4		Model IV: ages 12–14		Model V: ages 0–4		Model VI: ages 12–14		Model VII: ages 0–4		Model VIII: ages 12–14	
	OR	LCI	UCI	OR	LCI	UCI	OR	LCI	OR	LCI	OR	LCI	OR	LCI	OR	LCI
Driver Gender: Male	1.75	1.52	2.02	1.72	1.38	2.14	1.18	1.07	1.30	1.31	1.12	1.52	0.87	0.74	1.01	0.89
<i>Ref: Female</i>																
Driver Age: 21–24	1.04	0.87	1.25	1.32	1.01	1.73	1.35	1.19	1.53	1.91	1.53	2.39	1.05	0.86	1.27	1.36
Driver Age: 25–29	1.06	0.88	1.28	1.59	1.17	2.15	1.21	1.07	1.37	1.80	1.42	2.30	1.00	0.83	1.21	1.11
Driver Age: 40–49	0.81	0.64	1.03	0.59	0.46	0.76	0.84	0.69	1.02	0.73	0.60	0.88	0.97	0.73	1.29	0.78
Driver Age: 50–59	0.59	0.38	0.94	0.43	0.27	0.69	0.67	0.49	0.92	0.61	0.44	0.85	1.03	0.69	1.55	0.89
Driver Age: 60+	0.37	0.17	0.77	0.26	0.10	0.63	0.53	0.35	0.79	0.63	0.43	0.93	1.65	1.11	2.45	1.41
<i>Ref: 30–39</i>																
BAC .08							2.18	1.87	2.54	3.14	2.53	3.89	1.09	0.86	1.39	0.97
<i>Ref: BAC<.08</i>																
6:00 AM–9:59 AM	0.78	0.58	1.04	0.59	0.34	1.03	1.19	1.03	1.38	1.13	0.89	1.43	1.03	0.83	1.27	0.86
5:00 PM–7:59 PM	2.33	1.96	2.77	1.82	1.34	2.47	0.97	0.85	1.11	0.98	0.80	1.19	0.73	0.59	0.89	1.03
8:00 PM–5:59 AM	4.63	3.86	5.56	3.54	2.74	4.58	0.96	0.85	1.10	0.78	0.65	0.95	0.67	0.54	0.82	0.59
<i>Ref: 10:00 AM–4:59 PM</i>																
Multi-Vehicle Crash	0.64	0.50	0.82	0.60	0.43	0.85	0.39	0.33	0.46	0.48	0.38	0.60	3.74	2.19	6.39	14.55
<i>Ref: Single-Vehicle</i>																
													1.52	1.79	58.71	3.61
													2.10	0.90	1.15	

BAC stands for Blood Alcohol Concentration. LCI and UCI denote the lower and upper 95% confidence interval limits. Each of the eight columns represents a different model. The independent model is indicated in the first row. The second row indicates the age of the children who were included in the model.

Table 5

Fatally injured children. Annual percentage killed by a BAC .08, speeding, and red-light violator drivers. Percentage properly belted. 1982–2011

year	BAC .08			Speeding			Red Light			Seat Belt		
	%	LCI	UCI	%	LCI	UCI	%	LCI	UCI	%	LCI	UCI
1982	20.6	18.0%	23.2%	18.5	16.1%	21.0%	6.6	5.0%	8.2%	5.9	4.3%	7.6%
1983	22.6	19.7%	25.4%	18.1	15.5%	20.7%	5.2	3.7%	6.8%	10.7	8.5%	13.0%
1984	21.3	18.6%	24.1%	18.7	16.0%	21.3%	7.5	5.8%	9.3%	15.2	12.6%	17.9%
1985	17.2	14.7%	19.6%	17.1	14.7%	19.5%	8.1	6.3%	9.9%	20.2	17.4%	23.0%
1986	15.1	12.8%	17.5%	17.2	14.7%	19.7%	9.2	7.3%	11.0%	23.2	20.3%	26.2%
1987	14.6	12.3%	16.8%	17.8	15.3%	20.2%	5.8	4.3%	7.3%	28.5	25.5%	31.6%
1988	17.5	15.1%	19.9%	17.8	15.4%	20.2%	6.9	5.3%	8.5%	30.7	27.7%	33.8%
1989	14.3	12.1%	16.5%	18.1	15.7%	20.5%	8.9	7.2%	10.7%	29.9	26.9%	32.8%
1990	17.7	15.2%	20.3%	18.5	15.9%	21.1%	9.1	7.2%	11.0%	31.1	27.9%	34.4%
1991	12.8	10.8%	14.9%	17.0	14.8%	19.3%	7.7	6.1%	9.3%	33.4	30.4%	36.3%
1992	12.8	10.8%	14.9%	17.3	15.0%	19.7%	8.7	7.0%	10.4%	35.1	32.1%	38.2%
1993	13.9	11.8%	16.0%	17.3	15.0%	19.6%	7.8	6.2%	9.4%	38.0	34.9%	41.0%
1994	14.1	12.1%	16.2%	15.5	13.4%	17.6%	7.9	6.3%	9.4%	43.7	40.6%	46.7%
1995	10.9	9.1%	12.7%	20.7	18.3%	23.0%	8.7	7.1%	10.3%	42.8	39.8%	45.8%
1996	13.9	11.8%	15.9%	17.1	14.9%	19.2%	6.2	4.8%	7.6%	47.1	44.0%	50.1%
1997	11.3	9.4%	13.1%	17.8	15.6%	20.0%	6.5	5.1%	7.9%	45.5	42.5%	48.5%
1998	11.4	9.6%	13.3%	17.6	15.4%	19.8%	6.7	5.3%	8.2%	46.4	43.3%	49.4%
1999	14.6	12.5%	16.8%	17.7	15.4%	20.0%	5.6	4.2%	6.9%	45.9	42.8%	49.0%
2000	11.7	9.8%	13.7%	18.3	15.9%	20.6%	7.0	5.4%	8.5%	53.1	49.9%	56.2%
2001	12.9	10.9%	15.0%	17.3	15.0%	19.6%	7.7	6.1%	9.3%	51.6	48.5%	54.8%
2002	14.1	11.9%	16.3%	19.4	16.9%	21.8%	6.3	4.8%	7.8%	53.3	50.0%	56.5%
2003	10.5	8.6%	12.4%	19.2	16.8%	21.6%	3.4	2.3%	4.6%	50.6	47.5%	53.8%
2004	12.4	10.4%	14.5%	18.8	16.5%	21.2%	6.5	5.0%	8.0%	53.2	50.1%	56.4%
2005	14.2	12.0%	16.4%	20.1	17.6%	22.7%	6.6	5.0%	8.1%	57.3	54.1%	60.6%
2006	11.9	9.8%	14.1%	21.8	19.0%	24.5%	3.8	2.6%	5.1%	59.0	55.6%	62.3%
2007	11.5	9.3%	13.7%	22.0	19.2%	24.9%	5.6	4.0%	7.2%	57.8	54.2%	61.3%
2008	10.7	8.3%	13.1%	21.9	18.7%	25.2%	4.6	3.0%	6.3%	58.3	54.3%	62.3%

year	%	BAC .08			Speeding			Red Light			Seat Belt		
		LCI	UCI	%	LCI	UCI	%	LCI	UCI	%	LCI	UCI	%
2009	10.7	8.3%	13.1%	22.2	19.0%	25.4%	4.3	2.7%	5.8%	57.6	53.7%	61.6%	
2010	15.6	12.7%	18.5%	21.9	18.6%	25.2%	3.7	2.2%	5.2%	63.0	59.1%	67.0%	
2011	11.3	8.8%	13.9%	19.3	16.1%	22.5%	4.3	2.6%	5.9%	62.8	58.7%	66.9%	

BAC stands for blood alcohol concentration. For each driver condition, LCI and UCI denote 95% confidence interval.