Comparison of Teen Driver Fatality Rates by Vehicle Type in the United States

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Abstract

Objectives: To compare national fatality rates for teen drivers by vehicle type.

Methods: Fatality rates were calculated for 16- to 19-year-old drivers by vehicle type using data from the Fatal Analysis Reporting System (1999–2003) and estimates of miles driven from the National Household Transportation Survey (2001). Relative fatality risks for teen drivers of sports utility vehicles (SUVs) and pickups were calculated using passenger cars as a reference.

Results: Per vehicle mile driven, the fatality risk for both male and female teens driving SUVs was decreased relative to passenger car drivers (male teens: relative risk [RR], 0.33 [95% confidence interval [CI] = 0.29 to 0.37]; female teens: RR, 0.45 [95% CI = 0.34 to 0.59]). Fatality rates for male teens driving pickups were also lower per mile driven compared with male passenger car drivers (RR, 0.55 [95% CI = 0.51 to 0.60]). Fatality rates for female teens driving pickups and passenger cars were not statistically different but appear potentially higher for pickups (RR, 1.19 [95% CI = 0.98 to 1.44]). Both SUVs and pickups demonstrated significantly higher rates of fatal rollovers than passenger cars. Female adolescent drivers of SUVs and pickups were at particularly high risk for fatal rollovers per vehicle mile driven compared with passenger cars (SUV: RR, 1.88 [95% CI = 1.19 to 2.96]; pickup: RR, 3.42 [95% CI = 2.29 to 5.10]).

Conclusions: Fatality rates for teen drivers vary significantly by vehicle type. From 1999 to 2003 in the United States, fatal rollovers were significantly more likely per mile driven for teen drivers of both SUVs and pickups compared with passenger cars. However, overall fatality rates (i.e., all crash types) for teen drivers of SUVs and male drivers of pickups were lower per mile driven than for teen drivers of passenger cars. The results of this ecological analysis cannot predict the individual-level fatality risk for teens driving different vehicle types. However, the significant variability in fatality rates among SUVs, pickups, and passenger cars seen at a population level suggests that vehicle choice should be further explored as a potentially modifiable risk factor in interventions to address teen driver safety.

ACADEMIC EMERGENCY MEDICINE 2007; 14:850–855 © 2007 by the Society for Academic Emergency Medicine

Keywords: traffic accidents, injuries, trauma, prevention, adolescents, teens

Motor vehicle crashes are the leading cause of death for adolescents in the United States.[1] Teens are particularly at risk while driving; in 2004, more than 3,500 drivers aged 15–20 years died, and more than 300,000 were injured in motor vehicle crashes.[2] Per vehicle mile driven, teenagers are involved in four to eight times the fatal crashes of mature drivers.[3] While teen drivers often simply fall prey to their own immaturity and inexperience, nighttime driving and driving with teen passengers are specific risk factors for driver fatality.[4,5]

The type of vehicle available for use by a teen driver (passenger car, sports utility vehicle [SUV], or pickup) may also affect his or her likelihood of a fatal crash. Parents of teen drivers often underestimate safety differences between vehicles, and frequently base decisions regarding choice of vehicles for their children on factors other than safety.[6] Larger vehicles, such as most SUVs and pickups, are protective to their drivers in common crash types such as frontal and side impacts.[7–9] However, many of these same vehicles have low static stability (track width divided by twice the height of center of gravity)[10] that increases their likelihood of rollover,[11,12] particularly in the hands of an inexperienced driver.[13]

Rollovers account for only a minority of all motor vehicle crashes yet receive considerable attention due to their high fatality rate for involved occupants[10,14] and thus

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Received April 30, 2007; revisions received June 20, 2007, and June 21, 2007; accepted June 22, 2007.

The authors do not have any financial or other conflicts of interest to disclose.

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ISSN 1069-6563
PII ISSN 1069-6563583

doi: 10.1197/j.aem.2007.06.038

their disproportionate contribution to annual traffic fatalities.[13] The increased rollover risk for SUVs and pickups appears to largely neutralize their protective characteristics for adult drivers,[15,16] but the effect among teen drivers remains unclear. Previous analyses of driver fatality rates by vehicle type have generally used registration data (insured person–years) as a measure of driving exposure.[15,16] Unlike direct measures of exposure (such as vehicle miles driven), this method allows only limited differentiation between the travel patterns of adolescents and adults.[17,18]

Our objective was to compare teen driver fatality rates by vehicle type (SUV, pickup, and passenger car) in the United States. This study adds to existing literature and informs the ongoing debate regarding optimal vehicle choice for adolescents through its use of nationally representative fatal motor vehicle crash data and direct estimates of vehicle miles driven specific to 16 to 19 year olds.

METHODS

Study Design

We performed a retrospective analysis of fatal crashes involving drivers aged 16 to 19 years in passenger cars, SUVs, and pickups, adjusted for exposure as measured by vehicle miles driven. Because vehicle choice for teens is primarily in the hands of their parents, we chose to conduct our analysis solely from a parental perspective (i.e., safety of teen drivers themselves) rather than a societal perspective (i.e., considering the safety of other teen occupants or occupants of other vehicles). Parents may consider the impact of vehicle choice for their teen on the safety of other individuals to some degree. However, we believe the main concern for families is likely to be their teen's safety. Thus, we focused in this work on teen drivers alone.

Motor vehicle crash data and estimates of vehicle miles driven by teen drivers were obtained from two publicly available governmental databases: the Fatality Analysis Reporting System (FARS)[19] and the National Household Transportation Survey (NHTS).[20] The study was deemed exempt from consent by the institutional review boards of the University of Michigan and The George Washington University.

Study Setting and Population

FARS is a census of all motor vehicle crashes in the United States resulting in at least one death within 30 days of the crash.[19] The database is maintained by the Department of Transportation and includes information regarding involved vehicles and persons as well as circumstances of the crash. Data on crashes fatal to drivers aged 16–19 years were obtained from FARS for 1999–2003.

NHTS is a national, nonclustered, random-digit telephone survey conducted periodically by the Department of Transportation to provide a comprehensive measure of transportation patterns in the United States.[20] The most recent NHTS, performed in 2001, collected data on 26,038 households (60,282 individuals) between March 2001 and May 2002. Data collection consists of three phases. An initial interview documents all individuals and available vehicles in the household. The household is also assigned a 24-hour "travel day" and mailed a diary to record all trips taken during this time. Individual interviews are conducted with each person in the household to document specifics of their travel. Finally, odometer readings are recorded for each family vehicle before and after the interviews. The NHTS data sets include probability weights that incorporate several stages of nonresponse and noncoverage adjustment (using 2000 U.S. national census data) to reduce sampling error and bias. Replicate weights are also included to allow calculation of standard errors that account for the complex design of the survey. A full description of the NHTS sampling scheme and weighting procedure is available online at http://nhts.ornl.gov.

Data Analysis

Simple statistics, including frequencies, means, and proportions, were calculated as appropriate for both FARS and NHTS data sets. Preliminary analysis suggested that the proportion of miles driven by teens in each vehicle type varied by gender. Chi-square statistics were utilized to formally test this difference.

Driver fatality rates, defined as teen driver fatalities per 100 million vehicle miles driven, were calculated using motor vehicle crash mortality data stratified by vehicle type and gender (e.g., total male adolescents killed while driving an SUV ÷ total miles driven in SUVs by male adolescents). In an effort to create more robust fatality rate estimates, five consecutive years of FARS data (1999–2003) were utilized. However, because NHTS is only repeated periodically (every five to seven years), we were unable to calculate specific estimates of miles driven for each year in this sample frame. Therefore, we used estimates of miles driven from the most recent NHTS (2001) as the estimates of travel exposure for each year of the 1999–2003 FARS data. Following precedent,[21] our choice of FARS data "centered" on the 2001 NHTS data (i.e., FARS data from the same year as the most recent NHTS ±2 years) was an attempt to average any changes in travel behavior that may have occurred during that five-year period.

Fatality rates due only to rollover crashes per vehicle mile driven were also calculated for each vehicle type and gender group to estimate the contribution of this crash type to each vehicle's overall fatality rate. SUDAAN software[22] was used to calculate standard errors for weighted estimates of vehicle miles driven to account for the complex sampling design of the NHTS. SAS[23] software was used to calculate driver death rates.

Adjustment of fatality rates must be judicious in this type of analysis, because the only method of "controlling" for covariates is stratification or subsetting of both the numerator and the denominator by the same factor of interest. As noted previously, we chose to control for gender via stratification due to the well-documented disparity between male and female adolescent fatality rates from motor vehicle crashes.[24] In addition, we also attempted to reduce variation in vehicle age among passenger cars, SUVs, and pickups in our final sample. The popularity of SUVs is a relatively new phenomenon. The average age of SUVs on the road is more than two years younger than the average age of passenger vehicles and more than three years younger than the average pickup.[25] Older vehicles, particularly those more than ten years old, confer a higher risk of serious injury and death than newer vehicles when involved in a crash.[26] Because both FARS and NHTS include data on vehicle age, we were able to limit both the numerator (FARS) and denominator (NHTS) to "younger" vehicles (less than ten years) for calculation of fatality rates. Limiting the analysis sample in this way decreased the variation in vehicle age between vehicle types significantly. In our final sample, the mean age of passenger cars driven by teens was 5.5 years (95% confidence interval [CI] = 5.3 to 5.6). The mean age for SUVs was 6.1 years (95% CI = 5.5 to 6.7), and the mean age for pickups was 4.9 years (95% CI = 4.6 to 5.1). Further stratification and/or subsetting of data to control for additional factors were not possible due to NHTS sample size limitations.

In NHTS, vehicles identified by the variable "transportation mode on trip" as cars (01), SUVs (03), and pickup trucks (04) were included. FARS includes "body types" (e.g., two-door sedan, hardtop, coupe, and so on) but does not contain broad vehicle type categories corresponding to those in NHTS. Therefore, vehicles in FARS were selected for inclusion in the analysis and categorized by body type according to the following scheme: passenger cars (body types 1–9), SUVs (body types 14–16, 19), and pickups (body types 30–33, 39). Vans (body types 20–22, 28–29), buses, commercial vehicles, medium/heavy trucks (>10,000 lb), and vehicles modified for work were excluded from both data sets. Rollovers were defined in FARS as crashes where a rollover was the primary event.

Finally, relative risks (RRs), defined as the ratio of death rates for SUVs and pickups relative to passenger cars, were calculated. Ninety-five percent CIs for fatality rates and RRs were calculated using methods described previously by Chen et al.[21]

RESULTS

Fatalities and Driving Exposure

A total of 5,045 adolescents (aged 16–19 years) were killed while driving passenger cars, SUVs, or pickups (model year 1992 or newer) in the United States between 1999 and 2003. Seventy-two percent of these fatally injured teen drivers were male (*n* = 3,633), and 28% (*n* = 1,412) were female.

The corresponding national cohort of teen drivers drove more than 179 billion miles during the same five-year period. Passenger car travel accounted for 70% of the total vehicle miles driven (124.61 billion), while pickup and SUV travel accounted for 18% (32.11 billion) and 12% (22.34 billion) of the total, respectively. Male teens drove an estimated 97.71 billion miles (55%), while female teens drove approximately 81.35 billion miles (45%). Vehicle type was not evenly distributed by gender. Male teens drove 57% of miles in a passenger car, 27% in a pickup, and 16% in a SUV, while female teens drove 85% of miles in a passenger car, 6% in a pickup, and 9% in a SUV ($p < 0.001$).

Overall Fatality Risk by Vehicle Type

Vehicle type demonstrated a significant effect on the relative fatality risk for teen drivers (Table 1). Per 100 million miles driven, the overall fatality risk for teens driving SUVs was 58% lower than for those driving passenger cars (RR, 0.42; 95% CI = 0.38 to 0.48). Gender-stratified differences in the fatality rates of SUVs compared with passenger cars were statistically significant for both male (RR, 0.33; 95% CI = 0.29 to 0.37) and female drivers (RR, 0.45; 95% CI = 0.34 to 0.59). The overall fatality risk for teen drivers in pickups was also lower than in passenger cars (RR, 0.82; 95% CI = 0.76 to 0.89). However, stratification by gender only identified a significant difference in fatality rates among male drivers (RR, 0.55; 95% CI = 0.51 to 0.60). The RR point estimate for female drivers

Table 1
Teen Driver Fatality Rates in the United States (1999–2003) by Vehicle Type, Crash Type, and Gender

	Male Driver			Female Driver			Overall		
Vehicle Type	Car	SUV	Pickup	Car	SUV	Pickup	Car	SUV	Pickup
Fatalities*									
Rollover crashes	198	63	156	117	22	30	315	85	186
All crash types	2,673	242	718	1,245	56	111	3,918	298	829
Vehicle miles driven† (billions)	55.39	15.41	26.91	69.22	6.93	5.20	124.61	22.34	32.11
Death rate‡									
Rollover crashes	0.36	0.41	0.58	0.17	0.32	0.58	0.25	0.38	0.58
All crash types	4.83	1.57	2.67	1.80	0.81	2.14	3.14	1.33	2.58
Relative risk (95% CI)§									
Rollover crashes	1.00	1.14 (0.86, 1.52)	1.62 (1.32, 2.00)	1.00	1.88 (1.19, 2.96)	3.42 (2.29, 5.10)	1.00	1.51 (1.19, 1.91)	2.29 (1.91, 2.75)
All crash types	1.00	0.33 (0.29, 0.37)	0.55 (0.51, 0.60)	1.00	0.45 (0.34, 0.59)	1.19 (0.98, 1.44)	1.00	0.42 (0.38, 0.48)	0.82 (0.76, 0.89)

SUV = sports utility vehicle.
* Data from National Highway Traffic Safety Administration, Fatality Analysis Reporting System: 1999–2003.[19]
† Data from Federal Highway Traffic Safety Administration, 2001 National Household Transportation Survey.[20] Weighted national estimates for total vehicle miles driven (billions) as vehicle driver stratified by sample subgroups.
‡ Teen driver deaths per 100 million vehicle miles driven based on weighted estimates.
§ Passenger car fatality rates used as reference for calculation of relative risks.

was actually higher for pickups compared with passenger cars (RR, 1.19), but this difference did not reach statistical significance (95% CI = 0.98 to 1.44).

Rollover Fatality Risk by Vehicle Type

Teen driver fatality rates per vehicle mile driven due specifically to rollover crashes were increased for both SUVs (RR, 1.51; 95% CI = 1.19 to 1.91) and pickups (RR, 2.29; 95% CI = 1.91 to 2.75) compared with passenger cars. Female adolescent drivers of SUVs and pickups were at particularly high risk for fatal rollovers per vehicle mile driven (SUV: RR, 1.88 [95% CI = 1.19 to 2.96]; pickup: RR, 3.42 [95% CI = 2.29 to 5.10]). The rollover fatality risk for male pickup drivers was 62% higher than for male drivers of passenger cars (RR, 1.62), and although the RR point estimate for male SUV drivers suggested a similarly increased rollover fatality risk (RR, 1.14), the result was not statistically significant.

DISCUSSION

Our analysis utilized nationally representative data for both fatal crashes and travel exposure to compare fatality rates of adolescent drivers across vehicle types (passenger cars, SUVs, pickups). Previous analyses of vehicle type have generally used registration data (person–years insured) to estimate exposure. This methodology does not allow adequate differentiation between the travel behaviors of young drivers. By using direct estimates of driving behavior taken from the National Household Transportation Survey, we were able to calculate teen driver fatality rates by vehicle type and gender specifically adjusted for travel exposure among 16 to 19 year olds.

Per vehicle mile driven, we found that national fatality rates for teen drivers of passenger cars were twice as high as for teen drivers of SUVs and 1.2 times higher than for teen drivers of pickups. These lower rates were measured despite markedly higher rates of fatal rollovers for both SUVs (RR, 1.51) and pickups (RR, 2.29) compared with passenger cars.

Improving traffic safety for teenagers should be a priority in the United States, given that motor vehicle crashes are the leading cause of death in this age group.[1] Graduated licensing systems are gaining acceptance and have been shown to be protective.[27] However, parents remain interested in the question, “What is the safest vehicle for my teenager to drive?” Relatively few studies have specifically examined this question and, to our knowledge, this is the first to incorporate direct estimates of travel exposure into an analysis of teen driver fatality risk in various vehicle types.

Previous analyses of driver fatality rates have demonstrated differences between vehicle types among adult drivers.[15,16] Our results demonstrate similar variability among adolescents. In addition, our analysis suggests that per vehicle mile driven, teens driving SUVs and pickups experience lower overall fatality rates than youths of similar age and gender driving passenger cars. This finding was somewhat surprising given that these vehicle types, due to low static stability, are known to be at increased risk for rollover crashes.[11,28] Compared with older drivers, teen crashes are more likely to involve only one vehicle, to be the result of driver error, and to involve speeding.[29] Thus, we suspected the interaction of novice driving errors and decreased stability in taller vehicles would result in a significantly higher overall risk for teen driver fatality in SUVs and pickups. Although our analysis demonstrated significantly higher fatality rates per vehicle mile driven due to rollovers for SUVs and pickups compared with passenger cars, the overall risk (all crash types) was significantly lower.

There are several possible explanations for the persistent protective effect of SUVs and pickups despite their rollover risk among teen drivers. First, despite the high fatality rate for occupants involved in rollover crashes, other crash types (e.g., frontal or side impact) remain far more common.[13] Other characteristics of SUVs and pickups have been shown to be protective in these crash types.[7–9] Therefore, on a per-mile basis, the protective characteristics of SUVs and pickups may outweigh the fatality risk conferred by their low static stability. Teen drivers, particularly males, also engage in risky driving behaviors (such as speeding, running traffic lights, and following other cars too closely) more frequently than more mature drivers. These behaviors can increase the severity of crashes even when they do not involve a rollover.[2,3,30,31] This may alter the relative effect size of factors such as vehicle mass on adolescent driver fatality rates as compared with adults.

LIMITATIONS

Our analysis demonstrates the potential impact of vehicle choice on the fatality risk for teen drivers, but its implications must be considered carefully. Ecological analyses, such as this one, utilize aggregated data to allow population-level risk comparisons. Grouping individual characteristics in this way can sometimes mask or alter more complex associations, a phenomenon sometimes referred to as “ecological fallacy.”[32] Population-level analyses offer an important tool for studying complex public health problems and, in some cases, can actually be a more appropriate methodology than individual-level investigations.[33–35] However, any resulting associations, such as our finding that teen SUV drivers experience lower fatality rates compared with passenger car drivers, cannot be used to predict variation in the individual-level fatality risk for a particular teen driver.

Our study was not designed to account for the significant variation that exists among individual models within each broad vehicle category. Furthermore, driving exposure data from NHTS were only available for 2001. This precluded specific calculation of fatality rates for each year of available FARS data. For this reason, changes in driving exposure due to changes in the composition of the vehicle fleet (e.g., increase in popularity of SUVs) were not reflected in our results.

Sample size limitations in NHTS also precluded the separate analysis of 16- and 17-year-old drivers from older teens. Given that a teen driver’s highest risk of death occurs during the first few hundred miles of driving,[36] it is possible that the increased risk of rollovers among SUVs and pickups exerts a larger effect in this youngest age group. In addition, it is likely that unmeasured interactions between driver characteristics and vehicle type produce variations in the rate of fatalities per vehicle mile driven among different vehicle types. We were unable to control for behaviors, such as seatbelt use, traveling with other teen passengers, alcohol use, and nighttime driving, that significantly affect the fatality risk for motor vehicle occupants and likely vary across vehicle types.[21,37,38]

Finally, our analysis was performed solely from the perspective of adolescent driver safety. Drivers of smaller passenger cars[39] and pedestrians[40,41] are at increased injury and fatality risk when they are involved in a crash with larger vehicles such as SUVs or pickups. Research suggests that the societal benefit of driver protection conferred by SUVs is almost entirely outweighed by the increased damage they inflict on other drivers.[42] Given the disproportionate involvement of adolescents in motor vehicle crashes, increasing the number of teen drivers in large vehicles would almost certainly exaggerate these problems.

CONCLUSIONS

The ranking of motor vehicle crashes as the leading cause of death for adolescents in the United States highlights the urgency of identifying modifiable risk factors and implementing effective behavioral and policy strategies. Fatality rates for teen drivers vary significantly by vehicle type. From 1999 to 2003 in the United States, fatal rollovers were significantly more likely per mile driven for teen drivers of both SUVs and pickups compared with passenger cars. However, overall fatality rates (i.e., all crash types) for teen drivers of SUVs and male drivers of pickups were lower per mile driven than for teen drivers of passenger cars. The results of this ecological analysis cannot predict the individual-level fatality risk for teens driving different vehicle types. However, the significant variability in fatality rates among SUVs, pickups, and passenger cars seen at a population level suggests that vehicle choice should be further explored as a potentially modifiable risk factor in interventions to address teen driver safety.

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