Traffic Safety Facts
Research Note

NCSA National Center for Statistics & Analysis

September 2003 DOT HS 809 636

Younger Drivers and Sport Utility Vehicles

John Kindelberger and Ana María Eigen*

In the years 1992 through 2001, 986 sport utility vehicle (SUV) drivers of ages 16 through 19 years were fatally injured in U.S. rollover crashes – 128 in the year 2001, the most recent year for which complete data exist in the Fatality Analysis Reporting System (FARS). In these same years, 1,345 SUV drivers of ages 20-24 sustained fatal injuries in rollovers; of these, 326 occurred in the year 2001. Serious injuries were sustained in SUV rollovers by an estimated 16,000 drivers of ages 16-24 in the years 1992-2001, as estimated by the National Automotive Sampling System's General Estimates System (GES).

In response to concerns over numbers such as those cited above, this note looks at driving risks associated with younger drivers in SUVs. In the United States, the number of SUVs in the fleet has more than doubled from 10 million in 1995 to 21 million in 2001[1]. With this increase, interest in the rate and circumstances of SUV crashes (particularly rollovers) has grown. In particular, members of the safety community are concerned about the increase in use of aging SUVs by younger drivers who may lack experience in the handling of these vehicles, but may be buying the used vehicles as they become affordable.

To address the concerns raised, this note addresses the following topics:

- Younger drivers in SUV crashes
- Relative risk of rollover among differing age groups
- Rollovers in aging SUVs
- Groups at high risk

For this note, drivers of ages 16 through 24 are classified as younger drivers.

Background

Based on weighted estimates extracted from the GES, about 114 million drivers at least 16 years old were involved in police-reported crashes over the period 1992 through 2001. About 2.5 million of these crashed vehicles experienced a rollover, of which an estimated 1.6 million resulted in fatal or non-fatal injuries to either drivers or passengers. About 20 percent of these vehicles were SUVs. Among all rollovers, about 40 percent occurred with a younger driver at the wheel, and about 36 percent of these younger drivers were in SUVs.

As SUVs have grown in popularity, numbers of crashes involving SUVs have grown as well. Younger drivers have traditionally been involved in about 25 percent of SUV crashes (Table 1).

Table 1
Younger (16-24 yrs) Drivers in SUV Crashes
Numbers and Proportions by Year

Year	Younger Drivers in SUV Crashes	Younger Drivers as Proportion of All SUV Crashes
1992	99,000	25%
1993	113,000	27%
1994	128,000	27%
1995	133,000	27%
1996	149,000	26%
1997	151,000	25%
1998	163,000	24%
1999	235,000	23%
2000	268,000	24%
2001	321,000	27%

Source: NCSA, NHTSA, NASS GES 1992-2001

Definitions and Constraints

The GES is a nationally representative weighted sample of police reported motor vehicle crashes of all types, from minor to fatal. This note's analyses were conducted on GES cases from 1992 through 2001 involving drivers 16 years old in passenger cars, SUVs and non-SUV light trucks. SUV status was assigned to GES classified compact utility vehicles, large utility vehicles, and utility station wagons. For this note "non-SUV" light trucks include vans, minivans, and pickups. Excluded are buses, motorcycles, snowmobiles, motor homes, construction equipment, all-terrain vehicles, farm equipment, large limousines, or medium to heavy trucks. The GES body type variable categories have not changed since 1992, so the years analyzed do not differ in that respect.

*John Kindelberger is a Mathematical Statistician and Ana María Eigen is a Mechanical Engineer with the Mathematical Analysis Division of the National Center for Statistics and Analysis, NHTSA.

[1]Source: R.L. Polk Co.

The data were segmented for analysis into the following variables:

- Driver age: Younger (16-24)/ older (25+)
- Vehicle type: SUV/non-SUV
- Vehicle crash type: Rollover/ non-rollover
- Vehicle age in years: Derived from model year (MY) and crash date
- Vehicle age category: Less than 5 years/5 years or more
- Model year category: 1997 or earlier/1998 or later

Driver gender was used as it appears in the GES. The question of chassis was not addressed and SUVs were examined in total because of the body type limitations in the GES.

To test the significance of relative risks and odds ratios under the GES sample design, the SUDAAN (SUrvey DAta ANalysis Software for Statistical Analysis of Correlated Data) software package was utilized.

Analyses

Rollover Injuries

In the GES data, given that a police-reported crash has occurred where a passenger car or light truck has rolled over, the likelihood of at least one occupant in the rollover vehicle suffering injury at any level[2] is about 63 percent. This proportion was not found to differ significantly across age groups. The analogous risk for incapacitating or fatal injury[2], again across driver age groups, is about 18 percent. Since injury probabilities were found to be similar across groups once a rollover has occurred, the rollover analyses of this note are conducted with the event of interest being any rollover – regardless of resulting injury level - to take advantage of the larger sample size.

[2]Injuries in the NASS GES are assessed by police officers on the observational KABCO scale where K=Killed; A=Incapacitating Injury; B=Non-Incapacitating Injury; C=Possible Injury; O=No Injury; and U=Injured, severity unknown. For this note, "serious or fatal" refers to K or A on the KABCO scale.

SUV Rollovers

In the weighted GES data from 1992 through 2001, given that a vehicle is involved in a police-reported crash, the estimated incidence of rollover (injury or not) for SUVs was a statistically significant 5.19 percent. This rate translates to an estimated 359,000 SUV rollovers in the 10-year period. (Statistical significance in this note refers to a 95 percent confidence level.)

The comparable rate for non-SUVs was 2.00 percent. Thus, in the universe of GES-eligible police-reported crashes, the estimated risk of rollover for SUV drivers relative to that of non-SUV drivers is 5.19/2.00=2.59, or more than two and one half times as high. This number is called the "relative risk" and is statistically significant in this result. All age groups were more likely to roll over in an SUV than in a non-SUV, as summarized in Table 2.

Table 2
Rollover Percentages and Relative Risks
By Vehicle Type and Driver Age Group
Among Police Reported Crashes 1992-2001

Rollover Percentage			
Driver Age Group	Vehicle Type		Relative Risk of Rollover, SUV vs. non-SUV
	SUV	Non-SUV	
All	5.19	2.00	2.59
16-24	7.43	3.14	2.36
25 and up	4.42	1.55	2.86

Source: NCSA, NHTSA, NASS GES 1992-2001

Note that the relative risk does not depend on the relative proportions of SUV to non-SUV in the crash population, but rather on the proportions of rollovers in crashes within each vehicle type.

Driver Age

The highest individual rollover risk in Table 2 is that of drivers of ages 16-24 in SUVs, who experienced rollovers in 7.43 percent of their crashes. The comparable percentage of older drivers was 4.4 percent, so the relative risk is 7.4/4.4 = 1.68, denoting a 68 percent higher risk for younger drivers. The difference is not limited to SUVs among passenger cars and non-SUV light trucks, the GES data indicate that younger drivers are twice as likely to roll over in a crash than older drivers (Table 3).

Table 3
Rollover Percentages and Relative Risks
By Vehicle Type and Driver Age Group
Among Police Reported Crashes 1992-2001

Rollover Percentage			
Vehicle Type	Driver Age Group		Relative Risk of Rollover, Younger vs. Older Driver
	16-24	25 and up	
SUV	7.43	4.42	1.68
Non-SUV	3.14	1.55	2.03

Source: NCSA, NHTSA, NASS GES 1992-2001

Gender

About 65 percent of younger drivers and 58 percent of older drivers in SUV crashes were male. Among younger SUV drivers, male drivers were found to be 23 percent more likely to roll over in a crash than female drivers. The gender difference for older drivers was not statistically significant (Table 4).

Table 4
Rollover Percentages and Relative Risks
By Driver Age Group and Driver Gender
Among Police Reported Crashes 1992-2001

Rollover Percentage			
Driver Age Group	Driver Gender		Relative Risk of Rollover, Male vs. Female Driver
	Male	Female	
16-24	7.94	6.46	1.23
25 and up	4.66	4.10	Non-significant

Source: NCSA, NHTSA, NASS GES 1992-2001

The gender difference is also seen in non-SUVs, where males across age groups were about 50 percent more likely to rollover in a crash.

Rollovers in Aging SUVs

To examine the possible consequence of older used SUVs becoming affordable for a new batch of (possibly

younger) owners, relative risk of rollover was assessed for both driver age groups in older vs. newer SUVs. In GES data, the risk of a young driver rollover in an older (5 or more years on crash day) SUV is 1.16 times that of a young driver rollover in a newer SUV, a risk increase of 16 percent. In older drivers, the risk increase is 23 percent. Thus, the risk of rollover has been higher in older SUVs than in newer ones for both age groups (Table 5).

Table 5
Rollover Percentages and Relative Risks
By Driver Age Group and Vehicle Age
Among Police Reported Crashes 1992-2001

Rollover Percentage			Relative Risk of Rollover, Male vs. Female Driver
Driver Age Group	Vehicle Age on Crash Date		
	5 Years or More	Less than 5 Years	
16-24	7.85	6.77	1.16
25 and up	4.92	3.99	1.23

Source: NCSA, NHTSA, NASS GES 1992-2001

The effect is not limited to SUVs. For GES passenger cars and non-SUV light trucks over all driver ages, rollover risk was found to be 23 percent higher in an older vehicle than in a newer one.

The apparent vehicle age effect raises certain questions, such as: Is the observed difference an effect of the number of years the vehicle has been in use, or of design changes through the model years? To explore this question, a logistic regression model was fit where the population was SUVs in GES crashes, the response was rollover, and the predictors were driver age; driver sex; model year category (with cutoff year 1998); and vehicle age in years. Both types of vehicle age variables were included to allow a vehicle aging effect test while controlling for model year. The numerical rather than categorical setup for vehicle aging was necessary because in the 1998 or newer model year category no vehicle was over 5 years old in 2001, and was desirable because logistic regression allows numerical variables as predictors, enabling a test for an incremental vehicle aging effect.

Table 6 gives a brief explanation of each variable and its effect on the odds of a rollover (when all other model variables are held constant) as determined by the statistic known as the "odds ratio." Note that the odds ratio is similar in form to the relative risk, but reflects the increase of the odds of the rollover, where the odds in this situation are defined as

Probability of Rollover/
(1 – Probability of Rollover).

Table 6
Results of Logistic Regression
Where Population is SUVs in Police-Reported Crashes (US 1992-2001) and Response is Rollover
Odds Ratios and Explanations by Significant Variable

Variable	Odds Ratio	Increase in Odds of Rollover
Driver Age Group	1.63	63% increase if driver 16-24
Driver Gender	1.13	13% increase if driver male
Vehicle Age in Years (1,2,3…)	1.03	3% increase for each added year of vehicle age
Model Year (pre- or post- 1998)	Not statistically significant – dropped from model	

Source: NCSA, NHTSA, NASS GES 1992-2001

As detailed in Table 6, the model year variable was not found to be statistically significant in this model, but the vehicle age-in-years effect is seen as a three percent increase in the odds of rollover for every added year of vehicle use. Although that odds ratio may seem small, it was statistically significant, and would "compound" over each additional year of age.

For another look at this extended age effect, a similar model was run on MY 1997 or earlier vehicles only but used the categorical vehicle age of "5 years or older" vs. "less than five years old." In this model, the odds of rollover were 19 percent higher for the older vehicle category.

The conclusion suggested by the preceding results is that, under conditions seen in the recent past, SUVs become more likely to be involved in rollovers as they age. It may be more reasonable to suggest that the age "effect" is in fact due to some other factor or factors related to vehicle age, such as driver socio-economic status or vehicle condition. For instance, younger SUV drivers (of both genders) have a greater tendency to be in older SUVs – 61 percent as compared to 46 percent of the older drivers. However, the driver age and vehicle age factors each supplied a significant main effect to the model, independently of each other. An interaction term was not significant; this simply means that the driver age effect and the vehicle age effect do not depend on each other.

Although the premise of the vehicle age makes sense from a socio-economic standpoint, the engineering issues are less clear. Similar to other vehicle types, the SUV suffers the detriments of disrepair. Modifications in design uniquely act to improve SUV handling. As vehicles age, greater care must be given to brakes, tires, engine function, and transmission operation. These issues cannot be easily disaggregated from those that are inherent to handling of older vehicles. For example, within a GES qualified case, braking failures may exist with evidence remaining at the crash site, however, no recording mechanism exists to capture these data. Further, the state of tire repair may be masked by the events of the crash as in the case of tread separation. Engine or transmission malfunction, although speculative, also impair driving operations.

Although the model year variable was not significant in the GES analysis, further research may be called for as

data accumulate. SUVs have undergone design changes over the period of this study, including but not limited to: suspension, steering, and changing tire requirements. The first generation of SUVs operated like their heavier truck counterparts. Steering inputs require great precision and penalty exists for exaggerated movements. SUVs do not benefit from the recovery characteristics inherent to passenger cars. In concert with the suspension changes are variation in the tires used for the SUV. In earlier SUVs, light truck tires enhanced the handling discrepancies with the passenger car. In the second generation of SUVs, however, passenger car tires have become more pervasive.

When considering the effect of young drivers versus older drivers, it may be noted that inexperience likely acts to increase the risk of rollover crashes, but the effect of older vehicles complicates this issue. It may be useful to examine younger drivers operating older vehicles with regard to inexperience with SUV handling and mechanical difficulties. The disaggregating of these two conditions becomes very complicated with existing data. Within the data sets, it is possible to identify the model year of the vehicle and calculate the years it has been in service at the date of the crash, but the vehicle condition prior to the crash due to waning maintenance may be unknown and no clear method exists for uniform tracking.

Limitations

The risk and odds estimates in this analysis used only data from the GES, a weighted sample of all US police-reported crashes. This study was restricted to more general characteristics and does not address behavior-based variables such as alcohol, speeding, and safety belt usage. Further research is needed to explore the relationship between behavior-based variables and SUV rollover crashes among younger drivers.

Conclusions

Analysis of GES data for the years 1992 through 2001 produced certain significant findings regarding drivers in SUV rollovers:

- As a group, drivers of ages 16-24 in crashes have been significantly more likely to roll over than drivers over age 24.
- Among younger drivers of SUVs that crashed, males have been more likely to roll over than females. The gender difference for older SUV drivers was negligible.
- In both younger and older drivers, older SUVs in crashes have been more likely to roll over than newer SUVs.
- Effects on rollover of driver age, driver gender, and vehicle age are not limited to SUVs, but the higher risk of rollover in an SUV crash adds to the overall risk where the other variables are involved.

NHTSA plans to continue research into the subject of this note. Potential areas of further inquiry include behavior-based variables in different age groups and vehicle types, the aging effect in various vehicle types, and application of exposure data from appropriate databases. NHTSA will continue to provide information on younger drivers, SUVs, rollovers and similar issues as data become available and new research is conducted.

U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA
People Saving People
www.nhtsa.dot.gov

For additional copies of this research note, please call 1-800-934-8517 or fax your request to 202-366-3189. For questions regarding the data reported in this research, contact John Kindelberger (202-366-3365) or Ana María Eigen (202-366-2903). This research note and other general information on highway traffic safety may be accessed by internet users at: http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/AvailInf.html