BRIEF REPORT

Child passenger injury risk in sibling versus non-sibling teen driver crashes: a US study

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Several international jurisdictions allow family exemptions to graduated driver licensing passenger restrictions. The objective of this research was to examine differences in injury risk to US child passengers in crashes involving sibling versus non-sibling teen drivers, and to compare outcomes with crashes involving adult drivers. Insurance claim and telephone survey data were collected on 16 233 child passengers (representing 289 329 children) in 17 US jurisdictions. There was a trend toward higher restraint non-use by child passengers in the non-sibling group than in the sibling group (9.6% vs 4.7%; $p=0.08$). Children in the sibling group had a 40% lower risk of injury than those in the non-sibling group (adjusted OR 0.60, 95% CI 0.40 to 0.90); however, injury risk was higher in the sibling group than in children traveling with adults (adjusted OR 1.57, 95% CI 1.09 to 2.26). Child passengers riding with sibling teen drivers may be safer than those riding with non-sibling teens, but not as safe as those riding with adult drivers.

Restrictions on the number of passengers newly licensed teens can carry in the absence of an adult supervisory driver have been shown to be effective in reducing injury risk.^{1–3} Several US states and New Zealand include passenger restrictions in their graduated driver licensing laws that allow exemption for family members.⁴ These are also under consideration in several Australian jurisdictions. Whether the relationship between teen drivers and their passengers, comparing siblings versus peers, makes a difference to injury risk has, however, not yet been explored.

We aimed to examine the association between the relationship of teen drivers (sibling vs non-sibling) with their child passengers and the risk of injury to children in a US sample. Secondly, we aimed to compare the characteristics and outcomes of these child passengers in crashes involving teen drivers with those involving adult drivers.

METHODS

Data were collected as part of an ongoing prospective study from 1 December 2000 to 31 December 2005 via insurance claim records and a validated telephone survey.⁵ Inclusion criteria included State Farm-insured passenger vehicles, model year 1990 and newer (to represent the modern passenger vehicle fleet), with at least one child passenger aged ≤ 15 years. The crashes examined occurred in 16 US states and the District of Columbia, representing 3 large regions (East: New York, New Jersey (until November 2001), Pennsylvania, Delaware, Maryland, Virginia, West Virginia, North Carolina and the District of Columbia; Midwest: Ohio, Michigan, Indiana and Illinois; and West: California, Nevada, Arizona and Texas (from June 2003)).

The main outcome variable of interest was injury risk. Injuries were defined as those with Abbreviated Injury Scale scores of ≥ 2 , including concussions and more serious brain

injuries, facial bone fractures, spinal cord injuries, internal organ injuries and extremity fractures.

A stratified cluster sample was designed to select vehicles (the unit of sampling) for conducting telephone surveys with the driver. Probability sampling was based on two criteria: whether the vehicle was towed from the scene or not, and the level of medical treatment received by the child passenger(s). If a vehicle was sampled, the cluster of all child passengers in that vehicle was included in the survey. A 2.5% sample of crashes in which children received no medical treatment was also included to maintain the representativeness of the sample.

Figure 1 details the derivation of the study sample from the initial eligible population. Claim representatives correctly identified 98% of eligible vehicles. Of the 240, 379 cases selected: full crash data were obtained with consent for 64% of cases; in 9% of cases policyholders could not be contacted or only partial data were received; and there was a 27% refusal rate. Of the policyholders who consented, 16% were sampled for an interview, 76% of whom were successfully contacted and screened for the full survey. A full survey was obtained for 10 704 crashes. A comparison of the sample with known population values from State Farm claims showed minimal differences for the following factors: geographic region of the insured vehicle, vehicle type, non-drivability after the crash and mean age of the child occupants.⁶ When compared with the 2000 United State Census, study participants had a similar distribution of race and ethnicity and family income, and a slightly higher level of education than the driver.⁷

To assess differences in the distribution of passenger and driver characteristics by classification of driver, Pearson's χ^2 tests were used. The adjusted relative risks of injury for children in crashes comparing the three driver classifications were computed, producing point estimates of the risk with associated 95% CIs. In examining injury risks, we also controlled for variables that have previously been shown to predict injury to child passengers. These included age (0–8, 9–12 and 13–15 years), seating row (front vs rear), restraint status (yes or no), gender of driver, and vehicle type (passenger car, cargo van, pickup truck, sport utility vehicle and minivan).

As sampling was based on the likelihood of an injury, subjects least likely to be injured were under-represented in the study sample in a manner potentially associated with the predictors of interest. To account for the stratification of subjects by medical treatment, towaway status of the vehicle, clustering of subjects by vehicle and the disproportional probability of selection, Taylor Series linearization estimates of the logistic regression parameter variance were calculated using SAS-callable SUDAAN V.9.0 (Research Triangle Institute, Research Triangle Park, North Carolina, USA, 2006). Because injury is a relatively rare event, the odds ratio (OR) can be interpreted as a good estimate of relative risk.

All protocols were approved by the institutional review boards of The Children's Hospital of Philadelphia and the University of Pennsylvania.

Figure 1 Derivation of study sample from initially eligible population (12 December 2000–31 December 2005). *At the onset of the project, consent was obtained from all eligible subjects before sampling. Beginning in June 2003, sampling of eligible subjects was performed, thus restricting consent to those who would go on to the screening interview. †Other includes refusals, failure to contact the subject and incomplete data collection. Child passengers were classified into three groups based on the status of the driver: (1) sibling teen drivers—drivers aged 15–19 years with at least one sibling in the vehicle and all passengers aged <21 years (common age limit of passenger restrictions); (2) non-sibling teen drivers—drivers aged 15–19 years without a sibling in the vehicle and all passengers aged <21 years; and (3) adult drivers—drivers aged at least 21 years or drivers aged <21 years who were parents (as injury risk did not differ for these groups: 1.10% and 1.01%, respectively). Cases excluded from the analysis included those in which passengers were of unknown age or seating row; drivers were aged <15 years or of unknown age or gender; drivers were teens with an unknown relationship with the child passenger or had at least one passenger aged ≥21 years present; drivers were 20 years of age and not a parent; and crashes were classified as “no collision”. In all, 609 child passengers were excluded.

RESULTS

Complete interview data were obtained for 16 233 children, representing 289 329 child passengers in the study population. Table 1 summarizes passenger and driver characteristics by driver classification group.

The distribution of child passengers among the driver classifications was adult drivers 96.1%, sibling teen drivers 2.3% and non-sibling teen drivers 1.5%. Limited solely to the two teen driver groups, 60% of child passengers were driven by siblings. In general, child passengers of adult drivers were much younger, and in turn less likely to be unrestrained and seated in the front, than those driven by either teen driver group. Within the teen driver groups, there was a trend toward

higher restraint non-use among child passengers in the non-sibling group than among the sibling group.

Table 2 summarizes child passenger injury risk and unadjusted and adjusted ORs for the three driver classifications. Injuries were reported in 2148 sampled children, representing an estimated 3504 children or 1.2% of the study population (1.1% with adult drivers, 3.3% with sibling teen drivers and 5.6% with non-sibling teen drivers).

Child passengers traveling with either teen driver group were at a significantly higher risk of injury than those traveling with adult drivers, even after adjusting for age, seating row, restraint status of child passenger, gender of driver and vehicle type. When we limit the comparison to the crashes involving teen

Table 1 Child passenger and driver characteristics (weighted %, unweighted n) by three driver classifications and comparisons for sibling versus non-sibling teen drivers

Characteristic	Adult driver (n = 14 782)	Sibling teen driver (n = 715)	Non-sibling teen driver (n = 736)	p Value*
Child age (years)				
0–8	62.4 (8292)	8.5 (43)	13.2 (68)	0.001
9–12	23.5 (3954)	18.7 (145)	7.5 (50)	
13–15	14.1 (2536)	72.8 (527)	79.3 (618)	
Male driver	27.9 (4114)	30.3 (251)	45.8 (404)	0.02
No child restraint	2.1 (630)	4.7 (87)	9.6 (165)	0.08
Seating row				
Front	19.1 (3658)	64.9 (420)	52.5 (376)	0.02
Vehicle type				
Passenger car	43.6 (7047)	76.1 (526)	74.2 (538)	0.28
Cargo van	1.9 (297)	0.9 (3)	0.3 (4)	
Pickup truck	7.2 (1001)	4.4 (43)	11.0 (64)	
Sport utility	24.2 (3251)	13.4 (92)	11.2 (93)	
Minivan	23.2 (3186)	5.3 (51)	3.3 (37)	

*Comparison of the distribution of characteristics (χ^2 test) across the two teen driver classifications only.

Table 2 Abbreviated Injury Scale (AIS) ≥ 2 injury risk, and crude and adjusted ORs of AIS ≥ 2 injury by classification of driver

Driver classification	Injury risk, % (unweighted n)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)*
Adult	1.1 (1755)	1.00 (reference)	1.00 (reference)
Sibling teen	3.3 (172)	3.08 (2.26 to 4.22)	1.57 (1.09 to 2.26)
Non-sibling teen	5.6 (221)	5.41 (3.96 to 7.39)	2.62 (1.83 to 3.76)
Sibling teen vs non-sibling	NA	0.57 (0.38 to 0.85)	0.60 (0.40 to 0.90)

AIS, Abbreviated Injury Scale; NA, not applicable.

*Adjusted for age, seating row, restraint status of child passenger, gender of driver and vehicle type.

drivers, child passengers in the sibling group were at a 40% lower risk of injury than those in the non-sibling group (adjusted OR 0.60, 95% CI 0.40 to 0.90).

DISCUSSION

This study is the first study to explore differences in injury risk for children traveling with teen drivers who are siblings versus other relationships. We found a trend toward more children being unrestrained in crashes involving non-sibling teen drivers and a higher injury risk for these children than crashes involving sibling teen drivers. However, the adjusted injury risk for the sibling group was still approximately 1.5 times that of children in crashes involving adult drivers. (For the non-sibling group, this risk was 2.5 times greater.) Therefore, our findings indicate that the child passengers of sibling teens may be safer than those of non-sibling teens, but not as safe as when riding with adults.

Studies in other teen risk domains demonstrate negative influences of siblings on adolescent risk behaviors,⁸ with sibling influence sometimes stronger than parental⁹ or peer influence.¹⁰ Therefore, parents should consider the risk-taking nature of the siblings when assessing whether they should ride together without an adult.

Parents should also consider whether the planned drive involves a specific destination. Research has shown that recreational driving without a predetermined destination results in a higher crash risk than purposeful trips, such as to school or to work.¹¹ Such differences among the sibling versus non-sibling group may have influenced our findings; however, these data were not collected. If riding with siblings more often includes purposeful trips than with non-siblings, this may have contributed to the lower injury risk found for our sibling group.

Limitations associated with the use of volunteer insurance claimants as participants and reliance on report of drivers include potential selection and misclassification biases. Comparison between the included sample and the eligible population, however, demonstrated little difference in several key characteristics of relevance to the study, suggesting that the impact of potential selection bias on our results was likely to be limited. Ongoing comparisons of driver-reported child restraint and seating position data to that obtained by on-site crash investigations have also demonstrated a high degree of agreement ($\kappa = 0.56$ for any restraint use), and our findings for these are similar to those of other recently reported population-based studies,¹² suggesting that misclassifications may also be limited.

Our analyses focused on injury risk in the event of a crash, not on exposure-adjusted crash rates. We could not calculate the rate of crash involvement per miles driven with child passengers for the different age groups of drivers. Likewise, we could not determine whether non-sibling teen driving is more frequent than sibling teen driving or, for example, more frequent specifically during night-time hours when crash risk is higher, which could contribute to the higher injury risk found

for child passengers of non-sibling teens. Such analyses are important for more conclusive findings and would further inform whether family exemptions on passenger restrictions are justified. Future research should also examine differences by trip purpose, as well as by jurisdictions with and without passenger restrictions and family exemptions, and by passenger age groups (eg, 8–12 vs 13–15 years). There were too few cases among the teen driver groups to explore such differences in the present study.

Implications for prevention

Our findings provide cautioned support for child passenger carriage by sibling teens relative to non-sibling teens, while recognizing that the safest alternative is to ride with an adult. Further research is needed to understand why riding with a sibling teen may be safer than riding with a non-sibling teen, and under what circumstances.

Family exemptions can allow passenger restrictions to be more readily accepted by both parents and policy makers, and may be an important first step for jurisdictions with no restrictions. Parents, pediatricians, advocates and legislators should recognize riding with sibling teens as potentially safer than riding with non-sibling teens, but not as safe as riding with an adult, and should continue to seek increased restraint use regardless of whether traveling with siblings, other teens or adults.

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Key points

- There was a trend toward higher restraint non-use by children in crashes involving non-sibling teen drivers than those involving sibling teen drivers (9.6% vs 4.7%, respectively; $p = 0.08$).
- Children in the sibling group had a 40% lower risk of injury than those in the non-sibling group (adjusted OR 0.60, 95% CI 0.40 to 0.90); however, injury risk was higher in the sibling group than in children traveling with adults (adjusted OR 1.57, 95% CI 1.09 to 2.26).
- Our findings indicate that child passengers of sibling teens may be safer than those of non-sibling teens, but not as safe as those with adult drivers.

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The sponsor contributed to data collection. The sponsor did not contribute to the design, data management, analysis and interpretation of the data, or to preparation, review or approval of the manuscript.

TMS, MJK and FKW had full access to all of the data in the study and take full responsibility for the integrity of the data and the accuracy of the data analysis. TMS, MJK, FKW were involved on conception and design of the study, analysis and interpretation of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content and provided final approval for publication.

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