Grandparents Driving Grandchildren: An Evaluation of Child Passenger Safety and Injuries

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KEY WORDS
child passenger safety, family issues, motor vehicle accidents, motor vehicle safety

ABBREVIATIONS
NHTSA—National Highway Traffic Safety Administration
PCPS—Partners for Child Passenger Safety
OR—odds ratio
CI—confidence interval

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WHAT'S KNOWN ON THIS SUBJECT: Appropriate child-restraint and seating practices reduce child-passenger injury risk, and child-passenger safety education typically targets parent drivers. Grandparents also drive with their grandchildren, yet little is known about their child-passenger safety practices or injuries after crashes.

WHAT THIS STUDY ADDS: In this study, grandparents represented nearly 10% of drivers in crashes involving child occupants. The adjusted risk of child injury for grandparent drivers was 50% lower than that for parent drivers, despite less optimal use of child restraint in grandparent-driver crashes.

abstract

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OBJECTIVES: To compare restraint-use practices and injuries among children in crashes with grandparent versus parent drivers.

METHODS: This was a cross-sectional study of motor vehicle crashes that occurred from January 15, 2003, to November 30, 2007, involving children aged 15 years or younger, with cases identified via insurance claims and data collected via follow-up telephone surveys. We calculated the relative risk of significant child-passenger injury for grandparent-driven versus parent-driven vehicles. Logistic regression modeling estimated odds ratios (ORs) and 95% confidence intervals (CIs), adjusting for several child occupant, driver, vehicle, and crash characteristics.

RESULTS: Children driven by grandparents comprised 9.5% of the sample but resulted in only 6.6% of the total injuries. Injuries were reported for 1302 children, for an overall injury rate of 1.02 (95% CI: 0.90–1.17) per 100 child occupants. These represented 161 weighted injuries (0.70% injury rate) with grandparent drivers and 2293 injuries (1.05% injury rate) with parent drivers. Although nearly all children were reported to have been restrained, children in crashes with grandparent drivers used optimal restraint slightly less often. Despite this, children in grandparent-driven crashes were at one-half the risk of injuries as those in parent-driven crashes (OR: 0.50 [95% CI: 0.33–0.75]) after adjustment.

CONCLUSIONS: Grandchildren seem to be safer in crashes when driven by grandparents than by their parents, but safety could be enhanced if grandparents followed current child-restraint guidelines. Additional elucidation of safe grandparent driving practices when carrying their grandchildren may inform future child-occupant driving education guidelines for all drivers. *Pediatrics* 2011;128:289–295

Motor vehicle crashes are the leading cause of death in children older than 3 years of age.[1] Given that the appropriate child restraint in the rear seat dramatically reduces child injury risk,[2,3] a primary focus of child-passenger safety efforts is on promoting child-passenger safety among parent drivers.[4–6]

However, parents and even custodial parent surrogates are not the only drivers of young children. A recent National Highway Traffic Safety Administration (NHTSA) study found that almost one-half of adults who drove with a child passenger under the age of 9 years within the past year lived outside the child's home. The frequency of such trips is likely less than that for in-home drivers, but up to 33% of nonresidential drivers will make trips with children a few days per month, 14% a few days per week, and 5% almost every day. Of such nonresidential adult drivers, 42% were the child's grandparents.[7] Thus, grandparents who are not full-time custodial caretakers represent a significant pool of drivers with child passengers.

Of note, older driver age (beginning after 55 years of age but especially over 65 years of age) is associated with increased risk of motor vehicle crashes.[8,9] The NHTSA estimates that currently 38 million adults in the United States are older than 65 years of age (13% of the total population) and that 30 million are licensed to drive.[10] By 2030, the population over the age of 65 years is expected to increase to 70 million (20% of the total population).[11] Many grandparents are in the age group older than 55 years, with an average age in 1 survey of 64 years.[12] Thus, grandparents not only represent a substantial pool of drivers of young children, as a group they likely include a significant proportion of higher-risk drivers. Yet, few studies have explored grandparents in their role as drivers of children or for their child-passenger safety practices.

Therefore, the primary objective of this study was to compare restraint-use practices and injuries among children in crashes with grandparent versus parent drivers. Our hypothesis was that grandparent-driven children would be at increased risk of injury, likely attributed at least in part to factors such as more common travel in older and less crash-worthy vehicles, increased crash severity, and less compliance with current best-practice recommendations regarding the appropriate use of child restraints and rear seating.

METHODS

Study Design and Data Collection

Data were collected as part of the Partners for Child Passenger Safety (PCPS) Study, which was conducted from June 1998 through November 2007. A detailed description of the study design and methods has been previously published.[13] In brief, this study was a large-scale, child-specific crash-surveillance system using insurance claims to the State Farm Mutual Automobile Insurance Company as the source of subjects and telephoneinterviews with the driver as the primary data source. For this study, all crashes reported to State Farm were eligible for sampling and ranged in severity from minor vehicle damage to severe crashes involving injury. Vehicles qualified for inclusion if they were insured by State Farm, were of the model year 1990 or newer, and were involved in a crash with at least 1 child occupant younger than 16 years of age. Crashes were analyzed from 3 major geographic areas in the United States, comprising 15 states and the District of Columbia, during our study period (New York, Pennsylvania, Delaware, Maryland, Virginia, Washington, DC, West Virginia, and North Carolina in the East; Ohio, Michigan, Indiana, and Illinois in the Midwest; and California, Nevada, Arizona, and Texas [beginning June 17, 2003] in the West). For policy holders consenting to the study, limited data were transferred electronically to researchers at the Children's Hospital of Philadelphia and the University of Pennsylvania.

In the PCPS study, stratified cluster sampling was used to select vehicles for inclusion in the surveillance system. Vehicles with child occupants who received medical treatment were oversampled, so that the majority of injured children would be selected while overall population representation was maintained. All child occupants in a sampled vehicle were included in the survey. Drivers of sampled vehicles were contacted by telephone and screened by an abbreviated survey. All vehicles with 1 or more injured child occupants were selected for a full interview, as well as a 10% random sample of those vehicles without reported child occupant injury. In addition, a 2.5% sample of crashes in which no children received medical treatment also was selected. These full interviews involved a 30-minute telephone survey with the child's parent or guardian or an appropriate surrogate reporting crash and injury data. The median time interval between crash date and interview completion was 6 days; 95% were completed by 47 days.

Data were collected on several relevant motor vehicle crash variables and the resulting child injuries. For characteristics related to driver, child occupant, vehicle, and crash scene, these included driver age, gender, and restraint use; driver relationship to the child occupant; occurrence of driver injury; child age and gender; child-restraint use and seat position; vehicle type, model year, and weight; crash characteristics, including direction of

initial impact and rollover occurrence, single or multivehicle crash, and severity on the basis of reported intrusion and/or whether the vehicle was towed from the scene.

Survey questions regarding child injuries were designed to categorize injury body site and severity on the basis of the Abbreviated Injury Scale (AIS) scoring system[14] and had been previously validated for their ability to distinguish AIS scores of 2 or greater from less severe injuries.[15] Child occupants were classified as injured if the parent or driver reported any injury with an AIS score of 2 or greater (concussions and more serious brain injuries, all internal organ injuries, spinal cord injuries, and extremity fractures).

The data for this study were drawn from the PCPS database for crashes that occurred between January 15, 2003, and November 30, 2007, the time period during which questions were included regarding the relation of the driver to the child occupant. Driver relationship was considered as parent for drivers describing themselves as a parent, step parent, or foster parent. Self-described grandparents less than 30 years older than the corresponding child passengers were excluded ($n = 7$). Self-described parents who were 10 or fewer years older than the corresponding child passengers were likewise excluded ($n = 6$).

Verbal consent was obtained from eligible participants for the transfer of claim information from State Farm to The Children's Hospital of Philadelphia/University of Pennsylvania and for the telephone survey. The study protocol was reviewed and approved by the institutional review boards of both The Children's Hospital of Philadelphia and the University of Pennsylvania School of Medicine.

TABLE 1 Distribution of Passenger and Driver Characteristics for Child Occupants According to Driver Status (Grandparent Versus Parent) in the PCPS

Characteristic	Grandparent ($N = 1143$)	Parent ($N = 10\,716$)	P[a]
Child injury	0.70 (113)	1.05 (1189)	.024
Any child restraint	98.0 (1100)	98.7 (10 424)	.33
Level of child restraint			.004
Optimal restraint	72.5 (773)	79.3 (8036)	
Suboptimal restraint	25.5 (327)	19.3 (2388)	
Unrestrained	2.0 (377)	1.3 (292)	
Seated in the front row	20.7 (278)	18.0 (2271)	.10
Age of child, y			.017
0–3	24.7 (259)	30.1 (2778)	
4–8	36.9 (412)	32.9 (3542)	
9–12	25.1 (319)	22.6 (2680)	
13–15	13.3 (153)	14.4 (1716)	
Gender of child (male)	47.9 (544)	49.3 (5230)	.50
Gender of driver (male)	23.1 (276)	29.2 (3205)	.006
Driver restraint	97.7 (1112)	96.5 (10222)	.10
Driver injury	3.29 (154)	2.42 (1155)	.14
Median driver age (95% range)	58 (43–77)	36 (22–51)	NA

Data are weighted (%) (unweighted n).

[a] χ^2 Test that the proportions are the same for grandparent and parent drivers.

Data Analysis

The primary purpose of our analysis was to compute the odds of child-occupant injury in crashes involving grandparent drivers versus those involving parent drivers. Thus, χ^2 tests of association were used to compute P values under the null hypothesis of no association between driver relationship and risk of injury. Logistic regression modeling was used to compute the odds ratio (OR) of child-occupant injury for those vehicles driven by grandparents versus those driven by parents, both unadjusted and adjusted for several potential confounders, including differences in driver gender, restraint and injury, child age and gender, child seating position and quality of child-restraint use, vehicle type and model year, and crash-scene characteristics and severity.

Because sampling was based on the likelihood of injury, subjects who were least likely to be injured were underrepresented in this study sample.[13] To account for such potential bias and to adjust inferences to account for stratification of subjects according to medical treatment and clustering of subjects according to vehicle, robust χ^2 tests of association and Taylor series linearization estimates of logistic regression parameter variances were calculated using SAS-callable SUDAAN (Software for the Statistical Analysis of Correlated Data 10.0.1 [Research Triangle Institute, Research Triangle Park, NC]). Results of logistic regression modeling are expressed as unadjusted and adjusted ORs, with corresponding 95% confidence intervals (CIs). Because of the overall low risk of injury, these ORs are considered reasonable approximations of the relative risk.

RESULTS

During the study period, data were collected on 11 859 children, representing 240 897 child occupants in motor vehicle crashes. Grandparents comprised 9.5% of the drivers with the remainder, parent drivers. Passenger and driver characteristics are compared by driver status in Table 1. When compared with parent drivers, grandparent drivers were older (median age: 58 vs 36 years) and slightly less often male (23.1% vs 29.2%; $P = .006$). There was a suggestion of a higher injury rate for grandparent drivers

(3.29% vs 2.42%), although this difference was not statistically significant ($P = .14$). The number of children per vehicle was marginally lower for grandparent drivers (1.43 vs 1.56; $P < .001$). Fewer children aged 0 to 3 years and more children aged 4 to 8 years and 9 to 12 years were driven by grandparents (24.7% vs 30.1% for children aged 0–3 years, 36.9% vs 32.9% for children aged 4–8 years, and 25.1% vs 22.6% for children aged 9–12 years).

Nearly all children were reported to have been restrained at the time of the crash (98.0% for grandparent drivers and 98.7% for parent drivers; $P = .33$). However, child occupants in grandparent-driven vehicles more often were not restrained according to best-practice recommendations (25.5% vs 19.3%; $P = .004$). For children aged 4 to 8 years, the most prevalent age range for both driver groups, the type of restraint use differed significantly between grandparent-driven children (44.2% optimal, 51.1% suboptimal, and 0.4% no restraint) and parent-driven children (52.7% optimal, 46.8% suboptimal, and 1.0% no restraint). A small minority of children were seated in the front seat in both groups, but this difference did not reach statistical significance (20.7% for grandparent drivers and 18.0% for parents; $P = .10$).

Injuries were reported for 1302 children, representing 2454 child injuries over the study period or in 1.02% (95% CI: 0.90–1.17) of the child-occupant population. Grandparent-driver crashes resulted in 6.6% of the total injuries in this cohort: 161 child injuries with grandparent drivers and 2293 child injuries with parent drivers. The overall pattern of child injury was similar for both grandparent and parent drivers. Head injuries predominated (63.0%), followed by injuries to the extremities (16.6%), chest and abdomen (13.5%), face (5.7%), and spinal column (1.2%).

TABLE 2 Distribution of Vehicle and Crash Characteristics for Child Occupants According to Driver Status (Grandparent Versus Parent) in the PCPS

Characteristic	Grandparent ($N = 1143$)	Parent ($N = 10\,716$)	P^a
Vehicle type			<.001
Passenger car	57.4 (654)	38.4 (4328)	
Cargo van	1.2 (17)	1.3 (176)	
Pickup truck	8.1 (92)	6.8 (754)	
Sport utility vehicle	19.6 (214)	29.9 (3035)	
Minivan	13.8 (166)	23.6 (2423)	
Model year			.06
1990–1997	26.2 (334)	20.8 (2738)	
1998–2001	34.8 (432)	36.5 (3923)	
2002–2008	39.0 (377)	42.7 (4055)	
Initial impact direction			.06
Frontal	38.0 (446)	42.7 (4666)	
Onside	13.6 (167)	10.2 (1213)	
Offside	17.0 (200)	12.7 (1427)	
Rear	28.1 (232)	31.0 (2479)	
Rollover	1.6 (83)	2.0 (759)	
Other, miscellaneous, or unknown	1.6 (15)	1.4 (172)	
Posted speed limit, mph			.06
1–25	11.4 (109)	12.8 (1142)	
26–35	30.7 (357)	28.3 (2954)	
36–45	19.7 (260)	23.1 (2750)	
46–55	10.8 (165)	12.5 (1703)	
56–75	5.1 (91)	7.1 (938)	
None posted	17.5 (116)	13.7 (954)	
Unknown	4.8 (45)	2.6 (275)	
Crash severity			.49
Any intrusion	7.2 (210)	6.7 (2099)	
Tow away, no intrusion	25.7 (534)	28.2 (4847)	
None	67.0 (399)	65.1 (3770)	
Single-vehicle crash	14.0 (170)	16.7 (1870)	.16

Data are weighted (%) (unweighted *n*).

[a] χ^2 Test that the proportions are the same for grandparent and parent drivers.

Table 2 provides descriptive characteristics of the motor vehicles driven and the crashes that occurred in our study sample, stratified by driver relationship. Grandparents tended to drive more passenger cars and pickup trucks and fewer sport utility vehicles and minivans. Vehicle weights for the predominant classes of vehicle were very similar (mean weights for grandparent versus parent-driven passenger cars, sport utility vehicles, and minivans varied by <225 lb). There were no significant differences between grandparent and parent drivers with regard to other markers of crash type, including posted speed limit, direction of initial impact, and rollover occurrence, or crash severity, as determined by the presence of intrusion, tow away, or single- versus multiple-vehicle crashes.

For the nearly 5-year period of this study, the weighted number of children involved in crashes with parent drivers was 217 976, of which 2293 were injured (1.05%), compared with 22 921 driven by grandparents, of which 161 were injured (0.70%); thus, the unadjusted risk of child injury was 33% lower when grandparents were drivers (OR: 0.67 [95% CI: 0.47–0.95]). This would equate to a potential for an absolute reduction of 762 child-passenger injuries (from 2293 to 1531) over the course of our study if parent drivers posed the same injury risk as grandparent drivers. After adjusting for driver gender and restraint use, child age and gender, child restraint

use and seating position, vehicle type and model year, and crash-scene characteristics and severity markers, this finding was even more pronounced, with a 50% reduction in risk of injury to grandparent-driven children (OR: 0.50 [95% CI: 0.33–0.75]).

DISCUSSION

Grandparents account for a significant portion of the drivers (nearly 1 in 10) when children are in motor vehicle crashes. Despite the fact that grandparents do not comply with current best-practice recommendations for optimal child restraint as often as parents, children in crashes with grandparent drivers were at one-half the risk of injury compared with children in crashes with parent drivers.

The grandparent drivers in this cohort were, as expected, considerably older than parent drivers and slightly more often female, but they were remarkably similar to parent drivers with respect to driver-restraint use, child-occupant age and gender, child-occupant seat position, vehicle model year, and several specific crash type and severity characteristics. The high, nearly equivalent, rate of driver restraint in both groups (97.7% for grandparents and 96.5% for parents) deserves comment. Driver-restraint use typically increases with age, and these observed driver-restraint rates are considerably higher than those reported for crash victims of comparable ages studied in a recent report from Boston.[16] Perhaps driving their restrained children or grandchildren influenced our parent and grandparent drivers to restrain themselves (in our study, almost all child occupants were restrained). Children in crashes with grandparent drivers displayed higher rates of suboptimal restraint use and trended toward a higher rate of front-seat seating (known risks of injury for children[2,17]) than did children of parent drivers. In addition, grandparents tended to drive vehicles known to result in higher rates of crash injury for children (passenger cars and pickup trucks). In addition, there was a trend toward higher injury risk among the grandparent drivers. Even when accounting for these differences among grandparent and parent drivers, child occupants in crashes with grandparents had a 50% lower adjusted injury risk than those with parent drivers.

The lower child-injury risk with grandparent drivers also is notable given the observed increased child-restraint misuse among grandparents noted in another study. The NHTSA surveyed vehicles with child passengers for child-restraint system misuse in parking lots at locations such as fast-food restaurants, shopping centers, and child merchandise stores in 6 states from September 2002 to January 2003 and found a high rate (almost 73%) of misuse.[18] A subsequent NHTSA report describing the results of a workshop for the study's state site coordinators noted anecdotally that several participants found grandparents to not be particularly good practitioners of child-occupant protection. Among the cited weaknesses were lower overall restraint use when grandparents were driving, use of older restraint systems, and children sitting on a grandparent's lap.[19]

Previous studies highlight the range of roles that grandparents play in their grandchildren's care: some are occasional or frequent babysitters; others provide regular, everyday child care while parents are at work; and others function in primary caretaker or even custodial roles. In 2000, it was estimated that 5.8 million grandparents lived with their grandchildren and that 31% of these grandparents reported responsibility for these children.[20] On the basis of this considerable variability, it seems plausible that grandparents with more demanding caretaker roles adopt more parental child care styles and practices, which might include driving habits. Of interest, the findings of a recent study suggest that, compared with the situation where mothers do not work outside the home, toddler-aged children who were cared for by grandparents while mothers were at work had a lower incidence of significant injuries; however, this difference was not present for grandmothers who were described as the primary caregiver.[21] It is unfortunate that our study did not collect grandparent caretaker status data and could not distinguish between grandparent drivers in these distinct roles.

These results suggest that there are some unaccounted-for protective grandparent driving style characteristics. An extensive literature exists on older drivers, suggesting that as a group, they are more risk averse than younger drivers but suffer from perceptual deficiencies and problems judging and responding to traffic flow.[8,9] Perhaps grandparents are made more nervous about the task of driving with the "precious cargo" of their grandchildren and establish more cautious driving habits to offset these challenges. Such adaptations might mitigate child injury after crashes when compared with parent drivers, even with very comparable gross measures of crash severity. This phenomenon may vary by time spent with grandchildren and/or specific caretaker role.

Future studies should explore the differences in parent versus grandparent driving styles and related crash scenarios to better clarify the apparent protective effect of grandparent drivers on the child-occupant injury risk observed in our study. Additional

studies and educational initiatives also might explore ways to further improve grandparent child-passenger safety practices. Such research and advocacy efforts are important for a number of reasons: our population is aging and many "boomers" will become grandparents in the next 20 years; grandparents constitute a significant population of child caretakers and of drivers with child occupants; grandparents are a group that has been largely untargeted for specific child-occupant safety education; we found that despite a lower relative risk of child injury in crashes involving grandparent drivers, there is still room for improvement in their use of optimal restraint and rear-seat position; and, finally, if grandparents are doing something right in child-occupant injury prevention, maybe we can learn from them and apply this insight to more general driver-education content targeted to all drivers of children.

There are several limitations to this study. The PCPS study relied on parent (or guardian or proxy) reports for all child and crash characteristics and thus might be subject to reporting bias. Of note, our sample of states included a mixture of tort and no-fault states that might affect the reporting behaviors of drivers. However, driver-reported data on child-restraint use and seating position in the overall PCPS study was compared with evidence from crash-scene investigations in those cases that were so investigated, with a high degree of agreement noted ($k = 0.99$ for seat row and $k = 0.74$ for restraint use). In addition, our age-specific restraint use and seating-position results were similar to that reported in other relatively recent population-based studies, in which 83% to 99% of children younger than 8 years were restrained.[22] This research was conducted on crashes involving State Farm policyholders only. Because State Farm is the largest insurer of automobiles in the United States, with more than 35 million vehicles covered, the results are likely representative of the insured public in this country. Our study population did not include uninsured vehicles or those of model years older than 1990 and therefore were likely to represent a population of higher household income than the overall US population.[23] The descriptive statistics of restraint use from parents and grandparents may be biased toward higher appropriate restraint use than would be seen in a general population that includes a more representative sample of uninsured motorists; however, bias is less likely with the analyses that compared grandparent with parent restraint practices and outcomes unless low income differentially affected outcomes for these two groups. Finally, our study does not include information about non-crash exposure to vehicle travel. Therefore, we cannot estimate the overall risk of crash occurrence or child injury for grandparent versus parent driven child passengers; rather, we can only compare this risk of injury for those child passengers involved in crashes.

CONCLUSIONS

In this study of a large sample of motor vehicle crashes involving child occupants, grandparents represented a significant portion of drivers. Our findings further suggested that although children in crashes are at risk of injury when grandparents are drivers, this risk is lower than when parents are drivers, despite less optimal use of child restraint in grandparent-driver crashes. This finding was more robust when the analysis was adjusted for several additional potential confounders, including driver gender and driver-restraint use, vehicle type and model year, and crash-scene characteristics and severity. These results suggest that grandchildren may be safer in crashes when driven by grandparents than by their parents, but child safety could be enhanced if grandparents followed current child-restraint guidelines. Additional elucidation of safe grandparent driving practices when carrying their grandchildren may inform future child-occupant driving-education guidelines for all drivers.

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REFERENCES

1. Centers for Disease Control and Prevention. WISQUARS leading causes of death reports, 1997–2007. Available at: http://webappa.cdc.gov/sasweb/ncipc/leadcaus10.html. Accessed June 1, 2010
2. Durbin DR, Chen I, Smith R, Elliot MR, Winston FK. Effects of seating position and appropriate restraint use on the risk of injury to children in motor vehicle crashes. *Pediatrics*. 2005;115(3). Available at: www.pediatrics.org/cgi/content/full/115/3/e305
3. National Highway Traffic Safety Administration (NHTSA). *Traffic Safety Facts: 2007 Data: Children*. Washington, DC: US Department of Transportation; 2009. Report DOT HS 810 987
4. Winston FK, Erkoboni D, Xie D. Identifying interventions that promote belt-positioning booster seat use for parents with low educational attainment. *J Trauma*. 2007;63(3 suppl):S29–S38

5. Lennon A. A risky treat: exploring parental perceptions of the barriers to seating their children in the rear seats of passenger vehicles. *Inj Prev*. 2007;13(2):105–109
6. Tessier K. Effectiveness of hands-on education for correct child restraint use. *Accid Anal Prev*. 2010;42:1041–1047
7. National Highway Traffic Safety Administration (NHTSA). *2007 Motor Vehicle Occupant Safety Survey, Vol 5: Child Safety Seat Report*. Washington, DC: US Department of Transportation; 2008. Report DOT HS 810 978
8. McGwin G, Brown, DB. Characteristics of traffic crashes among young, middle-aged, and older drivers. *Accid Anal Prev*. 1999; 33(2):181–198
9. Mayhew DR, Simpson HM. Collisions involving senior drivers: high risk conditions and locations. *Traffic Inj Prev*. 2006;7(2): 117–124
10. National Highway Traffic Safety Administration (NHTSA). *Traffic Safety Facts: 2007 Data: Older Population*. Washington, DC: US Department of Transportation; 2008. Report DOT HS 810 992
11. Dickerson AE, Molnar LJ, Ebt DW, et al. Transportation and aging: a research agenda for advancing safe mobility. *Gerontologist*. 2007;47(5):578–590
12. American Association of Retired Persons. *The Grandparent Study 2002 Report*. Washington, DC: American Association of Retired Persons; 2002
13. Durbin DR, Bhatia E, Holmes JH, et al. Partners for child passenger safety: a unique child-specific crash surveillance system. *Accid Anal Prev*. 2001;33(3):407–412
14. Association for the Advancement of Automotive Medicine. *The Abbreviated Injury Scale, Revision 1990*. Barrington, IL: Association for the Advancement of Automotive Medicine; 1990
15. Durbin DR, Winston FK, Applegate SM, Moll EK, Holmes JH. Development and validation of the Injury Severity Assessment Survey/ Parent Report: a new injury severity assessment survey. *Arch Pediatr Adolesc Med*. 1999;153(4):404–408
16. Bauzá G, LaMorte WW, Burke PA, Hirsch EF. High mortality in elder drivers is associated with distinct injury patterns: analysis of 187,869 injured drivers. *J Trauma*. 2008; 64(2):304–310
17. Elliott MR, Kallan MJ, Durbin DR, Winston FK. Effectiveness of child safety seats vs seat belts in reducing risk for death in children in passenger vehicle crashes. *Arch Pediatr Adolesc Med*. 2006;160(6):617–621
18. National Highway Traffic Safety Administration (NHTSA). *2004 Misuse of Child Restraints*. Washington, DC: US Department of Transportation; 2004. Report DOT HS 809 671
19. Decina LE, Lococo KH, Block AW; National Highway Traffic Safety Administration (NHTSA). *2005 Traffic Safety Facts Research Note: Misuse of Child Restraints: Results of a Workshop to Review Field Data Results*. Washington, DC: US Department of Transportation; 2005. Report DOT HS 809 851
20. Simmons T, Dye JL. *Grandparents Living With Grandchildren: 2000*. Washington, DC: US Census Bureau; 2003
21. Bishai D, Trevitt JL, Zhang Y, et al. Risk factors for unintentional injuries in children: are grandparents protective? *Pediatrics*. 2008;122(5). Available at: www.pediatrics.org/cgi/content/full/122/5/e980
22. Glassbrenner D. *The Use of Child Restraints in 2002*. NHTSA Research Note. Washington, DC: US Department of Transportation; 2003. Publication HS 809 555. 2003
23. Winston FK, Xie D, Durbin DR, Elliot MR. Are child passengers bringing up the rear? Evidence for differential improvements in injury risk between drivers and their child passengers. *Annu Proc Assoc Adv Automot Med*. 2007;51:113–127

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