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Association between driver and child passenger restraint: Analysis of community-based observational survey data from 2005 to 2019

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Abstract

Introduction.—Crash data suggest an association between driver seatbelt use and child passenger restraint. However, community-based restraint use is largely unknown. We examined the association between driver seatbelt use and child restraint using data from a state-wide observational study.

Methods.—Data from Iowa Child Passenger Restraint Survey, a representative state-wide survey of adult seat belt use and child passenger safety, were analyzed. A total of 44,996 child passengers age 0 – 17 years were observed from 2005 to 2019. Information about driver seatbelt use and child restraint was directly observed by surveyors and driver age was reported. Logistic regression was used to examine the association between driver seatbelt use and child restraint adjusting for vehicle type, community size, child seating position, child passenger age, and year.

Results.—Over the 15-year study period, 4114 (9.1%) drivers were unbelted, 3692 (8.2%) children were completely unrestrained, and another 1601 (3.6%) children were improperly restrained (analyzed as unrestrained). About half of unbelted drivers had their child passengers unrestrained (51.8%) while nearly all belted drivers had their child passengers properly restrained (92.3%). Compared with belted drivers, unbelted drivers had a 11-fold increased odds of driving an unrestrained child passenger (OR=11.19, 95%CI=10.36, 12.09). The association between driver seatbelt use and child restraint was much stronger among teenage drivers. Unbelted teenage drivers were 33-fold more likely (OR=33.34, 95%CI=21.11, 52.64) to have an unrestrained child passenger.

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Conflicts of interest

None

Conclusion.—These data suggest that efforts to increase driver seatbelt use may also have the added benefit of increasing child restraint use.

Practical applications.—Enforcement of child passenger laws and existing education programs for new drivers could be leveraged to increase awareness of the benefits of seatbelt use for both drivers themselves and their occupants. Interventions aimed at rural parents could emphasize the importance of child safety restraints.

Keywords

child safety restraint; driver seatbelt; rural areas; urban areas

Introduction

Unrestrained children riding in motor vehicles are at significant increased risk of crash-related injury and death [1 – 3]. Proper installation of age-appropriate child restraint systems, such as child safety seats or booster seats, and correct placement of children in restraints increase safety. Evidence shows that proper child restraint can reduce the risk of crash-related injury by 50% to 75% [4 – 6]. As a result, guidelines for proper child safety seat use based on variables such as age, height, and weight have been established by the American Academy of Pediatrics (AAP) [7] and the National Highway Traffic Safety Administration (NHTSA) [8]. Currently, all 50 states and District of Columbia have child passenger safety legislation and enforcement [9]. These efforts have led to an increase in child safety seat use reaching 90.9% across the United States in 2018 [10] and a decline in child passenger fatalities [11].

Although the use of child safety restraint has improved over time in the United States [10, 12], there remain a substantial number of children killed while riding in motor vehicles, many of whom are not properly restrained. In 2018, about one third of child passengers 0 to 12 years old fatally injured in motor vehicle crashes in the United States were unrestrained [13]. A more thorough understanding of factors influencing the use of child safety restraints is needed. Understanding these factors is important for targeted interventions and promoting optimal child passenger safety practices.

Prior research has reported an association between driver seatbelt use and child passenger restraint compliance [14 – 17]. However, these studies were conducted using crash data and might not depict an accurate picture of the distribution of child occupants in compliance with restraint guidelines. Given the difference in reported prevalence of overall child restraint use and the far lower prevalence of use reported in crash data, information on how to focus child seat use campaigns on high-risk drivers is warranted.

In this study we investigated the association between driver seatbelt use and child safety restraint use and examined if this association varied by factors such as driver age, vehicle type, and rurality.

Methods

Study population

Data analyzed in this study were derived from Iowa Child Passenger Restraint Survey conducted by the University of Iowa Injury Prevention Research Center and led by the Iowa Governor's Highway Traffic Safety Bureau. The survey is a representative state-wide survey of adult seat belt use and child passenger restraint use and observes approximately 3,000 drivers and their child occupants each year. The survey uses a stratified sampling scheme where the strata were determined by the population sizes of the communities. Approaches were taken so that the proportion of the overall sample in each stratum was close to both the proportion of the overall state population in the corresponding stratum, and the proportion of the state child population in the corresponding stratum. Within each stratum, survey locations were selected to ensure that all geographic regions of the state were well represented.

The survey was conducted at gas stations or other frequented locations in communities (e.g., swimming pools, aquatic centers, and community center parking lots) where the surveyor could approach motor vehicles carrying passengers who appeared to be up to seventeen years of age. When the surveyor approached the vehicle, they asked the driver if they would be willing to participate in a child passenger safety survey. If the driver agreed, the surveyor confirmed the driver age (<18 or ≥18) and the child's age(s), and quickly observed if the child was restrained and the child location within the vehicle. If the child was restrained, the surveyor noted the type of child restraint (child safety seat, booster seat, seat belt, none). Drivers of unrestrained children observed were reminded of Iowa child passenger law and offered a brochure outlining both current Iowa law and best practices. From 2005 through 2019, a total of 45,780 children ages 0 – 17 years were observed. We excluded 784 (1.7%) children with missing information on child restraint use, child's age, and vehicle type. Thus, our final analytical sample was 44,996.

Variables of interest

Driver seatbelt use and child passenger restraint

Information about driver seatbelt use and child restraint was directly observed. For a child who was restrained, we used the child's age and the type of restraint to determine whether the child was properly restrained in accordance with Iowa law [18]. A child passenger whose age was under 1 year and restrained with a child safety seat was classified as properly restrained, otherwise was coded as unrestrained. A child passenger whose age was from 1 year to 5 years and restrained with a child safety seat or a booster was classified as properly restrained, otherwise was coded as unrestrained. A child passenger whose age was from 6 years to 11 years and restrained with a child safety seat, a booster, or a seatbelt was classified as properly restrained, otherwise was coded as unrestrained. A child passenger whose age was from 12 years to 17 years and restrained with a booster or a seatbelt was classified as properly restrained, otherwise was coded as unrestrained. Completely unrestrained children and improperly restrained children were combined and analyzed as unrestrained.

Covariates

Communities were categorized as rural (fewer than 2,500 residents), town (2,500 – 9,999 residents), small urban (10,000 – 49,999 residents), and urban (50,000 residents or greater). Data on vehicle type was reported by surveyors and coded as car, pickup truck, pickup truck with a club cab (has an extra row of seats), van, and SUV. Other information collected in the survey included the seating position of child passenger within the vehicle (front seat vs. back seat) and the driver age (<18 or ≥18). Of note, prior to 2009, data on driver age was not collected.

Statistical methods

Characteristics of the study population are presented as frequency tabulations by driver seatbelt status. Multivariable logistic regression was used to calculate adjusted odds ratios (ORs) and corresponding 95% confidence intervals (CIs), which were used to identify factors associated with unrestrained child passengers. To investigate whether risk factors depend on the driver age, models were run separately for teen drivers (16–17 years old) and adult drivers (18+ years old). The stratified analysis by driver age was based on data from 2009 to 2019 because data on driver age was not collected prior to 2009. Covariates examined in the multivariable logistic regression models were community size, vehicle type, child seating position (front versus back), child passenger age, and year. All analyses were performed in SAS 9.4.

Results

Over the 15-year study period, 4114 (9.1%) drivers were unbelted, 3692 (8.2%) children were completely unrestrained, and another 1601 (3.6%) children were improperly restrained and analyzed as unrestrained. Table 1 shows the characteristics of the study population by driver seatbelt status. About half of unbelted drivers had their child passengers unrestrained (51.8%) while nearly all belted drivers had their child passengers properly restrained (92.3%). About three in four belted drivers and four in five unbelted drivers transported child passengers ages 1 – 11 years old. Unbelted drivers were most common in rural communities (34.5%) while belted drivers were most frequent in urban communities (38.5%). Belted drivers were more likely to have child occupants positioned in the back of the vehicle compared to unbelted drivers (78.4% vs 67.3%). Among unbelted drivers, passenger cars (42.7%) and SUVs (19.0%) were the most frequent vehicles used. Among belted drivers, passenger cars were the most frequent vehicles used (38.6%) followed by vans (27.2%). For drivers with available information on age, most child passengers were driven by drivers 18 years or older.

The results from the multivariable models are shown in Table 2. Compared with belted drivers, unbelted drivers had a 11-fold increased odds of having unrestrained child passengers (OR=11.19, 95%CI=10.36, 12.09). The association between driver seatbelt use and child passenger restraint was much stronger among teenage drivers. Unbelted teenage drivers were 33-fold more likely (OR=33.34, 95%CI=21.11, 52.64) to have unrestrained child passengers. Compared to child passengers under 1 year old, child passengers 1 – 5 years and 12 – 17 years old were 11 times more likely (OR=11.50, 95%CI=6.28, 21.07) and

almost 17 times as likely (OR=16.71, 95%CI=9.09, 30.73) to be unrestrained, respectively, while child passengers 6 – 11 years were 7 times more likely (OR=7.26, 95%CI=3.96, 13.31) to be unrestrained. Compared with urban communities, rural communities were associated with 18% increased odds of having unrestrained child passengers (OR=1.18, 95%CI=1.08, 1.29).

Compared with car drivers, pickup drivers were 64% more likely to have an unrestrained child passenger (OR=1.64, 95%CI=1.42, 1.89). Vehicles such as van and SUV were associated with decreased odds of unrestrained child passengers compared to passenger cars. Child passengers positioned in the back of the vehicle were almost 8-fold more likely to be unrestrained when the driver was a teenager (OR=7.69, 95%CI=5.41, 10.92) and 1.4-fold more likely to be unrestrained when the driver was an adult (OR=1.40, 95%CI=1.23, 1.59). Increasing year was associated with decreased odds for unrestrained child passengers.

Discussion

This study found that 90.9% of observed children riding in motor vehicles were restrained. A similar percentage was reported by the National Occupant Protection Use Survey (NOPUS) in 2018 [13]. The 2018 NOPUS data showed that 90.4% of child passengers under age 8 were restrained and 91.3% of children 8–15 years old were belted. The NOPUS is conducted annually and occupants of stopped vehicles are observed from the roadside at intersections controlled by stop signs or stop lights. The NOPUS roadside observers subjectively estimate vehicle occupants' age, while data on age is directly gathered from drivers in the Iowa Child Passenger Restraint Survey. In addition, the NOPUS does not collect information on the type of safety restraint, limiting their ability to assess whether a child restraint was age appropriate. Earlier studies have reported much lower percentages of child restraint use than those reported in the current study and the NOPUS survey. In Michigan in 1999, studies showed that 74.5% of children under 4 years of age were in safety seats [19] and 57.8% of children 4–15 years were restrained [20]. A child restraint study conducted in 2002 across several states (Arizona, Florida, Mississippi, Missouri, Pennsylvania, and Washington) reported that 62.3% of children riding in motor vehicles were restrained [21]. The higher percentage of child restraint use observed in recent years may be partially explained by the strengthening in child restraint laws as well as enforcement and parental behavioral changes [9, 12].

This study provides supporting evidence that a driver's seatbelt use is strongly associated with child passenger restraint use. The association of unbelted drivers with unrestrained child passengers was much stronger among teenage drivers. The findings from this study are consistent with previous studies reporting that unbelted drivers are more likely to have unrestrained child occupants in the vehicle. For example, a study examining factors associated with unrestrained child passengers using national crash data collected between 2011 and 2015 found a strong association of a driver seatbelt use with a child passenger being unrestrained and the strength of the association was inversely proportionate to the child age [14]. Using nonfatal data, the study found that 0- to 8-years old unrestrained passengers and 9- to 15-years old unrestrained passengers were 15 times and 18 times more likely to have unrestrained drivers, respectively. A similar trend in the associations

was observed across the same age groups but weaker when fatal crash data were analyzed. Findings from other studies based on crash data also concur with the results of the current study, showing that unrestrained child passengers are more likely have unbelted drivers [15 – 17]. These crash data have limitations. First, they might not provide an accurate distribution of children riding in compliance with restraint guidelines, a fundamental shortcoming. Second, data on occupant restraint use in a crash might not be accurate, especially when information on restraint use was reported by the child passenger or the driver. Inaccurate reporting of safety restraint use may occur when occupants have left their vehicles before the police arrived or occupants may falsely report the use of restraints to avoid tickets. Our study overcomes these limitations by using a sample weighted to the state population and by directly observing the use of driver seatbelt and child passenger restraint.

Studies have consistently shown that rural drivers are less likely to wear a seatbelt [22 – 24]. The current study found that rural communities were associated with unrestrained child passengers independent of the driver seatbelt status. This finding is consistent with a previous study reporting a lower use of child restraint in crashes occurring in rural communities compared to urban settings [16]. The lower use of safety restraints in rural communities may be explained by differences in the perceived importance of using child safety restraint. One previous study showed that urban parents were much more concerned about the risk of child injury in a crash than were rural parents [25].

Other factors associated with unrestrained child passengers included the vehicle in which the child was traveling and the child seating position. We found that vans and SUVs were less likely to have unrestrained children compared to passenger cars. These data are consistent with the 2018 NOPUS data which showed that restraint use was highest for vans & SUVs and lowest for passenger cars [10]. We found that the association between child seating position and restraint use depends on the driver age. Among teen drivers, back seat was strongly associated with a child being unrestrained. It would be quite helpful to understand what might have caused this effect modification to inform interventions to increase child occupant protection use.

This study has some limitations. Data on the child’s height and weight, which are helpful to determine appropriate restraint requirements, were not available due to challenges and accuracy of collecting this information in the field. As a result, we used only the child’s age to determine whether the child was properly restrained. Because the appropriate child safety restraint depends on the child’s age, height, and weight, it remains possible that we may have misclassified some child passengers. However, a possible misclassification is unlikely to change the conclusions of our study since only 3.6% of children were classified as improperly restrained while 8.2% of children were completely unrestrained. Moreover, data collectors did not determine whether child safety restraints were properly installed or fastened. These details would be helpful to determine whether the restraint meets AAP best practices.

Notwithstanding these limitations, the current study may have important implications. These data suggest that efforts to increase child restraint use may also have the added benefit of increasing driver seatbelt use, and, similarly, that highly visible enforcement of

child passenger laws [9] coupled with focused messages addressing both driver and child occupant protection may be helpful in increasing restraint use for both occupant groups. Given the strong relationship between driver seatbelt use and child safety restraint among teen drivers, enforcement of child passenger laws [9] combined with an emphasis of restraint use in education programs for new drivers could be leveraged to increase seatbelt use for both drivers themselves and their occupants. Interventions aimed at rural parents could emphasize the importance of child safety restraints. This study demonstrates an opportunity to promote driver belt use integrated with child safety seat use, especially in rural areas.

Conclusions

Unbelted drivers were strongly associated with unrestrained child passengers in a state-wide observational study and the association was much stronger among teenage drivers. Rural communities were also associated with unrestrained child passengers independent of the driver seatbelt status. These data suggest that efforts to increase child restraint use may also have the added benefit of increasing driver seatbelt use. This study demonstrates an opportunity to promote driver belt use integrated with child safety seat use, especially in rural areas.

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Highlights

- Community-based child passenger restraint use rates are largely unknown.
- Adherence to child restraint laws was examined via community-based observations.
- Unbelted drivers were more likely to have unrestrained child passengers than belted.
- Unbelted teen drivers were much more likely to have an unrestrained child passenger.

Table 1:

Characteristics of study population by driver seatbelt use status

Variables	Driver belted	
	Yes (n= 40882) n (%)	No (n= 4114) n (%)
Child passenger restrained		
Yes	37720 (92.3)	1983 (48.2)
No	3162 (7.7)	2131 (51.8)
Child passenger age		
< 1 year	1172 (2.9)	58 (1.4)
1 – 5 years	15806 (38.6)	1411 (34.3)
6 – 11 years	15613 (38.2)	1843 (44.8)
12 – 17 years	8291 (20.3)	802 (19.5)
Type of restraint used		
Belted	20940 (51.2)	993 (24.1)
Booster	8455 (20.7)	499 (12.1)
Child Safety Seat	9806 (24.0)	611 (14.9)
None	1681 (4.1)	2011 (48.9)
Seating position within the vehicle		
Back	32045 (78.4)	2768 (67.3)
Front	8837 (21.6)	1346 (32.7)
Vehicle type		
Car	15802 (38.6)	1756 (42.7)
Pickup	1169 (2.9)	437 (10.6)
Pickup club cab	3066 (7.5)	542 (13.2)
SUV	9718 (23.8)	780 (19.0)
Van	11127 (27.2)	599 (14.5)
Driver age		
16 – 17	1463 (3.6)	157 (3.8)
18+	26351 (64.4)	2092 (50.9)
Missing	13068 (32.0)	1865 (45.3)
Community		
Rural (< 2,500 residents)	6990 (17.1)	1420 (34.5)
Town (2,500 – 9,999 residents)	8542 (20.9)	996 (24.2)
Small urban (10,000 – 49,999 residents)	9616 (23.5)	782 (19.0)
Urban (≥ 50,000 residents)	15734 (38.5)	916 (22.3)

• Prior to 2009 data on driver age was not collected.

• Unrestrained child passenger: completely unrestrained or improperly restrained (A child passenger whose age was under 1 year and restrained with a child safety seat was classified as properly restrained, otherwise was improperly restrained. A child passenger whose age was from 1 year to 5 years and restrained with a child safety seat or a booster was classified as properly restrained, otherwise was improperly restrained. A child passenger whose age was from 6 years to 11 years and restrained with a child safety seat, a booster, or a seatbelt was classified as properly restrained, otherwise was improperly restrained. A child passenger whose age was from 12 years to 17 years and restrained with a booster or a seatbelt was classified as properly restrained, otherwise was improperly restrained.

Table 2:

Factors associated with child passengers being unrestrained

Variables	Multivariable ORs and 95% CI		
	ALL drivers	Teen drivers (16–17 years)	Adult drivers (18+)
Driver belted			
No	**11.19 (10.36, 12.09)**	**33.34 (21.11, 52.64)**	**15.36 (13.76, 17.14)**
Yes	**1.00**	**1.00**	**1.00**
Child passenger age			
< 1 year	1.00		1.00
1 – 5 years	11.50 (6.28, 21.07)	1.00 *	11.39 (5.82, 22.29)
6 – 11 years	7.26 (3.96, 13.31)		7.85 (4.01, 15.39)
12 – 17 years	16.71 (9.09, 30.73)	8.07 (4.57, 14.25)	17.58 (8.95, 34.52)
Community size			
Rural (< 2,500 residents)	1.18 (1.08, 1.29)	1.78 (1.16, 2.73)	1.25 (1.09, 1.43)
Town (2,500 – 9,999 residents)	1.10 (1.01, 1.20)	1.28 (0.84, 1.95)	1.13 (0.99, 1.29)
Small urban (10,000 – 49,999 residents)	1.13 (1.04, 1.24)	1.69 (1.08, 2.66)	1.06 (0.93, 1.21)
Urban (≥ 50,000 residents)	1.00	1.00	1.00
Vehicle type			
Pickup	1.64 (1.42, 1.89)	1.72 (0.90, 3.30)	2.08 (1.67, 2.58)
Pickup club cab	0.98 (0.88, 1.10)	1.13 (0.61, 2.07)	1.03 (0.88, 1.20)
SUV	0.59 (0.54, 0.65)	1.52 (0.97, 2.39)	0.60 (0.53, 0.69)
Van	0.55 (0.51, 0.60)	0.57 (0.29, 1.12)	0.66 (0.58, 0.76)
Car	1.00	1.00	1.00
Seating position within the vehicle			
Back	1.08 (0.99, 1.19)	7.69 (5.41, 10.92)	1.40 (1.23, 1.59)
Front	1.00	1.00	1.00
Year	0.88 (0.87, 0.88)	0.84 (0.79, 0.89)	0.93 (0.92, 0.95)

Notes:

• Overall odds ratio (OR) was calculated using data from 2005 to 2019.

• Stratified odds ratios (ORs) were calculated using data from 2009 to 2019 because prior to 2009 data on driver age was not collected.

• All models adjusted for community size, vehicle type, child seating position (front versus back), child passenger age, and year.

* For the teen driver model, child passenger age groups <1 year, 1 – 5 years, and 6 – 11 years were combined into one group because the model estimates were otherwise unstable.