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Factors Associated with Child Restraint Use in Fatal Motor Vehicle Crashes

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Abstract

Motor vehicle crashes (MVCs) are a leading cause of death among children. Multivariable analyses of age-appropriate child restraint system (CRS) use in the 'booster-aged' population are needed. The current study identified factors associated with age-appropriate CRS use in fatal MVCs for children 4–7 years old using 2011 to 2015 data from the Fatality Analysis Reporting System. Of 929 MVC fatalities, 32% of fatally injured children were in an age-appropriate restraint. While age-appropriate CRS use was higher for 4-, 5- and 6-year-olds relative to 7-year-olds (adjusted relative risk [aRR]: 2.57, 2.51, and 2.18, respectively; $p < .01$ for each comparison), black children (aRR: 0.62; $p < .01$) relative to white children, and drivers who had not used a lap-shoulder belt (aRR: 0.40; $p < .01$) relative to belted drivers were associated with lower levels of age-appropriate CRS use. Our findings underscore the continued importance of communicating best-practice guidelines on CRSs to caregivers of young children.

Introduction

Motor vehicle crashes (MVCs) remain a leading cause of death among 4- to 7-year-old children in the United States.¹ Over the last two decades a substantial decline in child fatalities from MVCs has been observed, largely attributed to advancements in legislation,

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public awareness, and passenger safety technology.^{2–4} Despite these improvements, recent evidence suggests that children still face elevated risk of injury and mortality from child restraint system (CRS) nonuse or misuse.^{3,5,6} In 2016, over one third of children 4–8 years old who were fatally injured in MVCs were entirely unrestrained.² The seat belt, albeit an improvement from unrestraint, is an inappropriate vehicle restraint system for most children under 8 years old. In young children, adult seat belt use significantly increases the risk of life-threatening trauma to the head, neck, and internal organs.^{7–11} Compared to the seat belt, CRS use reduces the risk of death in infants and toddlers, and decreases the odds of injury by 45% in children 4–8 years old.^{12,13} In addition to the physical protection, CRS use also provides economic benefits. Hospital expenditures for MVC related injuries were found to be lower in states with booster seat legislation compared to states without.⁴ Even when a CRS is used, misusing the CRS can substantially diminish its protective benefits.^{9,14–16} CRS misuse refers to installation (CRS to vehicle) and implementation (CRS to child) errors. The National Highway Traffic Safety Administration (NHTSA) found that 46% of CRSs exhibited at least one form of critical misuse in a nationwide observational study.¹⁷ Given the prevalence of CRS nonuse and misuse, the physical risk of injury and death, as well as the economic burden of hospitalization, young children and their caregivers would benefit from efforts to reduce CRS misuse and nonuse.

In 2011, the American Academy of Pediatrics (AAP) updated their best practice recommendations to emphasize that caregivers restrain children in CRSs that are developmentally appropriate and properly implemented.¹⁸ Specifically, the AAP advises against restraining children 4–8 years old (i.e. booster-aged) in seat belts, until they exceed the maximum height/weight threshold set by the booster seat manufacturer. Children may graduate to 3-point restraint systems, such as lap-shoulder seat belts, after outgrowing the booster seat. Typically, this transition occurs between the ages of 8 and 12 years, when the child reaches 4 feet 9 inches in height. The AAP guidelines for graduated restraint are informed by evidence, which shows that booster-aged children in seat belts are exposed to elevated risk of serious injury compared to those in CRSs.^{8,11,12}

Since the updated AAP policy, cross-sectional evidence suggests that children are still being inappropriately restrained or completely unrestrained.^{3,5,19} Furthermore, observational studies have connected several factors with the misuse or nonuse of CRSs, including legislation, socioeconomic indicators, race, age (of the child and parent), ease of the CRS installation, and parental beliefs.^{4,20–29} Although previous studies have shed light on the circumstances related to restraint use, few have analyzed population-level MVC fatality data using the AAP's definition of age-appropriate CRS use, while simultaneously adjusting for multiple risk factors. The objectives of this study were to identify factors associated with age-appropriate CRS use in fatal MVCs, as well as characterize overall patterns in CRS use among fatally injured 4–7-year-old child passengers.

Methods

Data Source

The data for this retrospective study were obtained from the 2011 to 2015 Fatality Analysis Reporting System (FARS) database from the NHTSA. The FARS is a census of all crashes

on US public roadways that result in the death of a pedestrian, motorist, or non-motorist within 30 days. The data elements in the FARS are based on primary source documents, such as police and medical examiner reports, and are compiled by trained technicians in each state. Among several indicators collected, motor vehicle occupant restraint use and misuse are derived from the reports of responding officers, which include first-hand observation and witness statements. The FARS database is maintained and standardized by the NHTSA. As the de-identified FARS data were obtained through public access, the current study was exempt from institutional review board approval.

Eligibility Criteria

There were 1,035 MVC fatalities among children 4–7 years old from 2011 to 2015. We limited our sample to MVC fatalities with documented restraint status that occurred in four-wheeled passenger vehicles. Therefore, after excluding fatalities that did not occur in the interior of four-wheeled passenger vehicles ($n=37$), and fatalities in which the restraint use of the child was unknown ($n=69$), we analyzed 929 of the 1,035 pediatric MVC fatalities. Although restraint use of the individual child was of interest, clustered units, which referred to vehicles containing more than one fatally injured child, were observed. After the criteria were applied, the sample consisted of 929 child fatalities in 873 vehicles and crashes.

Study Population

The outcome for this study was age-appropriate CRS use at the time of the collision. We dichotomized this variable into ‘age-appropriate CRS use’ and ‘CRS misuse or no CRS use.’ Although the FARS does not capture height and weight of motor vehicle occupants, the database includes a binary code for the presence of any restraint misuse (e.g., an occupant restrained by a loose or twisted vehicle restraint strap). The definition of age-appropriate CRS use was motivated by the current best practice recommendations of the AAP.¹⁸ Under the specific aims of this study, no use of a CRS was operationalized as equivalent to CRS misuse. ‘Age-appropriate CRS use’ referred to a child who was correctly restrained in an age-appropriate CRS (i.e., a car safety seat or a booster seat) and occupied a rear seat in the vehicle. By extension, ‘CRS misuse or no CRS use’ referred to any of following criteria: a child seated in the front row of the car, a CRS that had been misused, a child restrained by a seat belt or a miscellaneous restraint system (i.e. not a CRS or a lap-shoulder belt) or a child who was not restrained at all. Of the 929 fatally injured children, 67 (about 7%) were in a restraint system that was misused, and 325 (about 35%) were unrestrained at the time of the collision.

Several variables recorded in the FARS related to the child (including age, race, and sex), the driver (including age, sex, lap-shoulder belt use, and alcohol use), the vehicle (including type and manufacture year), and the crash (including time of day, day of the week, year, and roadway speed limit) were considered. When necessary, variables were recoded to mitigate the effect of small cell size. Child’s race (white, black, and other), driver’s age (< 24 years, 25–39 years, and ≥ 40 years old), and vehicle age (prior to 2005, 2005–2009, and after 2009) were condensed into 3-level categorical variables. Posted speed limit was dichotomized to contrast high speed (≥ 55mph) and low speed (<55mph) roadways.

Statistical Analysis

Contingency tables described the distribution of age-appropriate CRS use across each factor. Generalized log-binomial analysis was performed to obtain crude and adjusted relative risks (cRR and aRR, respectively) in addition to 95% confidence intervals (CI), as the overall frequency of age-appropriate CRS use was greater than 10%.³⁰ The study outcome of age-appropriate CRS use was sequentially regressed on each covariate to obtain cRRs. Variables with cRRs that met the statistical threshold of $p < 0.2$ were included in the adjusted model.

Missing values were observed in several study variables. MVC fatalities with insufficient data were excluded from the multivariate regression analysis. Consequently, the number of fatalities and clustered observations included in the multivariate model ($n=775$, $m=728$, respectively) was less than the total crash population ($N=929$, $M=873$) due to missing data (83 missing values for race, 49 missing for driver restraint use, 27 missing for speed limit, 2 missing for vehicle age, and 1 missing for driver's age). Contingent upon the amount of missing data in the selected variable, sample size varied accordingly in the bivariate regression models. The GENMOD procedure was invoked to fit the generalized log-binomial model from an estimating equation approach. All statistical operations were performed using SAS software, SAS Enterprise version 7.11.

Results

The sample included a total of 929 children 4–7 years old who were fatally injured in MVCs from 2011 to 2015 (Table 1). The total number of fatalities remained relatively stable throughout the study period. Both children and drivers in the sample displayed high-risk vehicle occupant behavior. While the front row of the vehicle was occupied by 10% of children, 24% of drivers did not use a lap-shoulder seat belt. Though the majority of drivers in our sample were young (aged 25–39 years), and female, 13% of drivers had police-reported alcohol use. Most crashes took place on high speed limit roadways (> 55 mph) between 6:00AM and 5:59PM, and involved passenger vehicles manufactured before 2005.

Though most children had used any restraint (including lap-shoulder belts and CRSs), the other 42% of fatally injured children were unrestrained or using a nonstandard restraint system (Table 2). An age-based pattern was observed in overall restraint type usage. As the age of the child increased, we also observed a discontinuation in booster seat use paired with a commensurate increase in lap-shoulder seatbelt use. Furthermore, as the age of the child increased, the percentage restrained in an age-appropriate CRS decreased (Table 3). A 22% reduction in age-appropriate CRS use was observed between age 4 and 7, as the percentage of children restrained in an age-appropriate CRS decreased from 38% at 4 years old, to 16% by 7 years old.

Age-appropriate CRS use was associated with several characteristics (Table 3). Of the investigated child factors, being older and black were associated with low age-appropriate CRS use. While 4- to 6-year-olds were over 2 times more likely to be restrained in an age-appropriate CRS than 7-year-olds, black children were 38% less likely to be restrained in an age-appropriate CRS than white children (95% CI: [0.45–0.84]). In the domain of driver factors, a low likelihood of age-appropriate CRS use was related to both young and

unrestrained drivers. Drivers aged 24 years or younger were 26% less likely restrain their child passengers in an age-appropriate CRS than drivers aged 25–39 years (95% CI:[0.56–0.98]). Among drivers, the failure to use a lap-shoulder belt was associated with a 60% decrease in the likelihood of age-appropriate CRS use (95% CI: [0.28–0.59]). Initially, drivers who had police-reported alcohol use were less likely to restrain their child passengers in an age-appropriate CRS than drivers with no police-reported alcohol use (cRR: 0.61; 95% CI: [0.42–0.88]), yet the association approached significance after adjusting for other factors (aRR: 0.72; 95% CI: [0.50–1.04]). In addition to person-level circumstances, characteristics of the vehicle and crash were also related to age-appropriate CRS use. While pickup trucks (aRR: 0.62; 95% CI: [0.40–0.95]) and SUVs (aRR: 0.75; 95% CI: [0.58–0.97]) were associated with lower age-appropriate CRS use than passenger cars, older vehicles (manufactured before 2009) had over 20% lower likelihood of age-appropriate CRS use than newer vehicles (manufactured after 2009). Although age-appropriate CRS use did not vary by weekends, the posted roadway speed limit was associated with age-appropriate CRS use. Children transported on roads with lower speed limits (<55mph) were 12% less likely to be restrained in an age-appropriate CRS than children travelling on roads with higher speed limits (95% CI: [0.62, 0.98]).

Discussion

Despite the efforts of policy makers and organizations, such as the AAP, the current study found that less than one third of children 4–7 years old who were fatally injured in MVCs from 2011 to 2015 were restrained in an age-appropriate CRS. Using a large, population-based sample, the current analysis of MVC fatalities has identified several factors associated with CRS use. As protective factors, newer vehicles and higher speed limit roadways were associated with an increased likelihood of age-appropriate CRS use. However, associations between restraint use and child's age and race, the driver's restraint use, and the type of vehicle, have been cited in past observational studies.^{24,25} More recently, children who were black, older, in a pickup truck, or transported by an unbelted driver were found to be associated with low usage of any vehicle restraint.²³ Given the relevance of these factors in the literature, the observed associations of age-appropriate CRS use with age, race, and driver restraint use merit more attention in future research. Overall, these findings may inform how clinicians, educators, and other child safety advocates give individualized counsel to the caregivers of booster-aged children.

In our analysis of pediatric MVC fatalities, the age of the child had the strongest effect on age-appropriate CRS use. We observed a decreased likelihood of age-appropriate CRS use with increased age of the child, even after we controlled for other relevant factors. Using data from an observational study, Ebel and colleagues found a similar decrease in the odds of proper restraint use by age in a sample of booster-aged children.^{24,31} Furthermore, the inverse relationship between the proportion of CRS use and the age of the child has been found in several cross-sectional studies, including those that specifically focus on unrestrained, CRS misuse, or age-appropriate restraint use.^{8, 9, 11, 22, 31, 32} Older children are more frequently observed as unrestrained,^{22,23} or restrained by an adult seat belt than younger children in the booster-aged cohort.^{6, 10, 12} A similar pattern was detected in our descriptive analysis of restraint system type by the age of the child. Given the classification

of the adult seat belt as an inappropriate restraint, age-based patterns in seat belt use likely influenced the observed effect of age on age-appropriate CRS use.

Related to the effect of age on age-appropriate CRS use, we also observed a pattern of increased adult seat belt use with increased child age. Although the AAP recommends that most children remain in booster seats until they are 57 inches and between 8 to 12 years old, our study found high levels of early seat belt use in older children—with a 10% increase in lap-shoulder belt use between age 6 and 7. Though these findings strictly apply to children in fatal MVCs, observational studies utilizing non-fatality data also identify increased frequency of seat belt usage with increased age of the child.^{6,9,12} Though some children in our sample may have truly outgrown their CRSs, past studies have found that some parents progress their booster-aged children to seat belts too quickly.^{11,27} Using a sample of 100 parents, Aita-Levey & Henderson reported that 56% of parents had prematurely transitioned their children out of booster seats and into adult seat belts.²⁰ Therefore, the observed increase in seat belt usage in the current study likely reflects this concept of premature graduation.¹¹

As early as the 1980s, injury research has connected race and preventative vehicle restraint behavior.^{33,34} In a cross-sectional survey of parents, Macy and colleagues found that white parents had a higher odds of reporting age-appropriate restraint use than nonwhite parents, adjusting for education and income, among other factors.²⁵ Though we found a strong association between race and age-appropriate CRS use, it is unsurprising that race, a social determinant of health, would relate to restraint use. In an analysis of fatality data from 2000 to 2014, Shin and colleagues found that restraint use in Indian lands was significantly lower than that of non-Indian lands.²⁹ Building upon early observational reports,^{33,34} our findings also suggest that fatally injured black children also face a higher risk of unrestrained and inappropriate restraint than white children. Furthermore, the observed racial difference in age-appropriate CRS use remained statistically significant, even after we adjusted for relevant risk factors. Despite decades of evidence connecting race to restraint use,^{21,23,34} our findings on race are alarming, given the disproportionate MVC mortality risk that black children face in the US.¹ It is exigent that injury researchers find novel methods to investigate the relationship between race and preventative transportation-related behaviors. While there have been several quantitative analyses of the relationship between race and CRS use,^{6,21,23,25} our understanding of the cognitions and cultural dynamics underlying these behaviors in the US is limited. Furthermore, methodologically diverse investigations of the relationship between race and CRS use may be informative to the process of developing targeted interventions.

Over 20 years of injury research has shown that unbelted drivers restrain their child passengers less frequently than restrained drivers.^{5,10,24,35} Huang and colleagues found that among children <14 years old, being driven by an unrestrained driver increased the odds of the child being unrestrained.²² The current study found that children who were transported by drivers who did not use lap-shoulder belts were less likely to be restrained in an age-appropriate CRS than children driven by belted drivers. As was suggested in an early study of CRS use,³⁵ it may be beneficial to incorporate driver restraint use into child passenger safety messages. Furthermore, our results suggest that these benefits may extend to age-

appropriate CRS use in booster-aged children. Unlike the race or age of the child, driver restraint use is a modifiable risk factor that could improve with behavioral interventions. For example, in a one year period, seat belt usage rose from 64% to 81% in North Carolina following the “Click it or Ticket” campaign, which combined intensive enforcement with public messages to promote driver seat belt use.³⁶ As we identified a strong association between adult lap-shoulder belt use and CRS use, connecting messages of age-appropriate child and driver restraint use in traffic safety campaigns would unify the issue of unrestraint and restraint misuse across all ages. Given the historical relevance of driver restraint use to child passenger safety, it is critical that advocates of child safety continue to promote the safe use of vehicle restraints to caregivers, for their own sake and the wellbeing of their children.

Limitations

Although we have identified several factors associated with age-appropriate CRS use, interpretations of our findings were constrained by the variables available for analysis. While the FARS is considered a census of all crashes, all records are based on primary source documents, which are subject to some degree of reporting bias. However, the FARS utilizes skilled technicians that are trained by NHTSA to perform quality checks and cross-reference information from multiple sources including records from hospitals, emergency medical services, and medical examiners. Furthermore, age-based CRS guidelines may lead to a small degree of classification error. As the FARS does not record the height and weight of all motor vehicle occupants, the current analysis could not account for these measures. Therefore, it is possible that some fatally injured children who had exceeded the height and weight requirement set by the booster seat manufacturer were adequately restrained by a seat belt. However, this potential misclassification was mediated by our choice of age group. The CDC estimate of 52 inches for the 95th percentile of height for 7.5-year-olds strengthens the assumption that most of the fatally injured children in our sample did not meet the minimum height requirement for adult seat belts.³⁷ As the importance of correct CRS use grows in the literature, large-scale surveillance databases should be encouraged to include the needed weight and height data.

The final limitation of our analysis is inherent to the FARS data. As the FARS is only intended to capture MVC fatalities, we restricted our sample to children who had died within 30 days of the MVC. In doing so, the children in our sample do not mirror those in the general population. Therefore, the reported percentages likely overestimate high-risk vehicle restraint behaviors, such as unrestraint or inappropriate restraint. For example, one nationally representative observational study found that less than 12% of children 4–7 years old were unrestrained in 2015.⁶ Contrast this reported percentage to the 2015 FARS estimate, in which 33% of fatally injured 4–7-year-old children were found to be unrestrained.³ Despite this limitation, the characteristics of the children in our sample do represent the population of children who are at highest risk for MVC-related fatality. Furthermore, this at-risk population of children would arguably benefit the most from interventions to improve rates of age-appropriate CRS use.

Conclusion

In analyzing factors related to age-appropriate CRS use, the current study investigated the effects of immutable factors like the age and race of the child, and modifiable factors like driver unrestraint. We have also identified an association between age-appropriate CRS use and vehicle type, vehicle manufacture year, as well as the posted speed limit. While these findings highlighted at-risk subpopulations that would likely benefit from targeted safety interventions, they also revealed the ongoing issue of appropriate CRS usage among booster-aged children. Although driver knowledge of best practice guidelines was not investigated, the current findings clearly indicate a divide between safety recommendations and outcomes. One previous study has found a connection between parental knowledge of best practice recommendations and booster seat use.²⁷ Future studies of parental attitudes toward CRS use may tease apart the influence of caregiver perceptions and beliefs on age-appropriate CRS use, adjusting for relevant demographic and vehicle factors. This information would contextualize our findings, as we have identified the importance of several person- and vehicle-level characteristics. Considering the long-standing influence of factors, such as age, race, and driver restraint use on CRS usage, the current study also provides clinicians and educators with meaningful talking points for parents and caregivers of booster-aged children.

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Table 1.

Sample Characteristics of Fatally Injured Children 4–7 Years Old, United States, 2011–2015

Characteristic	Age-appropriate Restraint Use	Inappropriate Restraint Use	No Restraint Use	Total Crash Population, n(%)*
Child (N=929)				
Age				
4	130	46	93	269 (29)
5	107	53	77	237 (25)
6	84	60	68	212 (23)
7	39	85	87	211 (23)
Sex				
Male	167	132	164	463 (50)
Female	193	112	161	466 (50)
Race				
White	260	170	168	598 (71)
Black	45	40	94	179 (21)
Other	20	16	33	69 (8)
Unknown	35	18	30	83
Seating Position				
Front Row	19	34	39	92 (10)
Second Row	310	177	206	693 (78)
Third Row	22	13	32	67 (8)
Other	5	17	11	33 (4)
Unknown	4	3	37	44
Driver (N=873)				
Age				
24 Years Old	46	44	56	146 (17)
25–39 Years Old	223	128	184	535 (61)
40 Years Old	76	54	61	191 (22)
Unknown	0	0	1	1
Sex				
Male	130	101	126	357 (41)
Female	215	125	176	516 (59)
Lap-Shoulder Belt Use				
Yes	291	168	158	617 (75)
No	42	42	127	211 (25)
Unknown	12	16	17	45
Alcohol use				
Yes	31	28	53	112 (13)
No	314	198	249	761 (87)
Vehicle (N=873)				

Characteristic	Age-appropriate Restraint Use	Inappropriate Restraint Use	No Restraint Use	Total Crash Population, n(%) [*]
Body Type				
Passenger car	204	128	127	459 (53)
Pickup truck	22	26	32	80 (9)
Van	42	22	38	102 (12)
SUV	77	50	105	232 (27)
Model Year				
2010	45	21	23	89 (10)
2005–2009	98	65	60	223 (26)
2004	201	139	219	559 (64)
Unknown	1	1	0	2
Crash (N=873)				
Time of Day				
6:00AM-5:59PM	228	145	188	561 (64)
6:00PM-5:59AM	117	81	114	312 (36)
Speed limit				
< 55 mph	100	87	91	278 (33)
55 mph or greater	239	130	201	570 (67)
Unknown	6	9	10	25
Weekend				
Yes	131	96	129	356 (41)
No	214	130	173	517 (59)
Year				
2011	70	47	53	170 (19)
2012	67	40	61	168 (19)
2013	64	41	66	171 (20)
2014	81	46	59	186 (21)
2015	63	52	63	178 (20)

^{*} Some percentages do not add to 100% due to rounding

Table 2.

Restraint System Type by the Age of the Fatally Injured Child, United States, 2011–2015

	Booster Seat	Car Seat	Booster Seat or Car Seat: Unknown Type	Lap-Shoulder Belt	Other Belt or No Use ^a	Total
	n (%)					
Age, years						
4	45 (17)	33(12)	52 (19)	33 (12)	106 (39)	269
5	48 (20)	17 (7)	42 (18)	40 (17)	90 (38)	237
6	44 (21)	10 (5)	30 (14)	44 (21)	84 (40)	212
7	20 (9)	2 (1)	17 (8)	64 (30)	108 (51)	211
Total	157 (17)	62 (7)	141 (15)	181 (19)	388 (42)	929

^aIncludes unrestraint and miscellaneous restraint types

Table 3.

Factors Associated with Age-Appropriate Restraint Use Among Fatally Injured Children 4–7 Years Old, United States, 2011–2015

Characteristic	Total*	Age-appropriate CRS use, %	Crude RR		Adjusted RR	
			Estimate	95% CI	Estimate	95% CI
	929	32				
Child						
Age						
	4 269	38	2.55	(1.78, 3.65)	2.57	(1.76, 3.75)
	5 237	37	2.39	(1.68, 3.4C)	2.51	(1.72, 3.64)
	6 212	33	2.28	(1.59, 3.29)	2.18	(1.46, 3.25)
	7 211	16	1.00	(Reference)	1.00	(Reference)
Sex						
	Female 463	34	1.00	(Reference)	1.00	(Reference)
	Male 466	29	1.17	(0.97, 1.42)	0.97	(0.83, 1.15)
Race						
	White 598	36	1.00	(Reference)	1.00	(Reference)
	Black 179	19	0.53	(0.38, 0.73)	0.62	(0.45, 0.84)
	Other 69	23	0.64	(0.41, 1.02)	0.72	(0.47, 1.10)
Driver[‡]						
Age (Years)						
	24 Years 155	26	0.79	(0.59, 1.06)	0.74	(0.56, 0.98)
	25–39 Years 574	33	1.00	(Reference)	1.00	(Reference)
	40 Years 199	33	1.01	(0.80, 1.28)	0.98	(0.79, 1.21)
Sex						
	Female 548	33	1.00	(Reference)	1.00	(Reference)
	Male 381	29	0.86	(0.71, 1.06)	1.05	(0.89, 1.25)
Lap-Shoulder Belt Use						
	Yes 649	39	1.00	(Reference)	1.00	(Reference)
	No 231	15	0.38	(0.27, 0.54)	0.40	(0.28, 0.59)
Alcohol use						
	Yes 120	20	0.61	(0.42, 0.88)	0.72	(0.50, 1.04)
	No 809	33	1.00	(Reference)	1.00	(Reference)
Vehicle[‡]						
Vehicle Type						
	Passenger car 483	36	1.00	(Reference)	1.00	(Reference)
	Pickup truck 85	20	0.57	(0.36, 0.88)	0.62	(0.40, 0.95)
	Van 114	37	1.00	(0.76, 1.33)	0.89	(0.66, 1.21)
	SUV 247	25	0.70	(0.55, 0.90)	0.75	(0.58, 0.97)
Vehicle Model Year						
	2010 92	46	1.00	(Reference)	1.00	(Reference)

Characteristic	Total*	Age-appropriate CRS use, %	Crude RR		Adjusted RR	
			Estimate	95% CI	Estimate	95% CI
2005–2009	233	39	0.86	(0.65, 1.13)	0.79	(0.63, 0.99)
2004	602	27	0.59	(0.45, 0.76)	0.72	(0.57, 0.90)
Crash[‡]						
Weekend						
Yes	377	29	0.85	(0.70, 1.04)	0.85	(0.69, 1.03)
No	552	34	1.00	(Reference)	1.00	(Reference)
Speed Limit						
<55mph	295	25	0.73	(0.58, 0.91)	0.78	(0.62, 0.98)
55 mph or greater	607	35	1.00	(Reference)	1.00	(Reference)

Abbreviations: RR, relative risk; CI, confidence interval

* The total number of observations in the multivariate model is less than 929

[‡]The distribution of this factor exclusively reflects the child as the unit of analysis Note: bolded results indicate significance of $p < 0.05$ in the adjusted analysis