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Booster Seat Effectiveness among Older Children: Evidence from Washington State

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ABSTRACT

Introduction: The American Academy of Pediatrics has recommended that children as old as 12 use a booster seat when riding in motor vehicles, yet little is known about booster seat effectiveness when used by older children. The objective was to estimate the association between booster use and injuries among children aged 8-12 who were involved in motor vehicle crashes.

Methods: The research team analyzed data on all motor vehicle crashes involving children aged 8-12 reported to the Washington State Department of Transportation for the period 2002-2015. The data were collected in 2015 and analyzed in 2016. Children who were in a booster seat were compared to children restrained by a seat belt alone. Logistic regression was used to adjust for potential confounders.

Results: In unadjusted models, booster use was associated with a 29% reduction in the odds of experiencing any injury relative to riding in a seat belt alone (OR, 0.709; 95% CI, 0.675, 0.745). In models adjusted for potential confounders, booster use was associated with a 19% reduction in the odds of any injury relative to riding in a seat belt alone (OR, 0.814; 95% CI, 0.749, 0.884). The risk of experiencing an incapacitating/fatal injury was not associated with booster use.

Conclusions: Children aged 8-12 involved in a motor vehicle crash are less likely to be injured if in a booster than if restrained by a seat belt alone. Because only 10% of U.S. children aged 8-12 use booster seats, policies encouraging their use could lead to fewer injuries.

INTRODUCTION

Motor vehicle crashes (MVCs) are the leading cause of death due to injury among children aged 8-12 in the United States.[1] In 2015, the most recent year for which Fatality Analysis Reporting System data are available, 242 children aged 8-12 died as a result of a MVC.[2]

Prominent groups such as the American Academy of Pediatrics (AAP) and National Highway Traffic Safety Administration (NHTSA) have suggested that children as old as 12 should use a belt-positioning booster seat when riding in a motor vehicle,[3, 4] and the use of booster seats by older children is, in fact, growing rapidly. According to the 2009 National Survey of the Use of Booster Seats, only 5% of children aged 8-12 used a booster seat.[5] By 2013, 10% of children in this age group used a booster seat.[6]

Very little is known about the effectiveness of booster seats among children over the age of 8. Only one previous study, by Ma et al., has examined the effectiveness of booster seats as compared to seat belts using data on older children.[7] However, this study has been characterized as underpowered and potentially unrepresentative.[8] Moreover, to increase sample size, Ma et al. combined data on children aged 4-10 with data on children aged 0-3, for whom booster seats are not recommended.

Studies focusing on younger children provide evidence that booster seat use reduces the risk of injury.[9-12] For instance, Durbin et al. examined data on children aged 4-7 involved in a MVC.[9] These authors found that booster seat use was associated with a 59% decrease in the odds of injury as compared to being restrained by a seat belt alone. Using data on children aged 4-8 involved in a MVC, Arbogast et al. found that booster seat use was associated with a 45% decrease in the odds of an injury as compared to being restrained by a seat belt alone.[10]

Drawing on crash data collected by the Washington State Department of Transportation (WSDOT) for the period 2002-2015, the effectiveness of booster seats as compared to seat belts among children aged 8-12 was examined. Logistic regression was used to adjust for factors such as seating position, direction of the impact, vehicle type, vehicle age, time of day, day of week, weather conditions, and the number of vehicles involved. Booster seat laws in the United States typically apply to children under the age of 8; no state currently requires children over 8 years of age to use booster seats.[13]

METHODS

Data Source, Sample Selection, and Outcome Variables

Data on MVCs came from the WSDOT, were collected in 2015, and analyzed in 2016. The data cover all MVCs on Washington public roadways reported to law enforcement officers during the period 1/2002 through 7/2015, and were obtained through a written agreement with the WSDOT in accordance with the Public Records Act, RCW 42.56. They contain information on the vehicles involved in the accident, the circumstances surrounding the crash (e.g., weather conditions and time of day), and driver and passenger characteristics. The WSDOT data also include detailed information on restraint device usage and injury severity.

The focus was on occupants aged 8-12 who rode in a passenger car or a light truck and were restrained by either a booster seat or seat belt alone. Pedestrians and children riding in vehicles such as school buses or motor homes were excluded from the analysis. During the period 2002-2015, nearly 92% of children aged 8-12 who were involved in a MVC were passengers in a car or light truck. Children who had missing information on age, type of restraint used, or severity of injury were also excluded from the analysis.

A total of 79,859 children aged 8-12 were observed in the WSDOT data. Of these, 5,932 (7.4%) were in a booster seat at the time of the MVC and 73,927 (92.6%) were restrained by a seat belt alone. Figure 1, which is based on the WSDOT data, shows a steep increase in booster seat use among 8-12-year-olds involved in a MVC. In 2002, only 2% of children aged 8-12 used a booster seat. By 2015, approximately 14% of children belonging to this age group used a booster seat.

Two outcomes were constructed, both of which were based on the 5-point KABCO scale used by WSDOT to characterize injuries sustained by persons involved in a MVC. The first was an indicator for experiencing any injury, including so-called "non-evident" injuries such as limping, momentary unconsciousness, nausea, and pain. The second was an indicator of whether the crash caused an incapacitating or fatal injury to the child. Examples of incapacitating injuries include severe lacerations, broken or distorted extremities, significant burns, unconsciousness, and paralysis. There is evidence that responding officers applying the KABCO scale often mistake minor injuries such as abrasions and contusions for incapacitating injuries, especially when there is copious bleeding.[14-16] However, responding officers are much better at distinguishing between the absence of an injury and non-evident/minor injuries.[14, 15]

Data Analysis

Logistic regression analysis was used to estimate the effect of using a booster seat relative to being restrained by a seat belt alone. Estimates were considered to be statistically significant if their 95% confidence interval did not include the value 0. Standard errors (used to calculate confidence intervals and p-values) were corrected for clustering at the county level.

This correction takes into account the fact that parents living in the same county may not behave independently.

Adjusted models included individual-, vehicle-, and crash-level variables. At the individual-level, these were indicators for seat position (front, back left, back middle, back right, and "other" seating position), gender, and age. It is particularly important to adjust for seating position because children in a child restraint system (CRS) are more likely to ride in the back than those who are restrained by a seat belt alone.[17] The results of previous studies suggest that sitting in the back of the vehicle reduces the likelihood of being fatally injured, especially for children.[18]

Vehicle-level variables included age of the vehicle at the time of the crash and indicators for vehicle type, model year, and vehicle style. Indicators for seat belt use by the driver, injury status of the driver, whether the driver was driving without a license, and whether the driver was listed by the reporting law enforcement officer as at fault were also included and served as proxies for unobserved driver characteristics. The crash-level variables included the number of persons involved in the MVC and indicators for the number of cars involved, the speed limit, direction of impact, whether the crash occurred on a rural road, the time of day, whether the crash occurred on the weekend, weather conditions, the month and year of the crash, and the county where the crash occurred.

RESULTS

Table 1 provides means (with standard deviations in parentheses) for the full sample and Appendix Table 1 (available online) provides variable definitions. Appendix Table 2 (available online) shows descriptive statistics for subsamples based on restraint type. Descriptive statistics for the month, year, and county indicators were suppressed for the sake of brevity, but are available upon request.

As shown in Appendix Table 2, Eleven % of children who rode in a booster seat suffered an injury. In comparison, 15% of children restrained by a seat belt were injured. Fatal/incapacitating injuries among children in the data set were rare: only 0.3% of children in booster seats, and 0.3% of children restrained by a seat belt alone, suffered a fatal or incapacitating injury. Type of restraint was associated with significant differences in observable characteristics. For instance, children who rode in a booster seat were more likely to be positioned in the back and were more likely to be in a newer vehicle.

The first and second columns of Table 2 report unadjusted estimates for any injury and fatal/incapacitating injury, respectively. The use of a booster was associated with a 29% reduction in the odds of any injury relative to being in a seat belt alone (odds ratio [OR], 0.709; 95% CI, 0.675-0.745). On the other hand, the use of a booster was not statistically related to the odds of fatal/incapacitating injury relative to being restrained by a seat belt alone.

The third and fourth columns of Table 2 show estimates adjusted for the individual-, vehicle-, and crash-level characteristics listed in Table 1 as well as the month, year, and county in which the crash took place. The use of a booster seat was associated with a 19% reduction in the odds of any injury relative to being in a seat belt alone (OR, 0.814; 95% CI, 0.749-0.884). Again, the use of a booster was not statistically related to the odds of experiencing a fatal/incapacitating injury relative to being restrained by a seat belt alone.

In Table 3, adjusted estimates by age (children aged 8-9 vs. children aged 10-12) are reported. Among children aged 8-9, the use of a booster was associated with a 13% reduction in the odds of any injury relative to being restrained by a seat belt alone (OR, 0.869; 95% CI, 0.818-0.923), while the use of a booster was not associated with a significant change in the odds of experiencing a fatal/incapacitating injury relative to being restrained by a seat belt alone.

Among children aged 10-12, the use of a booster seat was associated with a 33% reduction in the odds of any injury relative to being restrained by a seat belt alone (OR, 0.675; 95% CI, 0.505-0.902), while the use of a booster seat was not associated with a significant change in the odds of experiencing a fatal/incapacitating injury relative to being restrained by a seat belt alone. It should be noted, however, that the 13% reduction in the odds of any injury among children aged 8-9 is not statistically distinguishable from the 33% reduction in the odds of any injury among children aged 10-12.

DISCUSSION

Booster seats were first introduced in 1978, and have been growing rapidly in popularity since.[6, 19, 20] They are designed to improve seat belt fit for children who are too big for a harnessed child restraint system but too small for vehicle belts to fit properly. During a MVC, the lap belt should engage with the front of the pelvis and the shoulder belt should engage with the clavicle. When properly used, booster seats direct the force of the seat belt onto the skeleton as opposed to soft tissues.[19, 21]

Prominent groups such as the AAP and NHTSA suggest that children as old as 12 should use a belt-positioning booster seat when riding in a motor vehicle. However, very little is known about the effectiveness of booster seats as compared to seat belts when used by older children.

In fact, only one previous study, authored by Ma et al., has examined data on children between the ages of 8 and 12 involved in a MVC.[7] Ma et al. found that the association between booster seat use and severe injuries was not statistically significant at conventional levels.

However, booster seat use was associated with increased risk of minor neck injury (such as abrasions and contusions) and thorax injury as compared to the use of seat belts alone.

Although intriguing, there are a number of reasons to view the results described in the above paragraph with some skepticism.[8] Most relevant to the current study, Ma et al. combined data on children aged 4-10 with data on children aged 0-3, for whom booster seats are not recommended. Because belt positioning is critical for the safety of the child, premature graduation from a harnessed child restraint system to a booster seat (or from a booster seat to a seat belt) is thought to be particularly dangerous.[6]

Using data on all MVCs reported to WSDOT during the period 2002-2015 involving children aged 8-12, the effectiveness of booster seats as compared to seat belts was examined. Type of restraint used (booster seat vs. seat belt) was associated with significant differences in variables such as seating position, vehicle type, and vehicle year, all of which could be related to the risk of experiencing an injury in the event of a MVC. After adjusting for these and other factors, booster seats were found to be no more effective than seat belts at preventing fatal/incapacitating injuries, such as severe lacerations, broken or distorted extremities, unconsciousness, and paralysis. In contrast, there was a strong negative association between using a booster seat and the odds of any injury from a MVC. Specifically, the use of a booster seat was associated with a 19% reduction in the odds of experiencing any injury relative to being restrained by a seat belt alone. This estimate suggests that children aged 8-12 are safer in booster seats than in seat belts, but it is considerably smaller than estimates found by two teams of researchers who focused on younger children (i.e., children under the age of 9). Using data on children aged 4-7 involved in a MVC, Durbin et al. found that booster seat use was associated with a 59% decrease in the odds of injury as compared to being restrained by a seat belt alone;

Arbogast et al., who examined children aged 4-8 involved in a MVC, found that booster seat use was associated with a 45% decrease in the odds of an injury as compared to being restrained by a seat belt alone.[9, 10] However, because the current study used a different injury definition than was used by Durbin et al. and Arbogast et al., it would be premature to conclude that booster seat effectiveness is a function of age.

In 2007, Washington passed the Anton Skeen Act, which requires children less than 8 years of age to be in a CRS, and today every state except for South Dakota requires the use of booster seats. There is evidence that such requirements are effective. For instance, Winston et al. found that children aged 4-7 living in states that had implemented booster seat laws were 39% more likely to be appropriately restrained than their counterparts in states that had not implemented booster seat laws.[22] Eichelberger et al. compared booster seat use among children aged 4-8 involved in a MVC before and after the adoption of a booster seat law.[23] These authors found that adoption of a booster seat law was associated with an almost three-fold increase in the percentage of children who were appropriately restrained.

Booster seat laws, however, typically apply to children under the age of 8. Only two states (Tennessee and Wyoming) require 8-year-olds to use booster seats, and no state requires children over the age of 8 to use booster seats.[13, 23] The estimates of the association between booster seat use and the risk of injury discussed above suggest that extending the coverage of booster seat laws to older children would result in many fewer injuries, but there are several limitations to the current study that should be noted.

First, information on the child's height and weight is not available in the WSDOT data, but the decision to use a booster seat should, according to experts, be based primarily on these factors as opposed to age.[24, 25] Many states require children of a certain age to be in a CRS without providing exemptions for children of above-average height and weight.[13] Collecting information on the height and weight of crash victims could help researchers and policymakers craft such exemptions.

Second, 1.7% of children aged 8-12 were, according to the WSDOT, in a CRS other than a booster seat. These children were coded as being in a booster seat at the time of the accident. However, when they were excluded from the analysis, the estimated ORs reported in Tables 2 and 3 were qualitatively unchanged.

Third, the KABCO scale used by WSDOT does not contain nearly as much information on injuries sustained as was available to Ma et al. Although these authors found no differences in the risk of experiencing any injury, they did find that the use of booster seats was associated with an increased risk of neck and thorax injuries relative to the use of seat belts. Because the KABCO scale does not include information on where the injury occurred, it cannot be used to explore the effects of booster seats on neck and thorax injuries.

Lastly, the WSDOT data are not nationally representative, and parents in Washington could be better (or worse) at positioning booster seats than parents in other states. A recent field study by the NHTSA found that roughly 10 percent of children in booster seats had the lap belt sitting too high, across the child's stomach.[26] If parents in Washington are somehow less prone to making this mistake than parents elsewhere, then the results could overstate the relative effectiveness of booster seats as compared to seat belts alone.

CONCLUSIONS

Children between the ages of 8 and 12 who are involved in a motor vehicle crash are less likely to be injured if they are in a booster seat than if they are restrained by a seat belt alone. No state currently mandates the use of booster seats for children over the age of 8, and only 10% of 8- through 12-year-olds in the United States use booster seats.[6, 13] The results presented above suggest that the adoption of laws encouraging the use of booster seats among children aged 8-12 could lead to many fewer injuries.

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Figure 1. Booster Seat Use in Washington State

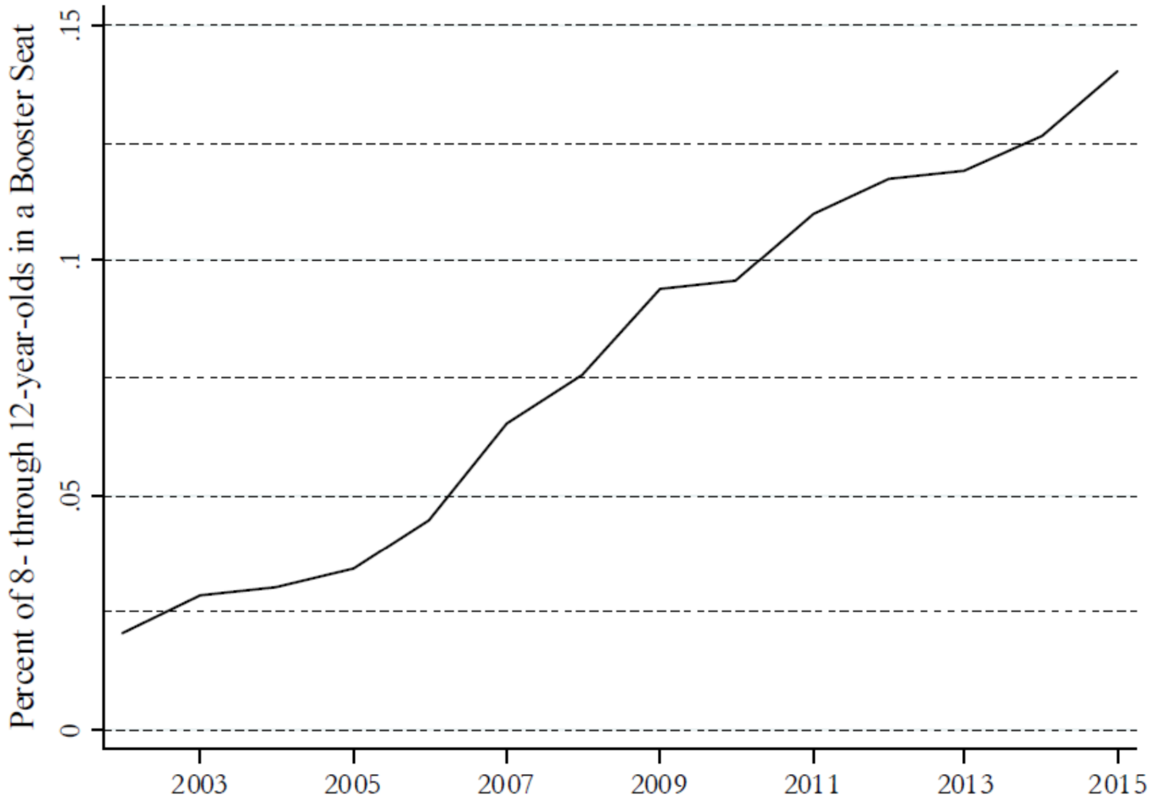

Table 1. Descriptive Statistics[a]

	Mean (SD)
Outcomes	
Any Injury	0.145 (0.352)
Fatal/Incapacitating Injury	0.003 (0.056)
Individual-level characteristics	
Front Seat	0.287 (0.452)
Back Left Seat	0.278 (0.448)
Back Middle Seat	0.098 (0.297)
Back Right Seat	0.322 (0.467)
Other Seating Position	0.014 (0.118)
Male	0.480 (0.500)
Age 8	0.203 (0.402)
Age 9	0.200 (0.400)
Age 10	0.200 (0.400)
Age 11	0.199 (0.399)
Age 12	0.199 (0.399)
Vehicle-level characteristics	
Car	0.442 (0.497)
Light Truck	0.558 (0.497)
Model Year ≤ 1990	0.089 (0.285)
1990 < Model Year ≤ 1995	0.160 (0.366)
1995 < Model Year ≤ 2000	0.278 (0.448)
2000 < Model Year ≤ 2005	0.301 (0.458)
2005 < Model Year ≤ 2010	0.134 (0.341)
Model Year > 2010	0.038 (0.191)
Vehicle Age	8.414 (5.745)
Coupe	0.028 (0.165)
Convertible	0.004 (0.066)
Hatchback	0.027 (0.162)
Sedan	0.332 (0.471)
Station Wagon	0.259 (0.438)
Jeep	0.062 (0.242)
Other Vehicle Style	0.287 (0.452)

Front-End Collision	0.336 (0.472)
Left-Side Collision	0.019 (0.138)
Right-Side Collision	0.022 (0.148)
Side Collision	0.042 (0.200)
Rear-End Collision	0.015 (0.121)
Other Collision	0.018 (0.131)
Driver Unbelted	0.004 (0.066)
Driver Injured	0.208 (0.406)
Driver No License	0.021 (0.145)
Driver At Fault	0.376 (0.484)
Crash-level characteristics	
Persons Involved	5.310 (2.209)
One-Car Crash	0.090 (0.286)
Two-Car Crash	0.742 (0.438)
Three-Plus-Car Crash	0.168 (0.374)
Speed Limit < 55MPH	0.734 (0.442)
Rural Road	0.081 (0.273)
Early Morning	0.007 (0.081)
Daytime	0.906 (0.291)
Evening	0.087 (0.282)
Weekend	0.375 (0.484)
Precipitation	0.182 (0.386)
No Precipitation	0.807 (0.395)
Other Weather	0.009 (0.096)
N	79,859

[a] Means (with standard deviations in parentheses) are based on data from the Washington State Department of Transportation (2002-2015). Means for binary variables can be interpreted as proportions.

Table 2. Unadjusted and Adjusted OR of Injury for Booster Seats Relative to Seat Belts[a]

	Unadjusted Models		Adjusted Models[b]	
	Any Injury	*Fatal/Incapacitating Injury*	*Any Injury*	*Fatal/Incapacitating Injury*
Booster Seat	**0.709**	1.003	**0.814**	1.349
	[0.675, 0.745]	[0.691, 1.460]	**[0.749, 0.884]**	[0.907, 2.004]

Boldface indicates statistical significance ($p < 0.01$).

Abbreviations: OR, odds ratio

[a] Each column represents results from a separate logistic regression based on data from the Washington State Department of Transportation (2002-2015). Odds ratios are reported with 95% confidence intervals in brackets. *Any Injury* corresponds to K, A, B, and C injuries on the KABCO scale, while *Fatal/ Incapacitating Injury* corresponds to K and A injuries.

[b] Adjusted for the individual-, vehicle-, and crash-level characteristics listed in Table 1, and the month, year, and county in which the crash occurred.

Table 3. Adjusted OR of Injury for Booster Seats Relative to Seat Belts by Age Group[a, b]

	8 to 9 Year Olds		10 to 12 Year Olds	
	Any Injury	*Fatal/Incapacitating Injury*	*Any Injury*	*Fatal/Incapacitating Injury*
Booster Seat	**0.869**	1.431	**0.675**	1.232
	[0.818, 0.923]	[0.827, 2.478]	**[0.505, 0.902]**	[0.556, 2.731]

Boldface indicates statistical significance ($p < 0.01$).

Abbreviations: OR, odds ratio

[a] Each column represents results from a separate logistic regression based on data from the Washington State Department of Transportation (2002-2015). Odds ratios are reported with 95% confidence intervals in brackets. *Any Injury* corresponds to K, A, B and C injuries on the KABCO scale, while *Fatal/ Incapacitating Injury* corresponds to K and A injuries.

[b] Adjusted for the individual-, vehicle-, and crash-level characteristics listed in Table 1, and the month, year, and county in which the crash occurred.

Appendix Table 1. Variable Descriptions

	Description
Outcomes	
Any Injury	= 1 if child suffered any injury, = 0 otherwise
Fatal/Incapacitating Injury	= 1 if child suffered a fatal or incapacitating injury, = 0 otherwise
Individual-level characteristics	
Front Seat	= 1 if child was sitting in the front of the vehicle, = 0 otherwise
Back Left Seat	= 1 if child was sitting in the back left of the vehicle, = 0 otherwise
Back Middle Seat	= 1 if child was sitting in the back middle of the vehicle, = 0 otherwise
Back Right Seat	= 1 if child was sitting in the back right of the vehicle, = 0 otherwise
Other Seating Position	= 1 if child was in an "other" or unknown seating position, = 0 otherwise
Male	= 1 if male, = 0 otherwise
Age 8	= 1 if eight years of age, = 0 otherwise
Age 9	= 1 if nine years of age, = 0 otherwise
Age 10	= 1 if ten years of age, = 0 otherwise
Age 11	= 1 if eleven years of age, = 0 otherwise
Age 12	= 1 if twelve years of age, = 0 otherwise
Vehicle-level characteristics	
Car	= 1 if vehicle was a car, = 0 otherwise
Light Truck	= 1 if vehicle was a light truck, = 0 otherwise
Model Year ≤ 1990	= 1 if vehicle model year was pre 1991, = 0 otherwise
1990 < Model Year ≤ 1995	= 1 if vehicle model year was between 1991 and 1995, = 0 otherwise
1995 < Model Year ≤ 2000	= 1 if vehicle model year was between 1996 and 2000, = 0 otherwise
2000 < Model Year ≤ 2005	= 1 if vehicle model year was between 2001 and 2005, = 0 otherwise
2005 < Model Year ≤ 2010	= 1 if vehicle model year was between 2006 and 2010, = 0 otherwise
Model Year > 2010	= 1 if vehicle model year was post 2010, = 0 otherwise
Vehicle Age	Vehicle age (in years) at time of crash
Coupe	= 1 if vehicle style was a coupe, = 0 otherwise
Convertible	= 1 if vehicle style was a convertible, = 0 otherwise
Hatchback	= 1 if vehicle style was a hatchback, = 0 otherwise
Sedan	= 1 if vehicle style was a sedan, = 0 otherwise
Station Wagon	= 1 if vehicle style was a station wagon, = 0 otherwise
Jeep	= 1 if vehicle style was a jeep, = 0 otherwise
Other Vehicle Style	= 1 if vehicle style was an "other" vehicle style, = 0 otherwise
Front-End Collision	= 1 if direction of impact was at the front end of the vehicle, = 0 otherwise
Left-Side Collision	= 1 if direction of impact was at the left side of the vehicle, = 0 otherwise
Right-Side Collision	= 1 if direction of impact was at the right side of the vehicle, = 0 otherwise
Side Collision	= 1 if direction of impact was at the side of the vehicle (which side unspecified), = 0 otherwise
Rear-End Collision	= 1 if direction of impact was at the rear end of the vehicle, = 0 otherwise
Other Collision	= 1 if an "other" type of collision, = 0 otherwise

Driver Unbelted	= 1 if driver was unbelted, = 0 otherwise
Driver Injured	= 1 if driver was injured, = 0 otherwise
Driver No License	= 1 if driver was driving without a license, = 0 otherwise
Driver At Fault	= 1 if driver was at fault, = 0 otherwise
Crash-level characteristics	
Persons Involved	Number of persons involved in the crash
One-Car Crash	= 1 if crash was a one-car crash, = 0 otherwise
Two-Car Crash	= 1 if crash was a two-car crash, = 0 otherwise
Three-Plus-Car Crash	= 1 if crash was a three-plus-car crash, = 0 otherwise
Speed Limit < 55MPH	= 1 if speed limit was less than 55 mph, = 0 otherwise
Rural Road	= 1 if crash was on a rural road, = 0 otherwise
Early Morning	= 1 if crash occurred during the early morning hours (1:00 a.m. to 5:59 a.m.), = 0 otherwise
Daytime	= 1 if crash occurred during the daytime hours (6:00 a.m. to 7:59 p.m.), = 0 otherwise
Evening	= 1 if crash occurred during the evening hours (8:00 p.m. to 12:59 a.m.), = 0 otherwise
Weekend	= 1 if crash occurred during the weekend (Friday, 6:00 p.m. to Monday, 5:59 a.m.), = 0 otherwise
Precipitation	= 1 if it was raining, snowing, sleeting, or hailing at the time of the crash, = 0 otherwise
No Precipitation	= 1 if there was no precipitation at the time of the crash, = 0 otherwise
Other Weather	= 1 if "other" weather conditions were recorded at the time of the crash, = 0 otherwise

Appendix Table 2. Descriptive Statistics by Restraint Type[a]

	Full sample	*Booster Seat* = 1	*Seat Belt* = 1
Outcomes			
Any Injury	0.145	0.109	0.147[b]
	(0.352)	(0.312)	(0.355)
Fatal/Incapacitating Injury	0.003	0.003	0.003
	(0.056)	(0.057)	(0.056)
Individual-level characteristics			
Front Seat	0.287	0.049	0.306[b]
	(0.452)	(0.215)	(0.461)
Back Left Seat	0.278	0.397	0.269[b]
	(0.448)	(0.489)	(0.443)
Back Middle Seat	0.098	0.110	0.097[b]
	(0.297)	(0.313)	(0.296)
Back Right Seat	0.322	0.433	0.314[b]
	(0.467)	(0.496)	(0.464)
Other Seating Position	0.014	0.011	0.014[b]
	(0.118)	(0.104)	(0.119)
Male	0.480	0.456	0.482[b]
	(0.500)	(0.498)	(0.500)
Age 8	0.203	0.514	0.178[b]
	(0.402)	(0.500)	(0.383)
Age 9	0.200	0.244	0.196[b]
	(0.400)	(0.430)	(0.397)
Age 10	0.200	0.135	0.205[b]
	(0.400)	(0.342)	(0.404)
Age 11	0.199	0.070	0.209[b]
	(0.399)	(0.255)	(0.407)
Age 12	0.199	0.037	0.212[b]
	(0.399)	(0.188)	(0.409)
Vehicle-level characteristics			
Car	0.442	0.381	0.447[b]
	(0.497)	(0.486)	(0.497)
Light Truck	0.558	0.619	0.553[b]
	(0.497)	(0.486)	(0.497)
Model Year ≤ 1990	0.089	0.030	0.094[b]
	(0.285)	(0.170)	(0.291)
1990 < Model Year ≤ 1995	0.160	0.101	0.164[b]
	(0.366)	(0.302)	(0.371)

1995 < Model Year ≤ 2000	0.278	0.240	0.282[b]
	(0.448)	(0.427)	(0.450)
2000 < Model Year ≤ 2005	0.301	0.358	0.296[b]
	(0.458)	(0.480)	(0.456)
2005 < Model Year ≤ 2010	0.134	0.206	0.128[b]
	(0.341)	(0.404)	(0.334)
Model Year > 2010	0.038	0.064	0.036[b]
	(0.191)	(0.245)	(0.185)
Vehicle Age	8.414	8.045	8.443[b]
	(5.745)	(5.169)	(5.787)
Coupe	0.028	0.018	0.029[b]
	(0.165)	(0.132)	(0.167)
Convertible	0.004	0.004	0.004
	(0.066)	(0.062)	(0.067)
Hatchback	0.027	0.024	0.027
	(0.162)	(0.154)	(0.163)
Sedan	0.332	0.284	0.336[b]
	(0.471)	(0.451)	(0.472)
Station Wagon	0.259	0.341	0.253[b]
	(0.438)	(0.474)	(0.435)
Jeep	0.062	0.030	0.065[b]
	(0.242)	(0.171)	(0.246)
Other Vehicle Style	0.287	0.299	0.286[b]
	(0.452)	(0.458)	(0.452)
Front-End Collision	0.336	0.345	0.335
	(0.472)	(0.475)	(0.472)
Left-Side Collision	0.019	0.018	0.020
	(0.138)	(0.132)	(0.139)
Right-Side Collision	0.022	0.018	0.023[b]
	(0.148)	(0.132)	(0.149)
Side Collision	0.042	0.048	0.041[b]
	(0.200)	(0.213)	(0.199)
Rear-End Collision	0.015	0.014	0.015
	(0.121)	(0.119)	(0.122)
Other Collision	0.018	0.013	0.018[b]
	(0.131)	(0.115)	(0.132)
Driver Unbelted	0.004	0.003	0.004
	(0.066)	(0.058)	(0.066)
Driver Injured	0.208	0.186	0.209[b]

	(0.406)	(0.389)	(0.407)
Driver No License	0.021	0.012	0.022[b]
	(0.145)	(0.111)	(0.147)
Driver At Fault	0.376	0.345	0.378[b]
	(0.484)	(0.475)	(0.485)
Crash-level characteristics			
Persons Involved	5.310	5.259	5.314
	(2.209)	(1.930)	(2.230)
One-Car Crash	0.090	0.077	0.091[b]
	(0.286)	(0.266)	(0.288)
Two-Car Crash	0.742	0.746	0.741
	(0.438)	(0.435)	(0.438)
Three-Plus-Car Crash	0.168	0.177	0.167
	(0.374)	(0.382)	(0.373)
Speed Limit < 55MPH	0.734	0.720	0.736[b]
	(0.442)	(0.449)	(0.441)
Rural Road	0.081	0.070	0.082[b]
	(0.273)	(0.255)	(0.275)
Early Morning	0.007	0.006	0.007
	(0.081)	(0.075)	(0.081)
Daytime	0.906	0.921	0.905[b]
	(0.291)	(0.270)	(0.293)
Evening	0.087	0.073	0.088[b]
	(0.282)	(0.261)	(0.284)
Weekend	0.375	0.337	0.378[b]
	(0.484)	(0.473)	(0.485)
Precipitation	0.182	0.183	0.182
	(0.386)	(0.386)	(0.386)
No Precipitation	0.807	0.806	0.807
	(0.395)	(0.395)	(0.395)
Other Weather	0.009	0.009	0.009
	(0.096)	(0.093)	(0.096)
N	79,859	5,932	73,927

[a] Means (with standard deviations in parentheses) are based on data from the Washington State Department of Transportation (2002-2015). Means for binary variables can be interpreted as proportions.

[b] Mean for *Seat Belt* = 1 subsample is statistically different from mean for *Booster Seat* = 1 subsample at the 5% level.