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Car Seat Inspection Among Children Older Than Three: Using Data to Drive Practice in Child Passenger Safety

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Abstract

Background—Motor vehicle crashes (MVCs) are a leading cause of unintentional death and disability among children ages 4-12 in the United States. Despite this high risk of injury from MVCs in this age group, parental awareness, and child passenger safety programs in particular may lack focus on this age group.

Methods—Retrospective cross-sectional analysis of child passenger safety seat checklist forms from two Safe Kids coalitions in Michigan (2013) to identify restraint type upon arrival to car seat inspections. Other variables included, if the coalition provided a new child safety seat and if the child had a sibling who underwent a car seat inspection. Chi-square statistics were used to compare change in restraint use upon arrival and at departure, the proportion of children attending a car seat inspection event by age, the age category of children by site, the proportion of children with siblings also undergoing a car seat inspection by age, and the distribution of a new child safety seat by age.

Results—Data were available from 1,316 Safe Kids Huron Valley and 3,215 Safe Kids Greater Grand Rapids car seat inspections. Just 10.8% of total seats inspected were booster seats. Child safety seats for infant and young children were more commonly inspected [rear-facing carrier (40.3%), rear-facing convertible (10.2%), and forward-facing (19.3%) car seats]. Few children at inspections used a seat belt only (5.4%) or had no restraint (13.8%). Children age 4 and above were found to be in a sub-optimal restraint at least 30% of the time.

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Michelle L Macy: Dr. Macy contributed to the study design, conducted the analyses and assisted with the interpretation of the results, critically reviewed and revised the manuscript and approved the final manuscript as submitted.
Amy J. Teddy: Mrs. Teddy contributed to the study design, assisted with interpretation of the results, critically reviewed and revised the manuscript and approved the final manuscript as submitted.

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Conclusion—Low proportions of parents use car seat inspections for children in the booster seat age group. The proportion of children departing the inspection in a more protective restraint increased with increasing age. This highlights an area of weakness in child passenger safety programs and signals an opportunity to strengthen efforts on The Forgotten Child.

Level of Evidence—Level III

Keywords

booster; child passenger safety; motor vehicle crashes; fatal crashes; injury; program evaluation

Background

Unintentional injury remains the leading cause of death and disability for children over the age of 1 in the United States (U.S.). In 2012, motor vehicle crashes (MVCs) made up the vast majority of childhood deaths in the U.S. followed by drowning and poisoning.[1] At particular risk for injury in MVCs are children aged 4-12 years. Children age 4-12 years old who were injured in MVC's were more likely to suffer significant abdominal injuries as a result of premature graduation to seat belts.[2,3] These injuries, known as 'seat belt syndrome', include intra-abdominal, spinal cord, and facial injuries. According to the Centers for Disease Control and Prevention, the MVC occupant-related injury rate for 4 to 12 year olds was nearly twice that of children younger than 4 years old (317 per 100,000 children age 4 to 12 years old vs. 171 per 100,000 children younger than age 4) in 2012. In addition, 191 children age 4 to 12 and 100 children younger than age 4 lost their lives as occupants in MVCs.[1] The American Academy of Pediatrics (AAP) provides guidelines for child restraint for children age birth through 12 years of age. Therefore, this study focused on children age 4 through 12 in order to align with APP guidelines.

The discrepancies in injury rates by age may be in part explained by lower observed rates of restraint use in 4-7 year olds (46% in booster seats and another 20% in car seats for a total of 66%) compared to the high observed rates of restraint use for younger children (98% in children under age one and 95% in children 1 to 3)[5], demonstrating a significant reduction in appropriate restraint use as a child ages. Booster seats have been shown to reduce the risk of serious injury by 45% in children aged 4-8 when compared with seat belt use alone.[4] Belt positioning booster seats are designed to optimize the vehicle belt fit in children who are shorter than 4′9″, the height where it is expected most children will safely fit a vehicle seat belt. Several factors account for low rates of booster seat use or early transition to vehicle seat belts. These include lack of knowledge about the safety benefits of booster seats, low perception of risk to child passengers, and lack of perceived threat of being ticketed for restraint violations.[6] In addition to previously stated factors, child passenger safety initiatives such as hospital based child passenger safety programs generally place greater emphasis on car seat inspections for infants and toddlers than car seat inspections for older children.

Child passenger safety technicians are a national resource, freely available in many communities, to address family questions and concerns regarding proper use of child safety seats. We are not aware of any prior research examining the ages of children receiving a car

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seat inspection. In this study we sought to examine car seat inspection utilization of two Safe Kids Worldwide™ coalitions in Michigan and compare changes in restraint behavior on departure from a car seat inspection across age categories. As a secondary aim, we examined associations between child age category and location, car seat inspection event, seat distribution, and family composition. Child restraint laws in most states throughout the U.S. require booster seat use until age 6 or 7 and much attention is placed on usage rates of booster seats in children aged 4-7 due to these restraint laws, many children beyond age 7 could continue to benefit from booster seat use and therefore we include older children in our evaluation.

Methods

Study Design

Data for this retrospective cross-sectional study were obtained from routine car seat inspections conducted by two Safe Kids Worldwide™ coalitions in Michigan (Huron Valley and Greater Grand Rapids).

Study Setting

Safe Kids Huron Valley provides services to residents of Washtenaw and Livingston counties and surrounding areas. Safe Kids Greater Grand Rapids provides services to Kent county residents and surrounding areas. According to the U.S. Census[19], Washtenaw and Livingston counties have a lower percent of the population under 5 years than does Kent county (5% vs. 7%). The populations from these counties also differ in racial/ethnic composition; with higher percentages of black/African American residents in Washtenaw and Kent counties (13% and 10%) than in Livingston county (1%) and higher percentage of Hispanic residents in Kent county (10%) than Washtenaw or Livingston counties (4% and 2%). Most adults have completed high school education (94% in Washtenaw and Livingston and 89% in Kent counties). Median household income ranged from $51,667 in Kent county to $59,055 in Washtenaw county to $72,359 in Livingston county.

Data Source

Car seat inspections were conducted at inspection stations and events that occurred between January 1, 2012 and April 30, 2013. Car seat inspection stations and events are both staffed with certified child passenger safety technicians who will inspect a child safety seat and educate the caregivers on appropriate use and installation. Stations are defined as sites that conduct car seat inspections at regular intervals and parents typically call ahead to schedule an appointment. Events are defined as car seat inspections that take place concurrently with another event (health fair, community event, etc) and are open to any family who is interested in obtaining the service.

Hard copy forms (Figure 1) completed by the child passenger safety technician at the inspection and submitted to Safe Kids were scanned by Safe Kids Worldwide. Data from the scanned forms were uploaded into Excel files that were provided to the research team for analyses. Data accuracy between the scanned form and the Excel files was verified by members of the research team who had access to electronic copies of the paper forms. Excel

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files were converted to Stata 13.1 (Stata Corp, College Station, TX) for analyses. The University of Michigan Institutional Review Board approved this study.

Variables

Child age was calculated by subtracting the date of birth from the date of the inspection. Children with negative values for calculated age and missing age were excluded. Child age was categorized as less than 1 year, 1 to 3 years, 4 to 7 years, and 8 years and older. Age categories were selected based on traditional child safety seat recommendations and Michigan state law which requires children 4 to 7 years to use a child safety seat and allows children to begin using a seat belt at age 8. In addition, child passenger safety technicians have the ability to indicate if a safety seat inspection was attended by the parent of an unborn child.

Restraint type was assessed by a child passenger safety technician on arrival and at departure and recorded on the data collection form. Restraint type was categorized into five groups: 1) infant carrier (rear-facing only without base, rear-facing only with base, base only); 2) rear-facing convertible; 3) forward-facing with harness; 4) belt positioning booster; and 5) seat belt (lap/shoulder and lap only). We excluded cases where there was no restraint indicated on departure from the inspection. Rear-facing infant carriers and rear-facing convertible car seats were combined for analyses comparing restraint use on arrival and departure. We generated a variable to indicate if the child departed in a less protective restraint (for example, changed from a rear-facing car seat to a forward-facing car seat), the same type of restraint, or a more protective restraint (for example, changed from a forward-facing car seat to a rear-facing car seat).

Other variables assessed for association with child age category included site (Huron Valley or Greater Grand Rapids), if the child restraint was checked at an event or an inspection station, if the child had a sibling who underwent a car seat inspection based on information about a second car seat on the same form or the presence of one or more additional forms from the same home address, and if the coalition provided a new child safety seat.

Analysis

Descriptive statistics were calculated for the study sample. We tabulated the restraint type in use on arrival and the restraint in use on departure within age categories. We compared changes in restraint between arrival to and departure from the inspection by age category using chi-square statistics. Chi-square statistics were also used to compare the proportion of children attending a car seat inspection event by age, the age category of children by site, the proportion of children with siblings also undergoing a car seat inspection by age, and the distribution of a new child safety seat by age.

Results

Data were available from a total of 4,531 car seat inspections (1,316 that occurred through Safe Kids Huron Valley and 3,215 through Safe Kids Greater Grand Rapids). We excluded 96 (2.1%) inspections with missing child age and 1,028 (22.6%) inspections conducted with

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parents of unborn children. Most (81.6%) inspections conducted with parents of unborn children occurred at an inspection station. There were 42 (<1%) children for whom no restraint type was indicated on departure; 11 were unborn, eight were children younger than 1 year, eight were children 1-3 years old, nine were children 4 to 7 years old, and six were children 8 years old and older.

There were 3,407 child safety seat inspections included in analyses. Sample characteristics are presented in Table 1. Less than one quarter (24.0%) of child safety seat inspections were conducted with children age four and above. The relationship between restraint on arrival and restraint on departure within age category is presented in Table 2. The proportion of children departing the inspection in a more protective restraint increased with increasing age (Table 3) ranging from 2.1% of children less than 1 year old to 20.2% of children 8 years old and older.

The Safe Kids Huron Valley Coalition conducted a greater proportion of car seat inspections for children older than 4 years than did Safe Kids Greater Grand Rapids (30.0% vs. 21.8%, $p<0.001$). For each increasing age category there were greater proportions of restraints inspected at events as opposed to inspection stations (Figure 2). There was also a relationship between increasing child age category and having a sibling who also underwent a car seat inspection. The proportion of children younger than 1 year with a sibling who underwent an inspection was 23.8% followed by 34.2% among children 1 to 3 years old, 53.7% among children 4 to 7 years old, and 62.1% among children 8 years old and older ($p<0.001$). Together these two coalitions distributed more than 1,600 child safety seats during the study period. Seats were distributed to half of the parents of children from birth to age 7 years who completed inspections. Roughly one-third of parents of children 8 years and older were provided a seat.

Discussion

This study focused on car seat inspection program use among child passengers older than 4 years and found this age group is under-represented relative to younger children. We found that only 1 in 10 car seat inspections are for booster seats and half are for rear-facing car seats. This finding was similar across the two sites in this study and is consistent with national observations of car seat inspections performed by Safe Kids Worldwide™ in 2009.[10]

Caregivers often need support and direction when choosing and installing child restraints. In a recent survey of 1000 parents by Safe Kids Worldwide™, seven out of ten parents did not know that optimal vehicle belt fit may not be obtained until a child reaches a height of 57 inches, and nine out of ten parents prematurely transition their child from a booster seat to a vehicle seat belt before their child reaches 57 inches tall leading to increased risk of injury and death.[10] This knowledge gap can be addressed in car seat inspections but there is currently low use of this service by parents of older children as demonstrated by results from this study.

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One reason for lower rates of inspection and/or interaction with this older age group may relate to the fact that booster seats are inherently less technical to install than an infant or convertible restraint. Nonetheless, effective interventions are needed to increase optimal restraint use and prolong use of age-appropriate restraints in child passengers. Roughly one-third of booster seat age children left their car seat inspection in a more protective restraint than when they arrived (4-7 years old = 17%, 8 years and older = 20.2%). This demonstrates the high rate of early transition noted in this age group. We suspect that children who departed an inspection in a “less protective” restraint were in a more appropriate restraint for their individual size or the unique circumstances in their vehicle or family.

As children increase in age they were increasingly more likely to visit a car seat inspection event rather than a car seat inspection station. Car seat inspection events typically run concurrently with other activities such as health or safety fairs which families attend with children of various ages. Primary reasons for attendance at events may not be for a car seat inspection, rather to take part in event activities. Technicians may find it of value to align efforts with community partners hosting events in order to increase intervention opportunities for the booster age child. Reasons for higher rates of inspection station use among parents of infants may include encouragement by clinicians, including obstetricians, midwives, pediatricians, family physicians, and nurse practitioners, for new or expecting parents to visit a car seat inspection station, targeted media towards new or expecting parents, and the presence of child passenger safety technicians at many birthing centers. Children older than 4 years were also more likely to have a sibling who underwent a car seat inspection, and in fact, may have been brought in with the sibling with no intention from the parent of having the restraint evaluated for the older child. Reasons for car seat inspection utilization by families of children in different age groups is an area for future study.

Given the high rate of older children who left a car seat inspection in a more protective restraint, our findings hint at the potential impact of an educational session with a certified child passenger safety technician (CPST) on booster seat use. During a session, a technician meets with the caregiver and, when possible, the child in order to educate the caregiver on proper restraint use. Standardized procedures are followed by each technician for car seat inspected. A checklist form is used to guide the technician and the data collected on these forms can be used to track the frequency with which parents of older children are utilizing these services and the immediate results of the encounter. CPST interactions with parents of older children may require more parental education or identification and support of parental motivation for prolonged restraint use and less emphasis on the technical aspects of restraint installation.

We have yet to understand how long-lasting this behavior change may be and if it continues to influence parental decisions surrounding premature transition of the child to a booster seat or the vehicle seat. More research is needed to understand these choices and what techniques technicians might employ to sustain behavior change. Data shows most technicians perform the majority of inspections with infants and toddlers.[5,10] There may be potential discomfort technicians experience during inspections with older children; given the technicians' more robust experience interacting with parents of infants and toddlers. Technicians also may benefit from skill development in areas of health behavior and health education. One such

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technique, motivational interviewing, has shown promise in other areas of community health in producing positive outcomes in health behavior choices but the application of motivational interviewing to child safety seat use has not been explored.

The National Child Passenger Safety (CPS) Certification Training is a program of Safe Kids Worldwide™, an international child injury prevention organization, which certifies individuals as child passenger safety technicians. Safe Kids Worldwide™ manages all aspects of this training program and collaborates with the National Highway Traffic Safety Administration and the National Child Passenger Safety Board. CPSTs put their knowledge to work by conducting car seat inspections, where parents and caregivers receive hands-on assistance for proper use of child restraint systems and safety belts. These dedicated technicians offer education, support, and guidance in all 50 states, the District of Columbia, and U.S. territories. Before the initial 2-year certification cycle expires, technicians are required to successfully complete a series of requirements to maintain their certification status. One of these requirements includes participating in at least six continuing education units (CEUs). The core requirement for these CEUs involves improving CPS *technical* knowledge. Although technical knowledge is essential to stay up-to-date on product advancements, this study may highlight an opportunity to consider developing educational offerings to reach this booster age demographic. The development of CEUs used to educate technicians on techniques to sustain health behavior change may be of significant value to the field of child passenger safety. In addition to offering trainings to technicians on how to sustain health behavior change, targeted booster seat campaigns including collaboration with primary care offices, preschools, daycare centers, Heat Start programs, and elementary schools may be effective to increase booster seat awareness and usage of seat check services.

Limitations

The results of this study were based on 18 months of child safety seat inspection forms from two Safe Kids coalitions in Michigan, and therefore may not be generalizable to the experiences of coalitions in other areas or child safety seat inspections that are not conducted under Safe Kids Worldwide™. Second, we conducted secondary analyses of data collected during the routine work of child passenger safety technicians completing the inspections and had no control over the initial data collection process. While we were able to verify the scanned data reflected the data entered on the forms, there is potential for data entry errors to have occurred in the completion of the forms during the course of an inspection. We attempted to minimize the impact of this limitation on our study findings by excluding inspections with missing information about child age and the restraint in use on departure from the inspection. We expect data entry errors and missing information occurred at random and therefore does not significantly bias our results. Caregivers and children who visited seat check events and inspection stations may not be representative of the general public. Families may seek these services because of concerns or challenges with use of a particular restraint or may be more concerned about child passenger safety than the U.S. population; however we cannot estimate the direction of this bias on our findings.

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Conclusions

Injury risk in MVC's has been dramatically reduced for infants and toddlers. Technicians throughout the United States play an important role in ensuring correct child safety seat selection, installation, and use for families who seek out these services. Children older than 4 represent a small percentage of the children utilizing car seat inspections but appear to benefit greatly from car seat inspections as reflected in the high rates of departure in a more protective restraint. These findings suggest an opportunity for increased attention by child passenger safety technicians and car seat inspection programs to older children who would still benefit from the use of a booster seat. Technicians may benefit older child passengers by evaluating their own programs to identify opportunities to increase outreach to this sub-optimally restrained group.

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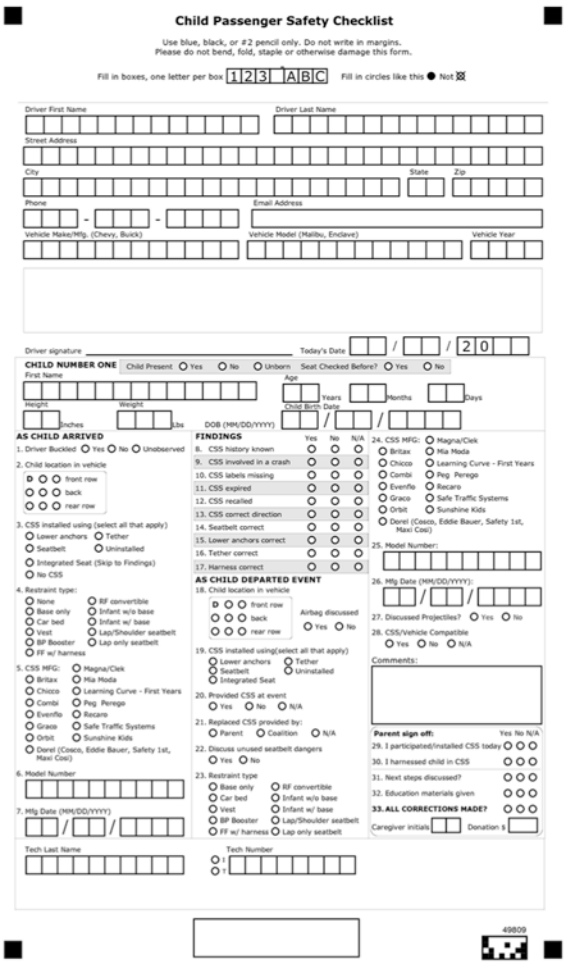

Figure 1. Child Passenger Safety Seat Checklist Form

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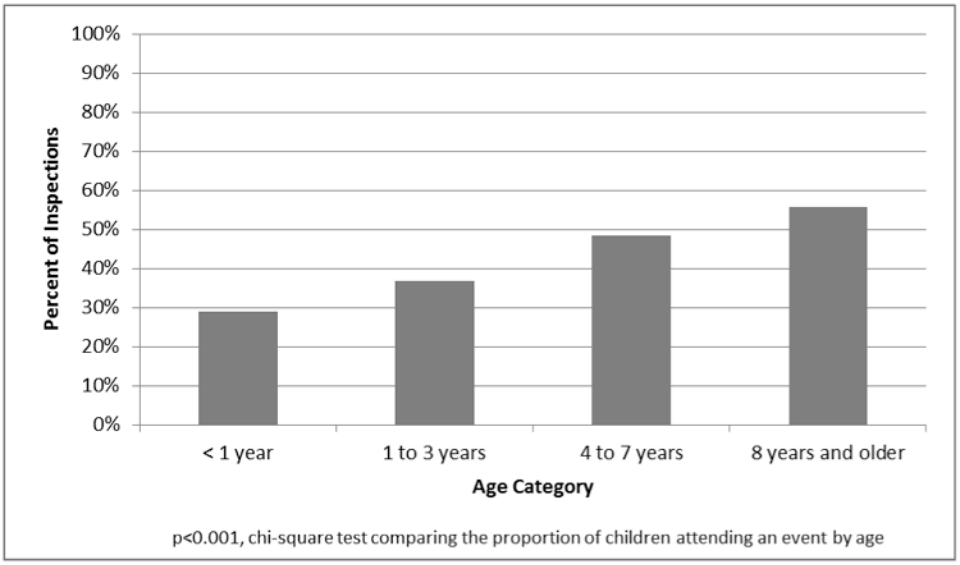

Figure 2. Proportion of Inspections Conducted at Events by Child Age Category

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Table 1

Sample Characteristics

	N=3,407	%
Child Age Category		
Birth to 1 year	1,173	34.4
1 to 3 years	1,417	41.6
4 to 7 years	643	18.9
8 years and older	174	5.1
Restraint on Arrival		
Rear-Facing Carrier	1,127	33.1
Rear-Facing Convertible	425	12.5
Forward-Facing	852	25.0
Belt Positioning Booster	478	14.0
Seat Belt	234	6.9
No Restraint	291	8.5
Restraint on Departure		
Rear-Facing Carrier	311	9.1
Rear-Facing Convertible	1,376	40.4
Forward-Facing	961	28.2
Belt Positioning Booster	618	18.1
Seat Belt	110	3.2
No Restraint	31	1.0
Safe Kids Huron Valley	900	26.4
Event	1,267	37.2

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Table 2
Restraint on Arrival and Departure by Age Category

Restraint on Departure	Rear-Facing Car Seat	Forward-Facing with Harness	Belt Positioning Booster	Seat Belt
Restraint on Arrival				
Less than 1 year old, n=1,165				
Rear-Facing Car Seat, n = 1052 (%)	1045 (99.3%)	4 (0.4%)	0	3 (0.3%)
Forward-Facing with Harness, n = 32 (%)	19 (59.4%)	12 (37.5%)	1 (3.1%)	0
Belt Positioning Booster, n = 6 (%)	3 (50%)	0	3 (50%)	0
Seat Belt, n = 4 (%)	1 (25%)	0	1 (25%)	2 (50%)
No restraint, n = 71 (%)	67 (94.4%)	1 (1.4%)	1 (1.4%)	2 (2.8%)
1 to 3 years old, n = 1,409				
Rear-Facing Car Seat, n = 486 (%)	406 (83.5%)	80 (16.5%)	0	0
Forward-Facing with Harness, n = 669 (%)	92 (13.7%)	559 (83.6%)	17 (2.5%)	1 (0.1%)
Belt Positioning Booster, n = 124 (%)	5 (4%)	68 (54.8%)	51 (41.1%)	0
Seat Belt, n = 32 (%)	0	25 (78.1%)	6 (18.8%)	1 (3.1%)
No restraint, n = 98 (%)	45 (45.9%)	48 (49.0%)	5 (5.1%)	0
4 to 7 years old, n = 634				
Rear-Facing Car Seat, n = 6 (%)	1 (16.7%)	5 (83.3%)	0	0
Forward-Facing with Harness, n = 148 (%)	0	106 (71.6%)	42 (28.4%)	0
Belt Positioning Booster, n = 308 (%)	1 (0.3%)	32 (10.4%)	274 (89.0%)	1 (0.3%)
Seat Belt, n = 91 (%)	0	5 (5.5%)	70 (76.9%)	16 (17.6%)
No restraint, n = 81 (%)	2 (2.5%)	15 (18.5%)	62 (76.5%)	2 (2.5%)
8 years and older, n = 168				
Rear-Facing Car Seat, n = 1 (%)	0	0	1 (100%)	0
Forward-Facing with Harness, n = 1 (%)	0	1 (100%)	0	0
Belt Positioning Booster, n = 37 (%)	0	0	32 (86.5%)	5 (13.5%)
Seat Belt, n = 102 (%)	0	0	34 (33.3%)	68 (66.7%)
No restraint, n = 27 (%)	0	0	18 (66.7%)	9 (33.3%)

Black cells include the child departed in the same type of restraint that they had arrived to the inspection station; gray cells include the child departed in a more protective restraint.

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Table 3

Change in Restraint from Arrival to Departure by Age Category

	Departed in Less Protective Restraint		No Change		Departed in More Protective Restraint		p-value
	%	95% CI	%	95% CI	%	95% CI	
Less than 1 year old n=1,165	6.8	5.5, 8.4	91.1	89.4, 92.7	2.1	1.3, 3.0	<0.001
1 to 3 years old n=1,409	13.9	12.2, 15.8	72.2	69.8, 74.4	13.9	12.2, 15.8	
4 to 7 years old n=634	20.3	17.4, 23.7	62.6	58.8, 66.3	17.0	14.3, 20.2	
8 years old and older n=168	19.6	14.3, 26.4	60.1	52.5, 67.3	20.2	14.8, 27.0	

Abbreviations: CI = Confidence Interval