Observation of Infant Restraint Use and Seating Locations

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ABSTRACT

A two-part observational study of rearward-facing infant restraints was conducted to determine usage rates and seating location within passenger vehicles. Factors thought to influence restraint use and seating location were also examined. Seating location of rearward-facing infant restraints in vehicles equipped with a passenger-side air bag was of particular interest because of the potential for injury to an infant placed in an air bag equipped passenger seat. A total of 549 infants in vehicles was observed at the entrances and exits of shopping centers and malls throughout the state of Virginia, and an additional 280 infant restraints were observed in vehicles parked in shopping center and mall lots. Use of restraints was found to be very high throughout the state (96 percent) with nearly half (49 percent) of all rearward-facing infant restraints placed in the front of the vehicle. A small sample of vehicles with passenger-side air bags was available for study (N = 28). In this subgroup, only two (7 percent) rearward-facing infant restraints were located in the front seat. Driver gender was found to be significantly associated with use of restraints and seating location; however, there was no significant association with geographic location or median income.

INTRODUCTION

Infant and child safety seats have clearly been one of the most successful motor vehicle injury prevention efforts undertaken in the last two decades. During the period 1978-85 all 50 states and the District of Columbia passed laws requiring the use of restraint systems for infants and young children. The National Highway Traffic Safety Administration (NHTSA) estimates that use of restraints reduced infant fatalities by 69 percent from 1982-87 (Partyka, 1988). National estimates of infant restraint use in 1991 were 87 percent (NHTSA, 1991). Infant restraint use has typically been high, even by adults who report inconsistent safety belt use (MMWR, 1993).

Despite this obvious progress, motor vehicle occupant fatalities remain the second largest cause of death for infants under one year of age, surpassed only by homicide (Waller, 1989). Research has also indicated that since 1984, motor vehicle occupant fatalities have increased among children younger than five years of age (Klein, 1990; Chorba, 1993). Although this increase appears to be related to an increase in on-the-road exposure, it points to the importance of proper infant and child restraint use (MMWR, 1991). There is some indication that when infant and child restraint use is low it is among rural and lower-income families and those who live in the southeast and mountain states (Stewart, 1993).

A new issue of concern is the potential for serious injury to an infant in a rearward-facing restraint seated in the front of a vehicle equipped with a passenger-side air bag. Laboratory research has shown that the interaction between a deploying air bag and the rearward-facing restraint could result in serious head and chest injuries to the infant (Sullivan, 1992). If a rearward-facing restraint is seated near or against the vehicle's dashboard, the deploying air bag is likely to interact with the infant restraint. As the air bag deploys, it could force the rearward restraint into the vehicle seat back at speeds of over 100 mph. This can occur at any crash speed where the impact force is sufficient to deploy the air bag. Rearward-facing infant restraints are intended for infants weighing up to 20 pounds and typically the infants are under one year of age. This type of restraint is beneficial in preventing neck and cervical spine injuries to infants, and indeed, infants should remain in a rearward-facing position for as long as possible. One solution is to move the rearward-facing restraint to a rear seating position in the vehicle. The rear of the vehicle has previously been found

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to offer the best protection in a crash (Williams, 1977; Kahane, 1986; Partyka, 1988). However, it is not possible to place the infant restraint in the rear of vehicles such as pickups and two-seater sports cars, and adults traveling alone with a small infant or one who needs frequent care may not wish to have the restraint in the rear. 2 NHTSA's observational study of restraint use in 19 cities found that the majority (61 percent) of infants traveled in the front seats of vehicles (Bowman and Rounds, 1989). Therefore, infant seating position becomes increasingly critical as passenger-side air bags become more prevalent in vehicles. Federal regulations require that all passenger cars be equipped with driver and right-side passenger air bags by the 1998 model year, and all pickups, vans, and utility vehicles be so equipped by the following model year (58 *Federal Register* 46551-68), but most manufacturers will meet the requirements long before these dates. In the 1995 model year, approximately 90 percent of passenger car models have standard passenger-side air bags (IIHS, 1994).

This study was undertaken to examine how infants are being transported in vehicles and to determine the seating location of infants within the vehicle. Although prior research has indicated that restraint use is highest for this age group, there has not been a recent observational study of restraint use nor one that examines socioecomic factors in geographic areas that include some very low socioecomic levels.

METHODS

A two-part observational survey of infant restraint use and seating location was conducted at shopping center and mall sites throughout the state of Virginia during May and June 1994. Five geographic regions comprised of rural, urban, and suburban areas were included in the survey (Table 1). These regions included a wide range of economic levels within the state from the higher income Northern Virginia region to the very low income Southwest Virginia region. In the first part of the study, referred to as the parking lot survey, trained observers surveyed parked cars in shopping center and mall lots for the presence and location of rearward-facing infant restraints. In the second part of the study, referred to as the moving survey, the observers looked for use of restraints and seating location within the vehicle for infants under one year of age. The observers had been trained in identifying this age group. Use of both forward- and rearward-facing restraints was noted, as well as non-use of restraints. Vehicles were surveyed as they stopped at the entrances and exits of shopping centers and malls. Data were collected on vehicle type, presence of other

Table 1
Infant Restraint Study Sites

Geographic Regions And Study Sites	Number
Northern Virginia (Centreville, Dale City, Falls Church, Fairfax, Manassas, Reston, Springfield, Sterling, Tyson's Corner)	183
North Central – Northwest Virginia (Charlottesville, Fredericksburg, Harrisonburg, Staunton, Winchester)	112
Central Virginia (Chester, Colonial Heights, Richmond)	121
Southeast Virginia (Chesapeake, Hampton, Newport News, Norfolk, Virginia Beach)	263
Southwest Virginia (Abingdon, Big Stone Gap, Galax, Lynchburg, Norton, Roanoke, Wytheville)	120
Total	**799**

passengers in front and rear seats, driver gender, infant restraint use, and location of the restraint. Vehicles were observed during daylight hours on weekends and weekdays.

The study also examined restraint use and seating location by geographic region within the state and by median income for each region using 1990 census data (U.S, Census Bureau, 1990). The vehicle's supplementary restraint system was determined through state registration and vehicle identification numbers. Observers noted the license plate number of all vehicles included in the study. The license plate numbers were then submitted to the Department of Motor Vehicles (DMV) to obtain the vehicle identification number (VIN) for each vehicle. The VIN is a 17 digit number that, when decoded permits identification of many of the vehicle's features, including the restraint system. No personal identifiers were obtained from the DMV. It was not possible to determine correct use of restraints in either portion of the survey, although such use is key in providing full crash protection. Correct use would include properly securing the infant in the restraint, the restraint to the vehicle, and using the appropriate type of infant restraint for the child's size and age.

RESULTS

In the moving survey, observers surveyed 549 infants in vehicles as the vehicles came to a stop at the entrances and exits of shopping centers and malls (Table 2). The majority of these infants (96 percent) were in a child restraint with 76 percent located in the rear of the vehicle. The majority of drivers were female (64 percent). Although infant restraint use was not found to differ significantly by geographic region, it was highest in the eastern portion of the state (100 percent).

Table 3 examines infant restraint use by driver gender and median income. Females were significantly more likely than males to use an infant restraint ($p<.01$); however, there was no difference in infant restraint use by income level.

Table 2
Use of Child Restraints (Moving Survey)

Restraint Use and Type	Percent	Number
Restrained – Forward facing	81	452
Restrained – Rearward facing	15	81
Unknown infant carrier*	<1	2
Infant carrier on lap	<1	1
Infant on lap	1	8
Unrestrained – sitting	<1	3
Unrestrained – standing	<1	2
Total	100	549

* Infant carrier other than those federally approved for use as a safety restraint in vehicles.

Table 3
Infant Restraint Use by Driver Gender and Income (Moving Survey)

	Percent Restrained	Number
Diver Gender*		
Male	93	169
Female	99	324
Median Income		
<25,000	95	175
25-39,000	99	230
40-54,999	95	59
≥ 55,000	97	29

* χ^2 17.38; $p<0.01$

In the parking lot survey a total of 280 vehicles with rearward-facing infant restraints were observed. Fifty-four percent of the rearward-facing restraints observed were positioned in the rear of the vehicle. Location of the restraint within the vehicle did not differ by type of vehicle, median income level, or geographic location within the state.

Overall, in the moving survey, more rearward-facing infant restraints than forward-facing were placed in the front seats of vehicles (49 percent versus 16 percent) (Table 4). When looking at the seating location of rearward-facing restraints only, more than half (57 percent) of the rearward-facing restraints in the moving study were located in the front of the vehicle, compared with just under half in the parking lot survey (46 percent) and in both surveys combined (49 percent). When examining seating location by passenger presence, infants in both rearward- and forward-facing restraints were significantly more likely to be seated in the rear of the vehicle if there were front seat passengers. When there was no rear seat passenger, female drivers were more likely to seat the infant in the front of the vehicle. Table 5 shows the percent of forward- and rearward-facing restraints seated in the front by gender and income group. Females were significantly more likely to place a rearward-facing infant restraint in the front seat than males ($p<0.01$). There was no difference by median income level in the percentage of restraints placed in the front seat.

Table 4
Seating Location for Forward- and Rearward-Facing Infant Restraints

	Front		Rear	
	Percent	**Number**	**Percent**	**Number**
Moving Survey				
Forward-facing	16	69	84	349
Rearward-facing	57	44	43	33
Parking Lot Survey				
Rearward-facing	46	129	54	151
All Rearward-facing	49	174	51	184

Table 5
Percent in Front Seating Location by Driver Gender and Income

	Forward-Facing		Rearward-Facing**	
	Percent	Number	Percent	Number
Driver Gender				
Male	14	20	39	13*
Female	17	49	70	31
Median Income				
<25,000	16	25	48	47
25-30,999	16	34	46	54
40-54,999	24	9	54	43
≥55,000	6	1	47	30

* $\chi^2 = 6.21$; $p < 0.01$.
** Number includes both moving and parking lot surveys

In both surveys combined, 28 vehicles were identified through the vehicle identification number as being equipped with passenger-side air bags. All rearward- and forward-facing infants in the vehicles with passenger-side air bags were restrained, and there was only one instance in each survey of a rearward-facing infant restraint positioned in the front passenger seat. There was a significant difference in seating location of rearward-facing restraints in vehicles with and without passenger air bags when the data were combined for both parts of the study ($p<0.0001$) (Table 6). The rearward-facing restraint was less likely to be in the front if the vehicle was equipped with a passenger air bag.

Table 6
Percent in Front Seating Location by Passenger Side Air Bag Status

	Rearward-Facing*		Forward-Facing	
	Percent	Number	Percent	Number
Passenger side air bag	7**	2	0	0
No passenger side air bag	50	172	16	69

* Number includes both moving and parking lot surveys.
** $\chi = 19.10$; $p < 0.0001$

DISCUSSION

This study found infant restraint use to be very high throughout Virginia, including the more rural, lower income areas where it might be expected that use would be lower. The nearly universal use of restraints is encouraging, but the extent to which child safety seats were used incorrectly in ways that compromise crash protection could not be determined adequately. NHTSA's 19-city surveys found misuse rates of infant restraints ranging from 20 to 60 percent (Bowman and Rounds, 1989).

Although restraint use was higher than in NHTSA's 19-city surveys, front seating location was lower. Nonetheless, front seating position for 49 percent of infants seated in rearward-facing restraints indicates less overall protection and the potential for a serious safety problem as passenger air bags become more prevalent. Although most drivers of vehicles with passenger air bags were placing the rearward-facing infant restraints in the rear of the vehicle, the sample size of vehicles with passenger air bags was small. This study found that more rearward-facing than forward-facing restraints were placed in the front of the vehicle, particularly by females. These were likely younger infants the driver felt needed more attention than an older infant seated facing forward. It is easier to maintain eye and verbal contact with a rearward-facing infant in the front seat, but contact can be maintained with a forward-facing infant in either seating position. Females are more likely to be driving alone with their infants, resulting in the preference for placing the infant in the front next to them.

An obvious solution to the risk of injury from a passenger-side air bag is to move the rearward-facing infant restraint to the rear of the vehicle, a seating position identified as being the safest. Prior studies have indicated that even in the absence of a passenger air bag, children are safest when restrained and seated in the rear of the vehicle. However, for lone drivers with an infant in need of care or those traveling in a two-seater vehicle, the rear seating position is not feasible.

Automobile manufacturers are working on technical modifications to air bag systems, such as air bag on/off switches and sensors in the seat to detect occupant size and presence. NHTSA has proposed regulations that would permit the installation of an optional manual cutoff switch for passenger air bags (59 *Federal Register* 51158-64). The proposed rule would apply only to vehicles without a rear seat, and the manual cutoff switches would be prohibited in passenger cars manufactured after September 1997 and light trucks manufactured after September 1998. NHTSA's intent is to give manufacturers time to develop technology that would automatically sense the

pressure of a rearward-facing infant restraint and deactivate the passenger air bag. Child restraint manufacturers are also working on modifications to the restraint that would absorb or deflect air bag energy (Weber, 1993). NHTSA now requires manufacturers of rearward-facing infant restraints and automobile manufacturers to label their products with warnings regarding the potential for serious injury when a rearward-facing infant restraint is placed in a vehicle seating position equipped with an air bag (59 Federal Register 7643-7647). Drivers should be encouraged to routinely place all rearward-facing infant restraints in the rear seat of the vehicle.

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