Abridgment

Study of Child Safety Seat Misuse

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ABSTRACT

In this paper are summarized the results of a study conducted to assess the extent of child safety seat misuse and to determine the factors and reasons associated with each type of misuse. Data were collected by observing 1,006 children in safety seats in vehicles entering parking lots at Hardee's Restaurants in 10 cities. Overall, misuse was 65 percent. Toddler, infant, and booster seats were misused at a rate of 66, 59, and 62 percent, respectively. For the 734 toddler seats observed, 40 percent of the children were not harnessed, 33 percent did not have the seat properly secured with the vehicle belt, and 85 percent of the tether-type seats were not tethered. Almost all of those responsible (95 percent) were aware that the children were not harnessed. The most common reason given was that the child slipped out of or took off the harness. Nearly 80 percent of those who did not use the tether strap (when required) stated that they knew that the tether was required and indicated resistance to the installation of a tether anchor. Approximately 75 percent of those who incorrectly belted the seat to the vehicle did not realize the belt routing was incorrect. Only a small number of safety seats were not belted (7 percent). In addition, 71 percent of those facing infant seats forward knew the seat was supposed to face the rear of the vehicle. The findings indicate that safety seats that are easier to use and present fewer opportunities for misuse are more often used correctly. Several countermeasures are proposed to reduce misuse of safety seats.

Child safety seats have proven to be an effective means of preventing or reducing injury to small children in the event of vehicular collision or rapid deceleration. The effectiveness of these devices is, however, dependent on proper use.

Eight years have passed since Tennessee became the first state to enact a mandatory child restraint law for infants and toddlers under a certain age. Since then every state has followed; Wyoming was the last state to pass this type of legislation in early 1985. Studies in 19 cities across the country have shown an increase in the use of child safety seats (1). This is probably due to the implementation of mandatory child restraint laws and educational efforts to increase awareness of child passenger safety. In an earlier study of restraint system use during 1983 in 19 cities, about 35 percent of children (aged 1 to 4 years) were observed in child safety seats (1), but many of these children were not harnessed in the safety seat. Observations also were made of unoccupied safety seats in parked vehicles, which indicated that approximately 60 percent of toddler seats were incorrectly installed. Another study of unoccupied toddler seats in parked vehicles found that approximately 75 percent of the installations had errors in belt routing, tether use, or both (2).

This study was funded by NHTSA to provide a more comprehensive evaluation of the use and misuse of child safety seats and to gain insights into why these seats are misused. This study was also intended to identify characteristics of the seats, adult users, and conditions related to misuse.

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DATA COLLECTION PLAN

Data were collected during the summer of 1984 at fast-food parking lots selected because of their high volumes of child passengers. This approach allowed the observer to select candidate subjects entering the parking lots and to obtain a complete and accurate observation on child safety seat use. At the same time information was obtained about specific types of misuse as well as other issues related to installation and use.

Observations were made at Hardee's Food Systems, Inc., restaurants. Hardee's showed a strong interest in the study and agreed to participate. In addition to providing assistance in selecting observation sites and in obtaining cooperation at local levels, Hardee's Food Systems, Inc., provided free food coupons for parents of small children who participated in the study.

Ten cities representing various geographic areas where Hardee's had nonfranchise restaurants were selected for data collection. The selected cities were

- Atlanta, Georgia
- Baltimore, Maryland
- Charleston, South Carolina
- Cincinnati, Ohio
- Des Moines, Iowa
- Detroit, Michigan
- Kansas City, Missouri and Kansas
- Oklahoma City, Oklahoma
- Pittsburgh, Pennsylvania
- St. Louis, Missouri

Because of restrictions on city and site selections, the results of this study are not representative of the entire country. However, the results were similar to findings in the "19 City Study" (1) and are be-

lieved to provide valid information on the use of child safety seats.

The data collection activities were accomplished by two observers, each trained in the identification and correct use of child safety seats and in the field work necessary for identifying seats and usage characteristics. The observation procedure consisted of meeting the target vehicles as they parked or waited in line at the drive-through window. The observers would inform the drivers that they were conducting a study and request permission to observe the child safety seat. A free food coupon was offered as an incentive to participate. If permission was granted, the observer would record the harnessing of the child and the installation of the seat. When incorrect use was observed, the driver of the vehicle was informed of this and told how to correctly use the seat. At the same time, the observer would attempt to learn why the seat was not used correctly.

The misuse information collected pertained to belt routing through (or around) the child seat, harness or shield use, tether use, and the correct facing direction of infant seats. The observers did not collect misuse information when correct use was seen; "correctly used" was recorded for that observation.

RESULTS

A total of 1,006 children in safety seats were observed, of which 734 (73.0 percent) were toddler safety seats, 150 (14.9 percent) were infant safety seats, and 122 (12.1 percent) were booster safety seats.

Misuse was observed for 64.6 percent of these seats. Table 1 gives the types of misuse observed in this study. Of the 734 toddler safety seats observed, 66.3 percent were misused. Infant and booster safety seats were misused in 59.3 percent and 61.5 percent of the observations, respectively. Detailed characteristics of misuse of toddler, infant, and booster seats are described in the following subsections.

TABLE 1 Percentage of Child Safety Seats Misused, by Type of Seat

Misuse Category	Seat Type		
	Toddler Seats	Infant Seats[a]	Booster Seats
Harness and/or shield not used	21.9	28.9	61.5
Harness and/or shield incorrectly used	18.4	4.0	0.0
Vehicle seat belt not used	4.8	9.4	13.9
Vehicle seat belt incorrectly used	28.1	14.1	0.8
Tether not used (tether seats only)	85.1	NA	NA
Tether incorrectly used (tether seats only)	0.9	NA	NA
Seat facing wrong direction	NA	33.3	NA
Overall seat misuse	66.3	59.3	61.5

Note: No. of occupied seats observed: toddler, 734; infant, 150; and booster, 122. NA = not applicable.

[a]Includes "infant-only" seats and convertible seats used in the infant mode.

Toddler Seats

There are various types of toddler safety seats, each with specific requirements for correct use. All toddler seats require a means of restraining the child in the seat. This is accomplished by use of harness straps, a combination of a shield and harness straps, or a full shield (no harness straps required). All toddler seats must be secured to the vehicle by means of the vehicle safety belt. In addition, some seats require the use of a top anchor strap (tether) to prevent the seat from rotating or pivoting forward in the event of a collision.

As the data in Table 1 indicate, 40.3 percent of the toddlers observed in toddler safety seats either were not harnessed or were improperly harnessed. Table 2 gives the types of improper harness and shield use observed. The most common misuse was observed for those seats that require the use of both shield and harness.

TABLE 2 Type of Incorrect Harness and Shield Use for Toddler Seats

Incorrect Use	Percentage of Incorrect Harness/Shield Use[a]
Harness not over shoulders	40.0
Shield and harness both required, shield not used	39.3
Shield and harness both required, harness not used	14.8
Harness very loose	3.7
Shield not attached properly	1.5
Other incorrect use	0.7

[a]Based on 135 toddler seats observed with incorrect harness and shield use.

Incorrect securing of the toddler seats using the vehicle seat belt represents another common misuse. As the data in Table 1 indicate, the vehicle belt was incorrectly routed in 28.1 percent and was not used at all in 4.8 percent of toddler seats observed, resulting in a 32.9 percent rate of misuse. Table 3 gives the breakdown of incorrect toddler seat belting. Of the 206 incorrectly belted seats, 65 percent (45.6 plus 19.4 percent) were belted too low.

The use of a tether strap was required on 29.2 percent of the toddler seats observed. When a tether was required, it was not used 85.1 percent of the time and was observed to be incorrectly used twice.

TABLE 3 Observed Incorrect Belt Use for Toddler Seats

Incorrect Use	Percentage of Incorrect Belt Routing[a]
Belt too low (through frame)	45.6
Belt around base (too low) and in front of frame	19.4
Belt around seat and child (instead of through frame)	9.2
Belt not in belt clip	7.3
Other incorrect routing	18.5

[a]Based on 206 toddler seats observed with incorrect belt use.

Different combinations of misuse are possible depending on the individual harness and shield, belting, and tethering requirements of each seat. Although 66.3 percent of the toddler seats were observed to be misused, 40.3 percent of the seats had one misuse, 20.1 percent had two misuses, and 5.9 percent had three misuses. Toddler seats that require a tether were misused more often than nontether toddler seats (93.0 percent misuse and 55.4 percent misuse, respectively).

Infant Seats

There are two types of infant seats: those designed exclusively for infants (infant-only) and convertible seats that can be used in the infant or toddler mode. All infant seats must be used facing rearward in a semireclined position. In addition, all infant seats must have provisions to belt the seat to the vehicle

(using the vehicle belt) and harness the child to the seat. In this study, 150 infant seats were observed, of which 52.7 percent were infant-only seats and 47.3 percent were convertible seats used in the infant mode. A slightly higher rate of misuse was observed in the convertible seats in the infant mode.

Proper use of infant safety seats requires that the harness be used to secure the child to the seat. The harness was not used in 28.9 percent of the observations and was incorrectly used in 4.0 percent of the observations (Table 1). Incorrect harness use primarily consisted of not routing the straps over the shoulders of the infant.

Some infant seats require the vehicle belt to be routed through the frame and other infant seats require the vehicle belt to be routed over the child's lap through clips provided for the belt. For infant seats where the vehicle belt is routed above the child's lap, 40.8 percent did not use the harness straps and many used them incorrectly. For seats that require belting to the vehicle through the frame, 4.8 percent did not use the harness and 9.6 percent incorrectly used the harness. It appears that parents thought the car belt in front of the child was sufficient protection and neglected the need for a harness.

All infant seats require the use of the vehicle belt to secure the seat to the vehicle; however, the belt was not used in 9.4 percent and was incorrectly routed in 14.1 percent of the observations (Table 1). The two predominant infant-only seats and some convertible seats require the use of the vehicle belt to secure the seat and the child every time the seat is used. The belt then must be removed for the child to be removed from the seat. Several of the convertible seats require the belt to be routed through the seat frame, which allows the seat to be permanently belted. There was a higher percentage of incorrectly belted seats when the belt routing was through the frame (permanently belted), but there was a higher percentage of not using the belt when the belt was designed to be routed over the child's lap.

Infant seats are designed to face rearward. However, 33.3 percent of the infants in seats were observed facing forward. (Note that infants older than 6 or 7 months were designated as toddlers thus providing a conservative measure.) Convertible seats used in the infant position were forward facing (misused) in 42.3 percent of the observations, whereas 25.3 percent of seats designed for infant use only were forward facing.

Because all infant seats must be belted to the vehicle, rearward facing, and the infant harnessed in the seat, it is possible to have three incorrect uses of each seat. Although 59.3 percent of the infant seats were recorded as misused, 33.3 percent had one misuse, 22.0 percent had two misuses, and 4.0 percent had three misuses.

Booster Seats

Most booster safety seats observed in this study are designed for children about 3 to 6 years in age and require both a means of securing the seat to the vehicle (using the vehicle belt) and upper torso restraint. The upper torso restraint can be provided by the shoulder harness of a three-point vehicle belt system or by a harness system secured by a tether strap.

Misuse of booster seats consisted of not using the harness or tether strap (upper torso support) or not using the vehicle belt at all. Of the 122 booster safety seats observed, 61.5 percent were misused. Booster seats were not harnessed 61.5 percent of the time (Table 1). Of those children using a harness, 76.6 percent used the shoulder harness from the three-point vehicle belt system and 23.4 percent were restrained by a harness system attached with a tether strap. More than 85 percent of the children in booster seats were belted.

There are two possibilities for incorrect use of booster safety seats. Although 61.5 percent of booster seats observed were misused, 46.7 percent had one incorrect use and 14.7 had two incorrect uses.

FACTORS ASSOCIATED WITH MISUSE

The following findings summarize how child safety seat misuse is related to other information collected:

- Overall, seat position had little effect on the misuse of safety seats, with the exception of the front-outboard position for booster seats where misuse was much lower. This position permits the use of the vehicle shoulder harness for upper torso restraint.
- Misuse of safety seats was more common when the driver was not belted. This relationship was more pronounced for booster seats.
- Overall, 86.5 percent of the seats were obtained new, and misuse was lower for such seats.
- Parents purchased 70.7 percent of the seats and 23.4 percent were received as gifts. Only a few seats were obtained from rental programs or were borrowed. Misuse was lower for seats obtained by parents as opposed to those obtained as gifts.
- Misuse increased with the age of the seats. Approximately 21 percent of the toddler seats and 17 percent of infant seats were more than 4 years old.
- When asked how the seat was first installed, 67.5 percent of the respondents stated that they followed manufacturer's instructions, 4.3 percent had installation demonstrated, and 28.2 percent installed the seat without using instructions. Misuse was higher for those installing the seats without the aid of instructions. For those individuals manufacturer's instructions, misuse was 58.6 percent even though 95.0 percent of these individuals stated that the instructions were easy to follow.
- Both mothers and fathers misused the seats at about the same rate.
- An overwhelming majority (85.3 percent) indicated that the child's safety was the primary concern in using the seat. Misuse was higher for those who gave nonsafety reasons for seat use.
- In general, the age of the child was not related to misuse.
- 54.6 percent of the respondents stated that their seat was used in more than one vehicle, and 46.7 percent of toddler seats that required a tether strap were used in more than one vehicle. Misuse, however, was no greater for seats that were used in more than one vehicle than for seats that always remained in one vehicle.

When seat misuse was observed, the parents were asked if they knew that the seat was being misused. Approximately 95 percent of those who had not harnessed the child or had incorrectly used the harness were aware that they were in error. The primary reasons for toddler seat misuse included: the child took the harness off (23.4 percent), the child did not like the harness or shield or was uncomfortable (13.5 percent), the harness did not fit properly (10.7 percent), and the harness was not necessary (12.1 percent). Responses for infant seats included: the harness did not fit (18.7 percent), the harness

was a hassle to use (14.5 percent), and the harness was not considered necessary (12.5 percent). Nearly 20 percent of those not using upper torso restraint in booster seats stated that it was not necessary, and a majority of the others gave responses relating to not wanting to use a harness-tether combination or install a tether anchor.

Nearly 80 percent of those not using a tether strap (when required) for toddler seats knew that it was required. A majority of reasons given for not using the tether strap were related to reluctance to install an anchor or drill a hole in the vehicle for the tether anchor or the fact that the seat was moved from vehicle to vehicle.

Nearly 75 percent of those incorrectly belting the seat to the vehicle did not realize that the belt was routed incorrectly. Other reasons provided for incorrect belt use included that it made no difference where the belt was routed, the belief that the incorrect routing was safer, the belt was rerouted to compensate for harness misuse, and the vehicle belt would not fit.

Although only a small number of seats were observed not belted to the vehicle, approximately 75 percent of those respondents knew that the seat was not belted. A majority of those who intentionally did not belt the seat gave reasons including: the belt was broken or removed from the vehicle, the driver was in a hurry, the child took it off, and the belt is only used on long trips.

For infant seats used in the forward-facing mode, 71.4 percent knew the seat was supposed to face rearward. More than 25 percent of those questioned knew that the seat was supposed to face rearward but did not know why, and an additional 18.4 percent thought the child was old enough to use the seat facing forward.

CONCLUSIONS

Various countermeasures, based on the types of misuse observed and reasons for misuse, can be developed. These countermeasures fall into three categories: (a) design modifications to the seat to make it more comfortable, easier to use, or less vulnerable to misuse; (b) vehicle design modification to make seat and tether installation easier and less vulnerable to misuse; and (c) education.

Design changes to the seat include the incorporation of full shields or harness pads instead of straps and buckle harnesses. This recommendation is made because of the comparatively higher incidence of harness nonuse with child seats incorporating straps-and-buckle harness systems. Harness systems should be designed to prevent children from easily slipping the harness off their shoulders. Design modifications can be incorporated to make belt routing less vulnerable to misuse by giving parents less of a choice in routing. To counter other common installation problems, more prominent warning stickers should be placed on tether-type seats indicating the necessity of using the tether strap, and the locations on the child seat through which the car belt should be routed should be clearly marked.

Vehicle design modifications include tether anchorages in the rear of the car to accommodate tether seats or tether harness systems for booster seats. Equipping vehicles with rear seat shoulder harnesses can provide upper torso restraint for many types of booster seats without the need for a tether harness system.

Recommendations of an educational nature are based on the lack of understanding by parents about the use and installation of child seats. A lack of knowledge of the hazards of misuse is evidenced by the fact that 86 percent used the seat for the child's safety; however, 62.7 percent of these individuals misused the seat. The need for education about how to properly use the seat is evidenced by the fact that 75 percent of those questioned did not realize that they had the vehicle belt improperly routed. Educational efforts should be designed to make parents aware of (a) the consequences of child seat misuse, (b) the common forms of misuse, and (c) how to take corrective action.

Obviously, different types of misuse will have different results in the event of a collision. Misuse involving not harnessing the child may offer no child protection whereas improperly routing the vehicle belt may not have catastrophic results. The findings of this study should be used with results of studies on consequences of different types of misuse to target higher priority educational needs or design modifications.

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