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CHILD RESTRAINT DEVICE USE AND MISUSE IN MICHIGAN

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16. Abstract

In 1994, nearly 87,000 children under the age of five were injured or killed in traffic crashes across the nation, with 2,336 of these injuries and fatalities occurring in Michigan. The use of child restraint devices (CRDs, also called child safety seats) has been identified as an effective means of reducing trauma incurred by young vehicle occupants involved in crashes. The primary purpose of the project reported here was to determine accurately a statewide CRD use-rate through a direct-observation survey of children at pediatric medical and day care centers. However, determining the frequency of CRD use may not capture the entire traffic safety picture for children. Studies done in other states have found that among those who use CRDs, misuse of the devices is high. Determining misuse among those using CRDs was a secondary purpose of the project. Misuse data was collected at day care centers across Michigan through driver interviews and CRD visual inspections.

The study showed that an estimated 74.5 percent of children under four years of age in Michigan are in a CRD when traveling in a motor vehicle. CRD use rates were highest in vehicles driven by a belted drivers, females, and drivers under the age of 60 years. The misuse portion of the study, while only a pilot study, discovered at least some degree of improper CRD use in 88.5 percent of inspections. The most common types of misuse discovered were related to snugness of fit (both installing the CRD tightly in the vehicle and securing the child in the CRD) and the use of clips (i.e., the safety belt locking clip and the CRD harness positioning clip). Drivers who had a high occurrence of misuse, as compared with drivers with low misuse, had younger children, lower educational levels, and were employed full or part time. Finally, most drivers had accurate, detailed knowledge of Michigan's mandatory CRD use law.

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INTRODUCTION

Motor vehicle crashes are a leading source of injury and death to individuals of all ages. Those under the age of five are no exception. In 1994, nearly 87,000 children under the age of five were injured or killed in traffic crashes across the nation (NHTSA, 1995) with 2,336 of these injuries and fatalities occurring in Michigan (OHSP, 1995). The use of child restraint devices (CRDs, also called child safety seats) has been identified as an effective means of reducing trauma incurred by young vehicle occupants involved in crashes. In order to reduce the number and rate of vehicle occupants under four years of age injured and killed in motor vehicle crashes, Michigan implemented a mandatory child restraint use law in April, 1982. According to this law, Michigan Vehicle Code 257.710d, any child under one year of age riding in either the front or back seat of a vehicle must be in a child restraint device. In addition, any child between the ages of one and four must be in a child restraint device when riding in the front seat of a vehicle and must be either in a child restraint device or belted when riding in the back seat.

Although surveys of child restraint use have been conducted, in the fourteen years since the law was implemented, a direct-observation survey of statewide child restraint *device* use has never been conducted. The effectiveness of the law, however, was investigated by Wagenaar and colleagues in several studies (Wagenaar, 1984; Wagenaar & Webster, 1985; Wagenaar & Maybee, 1986). In these studies, CRD use and its effects on injury for passengers under four years of age was determined by examining statewide crash reports from the Michigan State Police. A time-series analysis showed that immediately after implementation of the law, the CRD use rate increased from about 15 percent to 56 percent, while restraint use in other age groups showed little change. Wagenaar and his colleagues also found a corresponding 27.4 percent reduction in child injuries. While these studies are interesting and informative, gathering CRD use from crash-reports can be problematic. For example, CRD use on a crash report is often self-reported by the driver to the investigating officer. A crash-involved driver may report that a child was restrained when he or she was not, rather than admitting to a violation of the law. A direct-observation survey of CRD use would not be biased in this way.

Direct observation of statewide restraint use for all ages has been investigated regularly since 1984. However, CRD use for those under the age of four cannot be adequately derived from these surveys because too few passengers in this age group are seen in any randomly selected traffic stream. In a recent survey (Eby, Streff & Christoff, 1995), only 62 of the 9,864 occupants observed (less than 1 percent) were under the age of four (79 percent of the children were restrained). Thus, in order to determine accurately a statewide CRD use-rate, a direct-observation survey designed specifically for this purpose is necessary. This was the primary purpose of the project. At the same time, determining the frequency of CRD use may not capture the entire traffic safety picture for children. Non-statewide studies have found that among those who use CRDs, misuse of the devices is high (e.g., Bolton & Dale, 1996; Decina & Knoebel, 1996; Margolis, Wagenaar, & Molnar, 1992). Determining misuse among those using CRDs was a secondary purpose of the project.

METHODS

Sample Design

The goal of this sample design was to select observation sites that represent accurately all Michigan children under four years of age. An ideal sample minimizes total survey error while providing sites that can be surveyed efficiently and economically- in this case, sites that have a high likelihood of target age children present. To achieve this goal, the following sampling procedure was used.

To reduce the costs associated with direct observation of remote sites, the National Highway Traffic Safety Administration (NHTSA, 1992) safety belt survey guidelines allow states to omit from their sample space the lowest population counties, provided these counties account for 15 percent or less of the state's total population. These guidelines were adopted for the present survey of CRD use and misuse. Therefore, all 83 Michigan counties were rank ordered by population (U.S. Bureau of the Census, 1992) and the low population counties were eliminated from the sample space. This step reduced the sample space to the same 28 counties used in the current direct observation survey of safety belt use (Eby & Christoff, 1996).

Because we had little background information on the use and misuse of CRD in Michigan and because we wanted to be able to compare CRD use results with safety belt use, the same stratification procedure developed for the direct observation of safety belt use in Michigan (see Streff, Eby, Molnar, Joksch, & Wallace, 1993) was used in the present direct observation of CRD use and misuse. The 28 counties were separated into four strata. Table 1 shows the counties contained in each stratum. The strata were constructed by obtaining historical belt use rates and vehicle miles of travel (VMT) for each county. Historical belt use rates were determined by averaging results from three previous University of Michigan Transportation Research Institute (UMTRI) safety belt surveys (Wagenaar, Molnar, & Businski, 1987, 1988; Wagenaar & Molnar, 1989). Since no historical data were available for six of the counties, belt use rates for these counties were estimated using multiple regression based on per capita income and education for the other 22 counties (r^2 = .56; U.S. Bureau of the

Census, 1992).[1] These factors have been shown previously to correlate positively with belt use (e.g., Wagenaar, et al., 1987). Because we wanted to ensure that observation sites were selected within Wayne County it was chosen as a separate stratum. Three other strata were constructed by rank-ordering each county by historical belt use rates and then adjusting the stratum boundaries until there was roughly equal total VMT within each stratum. The stratum boundaries were high belt use (greater than 54.0 percent), medium belt use (45.0 percent to 53.0 percent), low belt use (44.9 percent or lower), and Wayne County (41.9 percent belt use).

Table 1. Listing of the Counties Within Each Stratum

Stratum Number	Counties
1	Ingham, Kalamazoo, Oakland, Washtenaw
2	Allegan, Bay, Eaton, Grand Traverse, Jackson, Kent, Livingston, Macomb, Midland, Ottawa
3	Berrien, Calhoun, Genesee, Lapeer, Lenawee, Marquette, Monroe, Muskegon, Saginaw, Shiawassee, St. Clair, St. Joseph, Van Buren
4	Wayne

Little CRD use information was available statewide to help in minimizing the number of sites needed to achieve a reasonably low relative error in the sample. Therefore, the number of observation sites for the survey (N = 88) was determined based on within- and between-county variances from previous belt use surveys and an estimated 20 target-age children (i.e., child under four years of age) per observation period in the current survey. Belt use rates were used because they are likely to correlate highly with CRD use (e.g., see Margolis, et al., 1992). The estimated number of children per observation period was based upon pilot testing.

A fundamental difficulty in surveying CRD use and misuse in a statewide sample is selecting observation sites where target-age children are concentrated, while minimizing

[1] Education was defined as the proportion of population in the county over 25 years of age with a professional or graduate degree.

potential bias in the demographics of drivers who may visit that site. Sites such as churches, fast-food restaurants, movie theaters, amusement parks, and shopping centers were considered but because of either the exclusivity of the drivers who may visit the location or the general lack of target-age children, these site were not used in this study. Two types of sites, however, satisfied our criteria. Because all children under four years of age receive medical care at some time, all pediatric centers and pediatric clinics in the 28 counties were included in the sample space. The other type of site was day care centers. This site type was used because there is a good concentration of target-age children and, because the state of Michigan subsidizes many day care centers, the use of a day care center is generally not based upon income or educational level. The day care centers had the additional benefit of a localized parking area in which misuse of CRDs could be investigated safely and effectively. Therefore, all registered day care centers in the 28 counties, including Head Start centers, were included in the sample space.

Within each stratum, twenty-two observation sites were selected randomly. Ten of the sites were chosen randomly from all identified pediatric medical facilities in the stratum and 12 were selected from all identified day care centers. The random selection of medical facilities was completed by generating a list of all pediatric medical facilities, numbering each one, and then randomly selecting 10 centers and 10 alternates, without replacement, from the list. The list of day care centers was obtained from the Family Independence Agency Directory of Child Day Care Centers, which maintains a list of all registered day care centers in Michigan. Twelve day care centers and 24 alternates were randomly selected from this list.

The day of week and time of day for CRD use observation was randomly assigned after determining when sites were open and active. No sites were observed on weekends. Since most day care centers conducted programs in which the majority of children participated, the concentration of target-age children arriving or leaving the site was greatest just prior to the beginning and just after the end of the program. Therefore, day care centers were sampled during periods of peak arrivals or departures.

Table 2 shows descriptive statistics for the 88 observation sites. As shown in this table, the sites were fairly well distributed over days of the week. The time of the observation was generally early in the day because this was when most day care centers were open and active. This table also shows that nearly every site observed was the primary site and most observations occurred on sunny or cloudy days.

Table 2. Descriptive Statistics for the 88 Observation Sites

Day of Week		Start Time		Site Choice		Weather	
Monday	8.0%	6-8 AM	25.0%	Primary	94.3%	Sunny	58.0%
Tuesday	10.2%	8-10 AM	26.1%	Alternate	5.7%	Cloudy	31.8%
Wednesday	20.5%	10-12 PM	27.3%			Rain	10.2%
Thursday	36.3%	12-2 PM	11.4%				
Friday	25.0%	2-4 PM	10.2%				
TOTALS	100%		100%		100%		100%

Data Collection Procedures

This study involved the collection of two distinct types of information about CRDs: use and misuse. The CRD use data were collected using direct observation procedures. The misuse data were collected using both a driver face-to-face interview and a visual/hands-on inspection of CRD placement in the vehicle and child placement in the seat. Because the two parts of the survey are distinct and the CRD misuse portion was a pilot test, the methods and results for each part are discussed separately.

CRD Use Procedures

Data collection for the CRD *use* part of study involved direct observation of vehicle occupants in which at least one occupant was under the age of four years. For these vehicles, driver age, sex, and shoulder belt use were recorded. In addition, CRD use for all children under four years of age in the vehicle was recorded. Sex was also recorded for these target-age children but was omitted from the analysis because of the difficulty in visually judging the sex of these young children. All above information was collected as the passenger car, van/minivan, sport utility vehicle, or pickup truck stopped at the day care or medical center. Occupants in other vehicle types were not included in the survey.

CRD Use Data Collection Forms: Two forms were used for CRD use data collection: a site description form and an observation form. The site description form (see Appendix A) provided descriptive information about the site including the site number, location, site type (medical or day care), site choice (primary or alternate), observer number, date, day of week, time of day, and weather. A place on the form was also furnished for observers to sketch the parking area and to identify observation locations and traffic flow patterns. Finally, a comments section was available for observers to identify landmarks that might be helpful in characterizing the site and to discuss problems or issues relevant to the site or study.

The second form, the observation form, was used to record driver shoulder belt use, CRD use of children under the age of four, sex, seating location, and vehicle information (see Appendix A). Each observation form was divided into two columns, with each column of sufficient size to record data for a single vehicle. Drivers observed with their shoulder belt worn under the arm or behind the back were recorded as belted, and information about the type of misuse was coded. Target-age children placed improperly in a CRD were recorded as being in a CRD. At each site, the observer carried several data-collection forms and completed as many observations as possible during the observation period.

Procedures at Each Site: All sites in the sample were visited by either one or two observers for a period of two hours. Upon arriving at a site, observers determined whether observations were possible at the site. If observations were not possible (e.g., the site was closed), observers proceeded to the alternate site. Otherwise, observers completed the site description form and then moved to the observation position at the entrance to the site. If more entrances than observers were present, the observers divided their observation time between all entrances.

Observers were instructed to observe each appropriate vehicle (passenger cars, van/minivans, sport utility vehicles, and pickup trucks) entering the facility to see if it contained at least one child under four years of age. If so, the observer recorded information on the driver, all target-age occupants, and the vehicle. After this information was recorded, the observer looked for the next vehicle. If traffic flow was heavy, observers were instructed to record data for the first eligible vehicle they saw and then look up and record data for the next eligible vehicle they saw, continuing this process for the remainder of the observation period.

CRD Misuse Procedures

Data collection for the CRD *misuse* part of the study involved driver interviews and visual/hands-on inspection of CRDs containing target-age children. All misuse data were collected at a subset of the day care center sites (seven from each stratum for a total of 28 CRD misuse sites). Misuse sites were selected by contacting each day care center from the CRD use portion of the study. Centers were first contacted by mail (see Appendix B) and then by telephone, to determine if we could conduct driver interviews with their clients as they dropped off or picked up their target-age children. Centers were contacted in random order, and the first seven centers in each stratum that agreed to participate were selected for the study.

CRD Misuse Data Collection Forms. Two forms were used for CRD misuse data collection: a driver interview and a CRD inspection form (see Appendix C). The driver-interview form contained questions about the vehicle (vehicle type, presence of air bags, frequency of driver vehicle use), target-child demographics (relationship to driver, age, weight, and sex), the CRD (e.g., how it was acquired, who installed it, how they learned to install it, who put the child in the seat, frequency of removal from vehicle), knowledge of the Michigan CRD law, and driver characteristics (marital status, education level, age, sex, health behaviors, employment, and income).

The CRD inspection form was used to collect information on various aspects of CRD use and installation including the seat make and model, the seat type (infant, toddler, convertible, or booster), the placement of the seat in the vehicle (location in vehicle, direction, placement of carrying handles and removable base, and the angle of recline), the attachment of the CRD to the vehicle seat (safety belt routing, use of locking clip, and tightness of installation), and placement of the child in the seat (use of harness straps, buckles, and positioning clip, appropriateness of seat back height, and use of padding). A comments section was also available for observers to identify any issues not covered in the form. This form was self-carboning so that when completed, the driver could keep a copy.

Procedures at Each Misuse Site. All sites in the sample were visited by a pair of observers for a period of two hours. A third observer was also at the site at the same time, conducting the CRD use portion of the study. Upon arriving at a site, observers contacted the day care center supervisor to inform him or her of their presence and intent to conduct the study. A large A-frame billboard was placed near the entrance of the center that announced, “University of Michigan Traffic Safety Survey. Five Minutes. Free Toy.” The billboard was used so that drivers would have some forewarning before they were approached by an observer. One observer always conducted the CRD inspection, while the other in the pair always conducted the driver interview.

As vehicles with target-age children parked at the day car center, the observer serving as the interviewer would approach drivers, tell them briefly about the study, and ask if they were willing to participate. If they agreed, the interviewer began asking them the questions on the driver interview form. At the same time, the second observer gave all children in the vehicle a small stuffed teddy bear (called a *Buckle-Me Bear*) and began the observation of the CRD containing the target-age child. If more than one target-age child in a CRD was present, then one of the children was selected randomly to participate.

Once the driver interview and the CRD inspection were completed (about five minutes), the driver was given a copy of the inspection form and told about any misuse that was discovered. The driver was also given a packet of information about proper CRD use, CRD recalls, and contact numbers for the researchers if there were questions or concerns. When this was finished, the pair of observers went to the next vehicle.

Observer Training

All observers were trained for both use- and misuse-data collection. Field observers participated in ten days of intensive training including classroom review of CRDs, proper CRD installation, and data collection procedures, as well as practice observations in a controlled setting, and field observations. Each observer received a training manual containing detailed information on field procedures for observations, data collection forms, and administrative policies and procedures. Included in the manual were a listing of the sites for the study which identified the location of each site and a site schedule identifying the date and time each site was to be observed.

The training was conducted in four parts. The first part was an intensive seminar on CRDs and their use, conducted by a local child restraint device expert. This seminar included hands-on examples of many different brands of CRDs (including all types of CRDs) and issues involved in the proper installation of CRDs. The second phase of training involved a complete review of the training manual, including the experimental and administrative aspects of the study, a review of the data-collection forms, and other general procedures for the study.

The third part of training involved practice data collection and interobserver reliability checking. To practice the misuse part of the study, the researchers placed life-size dolls in CRDs with known misuse in a variety of vehicles, had observers practice the driver interview and CRD inspection, and then gave them feedback on their performance. The use data collection was practiced by bringing observers to a local day care center and pediatric medical center, having them complete the use data-collection form, and giving them feedback on their performance. Once all observers were comfortable and competent with all data collection forms, they were tested for interobserver reliability. Observers worked in teams of two, observing the same vehicles, but recording data independently on separate data-collection forms. Teams were rotated throughout the training to ensure that each observer was paired with every other observer at least three times. Each observer pair practiced recording the information for each data-collection form until there was an interobserver reliability of at least 85 percent on all measures.

The final part of training consisted of practice under actual field conditions. During this phase of training, all experimental and administrative procedures were practiced. At the end of each session, feedback was given to all observers. Each observer was provided with an atlas of Michigan county maps and all necessary field supplies. Observers were given time to find assigned sites on the appropriate maps and plan travel routes to the sites. Field procedures were reviewed for the final time and observers were informed that unannounced site visits would be made by the field supervisor during data collection to ensure adherence to study protocols.

Data Processing and Estimation Procedures

Information from the site and data-collection forms were manually entered into a computer data file. The accuracy of the data entry was verified in two ways. First, all data were entered twice and the data sets were compared for consistency. Second, all data were checked for inconsistent codes and out-of-range variable values. In cases of error, the original data forms were reviewed and corrections were made. Data were analyzed using the Statistical Analysis System (SAS) package.

The CRD use observations were made at two different types of sites (child care centers and pediatric medical facilities) in four strata. Because the two types of sites were sampled independently of each other and because the sampling schemes were different, the use rate was first estimated separately for each type of site within each stratum. So that we could expand results to the population of target-aged children in Michigan, an overall statewide estimate of the CRD use by type of site was made by weighting the stratum estimates by the population of children under the age of four for the counties within each stratum. Finally, the overall statewide estimate for CRD use was calculated based upon the two statewide site-type estimates. The details of the estimates for the two types of sites, the estimates of the variances and confidence bands, and the calculation of relative error can be found in Appendix D.

RESULTS

As mentioned earlier, the study was divided into a survey of CRD use and a concurrent survey of the types of misuse that occur when a CRD is used. Because of the general lack of information about misuse and the low number of interviews/inspections that took place, the latter part of the study was a pilot only. Results for the two parts of the study are presented separately.

Child Restraint Device Use

Overall Child Restraint Device Use

As shown in Figure 1, the estimated child restraint device use rate for the state of Michigan was 74.5 ± 3.7 percent of all children under the age of four traveling in passenger cars, pickup trucks, sport utility vehicles, and van/minivans during the summer of 1997. The "±" value following the use rate indicates a 95 percent confidence band around the percentage. This value should be interpreted to mean that we are 95 percent sure that the actual CRD use rate falls somewhere between 70.8 percent and 78.2 percent. The relative error of the estimate was 2.6 percent which was well within the five percent or less relative error required for statewide surveys of safety belt use (NHTSA, 1992).

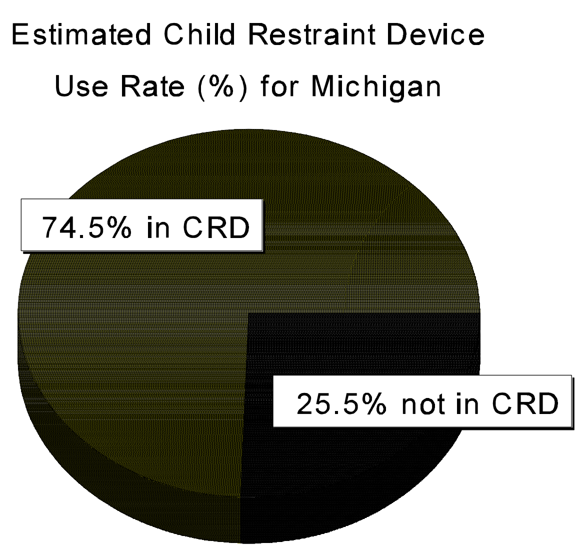

Figure 1. Statewide Child Restraint Device Use Rate.

Estimated CRD use rates and unweighted Ns for individual strata, by type of site, are shown in Table 3. As can be seen in the table, there was no consistent difference in CRD use rates between day care and medical centers. Comparing across the strata, we found that the CRD use rates generally follow the safety belt use rates (see Eby & Christoff, 1996), with one notable exception. Stratum four (Wayne County), which is consistently one of the lowest safety belt use rate areas of the state, had an overall CRD use rate that was higher than any other region of Michigan.

Table 3. Percent Child Restraint Device Use and Unweighted Number of Children Observed (N) by Stratum, Site Type, and Overall

	Day Care	Medical	Overall
Stratum 1	71.3 (N=209)	80.0 (N=110)	77.4 (N=319)
Stratum 2	83.2 (N=113)	72.4 (N=152)	77.0 (N=265)
Stratum 3	73.2 (N=194)	63.4 (N=112)	64.6 (N=306)
Stratum 4	63.8 (N=188)	82.8 (N=180)	79.6 (N=368)
STATE OF MICHIGAN	**72.6 (N=704)**	**75.1 (N=554)**	**74.5 (N=1,258)**

Use by Driver Safety Belt Use

The estimated CRD use rate by driver safety belt use is shown in Figure 2. Note that CRD use is significantly higher when the driver wears his or her safety belt. While not surprising, this result suggests that continued efforts to increase safety belt use will also increase the frequency with which CRDs are used.

Figure 2: Child Restraint Device Use Rates by Driver Safety Belt Use.

Use by Sex of Driver

Estimated CRD use by the sex of the person driving the vehicle in which the child was observed is shown in Figure 3. Women drivers tended to have children under the age of four in CRDs more often than men drivers. Since surveys have consistently shown that safety belt use rates for women are generally about ten percentage points higher than men (see Kostyniuk, Molnar, & Eby, 1996 for a review of Michigan drivers), this sex difference observed in the present study may be related to the higher safety belt use of women. An analysis of CRD use by driver belt use and sex showed that CRD use generally followed driver belt use.

Use by Age of Driver

Estimated CRD use by the age of the driver in which the child was observed is shown in Figure 4. The CRD use rates were approximately the same for the two youngest age groups (close to three-quarters). However, drivers 60 or more years of age had target-age children in CRDs only about one-half of the time. While the number of drivers in this age group was quite small, this result might suggest that grandparents or older relatives of young children may not own CRDs or may not be proficient in their use.

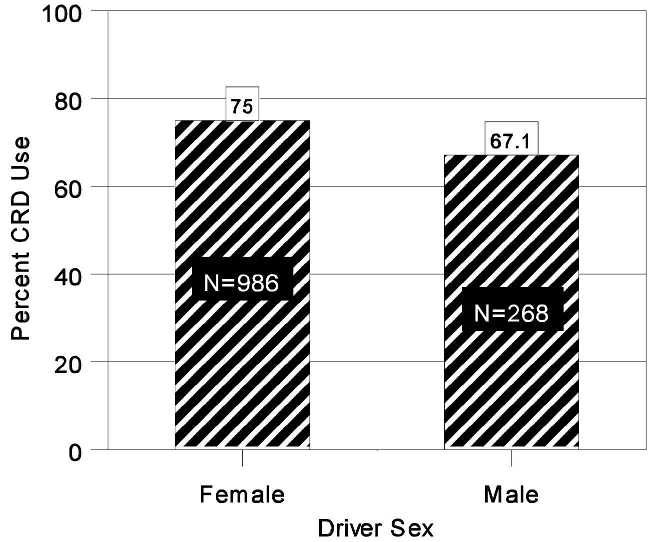

Figure 3: Child Restraint Device Use Rates by Driver Sex.

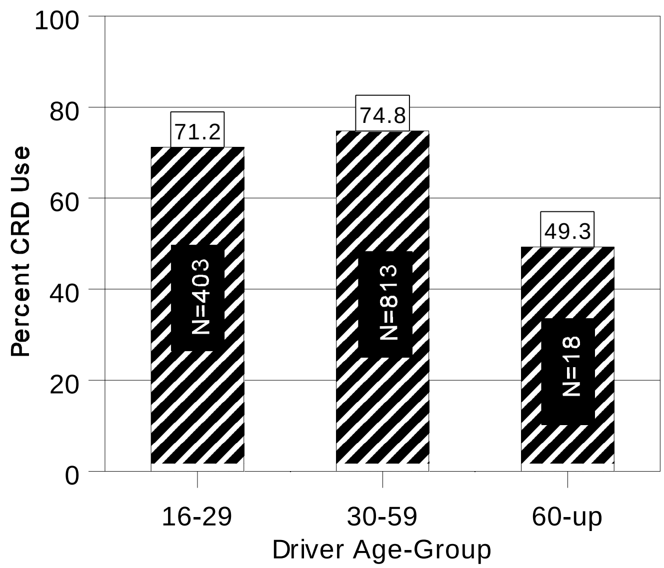

Figure 4: Child Restraint Device Use Rates by Driver Age Group.

Use by Seating Position

CRD use as a function of where in the vehicle target-aged children were seated is shown in Figure 5. Children seated in the front seat of a vehicle (either in the center or right side), tended not to be in a CRD. Fortunately, very few target-age children were riding in the front seat. We also discovered that children riding in the third row of a vehicle (either on the left or in the center) were not placed in CRDs very frequently. Since a third row of seats is only available in minivans and some sport utility vehicles, this low CRD use rate for two of the three seating positions may be due to the fact that many target-age children were being transported and there were not enough CRDs for everyone. Anecdotal reports from observers confirm this hypothesis. Again, fortunately, very few children under the age of four are found riding in the third row of seats.

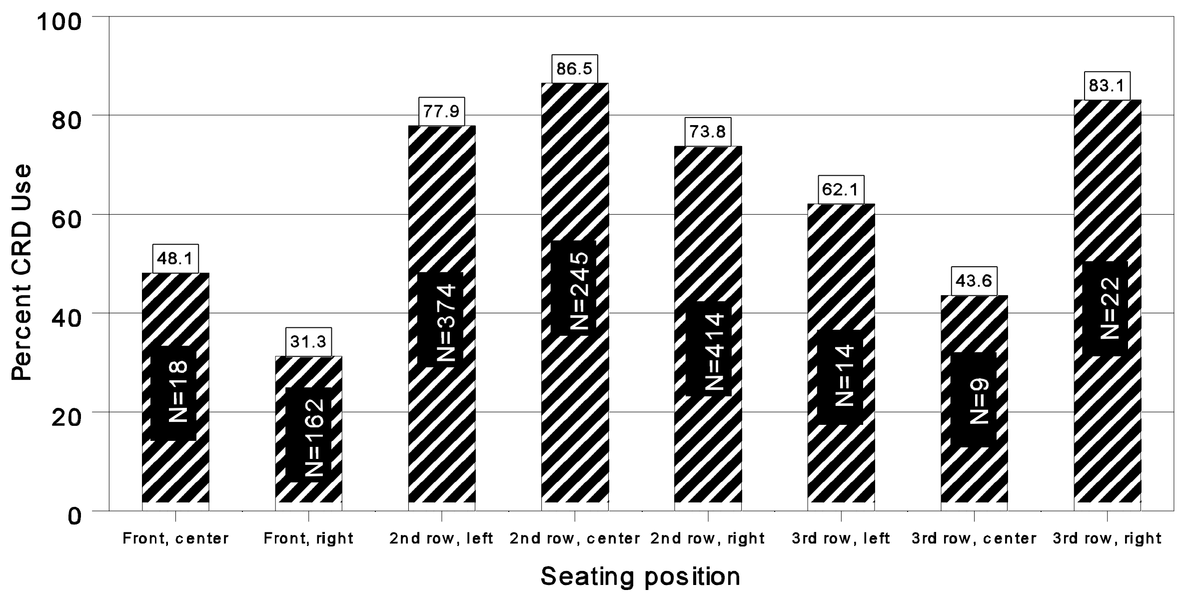

Figure 5: Child Restraint Device Use Rates by Vehicle Seating Position.

Child Restraint Device Misuse

Because this portion of the study was designed as a pilot test of CRD misuse data collection, a total of only 87 driver interviews and CRD inspections were conducted. While this number is sufficient to determine some statewide trends in CRD misuse, the number of interviews/inspections is too small to make strong conclusions about the types of CRD misuse occurring in Michigan. Also, because of the small number of respondents, the results reported in this section are not weighted by the population of children under four years of age. Because the methods and data collection instruments used in the present study proved to be effective in gathering CRD misuse information, a full-scale version of this part should be conducted.

Driver Characteristics

Table 4 shows the demographic characteristics of the 87 drivers who participated in the study. The vast majority of drivers were female, most had at least some college education, two-thirds were employed either part of full time, nearly all reported being married, about three-fourths did not smoke, slightly more than one-half exercised regularly, nearly all were the parent of the child selected for the CRD inspection, and most were driving passenger cars. The average age of the drivers was 33.6 years (SD=7.4 years), with ages ranging from 21 to 64 years.

Table 4: Driver Characteristics		
Characteristic	**Percent**	**Frequency**
Sex		
Male	13.8	12
Female	86.2	75
Education		
Less than high school degree	4.6	4
High school degree/GED	14.9	13
Some college	28.7	25
Bachelor's degree	31.0	27
Some graduate school	6.9	6
Graduate degree	13.8	12
Employment		
Full time	51.7	45
Part time	17.2	15
Student	2.3	2
Retired	1.1	1
Housewife/husband	27.6	24
Marital Status		
Married	89.7	78
Divorced	1.1	1
Widow/er	2.3	2
Single	6.9	6
Household Income		
$50,000 or more	65.5	57
$49,999 - $35,000	14.9	13
$34,999 - $25,000	10.3	9
$24,999 - $15,000	4.6	4
$14,999 - $5,000	1.1	1
$5,000 or less	1.1	1
Don't know	2.3	2
Do you currently smoke?		
Yes	24.1	21
No	75.9	66
Do exercise at least 30 min. three times/week?		
Yes	57.5	50
No	42.5	37
Relationship to Participating Child		
Parent	90.8	79
Other family member	6.9	6
Friend	1.1	1
Other	1.1	1

Vehicle Type Driven		
Passenger car	60.9	53
Van/Minivan	24.1	21
Sport utility vehicle	11.5	10
Pickup truck	3.4	3

Child and Child Restraint Device Characteristics

Table 5 shows the percent and frequency of various factors related to the children and child restraint devices that were inspected in the study. The majority of seats inspected were convertible seats; that is, the seats that are designed to work with both infants and toddlers. Very few CRDs integrated into the vehicle were observed. The analysis of CRD location showed that most seats were placed in the second row of seats in the vehicle. Our analysis of seat location and the presence of air bags showed that none of the CRDs were in a seating location in which an air bag was present.

The mean age of the children who participated was 20.7 months (SD=12.7 months), with a range from 1 to 54 months. The average weight of children participating was 24.8 lbs (SD=7.0 lbs), with a range from 8 to 41 lbs. Parents were asked to report the number of miles they had driven since the child was put in the seat, as well as the length of time the child had been in the seat. The mean distance was 6.9 miles (SD=7.1 miles), with a range of 0 to 30 miles. The mean duration was 13.4 minutes (SD=10.5 min), with duration ranging from one minute to one hour.

Table 5: CRD Characteristics		
Characteristic	**Percent**	**Frequency**
Type of CRD		
Infant	16.1	14
Convertible	73.6	64
Toddler	4.6	4
Booster	2.3	2
Integrated	3.4	3
How Seat Was Acquired		
Self purchase	67.8	59
Gift/loan from family member	8.0	7
Gift/loan from nonfamily member	16.1	14
Integrated	3.4	3
Other	1.1	1
Don't know	3.4	3
CRD Manufacturer		
Century	20.7	18
Cosco	9.2	8
Evenflo	28.7	25
Fisher-Price	13.8	12
Gerry Baby Products	8.0	7
Kolcraft	2.3	2
Other	8.0	7
Could not determine	9.2	8
Location of CRD in Vehicle		
Front, center	1.1	1
Front, right	3.4	3
2nd row right	39.1	34
2nd row, center	31.0	27
2nd row, left	25.3	22

Driver Knowledge and CRD Use

Table 6 shows that a large majority of drivers reported learning about how to install the CRD by reading the instructions provided. However, this source of information was never used for learning how to put the child in the seat. Instead, most people reported that they simply “figured it out” on their own. When asked about CRD use, drivers reported that the CRD tended to be left in the vehicle, rather than being moved around among vehicles. Several drivers commented that they had more than one CRD because they had multiple vehicles. Interestingly, a large majority of drivers believed that they had the CRD installed correctly and had the child placed in the seat correctly.

Table 6: Driver Knowledge of CRD and CRD Use		
Characteristic	**Percent**	**Frequency**
How driver learned to install CRD		
Instructions with CRD	71.3	62
Figured it out on their own	11.5	10
Instructions from other family member	4.6	4
Instructions from friend	1.1	1
Other	3.4	3
Integrated seat	3.4	3
Don't know	4.6	4
How Driver Learned to Put Child in CRD		
Instructions with CRD	0.0	0
Figured it out on their own	51.7	45
Instructions from other family member	36.8	32
Instructions from friend	5.7	5
Other	2.3	2
Don't know	3.4	3
How Often is CRD Removed from Vehicle		
Less than once a week	66.7	58
Once a week	10.3	9
Several times a week	4.6	4
Daily	14.9	13
Integrated	3.4	3
Driver Belief About Whether CRD was Installed Correctly		
Yes	96.6	84
No	3.4	3

Knowledge of Michigan's Mandatory CRD Use Law

As mentioned earlier, Michigan Vehicle Code 257.710d, requires that any child under one year of age riding in either the front or back seat of a vehicle must be in a child restraint device. In addition, any child between the ages of one and four must be in a child restraint device when riding in the front seat of a vehicle and must be either in a child restraint device or belted when riding in the back seat. We assessed whether drivers had detailed knowledge of this law by asking them four true/false questions about the law. First, drivers were asked to judge whether the following statement was true or false: "All children under one year of age must be in an approved safety seat when sitting in either the front or rear seat." Overall, 86.2 percent of drivers correctly reported that this statement was true. Second, drivers judged the statement, "When sitting in the front seat, all children older than one year of age and younger than four must be in an approved safety seat." Overall, 85.1 percent of drivers correctly reported that this statement was true. Third, drivers judged the statement, "When sitting in the back seat, all children older than one year of age and younger than four must be in an approved safety seat." Only 18.4 percent of drivers correctly reported that this statement was false. Finally, drivers judged the truth of the statement, "It is safe to use a rear-facing infant seat in the front seat of a car with a passenger-side air bag." Ninety-two percent of drivers correctly reported that this statement was false. Collectively, these results show that the drivers had fairly good knowledge of Michigan's mandatory CRD use law.

CRD Misuse

The main focus of this part of the study was to identify problems people have with properly installing CRDs in vehicles and placing children in the CRDs. This was achieved through visual inspection of CRD installation and children placed in the CRDs. Two levels of misuse were identified and labeled (major and moderate misuse) based upon an assessment of how errors might contribute to injury in the event of a crash. Types of major misuse were the following:

- Placing a rear-facing infant seat in the front seat of a vehicle with an air bag
- Using an incorrect CRD for the child's weight
- Not using the CRD base (infant seats only)
- Incorrectly routing the safety belt through the CRD
- Not using the safety belt to attach the CRD to the vehicle
- Not using the CRD harness straps to restrain the child
- Having the harness straps off of the child's shoulders
- Having the harness at an incorrect position relative to the child's shoulders
- Not securing the harness buckles
- Not securing the harness ends
- Using the wrong slot for harness routing over shoulders
- Using a CRD in which the seat back is below the child's ears (CRD too small for child)
- Not using proper padding when the CRD is too big for the child

Types of moderate misuse were the following:

- Reclining the CRD at an incorrect angle
- Leaving carrying handle in upright position (infant seats only)
- Not using a safety belt locking clip
- Incorrectly using a safety belt locking clip
- Having more than three inches of sagittal CRD movement (CRD not installed tightly enough)
- Having more than three inches of sideways CRD movement (CRD not installed tightly enough)
- Not having the harness straps adequately tightened
- Not using a harness strap positioning clip
- Incorrectly using a harness strap positioning clip
- Incorrectly positioning the harness strap positioning clip

Figure 6 shows the statewide overall misuse rate for the CRDs we inspected. This rate includes all vehicles in which at least one moderate or major misuse was discovered. Overall, only 10 of the 87 drivers (11.5 percent) had both the CRD installed and child placed correctly in the vehicle. This very high misuse rate is in agreement with the results of several other studies (e.g., Bolton & Dale, 1996; Decina & Knoebel, 1996; Margolis, Wagenaar, & Molnar, 1992). We found at least one major type of misuse in 40.2 percent of the observations, with 12.6 percent having two or more major types of misuse identified. The analysis of moderate misuse showed that 48.3 percent of the sample had no major types of misuse but at least one moderate type of misuse identified, with 16.1 percent having four or more moderate types of misuse identified.

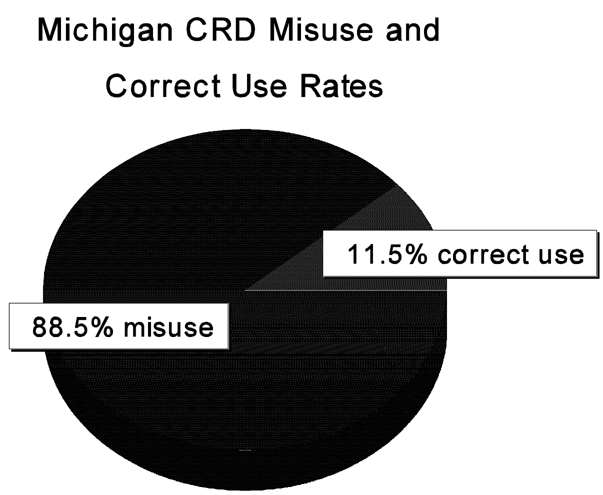

Figure 6: Michigan Child Restraint Device Misuse and Correct Use Rates

Patterns of CRD Misuse

The rate of each type of CRD misuse, by the severity of the error (major and moderate) and category of the error (placing the seat in the vehicle and placing the child in the seat), is shown in Table 7. This table reveals several interesting patterns. First, errors, regardless of severity, were more common when placing the child in the seat than when installing the seat in the vehicle. This is, perhaps, not surprising since a large majority of drivers reported that they learned to put the child in the seat without using instructions from others or the CRD manufacturer. Many reported that placing the child in seat was “obvious.” This finding suggests that educational efforts should strongly focus on the process of securing the child in the CRD, emphasizing that it may not be as self-evident as it appears. Second, certain types of misuse were quite common while others were infrequent. Generally, the most common problems were related to the tightness of fit; that is, securing the seat to the vehicle and strapping the child in the seat. Neither of these types of misuse could easily be corrected through verbal instruction. Rather, both would seem to require hands-on demonstration. Similarly, high misuse rates were found for items related to the safety belt locking clip and the harness positioning clip. Again, the proper use of both is difficult to convey through verbal means. With regard to infant seats, we found that the majority of parents left the infant-seat carrying handle inappropriately in an upright position. Finally, no CRD that we inspected was inappropriately placed rear-facing in a seat with an air bag. It appears that the recent warnings against this action have been effective.

Comparisons between high CRD misuse and low CRD misuse drivers

We were interested in determining whether drivers of vehicles in which frequent or major misuse were discovered differed in any systematic ways from the drivers where little or no misuse was discovered. Therefore drivers were grouped as either *high* CRD misuse (one or more major, or four or more moderate types of misuse) or *low* CRD misuse (three or less types of moderate misuse). The groups were compared using either analysis of variance or categorical analysis procedures to determine if they differed on driver demographics and other variables. The analyses showed that there was no difference between the high and low misuse groups on the type of vehicle, sex of driver, whether the driver reported that the seat was installed correctly, household income level, smoking or exercise habits, driver knowledge of Michigan CRD laws, driver relationship to child, who installed the CRD, how the CRD was acquired, how the driver learned to install the CRD and place the child in the CRD, driver age, or the distance and duration traveled since child was placed in the CRD. The frequency with which the CRD is removed from the vehicle approached being significant between the groups [$\div^{2}(1) = 3.37$; p=.07]. A larger proportion of the drivers in the high misuse group removed the CRD from the vehicle more than once a week while drivers in the low misuse group removed them less often. This result suggests that frequent removal of the CRD may lead to more errors in its use.

Table 7: Percent and Frequency (N) of Each Type of Misuse by Severity and Category				
Cate-gory	Misuse Severity	Description	%	N
Placing CRD in Vehicle	Major	Rear-facing infant seat in front of air bag	0.0	0
		Using an incorrect CRD for the child's weight	2.3	2
		Not using the CRD base (infant seats only)	14.3	2
		Incorrectly routing the safety belt through the CRD	14.9	13
		Not using the safety belt with CRD	0.0	0
		People making at least one major mistake placing CRD in vehicle	**17.2**	**15**
	Moderate	Reclining the CRD at an incorrect angle	1.1	1
		Not using a safety belt locking clip	25.3	22
		Leaving carrying handle in upright position (infant seats only)	57.1	8
		Incorrectly using a safety belt locking clip	5.7	5
		More than 3 inches of sagittal CRD movement	24.1	21
		More than 3 inches of sideways CRD movement	48.3	42
		People making at least one moderate mistake placing CRD in vehicle	**62.1**	**54**
	People making at least one mistake placing CRD in vehicle		**65.5**	**57**
Placing Child in CRD	Major	Not using the harness straps to restrain the child	4.6	4
		Having the harness straps off of the child's shoulders	1.1	1
		Harness at an incorrect position relative to shoulders	27.6	24
		Not securing the harness buckles	2.3	2
		Not securing the harness ends	1.1	1
		Using the wrong slot for harness routing	8.0	7
		CRD seat back is below the child's ears	1.1	1
		Proper padding not being used	1.1	1
		People making at least one major mistake placing child in CRD	**32.2**	**28**
	Moderate	Having the harness straps loosely fitted	56.3	49
		Not using a harness strap positioning clip	3.4	3
		Incorrectly using a harness strap positioning clip	23.0	20
		Incorrectly positioning harness strap positioning clip	48.3	42

		People making at least one moderate mistake placing child in CRD	**73.6**	**64**
	People making at least one mistake placing child in CRD		**75.9**	**66**

We discovered a significant difference between misuse groups on the age of the child who participated in the study [$t(1) = 6.27$; $p<.02$]. The average age of the children whose driver was in the low misuse group was 24.5 months, while the average age of child whose driver was in the high misuse group was 17.8 months. Of the 14 infant CRDs observed in the study only 4 were with drivers in the low misuse group. Thus, it is the youngest children we observed who tend to be improperly placed in CRDs and/or in CRDs that are improperly installed in the vehicle. A similar finding is reported by Margolis, Wagenaar, and Molnar (1992). This result is consistent with the facts that it is more difficult to install an infant CRD than other types of seats, there are more items to remember to do correctly, and it is difficult to find a seat of the proper size for the youngest children. The finding may also highlight the fact that many infants are too small to fit properly in a convertible CRD. Another factor that may contribute to higher misuse with younger occupants is lack of experience. Over time, parents may get better at properly installing CRDs. If so, this would suggest that new parents should get CRD training before or soon after their child is born.

We found that drivers in the two groups differed significantly in the level of educational attainment [$\div^2(2)=10.68$; $p<.005$]. Drivers in the high misuse group reported lower education levels than driver in the low misuse group. Since most drivers reported that they learned to install the CRD by reading the instructions that were provided by the CRD manufacturer, it is not surprising that those with lower educational levels had more difficulty with the CRDs. Drivers with a high educational level may also have greater access to information about correct CRD use (e.g., Internet WWW pages). This result suggests that hands-on educational programs may be effective in increasing the proper use of CRDs and that information programs should be available in a wide variety of media and locations.

Finally, we found that the two groups differed significantly in their employment status [$\div^2(1)=4.04$; $p<.05$]. There was a greater tendency for drivers in the low misuse group to be housewives or househusbands than drivers in the high misuse group who had a greater tendency to be employed either full- or part-time. We can offer no definitive explanation for this result, however it may suggest that employed drivers were more rushed than nonemployed drivers and spent less time ensuring correct CRD installation and placement of children in the CRD.

DISCUSSION

The estimated, statewide, child restraint device use rate for children under the age of four is 74.5 percent. This use rate shows that Michigan has a significant portion of its population under the age of four not using child restraint devices. The study identified several subgroups of the population with low CRD use. Targeting enforcement and public information and education (PI&E) programs at these subgroups would likely be effective in raising the CRD use rate. One of these subgroups included the counties contained in stratum three where CRD use was the lowest in the state: Berrien, Calhoun, Genesee, Lapeer, Lenawee, Marquette, Monroe, Muskegon, Saginaw, Shiawassee, St. Clair, St. Joseph, and Van Buren. We also found CRD use to be low in vehicles driven by males and in vehicles driven by unbelted drivers. Since male drivers have consistently lower safety belt use than female drivers in Michigan (see Eby & Christoff, 1996), this result suggests that CRD use may closely parallel safety belt use. If so, efforts to increase safety belt use should also be effective for increasing the frequency with which CRDs are used.

The pilot study of CRD misuse found that nine out of ten children under the age of four are either in CRDs that are installed incorrectly or are improperly placed in the CRD. The statewide CRD misuse rate of 88.5 percent, while not surprising, shows that great strides still need to be made to ensure the safety of children traveling in motor vehicles.

Through driver interviews, we found that most drivers were the parent of the child in the CRD inspected, most CRDs were purchased rather than received as a loan or gift, most drivers learned to install the CRD by reading manufacturer instructions, most drivers simply “figured out” how to put the child in the CRD, CRDs were usually kept in vehicles rather than being moved about, and drivers had fairly detailed and accurate knowledge of Michigan’s mandatory child restraint use law.

The analysis of type of misuse showed that people have greater difficulty in properly placing the child in the CRD than in installing the CRD in the vehicle. This is, perhaps, not surprising since most people do follow instructions for this task. This finding suggests that educational efforts should focus strongly on this component of CRD use (noting that the process is not self-evident) and that CRD manufacturers should include more detailed information on the proper placement of children in CRDs. We also found that the most common problems with CRD use were related to snugness of fit. People had difficulty installing the CRD tightly in the vehicle and in tightening the harness strap adequately on their children. The former is understandable. Because of seat padding and some vehicle designs, it can be difficult or impossible to tightly attach the CRD. This suggests that parents should check on CRD and vehicle design compatibility before purchasing a CRD or vehicle. On the other hand, the harness strap is fairly easy to use and to tighten. It may be that parents are reluctant to tighten the harness so tightly that their children cannot move about. CRD PI&E programs should highlight the dangers of not adequately securing the child in the seat.

Other common types of misuse were related to the use of the safety belt locking clip and the harness positioning clip. The safety belt locking clip helps to prevent the safety belt from unreeling during a crash in vehicles without an automatic locking retractor for the safety belts (most vehicles fit into this category). The positioning clip is designed to keep the harness straps in the proper position on the child's body. Both clips are difficult to learn how to use, especially through verbal instruction (i.e., either written or spoken instruction). Therefore, PI&E programs that focus on hands-on demonstration of the proper use of clips would probably be the most effective means for training parents on proper CRD use.

As a way of better understanding who may benefit the most from CRD use programs, we compared drivers with high CRD misuse to drivers with low CRD misuse. These two groups of drivers were quite similar except that drivers with high misuse tended to remove the CRD from the vehicle more than once per week, to have younger children, to have lower education levels, and were more likely to be employed full or part time rather than being a housewife or househusband.

In conclusion, the study provides a starting point for the statewide assessment of child occupant protection in Michigan. Several factors were identified that should prove beneficial in the design and targeting of both enforcement and PI&E programs. The misuse portion of the study, while only a pilot test, showed the marked problems associated with CRD use and provided tantalizing findings that could be invaluable for constructing educational programs to improve proper use of CRDs. A full-scale version of the misuse study would allow us to make strong conclusions about child restraint device use statewide.

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APPENDIX A

CRD Use Data Colletion Forms

SITE DESCRIPTION FORM

SITE # __ __ __ SITE NAME ______________________________
1 2 3

DATA TYPE	SITE TYPE	SITE CHOICE	DATE (month/day/year)
1G Use	1G Pediatric Clinic	1G Primary	___ ___/___ ___/1997
2G Misuse	2G Family Practice Center	2G Alternate	7 8 9 10
3G Both	3G Child Day Care Center	6	
4	5		

OBSERVER	DAY OF WEEK	WEATHER
1G Mark	1G Monday	1G Mostly Sunny
2G Not used	2G Tuesday	2G Mostly Cloudy
3G Scott	3G Wednesday	3G Rain
4G Dave	4G Thursday	4G Snow
5G Michelle	5G Friday	13
6G Carl	12	
7G Lidia		
8G Lisa		
11		

START TIME: __ __:__ __ (24 hr clock) END TIME: __ __:__ __ (24 hr clock)
14 15 16 17 18 19 20 21

INTERRUPTION (total number of minutes during observation period): __ __
22 23

COMMENTS & SITE SKETCH:

CRD USE OBSERVATION FORM **ATTENTION CODING: DUPLICATE COL 1 - 4 FOR EACH VEHICLES**

SITE # ___ ___ ___ (1 2 3) OBSERVER NO. ________ (4) PAGE #________

VEHICLE NO. 1

	DRIVER	CENTER	RIGHT
BELT USE	1G Not belted 2G Belted 3G B Back 4G U Arm 5	CRD 0G No 1G Yes 6	1G Not belted 2G Belted 3G B Back 4G U Arm 5G CRD 7
SEX	1G Male 2G Female 8	1G Male 2G Female 9	1G Male 2G Female 10
AGE	1G 0 - 3 2G 4 - 15 3G 16 - 29 4G 30 - 59 5G 60+ 11	NO DATA	1G 0 - 3 2G 4 - 15 3G 16 - 29 4G 30 - 59 5G 60+ 12
	~~~~~~~~~~~~~~2ND ROW~~~~~~~~~~~~~~		
	LEFT	**CENTER**	**RIGHT**
BELT USE	CRD 0G No 1G Yes 13	CRD 0G No 1G Yes 14	CRD 0G No 1G Yes 15
SEX	1G Male 2G Female 16	1G Male 2G Female 17	1G Male 2G Female 18
	~~~~~~~~~~~~~~3RD ROW~~~~~~~~~~~~~~		
	LEFT	**CENTER**	**RIGHT**
BELT USE	CRD 0G No 1G Yes 19	CRD 0G No 1G Yes 20	CRD 0G No 1G Yes 21
SEX	1G Male 2G Female 22	1G Male 2G Female 23	1G Male 2G Female 24
VEHICLE TYPE	1**G** Passenger car 2**G** Van 3**G** Utility 4**G** Pick-up 25		

VEHICLE NO. 2

	DRIVER	CENTER	RIGHT
BELT USE	1G Not belted 2G Belted 3G B Back 4G U Arm 5	CRD 0G No 1G Yes 6	1G Not belted 2G Belted 3G B Back 4G U Arm 5G CRD 7
SEX	1G Male 2G Female 8	1G Male 2G Female 9	1G Male 2G Female 10
AGE	1G 0 - 3 2G 4 - 15 3G 16 - 29 4G 30 - 59 5G 60+ 11	NO DATA	1G 0 - 3 2G 4 - 15 3G 16 - 29 4G 30 - 59 5G 60+ 12
	~~~~~~~~~~~~~~ 2ND ROW~~~~~~~~~~~~~~		
	LEFT	**CENTER**	**RIGHT**
BELT USE	CRD 0G No 1G Yes 13	CRD 0G No 1G Yes 14	CRD 0G No 1G Yes 15
SEX	1G Male 2G Female 16	1G Male 2G Female 17	1G Male 2G Female 18
	~~~~~~~~~~~~~~3RD ROW~~~~~~~~~~~~~~		
	LEFT	**CENTER**	**RIGHT**
BELT USE	CRD 0G No 1G Yes 19	CRD 0G No 1G Yes 20	CRD 0G No 1G Yes 21
SEX	1G Male 2G Female 22	1G Male 2G Female 23	1G Male 2G Female 24
VEHICLE TYPE	1**G** Passenger car 2**G** Van 3**G** Utility 4**G** Pick-up 25		

APPENDIX B

Day Care Center Participation Request Letter

Dear

Very little is known about how people use child safety seats to restrain child passengers in vehicles. This is surprising since automobile accidents are the leading cause of death and injury for children. In 1994 nearly 87,000 children under the age of five were injured or killed in traffic crashes across the United States, with 2,336 of these injuries and fatalities occurring in Michigan. The use of child restraint devices has been identified as an effective means for reducing trauma in a traffic crash. Unfortunately, many people report having a difficult time properly installing child safety seats in their vehicles.

In order to design programs to teach people the proper use of child safety seat, we first need to know the types of errors people make when installing the seats. In an effort to better understand these errors, the Michigan State Police Office of Highway Safety Planning has asked us to conduct a statewide survey of child safety seat use and misuse.

The statewide survey involves us going to a randomly-selected set of child care centers, where the concentration of children in cars is high, and inspect where and how the seat is placed in the car and how the child is placed in the seat. Your child care center has been selected as one of the survey sites and we are writing to ask your permission to conduct the survey on a single day over a two-hour period some weekday morning this summer.

The survey has the following characteristics:

ž It will be completely voluntary and will not disrupt traffic flow or parking. People with at least one child in a safety seat will be asked if they wish to participate in the survey as they park their vehicle. The actual survey of a vehicle will only last about fiveminutes. The survey should not disrupt your normal operations.

ž Those who participate will be compensated. All children in the vehicle will get a small stuffed animal. The driver will get our inspection results, information about proper use and recalls, and a child safety seat identification sticker to help identify children in vehicle crashes.

ž Your center will be compensated. We will provide you with a summary of the survey results and with information on the most common kinds of misuse which you can copy and provide to your parents.

ž The survey will be conducted by highly trained research staff. We have been involved in statewide occupant protection surveys since 1984. Every person on my research team will have received weeks of training and practice prior to conducting the survey. If there is a problem or you are unhappy with the conduct of the survey, we will discontinue it.

Before beginning the survey our staff will locate the site manager and show their UM staff identification cards, which includes their picture, and a letter of support from the Michigan State Police Office of Highway Safety Planning. A copy of this letter is included.

Finally, as much as is possible, we would like you to keep the purpose of this survey as confidential as you can. It is important to minimize the effect of performing the survey on the use of child safety seats among your parents. This will allow us to gather more accurate information on current use and misuse patterns and to generalize the results to other areas in the state where the survey is not conducted. It would be most helpful if you would just say that the University of Michigan Transportation Research Institute will be conducting a traffic safety survey and that this is being done with the permission and support of your board.

We will contact you soon to answer any questions you have about this survey. At this time we would also like to confirm your hours and days of operation, whether your operation is for the school year or full year, and if you have any scheduled closings between May 1 and July 31.

(*Contact numbers given)*

Sincerely,

David W. Eby, Ph.D.
Project Director
Michigan Child Safety Seat Survey

APPENDIX C
CRD Misuse Data Collection Forms

CRD DRIVER INTERVIEW

SITE # __ __ __ (1 2 3) SITE NAME ______________________________

OBSERVATION NO. ___ ___ (4 5) OBSERVER NAME ______________________________

VEHICLE TYPE	AIRBAGS IN VEHICLE		*FREQ. OF VEHICLE USE*	INSTALLED CORRECTLY
1G Passenger car 2G Van 3G Utility 4G Pick-up 6	Driver side 0G No 1G Yes 8G DK 9G 7	Passenger side 0G No 1G Yes 8G DK 9G 8	1G 1 - 25% 2G 26% - 50% 3G 51 - 75% 4G 76 - 100% 9G 9	0G No 1G Yes 8G DK 9G 10

TARGET CHILD			
RELATION TO CHILD	AGE	EST. WEIGHT	GENDER
1G Parent 2G Other family 3G Friend 4G Other 9G 11	_____ yrs. _____ _____ mo 12 13 14	____ ____ pounds 15 16	1G Male 2G Female 9G 17

CHILD RESTRAINT DEVICE INFORMATION					
HOW SEAT ACQUIRED	WHO INSTALLED CRD	KNOWLEDGE TO INSTALL CRD	WHO INSTALLED CHILD	KNOWLEDGE TO INSTALL CHILD	*REMOVED FROM VEHICLE*
1G Self 2G Other family 3G Hospital 4G Gift 5G w/Vehicle 6G Integrated 7G Other 8G Don't know 9G 18	1G Self 2G Other family 3G Friend 4G Other 5G Integrated 8G Don't know 9G 19	1G Instructions 2G Figured it out 3G Other family 4G Friend 5G Other 6G Integrated 8G Don't know 9G 20	1G Self 2G Other family 3G Friend 4G Other 8G Don't know 9G 21	1G Instructions 2G Figured it out 3G Other family 4G Friend 5G Other 8G Don't know 9G 22	1G Less than once/week 2G Once/week 3G Several times /week 4G Daily 5G Integrated 8G Don't know 9G 23

Time since child was put in seat: _____ _____ minutes 24 25	Distance since child was put in seat: _____ _____ mi. 26 27	Date seat was acquired (month/year) _____ _____ / _____ _____ 28 29 30 31

We would like to know how much people know about Michigan's current child restraint law. Please answer the following questions true or false.

All children under 1 year old must be in an approved safety seat when sitting in either the front or rear seat.	1**G** True 2**G** False 8**G** Don't know 9**G** 32
When sitting in the <u>front seat,</u> all children older than 1 and younger than 4 must be in an approved safety seat.	1**G** True 2**G** False 8**G** Don't know 9**G** 33
When sitting in the <u>rear seat,</u> all children older than 1 and younger than 4 must be in an approved safety seat.	1**G** True 2**G** False 8**G** Don't know 9**G** 34
It is safe to use a rear-facing infant seat in the front seat of a car with a passenger side air bag.	1**G** True 2**G** False 8**G** Don't know 9**G** 35

Finally, we would like a little information about you.

DRIVER INFORMATION					
<u>MARITAL STATUS</u>	**EDUCATION**	**GENDER/ AGE**	***<u>HEALTH HABITS</u>***	***<u>EMPLOYMENT</u>***	***<u>HOUSEHOLD INCOME</u>***
1**G** Married 2**G** Divorced 3**G** Widow/er 4**G** Single 5**G** Partners 6**G** Other 9**G** 36	1**G** < HS 2**G** HS/GED 3**G** Some coll. 4**G** Bachelor 5**G** Some grad 6**G** Graduate 9**G** 37	What is your gender? 1**G** Male 2**G** Female 38 What is your age? ____ ____ yrs. 39 40	Do you exercise for 30 minutes or more at least 3 times a week? 1**G** Yes 2**G** No 9**G** 41 Do you currently smoke tobacco? 1**G** Yes 2**G** No 9**G** 42	1**G** Full time 2**G** Part time 3**G** Student 4**G** Retired 5**G** Housewife/ househusband 6**G** Other 9**G** 43	1**G** > $50k 2**G** > $35k 3**G** > $25K 4**G** > $15K 5**G** > $5K 6**G** < $5K 8**G** Don't know 9**G** 44

CRD DATA COLLECTION FORM

SITE # __ __ __ (1 2 3) SITE NAME ____

OBSERVATION NO. ___ ___ (4 5) OBSERVER NAME ____

SAFETY SEAT MANUFACTURER			MODEL NAME/NUMBER
01G Century Products 02G Cosco 03G Evenflo 04G Fisher-price 05G Gerry Baby Prod. Cols. 6-7	06G Graco 07G Kolcraft Enterprises 08G MCP Enterprises 09G Playskool 10G Renolux	11G Strolee 12G Virco 13G Volvo 14G World Toy Discount 15G Other____________ 16G Don't know	____________________ - 01G 02G 03G Don't know 8

SEAT INFORMATION					
LOCATION	TYPE	***INFANT SEAT ONLY***		DIRECTION	ANGLE OF RECLINE
1G Front center 2G Front right 3G 2nd row-right 4G 2nd row-center 5G 2nd row-left 9	1G Infant 2G Convertible 4G Toddler 5G Booster 6G Integrated 7G Non-CRD 10	BASE 1G Appropriate 2G Not Approp. 3G NA 11	HANDLE 1G Correct 2G Incorrect 3G NA 12	1G Forward 2G Rearward 13	1G Less than 40 deg. 2G 40 deg. to upright 14

VEHICLE SAFETY BELT DATA			SAFETY SEAT MOVEMENT	
BELT TYPE	BELT ROUTING	LOCKING CLIP	FORE-AFT	SIDE-SIDE
1G Manual 2G Automatic 3G Integrated 15	1G Incorrect 2G Correct 3G Integrated 16	1G Not recommended 2G Recomm., not used 3G Recomm., used incorrectly 4G Recomm., used correctly 5G Integrated 17	1G Belt not used 2G 3" or less 3G More than 3" 4G Integrated 18	1G Belt not used 2G 3" or less 3G More than 3" 4G Integrated 19

HARNESS STRAP DATA						
STRAPS	TYPE	FIT	HARNESS HEIGHT	BUCKLES SECURE	ENDS SECURE	SLOT USED
1G Used 2G Not used 3G Not present 20	1G 3 pt. 2G 3 pt. w/T-bar 3G 3 pt. w/shield 4G 5 pt. 5G Not present 21	1G Off shoulders 2G Loose 3G Snug 4G Not present 22	1G Above shoulder 2G At shoulder 3G Below shoulder 4G Not present 23	0G No 1G Yes 2G Not present 24	0G No 1G Yes 2G Not present 3G DK 25	1G Top 2G Bottom 3G Other 4G Not present 26

SAFETY CLIP DATA			SEAT BACK HT.	PADDING
1G Used 2G Not used 3G NA 27	1G Fastened correctly 2G Fastened incorrectly 3G NA 28	1G At armpit level 2G Not at armpit level 3G NA 29	1G At/above ears 2G Below ears 30	1G Not recommended 2G Recomm., present 3G Recomm., not present 31

OTHER COMMENTS:

APPENDIX D
Calculation of CRD Use Rates, Variances, and Confidence Bands

The statewide CRD use rate was estimated from the separate statewide CRD use estimates from the two types of sites observed in this study-child care and pediatric medical centers. Because these two types of sites differed in how often and when they were visited by target-age children, the two were sampled separately using different sampling schemes.

Child care centers

Observation times at child care centers were set to capture the peak periods of arrivals or departures, which in essence caught all or most of the children coming to that center on the given day. We assume that the observations at each site are nearly a census of that site (i.e., everybody but that day's absentees). For each stratum, there are N possible sites within a stratum, of which n are sampled. This results in a one-stage cluster sampling design. At each sample site i, x_i children are observed, of which y_i are in CRDs.

The estimates of the totals were:

$$\hat{x} = \frac{N}{n} \sum_{i=1}^{n} x_i$$

$$\hat{y} = \frac{N}{n} \sum_{i=1}^{n} y_i$$

A nearly unbiased estimate of the proportion of children in CRDs was:

$$\hat{R} = \frac{\hat{y}}{\hat{x}}$$

The estimate of the variance was:

$$Var(\hat{R}) = \frac{1}{\hat{x}^2} \left[\frac{N(N-n)}{n} \times \frac{\sum_{i=1}^{n} (y_i - \hat{R} x_i)^2}{n-1} \right]$$

Pediatric medical centers

Although the number of hours of observation at child care centers and pediatric medical centers were similar, the patterns of arrivals and departures were different. Arrivals and departures at pediatric medical centers were spread over the hours of operation and only a portion of the children coming to those centers on the study day was observed. This amounts to a two-stage cluster sample, where the first stage is the site and the second stage is a time interval. However, at the second stage only one sample was taken. As such, part of the variance cannot be estimated precisely. This estimate of variance was approximated by splitting each observation period into two halves and treating each half as a cluster. This was not exact because values for two contiguous periods are probably correlated and we could not split the observation periods into equal duration intervals since this information was not available. Instead, since observations were recorded serially, observations were split into two equal contiguous parts. Using this procedure we found that the variance associated with second stage of sampling was quite small.

There are N sites (first stage clusters) of which n were sampled. Each first stage cluster *i* has M_i second stage clusters (i.e., time periods). For the simplified treatment, we assumed all M_i to be equal, $M_i = M = 8$, where the second stage clusters are one-hour intervals. From these, a sample of m_j clusters is drawn. As an approximation we assume $m = m_j = 2$, an observation period of two hours consisting of two clusters of one hour. At cluster *i*, secondary cluster *j* (i.e., at site *i*, hour *j*), a total of x_{ij} target-aged children are observed of whom y_{ij} are in CRDs. The equations used for the extrapolations to each primary cluster were:

$$\hat{x}_i = \frac{M}{m} \sum_{j=1}^{m} x_{ij}$$

$$\hat{y}_i = \frac{M}{m} \sum_{j=1}^{m} y_{ij}$$

and those to the total population were:

$$\hat{x} = \frac{N}{n}\sum_{i=1}^{n}\hat{x}_i$$

$$\hat{y} = \frac{N}{n}\sum_{i=1}^{n}\hat{y}_i$$

A nearly unbiased estimate of the CRD use ratio was calculated using the following:

$$\hat{R} = \frac{\hat{y}}{\hat{x}}$$

and the variance estimate was calculated using the following:

$$Var(\hat{R}) = \frac{1}{\hat{x}^2}\left[\frac{N(N-n)}{n}\times\frac{\sum_{i=1}^{n}(\hat{y}_i - \hat{R}\hat{x}_i)^2}{n-1}\right] + \frac{1}{\hat{x}^2}\left[\frac{N}{n}\times\sum_{i=1}^{n}\frac{M(M-m)}{m}\times\frac{1}{m-1}\sum_{j=1}^{m}[(y_{ij}-\hat{R}x_{ij})-(\hat{y}_i-\hat{R}\hat{x}_i)]^2\right]$$

The first term in this equation accounted exactly for the variance of the first stage of sampling. Since there were only two clusters at the second sampling stage, the second term in the above equation was simplified to:

$$\frac{N}{\hat{x}^2 n}\sum_{i=1}^{n}\tfrac{1}{2}\left[(y_{i2}-y_{i1})-\hat{R}(x_{i2}-x_{i1})\right]^2$$

Combining the Strata

For each type of site the statewide CRD use rate was calculated using the following equation:

$$\hat{R} = \frac{\sum_{i=1}^{4} \hat{R}_i P_i}{\sum_{i=1}^{4} P_i}$$

where R_i was CRD use estimate for stratum *i* and P_i was the population of target-age children in stratum *i*. The variance was calculated by the following:

$$Var(\hat{R}) = \frac{\sum_{i=1}^{4} Var(\hat{R}_i) P_i^2}{\left(\sum_{i=1}^{4} P_i\right)^2}$$

Combining the two site types for a statewide estimate of CRD use

The estimates for child care and pediatric medical centers were combined using the following:

$$\hat{R}_{all} = \left(\frac{\hat{R}_{childcare}}{Var(\hat{R}_{childcare})} + \frac{\hat{R}_{pediatric}}{Var(\hat{R}_{pediatric})} \right) \div \left(\frac{1}{Var(\hat{R}_{childcare})} + \frac{1}{Var(\hat{R}_{pediatric})} \right)$$

The variance for the statewide use estimate was calculated using:

$$Var(\hat{R}_{all}) = \frac{1}{\frac{1}{Var(\hat{R}_{childcare})} + \frac{1}{Var(\hat{R}_{pediatric})}}$$

Confidence bands for the statewide estimate were calculated with the following:

$$95\%\, Confidence\, Band = \hat{R}_{all} \pm 1.96\sqrt{Var(\hat{R}_{all})}$$

Finally, the relative error or precision of the estimate was computed using the formula:

$$Rel\, Err = \frac{Var(\hat{R}_{all})}{\hat{R}_{all}}$$

Federal guidelines for statewide safety belt surveys stipulate that the relative error of the statewide estimate should be less than five percent (NHTSA, 1992).