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CHILD SAFETY SEAT USE IN MICHIGAN

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16. Abstract

When properly restrained in an age-appropriate child safety seat (CSS), the risk of fatality for children is reduced by up to 71 percent. In 2000, there were 41,821 traffic fatalities throughout the nation with 2,373 of these fatalities occurring in children ages 14 and under. If CSSs were used 100 percent of the time in the year 2000, it is estimated that they could have saved the lives of 458 children. The use of CSSs has been identified as an effective means of reducing the incidence of death and trauma incurred by young vehicle occupants involved in crashes. The primary purpose of the project reported here was to determine accurately a statewide CSS use-rate through a direct-observation survey of children at pediatric medical and day care centers.

The study showed that 85.5 ± 2.6 percent of children under four years of age in Michigan were restrained in a CSS when traveling in a motor vehicle. CSS use rates were highest in vehicles driven by a belted driver, females, and drivers between the ages of 30 and 59. When compared to a similar study conducted in 1997, CSS use has increased across all categories. The study also showed that compared to 1997, unbelted drivers are increasingly more apt to restrain child occupants.

Although determining CSS use is a crucial part in the study of child passenger safety, it may not capture the entire traffic safety picture for children. Determining why CSSs are not being utilized and how they are being misused would provide critical information for more targeted Public Information and Education programs (PI&E).

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INTRODUCTION

The use of an occupant restraint system provides considerably increased protection against injury or death to individuals involved in crashes. The fatality rate for children involved in motor vehicle crashes is significantly reduced when they are properly restrained in child safety seats (CSS). Research indicates that the risk of death decreases by 71 percent for infants under one year and by 54 percent for children ages one to four when restrained in an age-appropriate CSS (National Highway Traffic Safety Administration, NHTSA, 2000). In 2000, there were 41,821 traffic fatalities throughout the nation with 2,373 of these fatalities occurring in children ages 14 and under (NHTSA, 2000) and 10 fatalities occurring in children aged four and under in the state of Michigan (M.H. Eschman, personal communication, October 30, 2001). If all child occupants under the age of five were restrained in a child safety seat 100 percent of the time, it is estimated that in 2000, 458 lives could have been saved (NTHSA, 2000). The proper use of child safety seats has been identified as the most effective means of reducing trauma incurred by young vehicle occupants involved in crashes.

In order to reduce the number of vehicle occupants under four years of age injured or killed in motor vehicle crashes, all 50 states and the District of Columbia have enacted child occupant protection laws. These laws vary widely with regard to age requirements and enforcement procedures (Insurance Institute for Highway Safety, 2001). Michigan implemented its own mandatory child restraint use law in April, 1982 and revised it in 2000. According to this law, Michigan Vehicle Code 257.710d, all children under the age of four traveling in a motor vehicle must be restrained in a child safety seat.

In the nineteen years since the law was implemented, only one direct-observation survey of statewide CSS use has been conducted in Michigan (Eby, Kostyniuk, Christoff, 1997). In this study, the authors found that although most drivers were aware of Michigan's mandatory CSS use law, only about 75 percent of children under 4 years of age were restrained in a CSS. Studies around the nation show that parents and drivers of unrestrained children cite many reasons for non-use including circumstances of the trip (i.e. left CSS in another vehicle), child's behavior, hassle of having a CSS in the vehicle, difficulty in installing a CSS, and problems with fitting multiple seats in one vehicle (Agran,

Winn, & Anderson, 1999; Ramsey, Simpson, & Rivara, 2000). NHTSA has recently made significant advances designed to increase the use of CSSs by establishing a universal child restraint anchorage system which will provide a standard attachment system for installing a CSS in all vehicles (NHTSA, 1999).

The effectiveness of Michigan's child restraint use law was investigated by Wagenaar and colleagues in several studies (Wagenaar, 1984; Wagenaar & Webster, 1985; Wagenaar & Maybee, 1986). In these studies, CSS use and its effects on injury to passengers under 4 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, CSS use increased from about 15 percent to 56 percent, while restraint use in other age groups showed little change. Wagenaar and colleagues also found a corresponding 27 percent reduction in child injuries. While these studies are interesting and informative, gathering CSS use from crash reports can be problematic. For example, CSS 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. Furthermore, NHTSA (1998) has found that roughly 4 percent of respondents who indicated they always restrain their child in a CSS, later reported that they had not properly restrained their child within the past day or week. A direct-observation survey, where CSS use is actually observed, would not have these biases.

Direct observation of statewide restraint use for all ages has been investigated regularly by UMTRI since 1984. However, CSS use for those under the age of 4 cannot be adequately derived from these surveys because too few passengers in this age group are seen in any randomly selected traffic stream. For example, in the most recent direct observation survey of Michigan restraint use (Eby, Fordyce, & Vivoda, 2000), only 13 of the 14,366 occupants observed (less than 1 percent) were judged to be under the age of 4 (54 percent of these children were restrained in a CSS). Thus, in order to determine accurately a statewide CSS use rate, a direct-observation survey designed specifically for this purpose is necessary. This was the primary purpose of the project. A secondary purpose of the study was to compare the use rates found in the present study to those found in a similar study conducted 4 years ago (Eby, Kostyniuk, & Christoff, 1997; Eby & Kostyniuk, 1999).

METHODS

Sample Design

The sample design was identical to the one used in Eby, Kostyniuk, and Christoff (1997; see also Eby & Kostyniuk, 1999). While the entire sampling procedure is presented in the previous report, it is repeated here for completeness.

The goal of this sample design was to select observation sites which represent accurately all Michigan children under four years of age. An ideal sample minimizes total survey error while providing sites that can be surveyed both 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, 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 CSS use. 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, Fordyce & Vivoda, 2000).

The 28 counties were then separated into four strata. Table 1 shows the counties contained in each stratum. Each stratum was constructed by obtaining historical safety 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 previously been shown to correlate positively with belt

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

use (e.g., Wagenaar, et al., 1987). Wayne County was chosen as a separate stratum because of the disproportionately high vehicle miles of travel (VMT) and because we wanted to ensure that observation sites were selected within Wayne County. Three other strata were constructed through 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 safety 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. 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

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 CSS use (e.g., see Margolis, Wagenaar & Molnar, 1992). The estimated number of children per observation period was based upon pilot testing.

A fundamental difficulty in surveying CSS use in a statewide sample is selecting observation sites where target-age children are concentrated, while minimizing 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 sites 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, every medical pediatric center in the 28 counties was included in the sample space. The second 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. 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 randomly selected. Ten of the sites were chosen randomly from all identified pediatric facilities in the stratum and 12 were selected from all identified day care centers. The 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.

After determining when sites were open and active, the day of week and time of day for CSS observations was randomly assigned. 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 demonstrated in this table, the sites were fairly well distributed over days of the week and time of observation. 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	12.5%	6-8 AM	17.1%	Primary 95.5%		Sunny	36.3%
Tuesday	19.3%	8-10 AM	19.2%	Alternate 4.5%		Cloudy	48.9%
Wednesday	23.9%	10-12 PM	15.9%			Rain	14.8%
Thursday	22.7%	12-2 PM	18.2%				
Friday	21.6%	2-4 PM	12.5%				
		4-5 PM	17.1%				
TOTAL	100%		100%		100%		100%

Data Collection Procedures

Data collection involved direct observation of vehicles in which at least one occupant was under the age of four. For these vehicles, CSS use for all children under four years of age in the vehicle was recorded. In addition, driver age, sex, and shoulder belt use were recorded. This same data were collected on adult front right passengers if present. 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 commercial or other types of vehicles were not included in the survey.

Data Collection Forms: Two forms were used for the data collection process: 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 center or day care), observer number, date, day of week, time of day, and weather. A place on the form was also provided for observers to sketch the parking area and to identify observation locations and traffic flow patterns. Finally, a comments section was made available for observers to identify landmarks that might be helpful in characterizing the site and to discuss problems or issues relevant to the site.

The second form, identified as the observation form, was used to record driver and front right passenger restraint use, sex, and age. CSS use of all children under the age of four, seating location, and vehicle information was also recorded (see Appendix A). Each observation form was divided into two sections, with each section of sufficient size

to record data for a single vehicle. Drivers and passengers observed with their shoulder belt worn under the arm or behind the back were identified as such. Target-age children placed improperly in a CSS were recorded as being in a CSS. At each site, the observer carried a sufficient amount of data-collection forms and completed as many observations as possible for the duration of the observation period.

Procedures at Each Site: All sites in the sample were visited by a team of two observers. Observation periods for medical centers lasted one and one half hours while the observation times for day care centers lasted 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 a randomly selected alternate site. Otherwise, observers completed the site description form and proceeded to the observation position at the entrance or exit of the site. If a site had more than one entrance, observers positioned themselves at different driveways and observed vehicles entering the site. When observing day care centers in the evening, observers typically recorded observations of vehicles exiting the site.

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, front right passenger, 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. When the site had only one driveway, both observers stood together and observed vehicles either entering or exiting the site. In order to ensure that a vehicle was not recorded twice, observers verbally identified which vehicle was to be observed.

Observer Training

Prior to data collection, field observers participated in three days of intensive training including classroom review of CSSs, proper CSS identification, data collection procedures, 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 the date and time each site was to be observed.

The training was conducted in two parts. The first phase involved a complete review of the training manual, including the administrative policies and procedures, a review of the data-collection forms, and other general procedures.

The second part of training involved practice data collection and inter-observer reliability checking. Practice data collection was performed at sites chosen to represent the types of sites and situations that would be encountered in the field. None of the day care or medical centers chosen for this phase of training included actual sites used in the study. At each practice site observers focused on properly completing the site description form, determining observer position and entrances to observe, identifying vehicles with target-age children, recording restraint use and type of restraint, and estimating age and sex. Once all observers were comfortable with both data collection forms, they were tested for inter-observer reliability. Observers worked in teams of two, observing the same vehicles, but recording data independently on separate data-collection forms. The forms were then compared for accuracy. Teams were rotated throughout the training to ensure that each observer was paired with every other observer at least two times. Each observer pair practiced recording the information for each data-collection form until there was an inter-observer reliability of at least 85 percent on all measures.

Each observer was equipped with an atlas of Michigan county maps and all necessary field supplies. Observers were given time to mark their assigned sites on the appropriate maps and plan travel routes to the sites. Field procedures were reviewed once again and observers were informed that unannounced site visits would be made by the field supervisor during data collection to ensure adherence to study protocols.

Observer Supervision and Monitoring

On at least two occasions throughout the data collection process, the field supervisor performed unannounced site checks. Contact between the field supervisor and

field staff was also maintained on a regular basis through staff visits to the UMTRI office to drop off completed forms and through telephone calls from staff to report progress and discuss problems encountered in the field. Field staff were instructed to call the field supervisor at home if problems arose before or after business hours.

Data Processing and Estimation Procedures

Information from the site description and observation forms were entered into an electronic format. 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. Errors were corrected after consultation with the original data forms. Data were analyzed using the Statistical Analysis System (SAS) package.

As previously discussed, observations were made at two different types of sites (day care and medical centers) 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 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 CSS 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 CSS 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 B.

RESULTS

Overall Child Safety Seat Use

As shown in Figure 1, the estimated child safety seat use rate for the state of Michigan was 85.5 ± 2.6 percent for all children under the age of four traveling in passenger cars, sport utility vehicles, van/minivans, and pickup trucks during June of 2001.[2] 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 CSS use rate falls somewhere between 82.9 percent and 88.1 percent. The relative error of the estimate was 1.5 percent which was well within the five percent or less relative error required for statewide surveys of safety belt use (NHTSA, 1992). When compared with the 74.5 ± 3.7 percent child safety seat use rate reported in 1997 (Eby, Kostyniuk, Christoff, 1997), we find that CSS use has increased significantly in Michigan during the last 4 years.

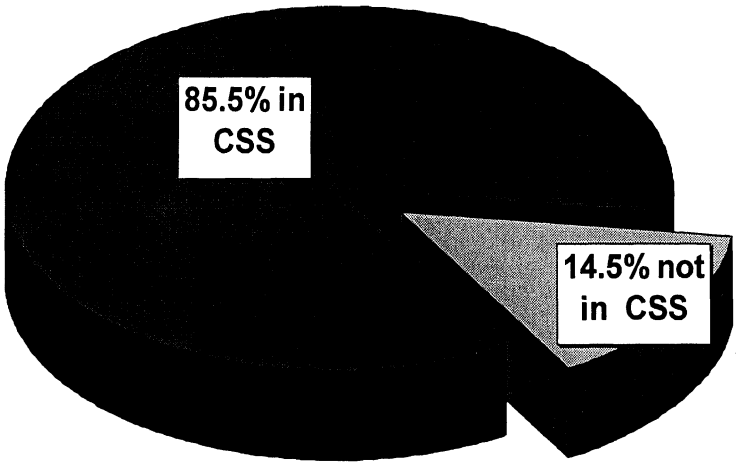

Figure 1. Estimated Statewide Child Safety Seat Use Rate

Estimated CSS use rates by site type along with unweighted Ns for each stratum are shown in Table 3. As can be seen in this table, use at medical facilities was generally slightly higher than use at day care centers. Comparing across the strata, we found that

[2] Of the 14.5 percent of children not restrained in a CSS, approximately 10 percent were using a safety belt and 4.5 percent were riding unrestrained.

the CSS use rates generally followed the safety belt use rates (see Eby, Fordyce & Vivoda, 2000).

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

	Day Care	Medical	Overall
Stratum 1	80.5 (N=241)	90.8 (N=163)	89.0 (N=404)
Stratum 2	82.4 (N=165)	86.3 (N=285)	85.0 (N=450)
Stratum 3	88.5 (N=200)	91.3 (N=183)	89.6 (N=383)
Stratum 4	81.9 (N=160)	80.0 (N=214)	80.9 (N=374)
STATE OF MICHIGAN	**83.2 (N=766)**	**86.8 (N=845)**	**85.5 (N=1,611)**

Use by Driver Safety Belt Use

The estimated CSS use rate by driver safety belt use is shown in Figure 2. Note that CSS use is significantly higher when the driver uses his or her safety belt. This finding is consistent with previous work in Michigan (Eby, Kostyniuk, & Christoff, 1997; Eby & Kostyniuk, 1999). Therefore, as the adult safety belt use rate increases, we would expect to see an increase in CSS use. While not surprising, this result suggests that continued efforts to increase safety belt use will also likely increase the frequency with which CSSs are used.

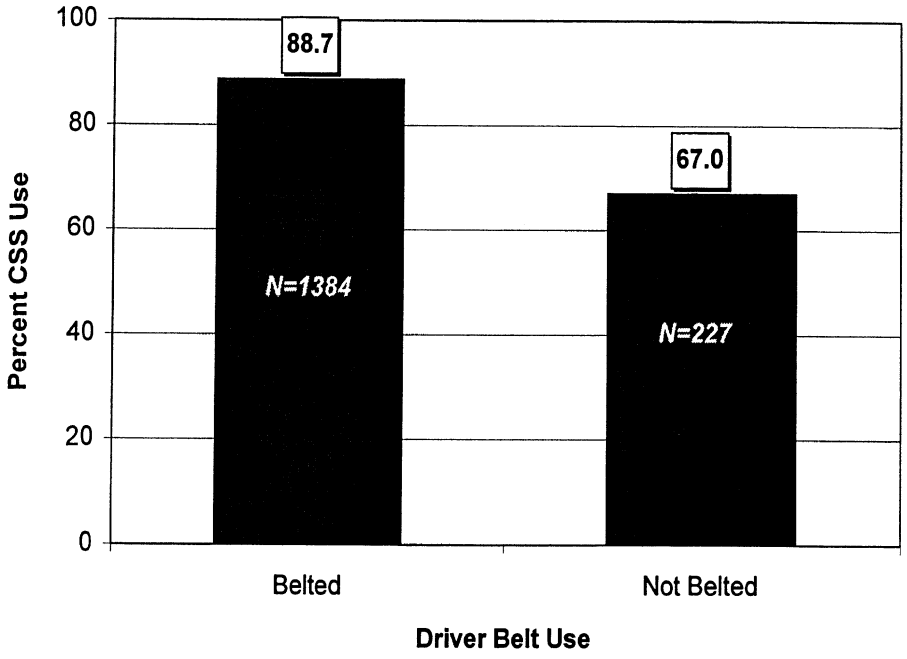

Figure 2: Child Safety Seat Use Rates by Driver Safety Belt Use.

Use by Sex of Driver

Estimated CSS use by the sex of the person driving the vehicle in which a target-aged child was observed is shown in Figure 3. There were about three times as many female drivers as male drivers. Little difference was found between male and female drivers in their use of CSSs for children under 4 years of age. This finding contrasts with the results of the previous study (Eby & Kostyniuk, 1999) where CSS use was significantly lower when a male was driving the vehicle. Since it is well established that males use safety belts at a lower rate than females in Michigan (Eby, Molnar, & Olk, 2000; Eby, Fordyce, & Vivoda, 2000) and elsewhere (see e.g., Lange & Voas, 1998; Williams, Wells, & Lund, 1987), the present results are encouraging.

Use by Age of Driver

In Figure 4, CSS use by the age of the driver in which a target-aged child was observed is shown. CSS use rates were higher for those drivers 30 to 59 years of age than for drivers who were younger, a finding consistent with previous work (Eby & Kostyniuk, 1999). A very small number of drivers over 60 years of age were observed. Of these drivers age 60 and above, about three-fourths utilized CSS for their young vehicle occupants, showing a large increase from the earlier study (Eby & Kostyniuk, 1999) where CSS use with those drivers was only 50 percent.

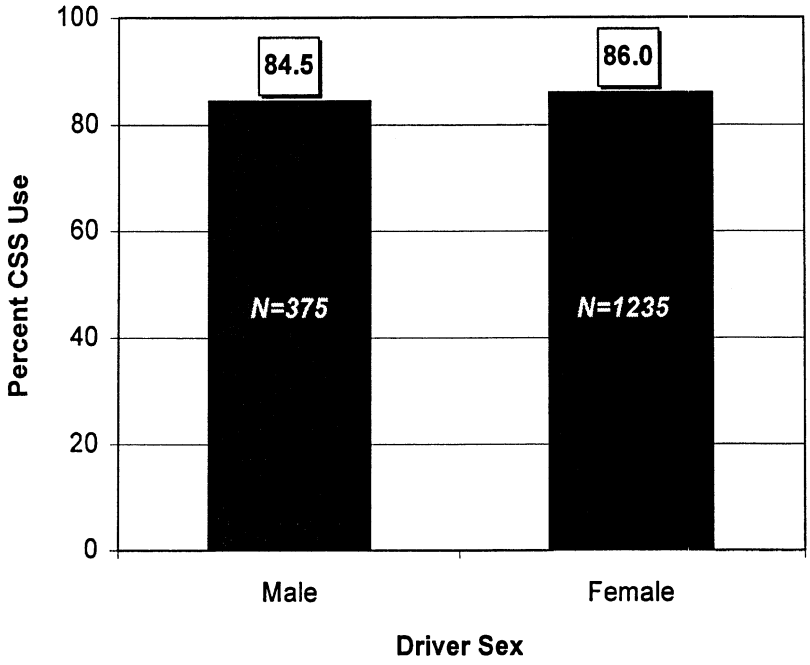

Figure 3: Child Safety Seat Use Rates by Driver Sex.

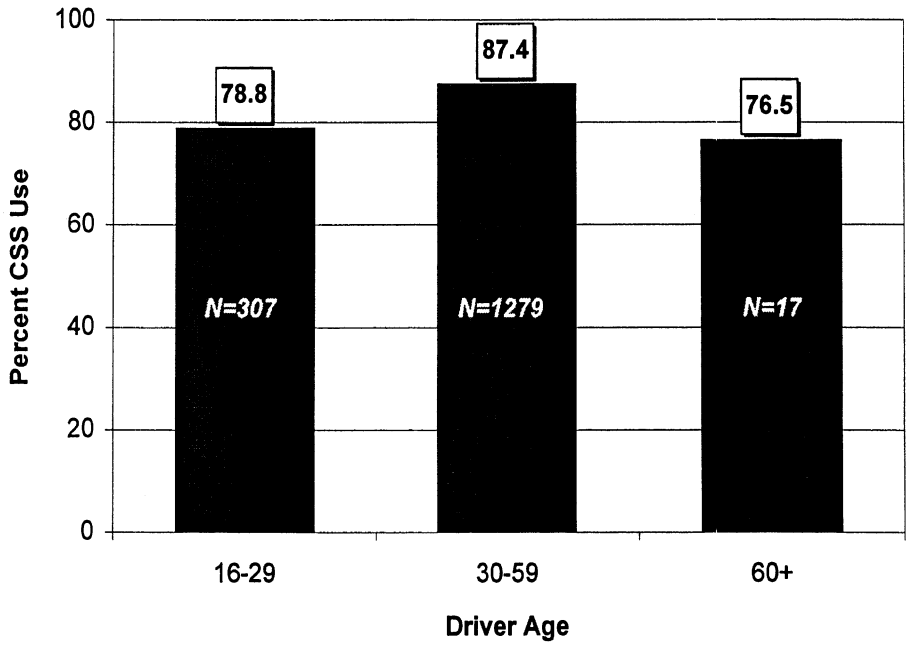

Figure 4: Child Safety Seat Use Rates by Driver Age.

Use by Seating Position

CSS use as a function of where in the vehicle target-aged children were seated is shown in Figure 5. CSS use was very high in the second row of seats where the vast majority of children under 4 years of age were seated. Children seated in the front seat of a vehicle (either in the center or right side), were restrained in a CSS at very low rates. Fortunately, very few target-age children were riding in the front seat. We also found that very few children were found riding in the third row of seats with CSS use high in the outboard positions and use quite low in the center position. The sample size for the third row seating position was too low to make any meaningful conclusions. These frequency and CSS use trends were consistent with the previous study (Eby, Kostyniuk, & Christoff, 1997; Eby & Kostyniuk, 1999).

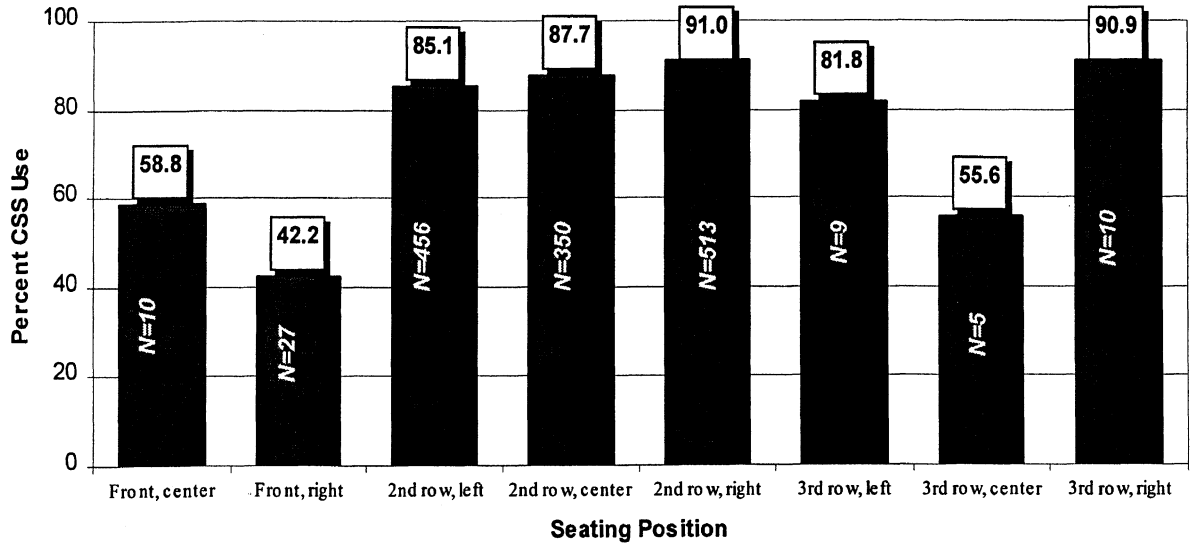

Figure 5: Child Safety Seat Use Rates by Vehicle Seating Position.

HISTORICAL TRENDS

Overall Child Safety Seat Use

Figure 6 shows the statewide CSS use rate for 1997 and 2001. CSS use has increased by 11 percentage points since 1997. This increase in CSS use suggests that efforts to increase the public's awareness of the importance of using a CSS have been quite effective and should continue.

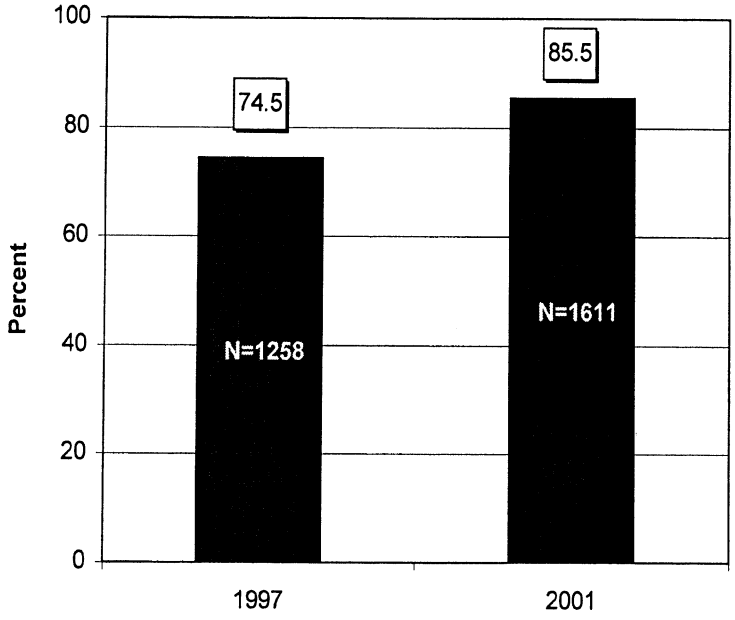

Figure 6: Statewide CSS Use Rates by Year.

Tables 4 shows a comparison between the 1997 and 2001 CSS use rates and unweighted Ns by stratum. The percentage point changes between the surveys are also presented. Each stratum experienced an increase in CSS use. The largest percentage point increase in CSS use was found in Stratum 3 where use went from the lowest in the state in 1997 to the highest in 2001. The smallest percentage point change was found in Stratum 4 (Wayne County), where use was the highest in the state in 1997 and was found to be the lowest in 2001.

Table 4. Child Safety Seat Use by Unweighted Number of Children Observed (N), and Percentage Point Change by Stratum			
	Overall		
	1997	2001	Percentage Point Change
Stratum 1	77.4 (N=319)	89.0 (N=404)	11.6
Stratum 2	77.0 (N=265)	85.0 (N=450)	8.0
Stratum 3	64.6 (N=306)	89.6 (N=383)	25.0
Stratum 4	79.6 (N=368)	80.9 (N=374)	1.3
STATE OF MICHIGAN	**74.5 (N=1,258)**	**85.5 (N=1,611)**	**11.0**

Use by Driver Safety Belt Use

The estimated CSS use rates for 1997 and 2001 as a function of driver safety belt use is shown in Figure 7. This figure shows that CSS use was consistently higher when the driver used his or her safety belt, which is in agreement with the results of other studies (see, e.g., Bolen & Bland,1999; Eby, Kostyniuk, & Christoff, 1997; Eby & Kostyniuk, 1999; Ferguson, Wells & Williams, 2000). In addition, there was a surprising increase in the percentage of unbelted drivers who restrain their child occupants in CSSs. In 1997 only about one-half utilized CSSs, while in the present study about two-thirds did so. This increase in CSS use for unbelted drivers is encouraging and may indicate a heightened awareness of the importance of CSSs as a result of programs that encourage their use.

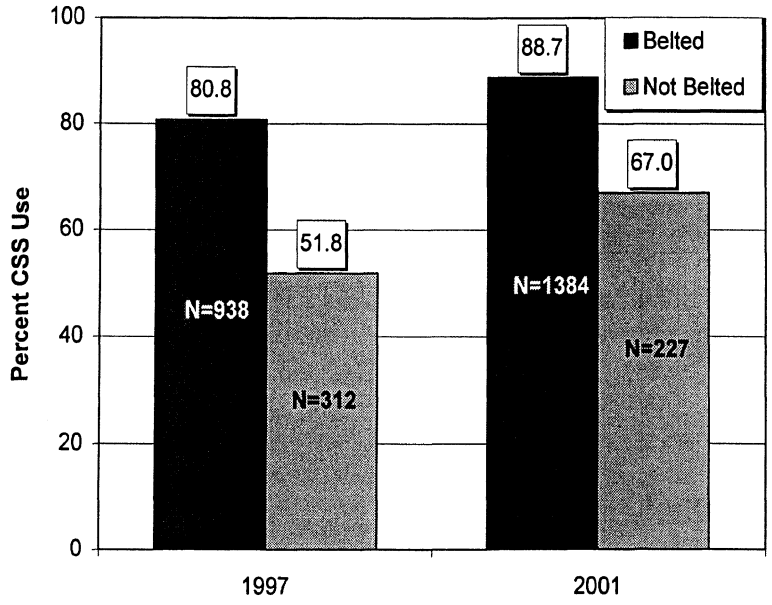

Figure 7: Child Safety Seat Use by Driver Safety Belt Use and Year.

Use by Sex of Driver

Figure 8 shows CSS use rates by the sex of the driver. Use rates for both males and females increased since 1997. In addition, the somewhat large difference between sexes found in 1997 has nearly disappeared in 2001. This result suggests that statewide and local efforts to promote CSS use have been quite effective among the male population.

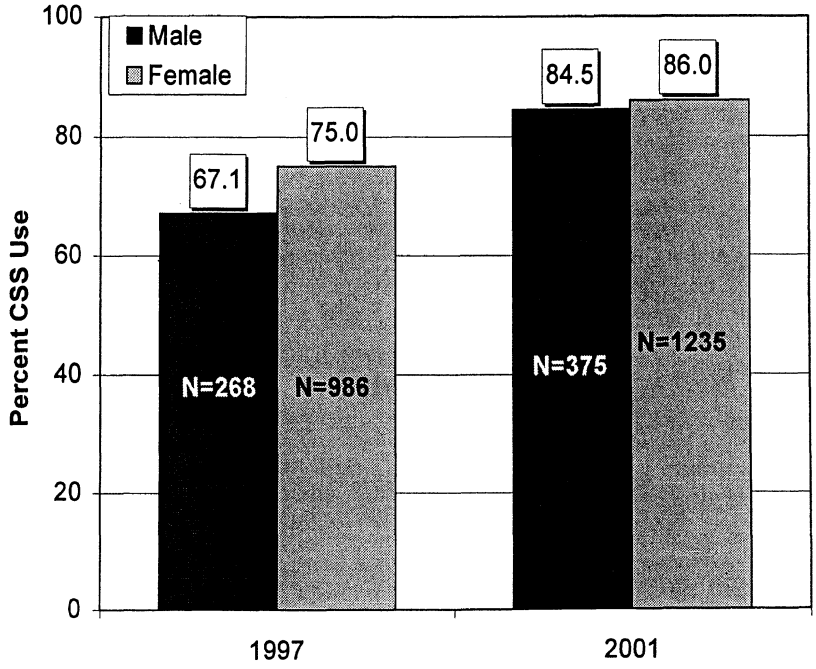

Figure 8: Child Safety Seat Use by Sex of Driver and Year.

Use by Age of Driver

CSS use by driver age is shown in Figure 9. CSS use in all driver age groups is higher in 2001 than in 1997. The most interesting increase is found in the 30 to 59 year old age groups where a 12.6 percentage point increase was observed. Since nearly 80 percent of drivers in the present study were in this age group, this increase represents a vast number of children across the state who are now being restrained in a CSS. We also discovered an extremely large increase in CSS use for drivers over 60 years of age. While, very few children were found riding with drivers of this age, the results could suggest that CSS use promotion programs have been reaching and influencing important low use groups.

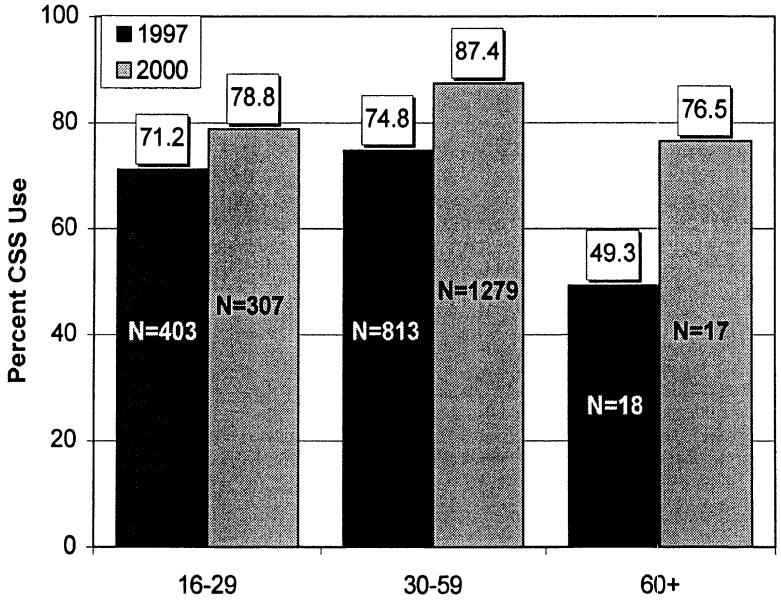

Figure 9: Child Safety Seat Use by Age of Driver and Year.

Use by Seating Position

Figure 10 shows estimated CSS use as a function of where in the vehicle target-aged children were seated. In all seating positions, the CSS use rate increased from 1997 to 2001. Although children seated in the front center or front right tended not to be restrained in a CSS, both studies found that only a few number of children were seated in these positions.

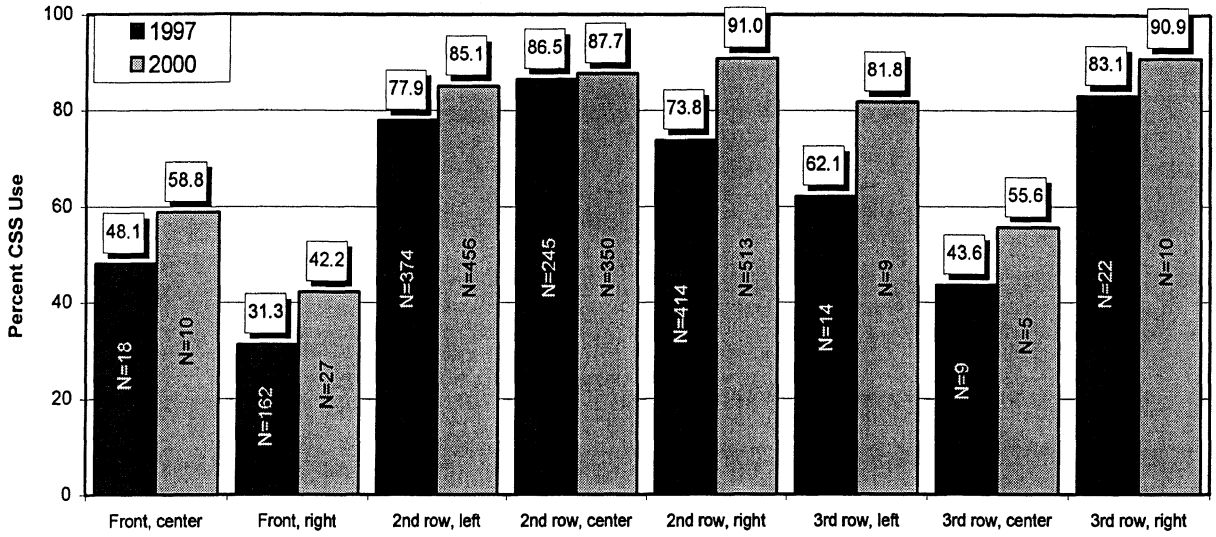

Figure 10: Child Safety Seat Use by Seating Position and Year.

DISCUSSION

The current statewide child safety seat use rate for children under the age of 4 is 85.5 ± 2.6 percent. When compared with the 1997 CSS use rate of 74.5 ± 2.6 percent, the present rate reflects a significant increase in Michigan's child safety seat use. This impressive increase of 11 percentage points suggests that efforts in Michigan to increase CSS use have been very successful. However, Michigan still has nearly 15 percent of its child occupant population traveling unrestrained in motor vehicles.

The study identified several subgroups of the population with lower CSS use. Targeting enforcement and Public Information and Education (PI&E) programs at these subgroups would likely be effective in raising the CSS use rate. One of these subgroups was Wayne County (Stratum Four) where CSS use was the lowest in the state. Little difference in CSS use was observed between male and female drivers. We also found CSS use to be lower in vehicles driven by unbelted drivers. Therefore, efforts to increase safety belt use should result in the increased use of CSSs.

Comparing the current study with results found in 1997, we found some interesting trends. Great strides have been made in getting traditionally low CSS use groups to use CSSs. Unbelted drivers, male drivers, drivers 60 years of age or older, and drivers in Stratum 3 all showed large increases in use since 1997. Efforts to increase use in these groups have clearly been successful. Of particular interest is the increase in CSS use found for unbelted drivers. Even though these unbelted drivers have chosen to ride unrestrained themselves, they are, perhaps, recognizing the importance of utilizing CSSs for their young child occupants.

While the current study shows that Michigan has been quite effective in increasing the use of CSSs, it is important to remember that the effectiveness of CSSs in preventing injury are greatly reduced if they are used improperly. Misuse of CSSs has been found to be quite high in Michigan and elsewhere (see Eby & Kostyniuk, 1999 for a review). For example, in 1997 Eby and Kostyniuk (1999) found some level of misuse in 85 percent of inspections they conducted. In order for Michigan to be able to fully assess its efforts in promoting child passenger safety, a statewide analysis of CSS misuse would be beneficial.

This information would provide Michigan with critical information for assessing the effectiveness of programs as well as to help tailor CSS programs more appropriately.

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APPENDIX A

CSS Use Data Collection Forms

SITE DESCRIPTION FORM - CSS2

SITE # ___ (1 2 3) SITE NAME/LOCATION _____

SITE TYPE

1☐ Medical Center

2☐ Day Care (4)

DATE (month/day): __ __/__ __/2001 (5 6 7 8)

OBSERVER

1☐ Steve
2☐ Amin
3☐ Jim
4☐ Jane
5☐ Linda
6☐ Jonathon
7☐ Dave (9)

DAY OF WEEK

1☐ Monday
2☐ Tuesday
3☐ Wednesday
4☐ Thursday
5☐ Friday (10)

WEATHER

1☐ Mostly Sunny
2☐ Mostly Cloudy
3☐ Rain
4☐ Snow (11)

START TIME: __ __:__ __ (24 hour clock) (12 13 14 15) END TIME: __ __:__ __ (24 hour clock) (16 17 18 19)

INTERRUPTION (total number of minutes during observation period): __ __ (20 21)

COMMENTS & SITE SKETCH:

SITE # ___ ___ ___ (1 2 3) **ATTENTION CODING: DUPLICATE COL 1 - 3 FOR ALL VEHICLES** PAGE #_____

DRIVER	CENTER	RIGHT		DRIVER	CENTER	RIGHT
4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 4	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 5	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 6	BELT USE	4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 4	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 5	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 6
1☐ Male 2☐ Female 7	NO DATA	1☐ Male 2☐ Female 8	SEX	1☐ Male 2☐ Female 7	NO DATA	1☐ Male 2☐ Female 8
1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 9	NO DATA	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 10	AGE	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 9	NO DATA	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 10
~~2ND ROW~~~~~~~~~~				~~~~~~~~~~2ND ROW~~~~~~~~~~		
LEFT	**CENTER**	**RIGHT**		**LEFT**	**CENTER**	**RIGHT**
1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 11	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 12	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 13	BELT USE	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 11	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 12	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 13
~~3RD ROW~~~~~~~~~~				~~~~~~~~~~3RD ROW~~~~~~~~~~		
LEFT	**CENTER**	**RIGHT**		**LEFT**	**CENTER**	**RIGHT**
1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 14	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 15	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 16	BELT USE	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 14	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 15	1☐ Infant 2☐ Toddler 3☐ Booster 4☐ Belted 5☐ B Back/U Arm 6☐ Unrestrained 16
1☐ Passenger car 2☐ Van 3☐ Utility 4☐ Pick-up 17		Office Use Only: ___ ___ ___ 18 19 20	VEH TYPE	1☐ Passenger car 2☐ Van 3☐ Utility 4☐ Pick-up 17		Office Use Only: ___ ___ ___ 18 19 20

APPENDIX B

Site Listing

Site	Name	Address	City	County	Stratum
1	Creyts Road Health Center	1401 S. Creyts	Lansing	Ingham	1
2	Pediatric Care of Lansing	2909 E. Grand River	Lansing	Ingham	1
3	Mason Community Health	800 E. Columbia	Mason	Ingham	1
4	Drs. Hennessey & Mohan	3955 Okemos Rd. A-1	Okemos	Ingham	1
5	Court One Medical Prof. Ctr.	1515 Lake Lansing Rd	Lansing	Ingham	1
6	Promed Pediatrics	4200 S Westnedge Ave	Kalamazoo	Kalamazoo	1
7	Royal Oak Pediatric Clinic	26657 Woodward Ave	Huntington Wds.	Oakland	1
8	Drs. Barnes, Gilbert & Mitchell	2370 Walton Blvd	Rochester	Oakland	1
9	Child Health Associates	3100 E. Eisenhower Pkwy, 100	Ann Arbor	Washtenaw	1
10	University of MI Health Center	200 Arnet Street, Ste 200	Ypsilanti	Washtenaw	1
11	Grand Traverse Children's Clinic	3537 W. Front Street	Traverse City	Grand Traverse	2
12	Center for Family Health	1100 East Michigan Avenue	Jackson	Jackson	2
13	Forest Hills Pediatric Assoc	751 Kenmoor Ave, SE	Grand Rapids	Kent	2
14	Pediatric Assoc. Kentwood	4444 Kalamazoo SE	Grand Rapids	Kent	2
15	Brighton Pediatrics, P.C.	8550 W. Grand River Ave, 300	Brighton	Livingston	2
16	Clinton Preferred Pediatrics	15500 19 Mile, Suite 300	Clinton Twp.	Macomb	2
17	Pediatric Clinic, P.C.	25650 Kelly Road	Roseville	Macomb	2
18	Pediatric Clinic, P.C.	35050 23 Mile Road	New Baltimore	Macomb	2
19	Schomaker & Medgalls, P.C.	13355 East 10 Mile	Warren	Macomb	2
20	Willow Pediatrics	65 Macomb Place	Mt. Clemens	Macomb	2
21	McLaren Family Care Center	10090 E. Lippencotte Ave.	Davison	Genesee	3
22	McLaren Family Center	2420 Owen Road	Fenton	Genesee	3
23	McLaren Family Center	103 East Main Street	Flushing	Genesee	3
24	McLaren Family Care Center	319 South Bridge Street	Linden	Genesee	3
25	McLaren Family Practice	809 West Dryden Road	Metamora	Lapeer	3
26	Ped & Adol. Health Care Assoc.	1414 West Fair Avenue, 36	Marquette	Marquette	3
27	Drs. Kant & Shah Pediatrics	814 North Macomb	Monroe	Monroe	3
28	Hackley Hosp. - Infant Support	1706 Clinton	Muskegon	Muskegon	3
29	Children's Health Center	1321 Stone Street	Port Huron	St. Clair	3
30	River Country Pediatrics	1123 West Broadway Street	Three Rivers	St. Joseph	3
31	DMC Health Care	22341 8 Mile	Detroit	Wayne	4
32	Downriver Pediatric Associates	3516 Fort Street	Lincoln Park	Wayne	4
33	Family Care Medical Center	5831 West Vernor Highway	Detroit	Wayne	4
34	Metro Associates in Pediatrics	20010 Farmington Road	Livonia	Wayne	4
35	Children's Hospital - Ped. Urology	3901 Beaubien	Detroit	Wayne	4
36	Pediatric Care Center P.C.	9716 Dix	Dearborn	Wayne	4
37	Woods Pediatric Clinic	19925 Vernier Road	Harper Woods	Wayne	4
38	Child Health Assoc./St. Joseph	990 West Ann Arbor Trail	Plymouth	Wayne	4
39	Pediatric Healthcare Associates	1600 S. Canton Center	Canton Twp.	Wayne	4
40	Frank Raiford III, MD	3800 Woodward	Detroit	Wayne	4
41	Kindercare Learning Center	525 East Saginaw Highway	East Lansing	Ingham	1
42	Educational Child Care Center	1715 West Main	Lansing	Ingham	1
43	Country Days Child Dev. North	205 North Main Street	Clawson	Oakland	1
44	Good Shepard Lutheran Preschool	1950 South Baldwin	Lake Orion	Oakland	1
45	One Small Step Childcare	21551 West Eleven Mile Road	Southfield	Oakland	1

Site	Name	Address	City	County	Stratum
46	Baldwin Early Learning Center	212 Baldwin	Pontiac	Oakland	1
47	WSC Childcare Center	76 Williams Street	Pontiac	Oakland	1
48	Trinity Child Development Center	113 Wessen Street	Pontiac	Oakland	1
49	Children's World Learning Center	25761 Greenfield	Southfield	Oakland	1
50	Doherty Elementary School	3575 Walnut Lake Road	W. Bloomfield	Oakland	1
51	Munson Medical Ctr. Child Care	1105 6th Street	Traverse City	Grand Traverse	2
52	ABC Academy	800 Laurence Avenue	Jackson	Jackson	2
53	School Bell	7172 W. Grand River	Brighton	Livingston	2
54	St. Thomas The Apostle Preschool	1429 Wilcox Park Drive	Grand Rapids	Kent	2
55	Franciscan Child Dev. Center	11761 Downes NE	Lowell	Kent	2
56	Lowell YMCA Child Dev. Center	404 Hudson Street	Lowell	Kent	2
57	St. Peter Lutheran Young Child Ctr.	37601 31 Mile Road	Richmond	Macomb	2
58	Kings Kids Wesleyan Day Care	11711 26 Mile Road	Washington	Macomb	2
59	Child's Choice Preschool	24530 Harper Avenue	St. Clair Shores	Macomb	2
60	Zeeland Christian Preschool	334 West Central	Zeeland	Ottawa	2
61	St. John School Preschool	2010 Irwin Avenue	Albion	Calhoun	3
62	Adventurous Beginnings	415 South 28th Street	Battle Creek	Calhoun	3
63	Doodle Bugs Daycare	5300 Davison Road	Burton	Genesee	3
64	Child's World	4104 Manor	Grand Blanc	Genesee	3
65	Faith Lutheran Preschool	12534 Holly Road	Grand Blanc	Genesee	3
66	Montrose Child Dev. Center	126 Hickory	Montrose	Genesee	3
67	Mr. McGregor's Garden	510 McClellan Avenue	Marquette	Marquette	3
68	Muskegon Public School Pre-K	1826 Hoyt Street	Muskegon	Muskegon	3
69	Little Learner Day Care	10397 Gratiot	Columbus Twp	St. Clair	3
70	Orchard Acres Day Care	300 Peachtree Street	Constantine	St. Joseph	3
71	Kinderkirk Nursery	22122 West McNichols	Detroit	Wayne	4
72	Hartford Head Start	19555 West McNichols	Detroit	Wayne	4
73	Loving Elementary Head Start	1000 Lynn	Detroit	Wayne	4
74	Children's Center	20210 SchoenherrRoad	Detroit	Wayne	4
75	Westminster Children's Center	17567 Hubble Street	Detroit	Wayne	4
76	Grosse Pointe Pre-K	17150 Maumee	Grosse Pointe	Wayne	4
77	L'il Guys & Dolls Learning Center	30900 6 Mile Road	Livonia	Wayne	4
78	Montessori Center of Our Lady	36800 Schoolcraft	Livonia	Wayne	4
79	Little Lamb Christian Preschool	17125 Fordline Road	Riverview	Wayne	4
80	Riverview High School Preschool	12431 Longsdorf	Riverview	Wayne	4
81	Cradles Cribs Daycare & Tots Ctr.	2801 Boardwalk Street	Ann Arbor	Washtenaw	1
82	Gretchen's House	2625 Traver Blvd.	Ann Arbor	Washtenaw	1
83	Mother's Apron Pre-K Day Care	12000 Larkins Road	Brighton	Livingston	2
84	Little Tots of Plymouth	12401 Ridge Road	Plymouth	Wayne	4
85	Childtime Children's Center	34203 Ford Road	Westland	Wayne	4
86	Bethlehem Church Nursery School	1050 Peninsula Driver	Traverse City	Grand Traverse	2
87	Little Friends Country Preschool	1910 Werner Street	Marquette	Marquette	3
88	River Raisin Head Start	2121 South Custer Road	Monroe	Monroe	3

APPENDIX C

Calculation of CSS Use Rates, Variances, and Confidence Bands

The statewide CSS use rate was estimated from the separate statewide CSS 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 CSSs.

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 CSSs 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 CSSs. 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:

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

A nearly unbiased estimate of the CSS 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:

$$\frac{N}{\hat{x}^2 n}\sum_{i=1}^{n} 12\left[(y_{i2} - y_{i1}) - \hat{R}(x_{i2} - x_{i1})\right]^2$$

Combining the Strata

For each type of site the statewide CSS 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 CSS 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:

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

Combining the two site types for a statewide estimate of CSS 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:

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

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