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Patterns of Child Restraint Use in Michigan

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16. Abstract

The objective of this study was to determine the child occupant restraint use in the state of Michigan through an observational survey. This study, the second yearly survey of restraint use in Michigan, enables the identification of emerging trends; examination and measurement of changes resulting from standard enforcement legislation; and the assessment of the effects of Operation ABC (America Buckles Children), a Public Information and Education (PI&E) program. Analysis of national personal travel data identified schools and non-school sites (fast food restaurants, skating rinks, malls, movie theaters, and recreation centers) as locations frequently visited by children 4 to 15 years of age that were also suitable for an observational study. A stratified random sampling design was developed and 128 sites (4 school and 28 nonschool in each of 4 strata) were sampled. Trained observers visited the sites, located vehicles with target age children, and recorded the occupant restraint use of the children (in all seating positions) and driver of the vehicle, along with other descriptive information. The results showed that overall child occupant restraint use in Michigan was 81.1 ± 1.8 percent. In addition, child occupant restraint use followed closely the driver belt use, with child occupant restraint use more than 86 percent when the driver was using a safety belt. Child occupant restraint use varied by age group with children under 4 years of age more likely to be restrained than children 4 to 15 years of age. Child occupants in sport utility vehicles, vans/minivans, and pickup trucks were more likely to be restrained than those in passenger cars. Restraint use varied by seating position, with older children in the front right position more likely to be restrained than in other seating positions. Restraint use also varied by whether the trip was to a school or nonschool site, with older children less likely to be restrained at school than nonschool sites. There were no differences in restraint use by the sex of the child or by day of week.

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INTRODUCTION

The state of Tennessee enacted the first mandatory child restraint use law in January of 1978 (Williams, Wells, & Ferguson, 1997). By 1985, the remaining 49 states and the District of Columbia passed legislation mandating restraint use by children (Rock, 1996). An assessment of these laws indicated that they produced an immediate increase in use and a 9 percent reduction in child occupant fatalities (Rock, 1996; Center for Disease Control, CDC, 1991). The introduction of these laws, along with educational programs and media publicity were largely responsible for an increase in child restraint use (Evans & Graham, 1990).

A current analysis of national child restraint use rates indicates that the majority of child passengers in motor vehicles are restrained. The restraint use rate for infants is 93 percent, and the rate is 68 percent for children aged 5 to 15 (National Highway Traffic Safety Administration, NHTSA, 1999). Although trends have shown a continual increase in child restraint use for occupants under the age of 15 (Bolen & Bland, 1999), the majority of children killed in motor vehicle crashes were not using restraints. Of the 2,108 motor vehicle fatalities among children in 1997 (Insurance Institute for Highway Safety, IIHS, 2000), almost 51 percent of fatally injured children aged 0 to 4, 54 percent aged 5 to 9, and 67 percent aged 10 to 15 were unrestrained (NHTSA, 1999). The considerable number of child occupants that continue to ride unrestrained may be attributed to the fact that many children are not covered by either child restraint use laws or adult safety belt use laws due to gaps and exemptions in coverage.

The ages of children covered by mandatory child restraint use laws vary from state to state; however the laws in most states cover children up to age 5, and one-third apply to children over the age of 6 (NHTSA, 1996). Because restraint use laws in many states pertain only to front seat occupants, children may legally ride unrestrained in the back seat of motor vehicles (IIHS, 2000). In addition, many states have exemptions from mandatory child restraint use laws for drivers who are not the parent or guardian of the child passengers (NHTSA, 1996; IIHS, 2000). Many states also have provisions in their laws that allow children to ride unrestrained if all of the available safety belts in the vehicle are

in use (NHTSA, 1996). Children riding in pickup trucks, out-of-state vehicles (IIHS, 2000), and children being fed or attended to (NHTSA,1996), are exempt from mandatory child restraint use laws in various states.

In 1997, the President of the United States directed the Secretary of Transportation to develop a plan for increasing safety belt use, called the *Presidential Initiative for Increasing Seat Belt Use Nationwide*. The first goal of the plan was to increase the national safety belt use rate to 90 percent by 2005. The second goal was to reduce child occupant fatalities (0 to 3 years of age) by 25 percent by 2005.

The State of Michigan recently amended its safety belt use legislation in order to continue to increase safety belt use, and to reduce occupant injuries and fatalities. The Michigan Vehicle Code now allows for standard enforcement of safety belt use and requires all children under the age of 4 to be in a child safety seat (CSS) regardless of seating position. While maintaining existing provisions requiring children between 4 and 16 years of age to be properly secured and belted in any seating position (Michigan Vehicle Code 257.710e), the new law deleted provisions that allowed children to ride in the back seat of motor vehicles without using the proper child restraint device. Previously, Michigan legislation mandated that every child under 1 year of age be in a CSS, that children between the ages of 1 and 3 be in a CSS if riding in the front seat, and that children 1 to 3 years of age be in a CSS or use an adult safety belt when riding in the back seat (Michigan Vehicle Code 257.710d).

When a state changes their safety belt use law to allow for standard enforcement, a significant increase in the safety belt use rate follows. Studies have shown that adult belt use has a significant effect on child safety. When Louisiana upgraded its adult safety belt use law from secondary to standard enforcement, child restraint use increased from 45 percent to 82 percent in a two year period, although the child restraint use law remained unchanged (National Safety Council, 1999). Children are much more likely to be belted in vehicles in which the adult driver is also belted (e.g., see Eby & Kostyniuk, 1999; Eby, Kostyniuk, & Vivoda, in press; NHTSA, 2000). Thus, as the adult safety belt use rate increases, we expect to see a reduction in child occupant fatalities, meeting the second

goal of the *Presidential Initiative*. It has been estimated that safety belts reduce the likelihood of fatal injuries in children by 36 percent. The use of CSSs reduce the likelihood of fatal injury by 69 percent for infants and 47 percent for toddlers (CDC, 1991). While the majority of infants are restrained regardless of the enforcement provision of safety belt use legislation, studies have shown that children aged 5 to 14 are more likely to be restrained in states with a standard safety belt use law (Bolen & Bland, 1999).

In addition to upgrading to standard enforcement, Michigan has received funding to undertake a special enforcement program intended to reduce child injuries caused by traffic crashes. The program, Operation ABC (America Buckles Children), launched in 1996, is based on the STEP (Special Traffic Enforcement Program) model, which combines periodic waves of stepped up law enforcement with intensive media coverage of the enforcement. Operation ABC consists of two annual mobilizations, in May and November, that combine high profile, zero tolerance enforcement of safety belt and child safety seat laws with an aggressive public information and education (PI&E) program. High visibility enforcement efforts are enhanced with extensive news coverage that focuses on not only the enforcement activity but also the benefits of proper child occupant restraint. Information is also disseminated directly through police officers who hand out educational materials along with citations.

Information on the current use of occupant restraint devices by children is critical for such programs. The annual statewide safety belt use survey is designed to determine safety belt use across the entire population of Michigan; as a result, the sample does not include many occupants under 16 years of age. For example, in 1999, only about 3 percent of the sample was under 16 years of age. Further, the annual survey only considers front-outboard seating positions, so backseat occupant restraint use is unknown. Thus, a complete survey of child occupant restraint device use requires a sampling design that targets locations frequented by children in motor vehicles and a survey methodology that includes observations of children in all seating positions. In 1999, such a survey was conducted to determine the baseline statewide child occupant restraint use rate. The purpose of the current study was to conduct a follow up survey of child occupant restraint use in Michigan, to measure changes in child restraint use resulting from recent legislative

changes and to assess the effects of the state's special enforcement and education programs.

METHODS

Sample Design

The sample design for the present survey was based upon the one used by Eby, Kostyniuk, and Vivoda (1999). All of the observation sites in the current study were the same as the sites used in the previous study, unless observations were not possible at the site. In this case, new sites were selected using the same sampling procedure. 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 that accurately represent locations visited by Michigan children 4 to 15 years of age (target age)[1]. 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.

Michigan consists of 83 counties, many of which are sparsely populated. 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 child occupant restraint use. Therefore, all 83 Michigan counties were rank ordered by population (U.S. Bureau of the Census, 1992) and the lowest population counties were eliminated from the sample space. This step reduced the sample space to the same 28 counties used in the most recent direct observation surveys of statewide safety belt use (see, e.g., Eby & Olk, 1998; Eby, Vivoda, & Fordyce, 1999).

In order to compare child occupant restraint use rates with statewide safety belt use and CSS use, the same stratification procedure developed for statewide direct observation surveys of safety belt and CSS use was used in the present survey (see Eby & Kostyniuk,

[1]Children under 4 years of age were included in the survey to the extent that they appeared in vehicles at the sites selected for observing older children.

1999; Streff, Eby, Molnar, Joksch, & Wallace, 1993). 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 UMTRI safety belt surveys (Wagenaar, Molnar, & Businski, 1987b, 1988; Wagenaar & Molnar, 1989). Because 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).[2] These factors have been previously shown to positively correlate with belt use (e.g., Wagenaar, Molnar, & Businski, 1987a). Wayne County was chosen as a separate stratum because of its disproportionately high VMT. Three other strata were constructed by rank-ordering each county by historical belt use rates and then adjusting the stratum boundaries until there were roughly equal total VMT within each stratum. The stratum boundaries were high belt use, medium belt use, low belt use, and Wayne County.

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

The number of observation sites for the survey (N=128) was determined based on within- and between-county variances from previous adult belt use surveys and an estimated 20 target age children per observation period for the current survey based upon pilot testing. Adult belt use rates were used because they are likely to correlate highly with occupant restraint use by children under 16 years of age.

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

The types of sites to be observed were determined by examining data from the 1995 Nationwide Personal Transportation Survey, NPTS, (Federal Highway Administration, 1997) for children 5-to-15 years of age from the northern Midwest region of the United States. The NPTS, conducted under sponsorship of the U.S. Department of Transportation, serves as the authoritative source of national data on daily personal travel of people over 5 years of age (Research Triangle Institute, 1997). Analysis of the NPTS data indicated that schools and places for recreation, eating, and shopping were the most frequent trip destinations. Analysis of NPTS data indicated that other sites were also easily accessed for a direct observation survey. Furthermore, for every automobile trip made by a target age child to a school, there were seven trips made to nonschool locations. Therefore, schools, malls, fast food restaurants, movie theaters, skating rinks, and recreational centers were selected as the sites to be observed in the study. For the purpose of sampling, malls, fast food restaurants, movie theaters, rinks, and recreation centers were combined. The resulting sampling space consisted of two groups, the combination of sites (called nonschool) and schools.

Within each stratum, 32 observation sites were randomly selected. Of these, 28 were randomly selected, without replacement, from all nonschool sites likely to be visited by children under 16 years of age (malls, fast food restaurants, movie theaters, skating rinks, and recreational centers); 4 were randomly selected, without replacement, from all public and private elementary, middle, and junior high schools. The random selections were made from current lists of such facilities purchased from a company that compiles lists for telemarketing and mail campaigns. In addition, alternative sites were selected for each of the 28 nonschool sites. To minimize the time required to get to an alternative site, alternative sites were randomly selected from sites within the same or adjacent zip code area. No alternative sites were selected for the school sites because observation times at schools were very restricted.

All selected observation sites were contacted to determine when the sites were open. Schools were contacted to determine their start and end times, and when they were in session. Nonschool sites were contacted to determine hours of operation and the best times to observe target age children visiting the site. Once the constraints on the time

when the site could be observed were determined, the day of week and time of day for observation were randomly assigned within the constraints. At nonschool sites, vehicles were observed either entering or leaving depending upon the constraints. At school sites, entering vehicles were observed in the morning and departing vehicles in the afternoon to match when the children would be in the vehicle.

Table 2 shows the descriptive statistics for the 128 observation sites used in the survey. As shown in this table, the sites were well distributed over time of day. The sites were also fairly well distributed over weekdays, while a higher percentage of sites were observed on weekends. The table also shows that approximately 95 percent of the sites were primary sites and the majority of the sites were observed during sunny weather.

Table 2. Descriptive Statistics for the 128 Observation Sites

Day of Week		Start Time		Site Choice		Weather	
Monday	10.2%	8-12 pm	24.2%	Primary	94.5%	Sunny	62.5%
Tuesday	14.8%	12-3 pm	36.0%	Alternate	5.5%	Cloudy	28.9%
Wednesday	11.7%	3-5 pm	25.7%			Rain	5.5%
Thursday	11.7%	5-9 pm	14.1%			Snow	3.1%
Friday	17.2%						
Saturday	21.1%						
Sunday	13.3%						
TOTALS	100%		100%		100%		100%

Data Collection

Data collection for the study involved direct observation of shoulder belt use and CSS use, estimated age, and sex. Trained field staff observed shoulder belt use of drivers and children under 16 years of age traveling in passenger cars, sport utility vehicles, vans, and pickup trucks during daylight hours from April 6 through May 2, 2000. Observation of safety belt use, estimated age, sex, and vehicle type were conducted when a vehicle entered or exited the site.

Data Collection Forms

Two forms were used for 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 (school, restaurant, or entertainment/recreation), site choice (primary or alternate), observer number, date, day of week, time of day, and weather. Space was also provided on the form for observers to sketch the site 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.

The observation form was used to record safety belt use, demographic information, and vehicle type (see Appendix A). Each observation form was divided in half with each half having room for the survey of a single vehicle. For each vehicle surveyed, its type was recorded as well as the driver's shoulder belt use, sex, and estimated age group. For each target age passenger, restraint use, sex, age group, and seating position were recorded. Children riding in a CSS were recorded as belted even if clear misuse was observable. Occupants observed with their shoulder belt worn under the arm or behind the back were noted but considered as belted in the analysis. For children in center seating positions, lap belt, rather than shoulder belt use was observed. At each site, the observer carried several data collection forms and completed as many as were necessary during the observation period.

Procedures at Each Site

Each site in the sample was visited by a pair of observers for a period of 30 minutes. Upon arriving at a site, observers determined whether observations were possible at the site. If observations were not possible (e.g., the business was closed), observers proceeded to the alternate site. Otherwise, observers completed the site description form and then moved to their observation positions at the entrance(s) or exit(s) of the site.

During the observation period, observers recorded data for as many vehicles as they could observe. If traffic flow was heavy, observers were instructed to record data for the

first vehicle they saw with target age children and then look up and record data for the next eligible vehicle they saw, continuing this process for the entire observation period.

Observer Training

Prior to data collection, field observers participated in 5 days of intensive training including both classroom review of data collection procedures and practice 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 was a listing of the sites for the study that identified the location of each site (see Appendix B for a listing of the sites), as well as a site schedule identifying the date and time each site was to be observed.

After intensive review of the manual, observers conducted practice observations at several sites chosen to represent the types of sites and situations that would actually be encountered in the field. None of these practice sites were included in the sample of sites observed during the actual study. Training at each practice site focused on completing the site description form, determining where to stand at the site, identifying vehicles with target age children, recording occupant restraint device use, and estimating age group and sex. 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 8 times. Each observer pair practiced recording safety belt use, sex, age group, seating position, and vehicle type until there was an interobserver reliability of at least 85 percent for all measures on drivers and passengers for all observers.

Each observer pair was provided 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 to plan travel routes to the sites. After marking the sites on their maps, the marked locations were compared with a master map of locations to ensure that the correct sites had been pinpointed. 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.

Observer Supervision and Monitoring

During data collection, each observer pair was spot checked in the field by the field supervisor. 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 during evening hours or on weekends.

Incoming data forms were examined by the field supervisor and problems (e.g., missing data, discrepancies between the site description form and site listing or schedule) were noted, discussed with field staff, and corrected. Attention was also given to comments on the site description form about site-specific characteristics that might affect future surveys (e.g., traffic flow patterns, traffic control devices, site access).

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. Child occupant restraint use rates, variances, and confidence bands were calculated using the procedures detailed in Appendix C.

RESULTS

Description of Drivers Observed

The sample was designed for estimating child occupant restraint use rates, therefore survey data are not appropriate for estimating statewide adult restraint use rates, such as for the driver. However, as a way of describing the drivers observed in the study, Table 3 presents several characteristics of drivers in the sample, including the percentage of safety belt use. While driver data should not be considered representative of statewide trends, the overall driver safety belt use rate is almost identical to the rate that was determined by the most recent statewide safety belt use survey (Eby, Fordyce, & Vivoda, 2000).

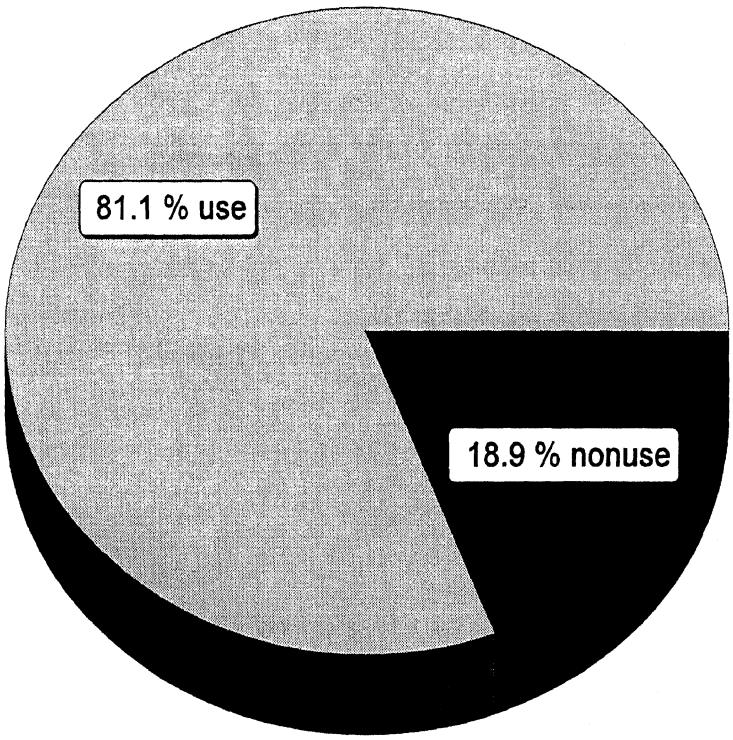
Table 3: Description of Driver Belt Use and Number Observed (N) in the Sample By Age Group and Sex.

	Male		Female		Overall	
Age	**Belted**	**Not Belted**	**Belted**	**Not Belted**	**Belted**	**Not Belted**
16-29	75.3% N=70	24.7% N=23	74.6% N=147	25.4% N=50	74.8% N=217	25.2% N=73
30-59	81.3% N=582	18.7% N=134	86.9% N=1225	13.1% N=185	85.0% N=1807	15.0% N=319
60+	86.7% N=13	13.3% N=2	78.6% N=11	21.4% N=3	82.8% N=24	17.2% N=5
Overall	80.7% N=665	19.3% N=159	85.3% N=1383	14.7% N=238	83.8% N=2048	16.2% N=397

Overall Child Occupant Restraint Use

As shown in Figure 1, the statewide occupant restraint use rate for passengers under 16 years of age traveling in passenger cars, sport utility vehicles, vans/minivans, and pickup trucks in Michigan during April and May 2000 was **81.1 ± 1.8 percent**. 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 child occupant restraint use rate falls somewhere between 79.3 percent and 82.9 percent. The use rate, 95 percent confidence band, and unweighted N for all rates shown in Figures 1 - 9 can be found in Appendix D.

Figure 1: Michigan Child Occupant Restraint Use Rate



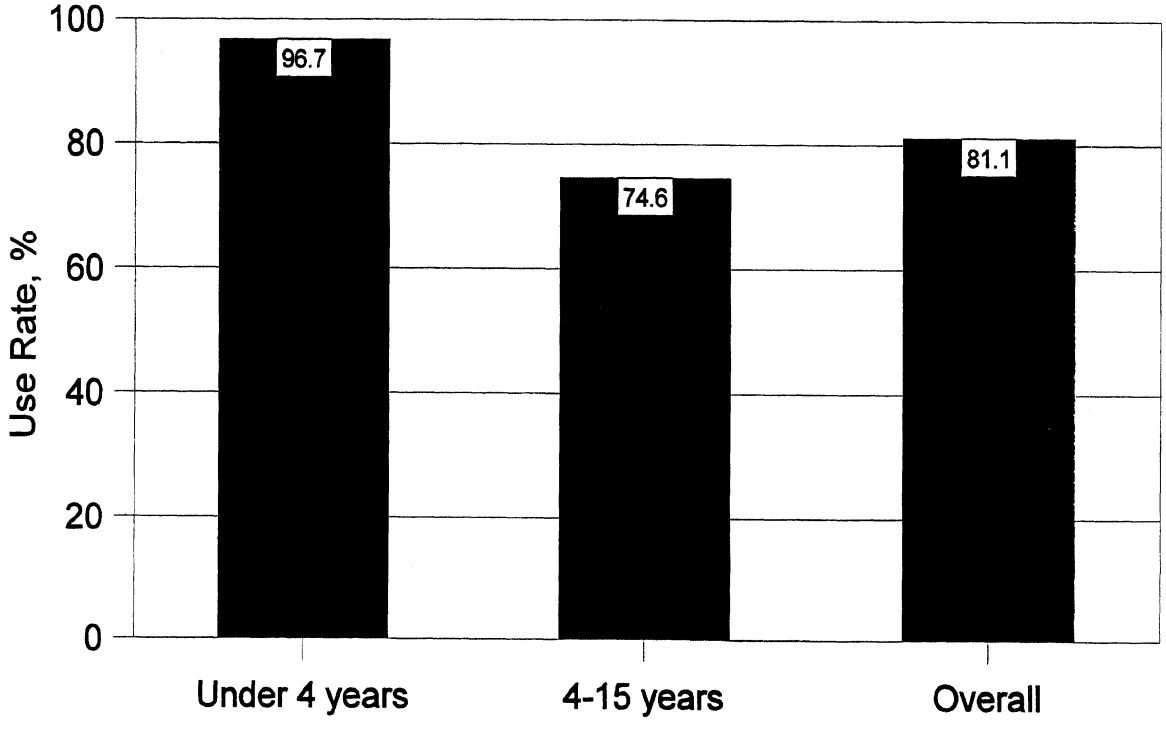
The estimated use rates and unweighted Ns for individual strata are shown in Table 4. Comparing across the strata, we find that the child occupant restraint use rates are similar to trends seen in the most recent statewide survey of safety belt use in Michigan (Eby, Fordyce, & Vivoda, 2000).

Table 4: Percent Child Occupant Restraint Use and Unweighted Number of Children Observed by Stratum and Overall.		
	Rate (%)	**Unweighted N**
Stratum 1	85.6 ± 3.0	968
Stratum 2	79.8 ± 3.3	830
Stratum 3	77.4 ± 3.2	888
Stratum 4	82.2 ± 4.4	682
STATE of MICHIGAN	**81.1 ± 1.8**	**3,368**

Child Occupant Restraint Use by Age

Figure 2 shows child occupant restraint use rates by age. As can be clearly seen, restraint use for children in the 0 to 3 year old age group is close to 97 percent. Restraint use for children aged 4 to 15 is significantly lower at 74.6 percent. A pattern of decline in child restraint use with increasing age has been found by other researchers as well (Agran, Anderson, & Winn, 1997; Bolen & Bland, 1999; Ferguson, Wells, & Williams, 1999).

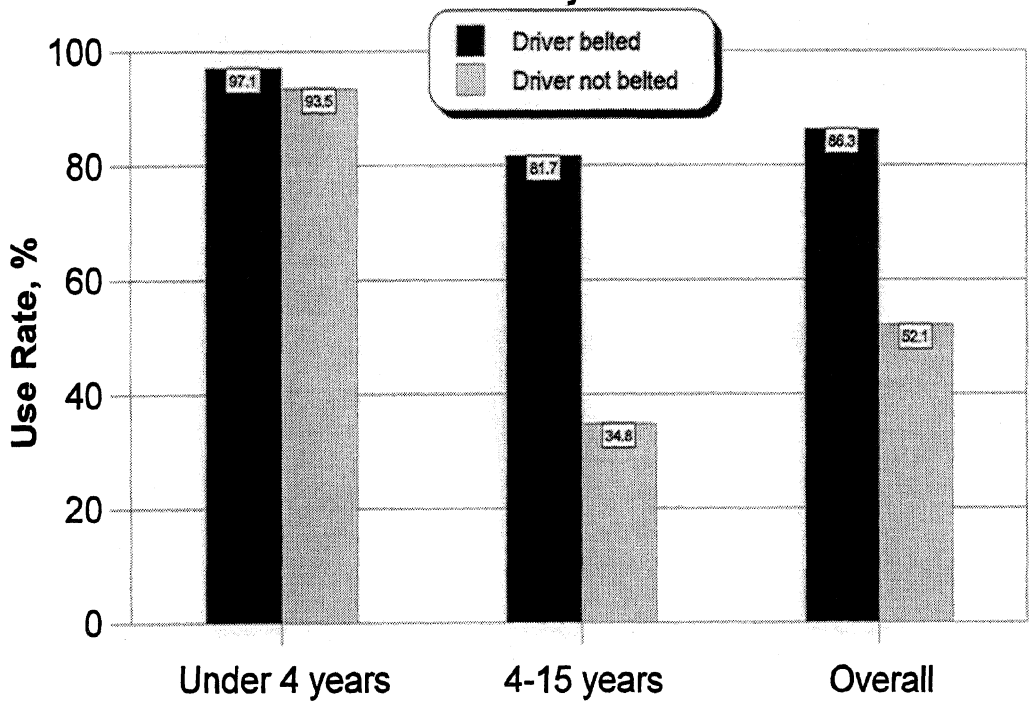
Figure 2: Child Occupant Restraint Use by Age



Child Occupant Restraint Use by Driver Belt Use

The estimated child occupant restraint use rates by driver belt use and age of the child occupant are shown in Figure 3. As can be seen, use was high for all age groups when the driver was belted, in agreement with the results of other studies (see, e.g., Bolen & Bland, 1999; Eby & Kostyniuk, 1999; Eby, Kostyniuk, & Christoff, 1997; Eby, Kostyniuk, & Vivoda, 1999; Edwards & Sullivan, 1997; Ferguson, Wells, & Williams, 1999; Miller, Spicer, & Lestina, 1998). The figure also shows that nearly all children under 4 years of age were restrained, regardless of the driver's belt use. However, a substantial difference (46.9 percentage points) is seen between child occupants in the 4 to 15 year old age group dependant upon the belt use of the driver.

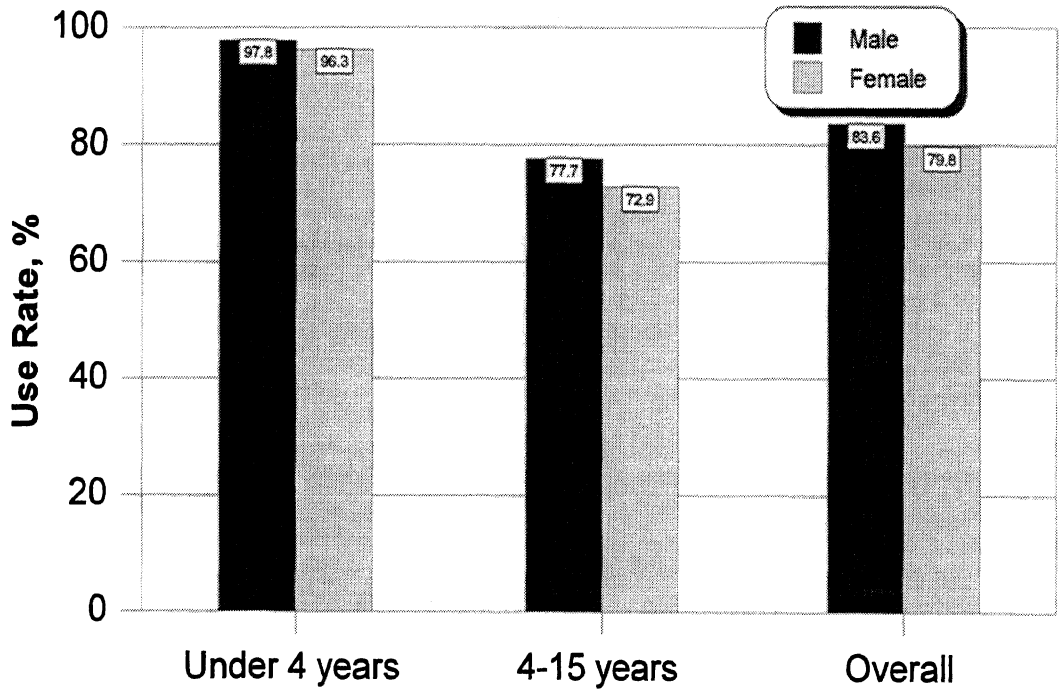
Figure 3: Child Occupant Restraint Use by Age and Driver Safety Belt Use



Child Occupant Restraint Use by Driver Sex

The estimated child occupant restraint use rates by driver sex and age of the child occupant are shown in Figure 4. Previous adult safety belt surveys conducted in Michigan have shown that females are more likely than males to use a safety belt (Eby, Molnar, & Olk, 2000). As children are much more likely to be restrained in vehicles in which the adult driver is also belted (e.g., see Eby & Kostyniuk, 1999; Eby, Kostyniuk, & Vivoda, in press; NHTSA, 2000), it could be expected that child passengers would have a higher restraint use rate in vehicles with a female driver. However, a statistical analysis reveals that there were no significant differences in child occupant restraint use as a function of driver sex. Restraint use rates were the same for children under 4 years of age and for children 4 to 15 years of age, regardless of driver sex. There was also no significant difference observed for both age groups combined.

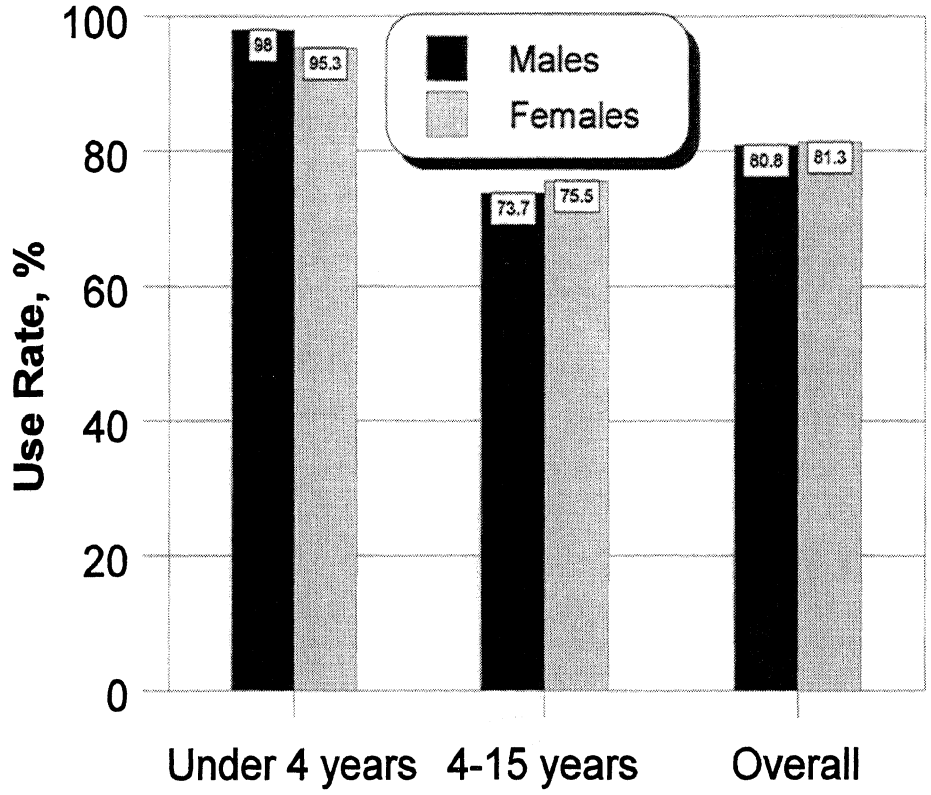
Figure 4: Child Occupant Restraint Use by Age and Driver Sex



Child Occupant Restraint Use by Child's Sex

Statewide child occupant restraint use rates for male and female children by age group and overall are shown in Figure 5. Unlike the clear sex differences in safety belt use that have been found for adult drivers and passengers (see, e.g., Agent, 1996; Eby, Vivoda, & Fordyce,1999; Lange & Voas, 1998), there was no significant difference in occupant restraint use between male and female child occupants for either of the two age groups or for the age groups combined.

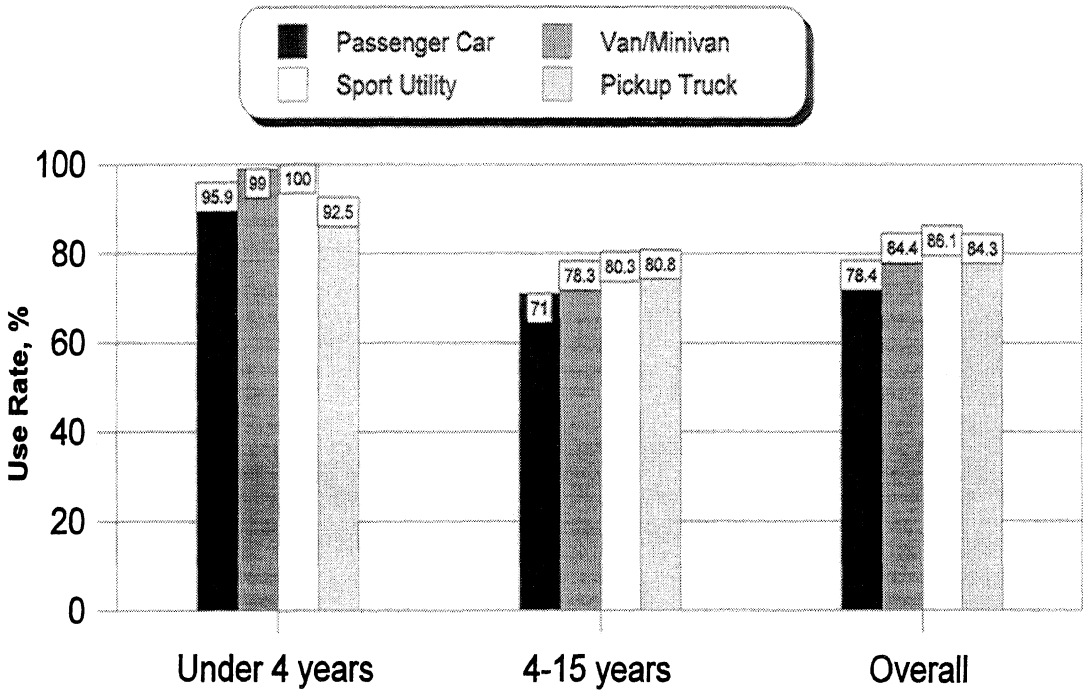
Figure 5: Child Occupant Restraint Use Rates by Child Sex and Age



Child Occupant Restraint Use by Vehicle Type

Shown in Figure 6 are the child occupant restraint use rates in Michigan by age group and overall for each of the four vehicle types observed in the study. Several interesting trends are evident. First, for all vehicle types, occupant restraint use was higher for the youngest age group than for older children. Second, in the youngest age group, restraint use (safety belt or child safety seat) did not vary as a function of vehicle type. Third, considering only the 4 to 15 year old age group, restraint use did not vary among the different vehicle types. Restraint use for passenger cars, 71.0 ± 3.3, was the exception, with a significantly lower use rate than the other vehicle types. Fourth, the overall child occupant restraint use rates by vehicle type followed a similar trend as the rates for the older children, with the lowest use rates found for passenger cars. These results are not typical of trends for safety belt use in Michigan. Front seat outboard occupants in passenger cars generally show the highest levels of restraint use; while restraint use by pickup truck occupants tends to be significantly lower than restraint use by occupants in other vehicle types. These trends can be seen in recent statewide surveys of safety belt use in Michigan (see, e.g., Eby & Christoff, 1996; Eby, Fordyce, & Vivoda, 2000; Eby & Hopp, 1997; Eby & Olk, 1998; Eby, Vivoda, & Fordyce, 1999, 2000).

Figure 6: Child Occupant Restraint Use by Age Group and Vehicle Type



Child Occupant Restraint Use by Seating Position

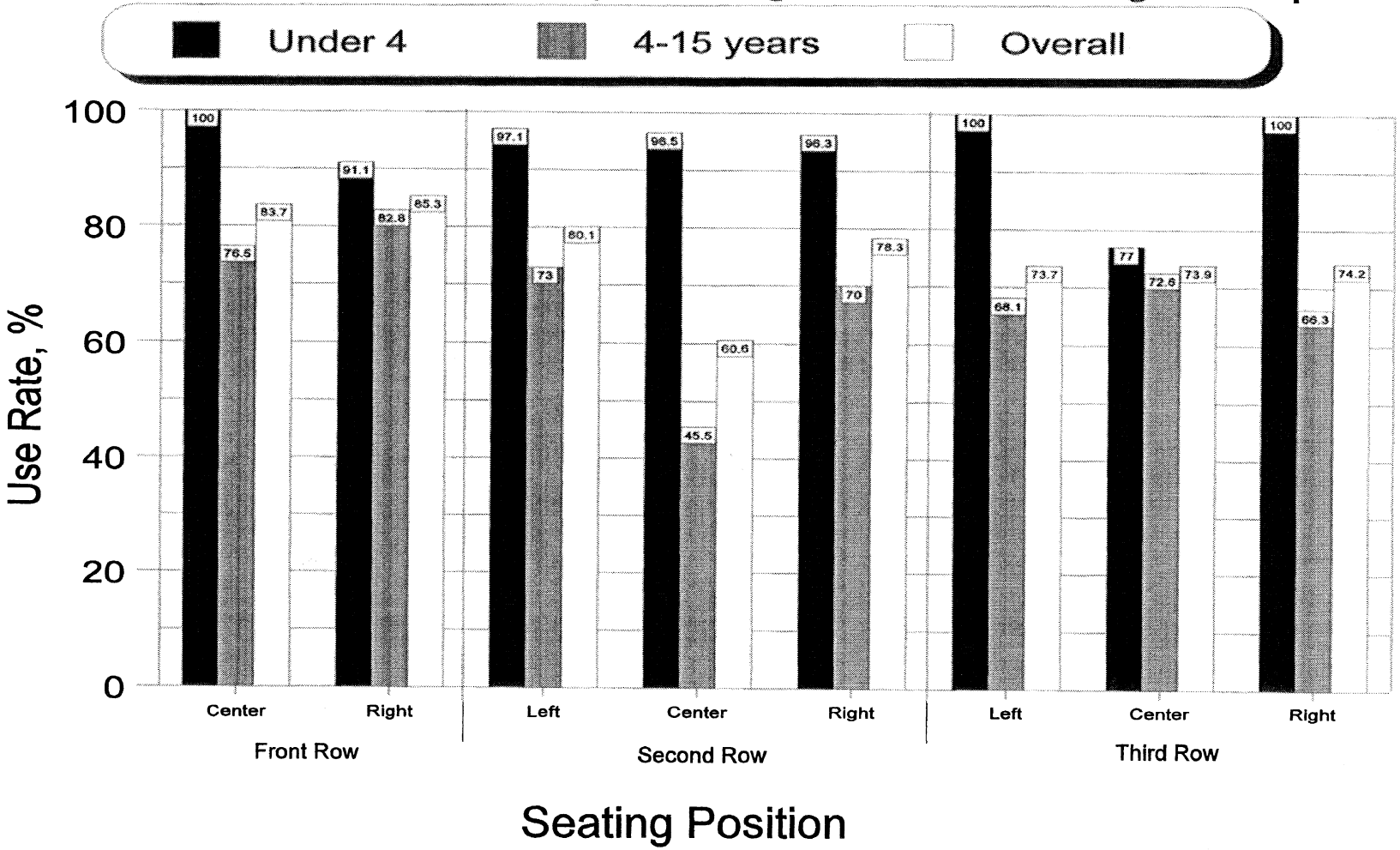
Child occupant restraint use rates by seating position, age group, and overall are shown in Figure 7, with each graph showing a different row of seats in the vehicle. Examination of the front seat rates show that there are no significant differences in overall child restraint use, regardless of seating position. Evidence suggests that older children were less likely to be restrained in the center seating position than younger children, although the low numbers of children (N=26) found in this seating position limits the confidence with which we can interpret this finding. In the right seating position, restraint use was high for both age groups, although it decreased with age. The right position was also a quite common seating position for older children, with nearly half of the older children in the sample found in this position.

Very few children in the youngest age group were seated in the front right seating position (N=22). As shown in Figure 7, the restraint use rates for the second row of seats varied greatly by age group. The youngest children, regardless of seating position, were restrained at a rate higher than 90 percent, whereas the use rates for older children were about 70 percent for the left and right position and only 46 percent for the center position. Almost all of the young children observed were found in the second row of seats, and about half of the older children were seated in this row.

Finally, very few children were found in the third row of seats (N=122). For the left and right seating positions, the restraint use rates for 4 to 15 year old children were similar to the rates for children of this age in the second row. However, restraint use rates were higher for children of this age group seated in the center position of the third row than in the center position of the second row. Children in the youngest age group who were seated in the third row center seating position had a use rate of 77 percent, a marked difference from children of this age in all other seating positions and rows, where restraint device use ranged from 90 to 100 percent. Again, this finding should be interpreted with caution, due to the low number of observations of children aged 3 and under found in this seating position (N=5). A survey designed specifically to examine restraint use in children 3 and under in the state of Michigan also found a low use rate for the third row center seating position (Eby & Kostyniuk, 1999).

Unlike the youngest age group, restraint use for children aged 4 to 15 varied depending upon row of seats, regardless of seating position within each row. Children in the front row were restrained at a rate of almost 83 percent, while children in the second and third row were only restrained at a rate of 68 percent.

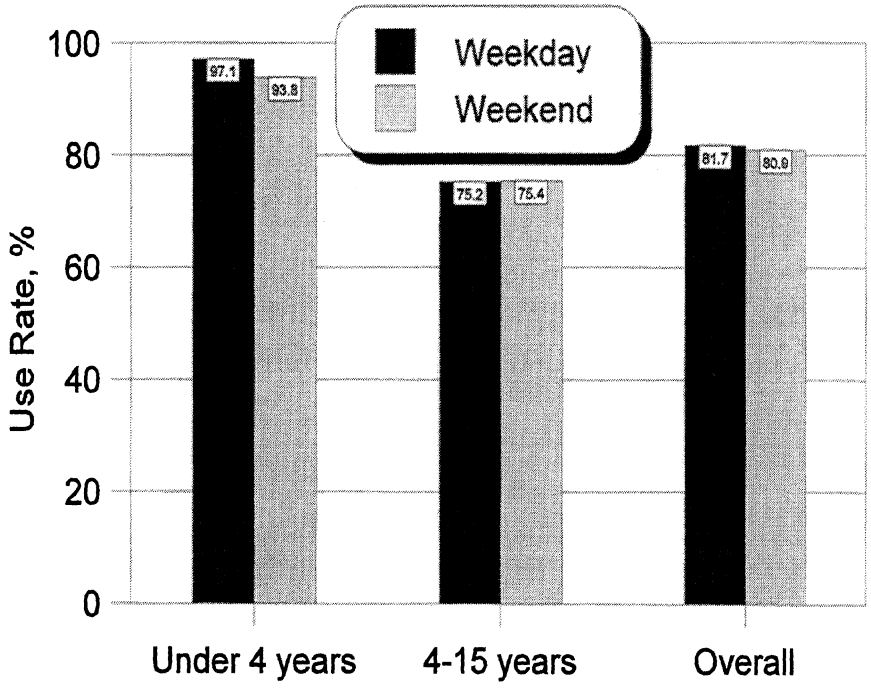
Figure 7: Restraint Use by Seating Position and Age Group



Child Occupant Restraint Use by Weekday/Weekend

Shown in Figure 8 are the child occupant restraint use rates by weekday (Monday through Friday) and weekend (Saturday and Sunday). There was no significant difference between occupant restraint use on the weekdays or weekend for either age group, or for the age groups combined.

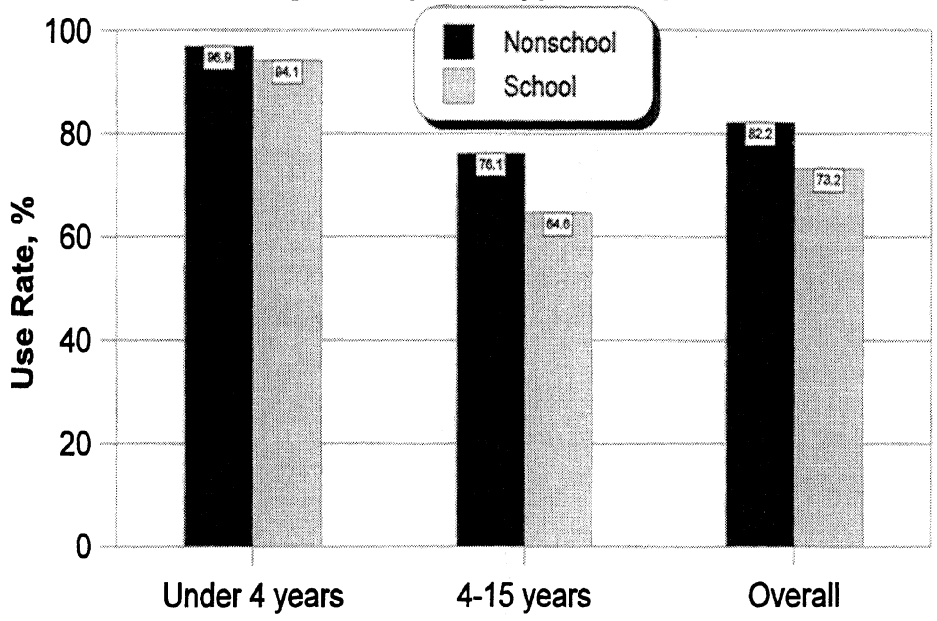
Figure 8: Child Occupant Restraint Use Rates by Age Group and Day of Week



Child Occupant Restraint Use by Type of Trip

Figure 9 shows child occupant restraint use rates by age group and the type of trip. There was little difference in occupant restraint use by type of trip for the youngest age group. However, for the 4 to 15 year old age group, restraint use was significantly lower for school trips. As 4 to 15 year old children comprise a large proportion of observations in this study, the overall use rate for school trips is lower, resulting in a difference of nearly ten percentage points by trip type.

Figure 9: Child Occupant Restraint Use Rate by Age Group and Type of Trip



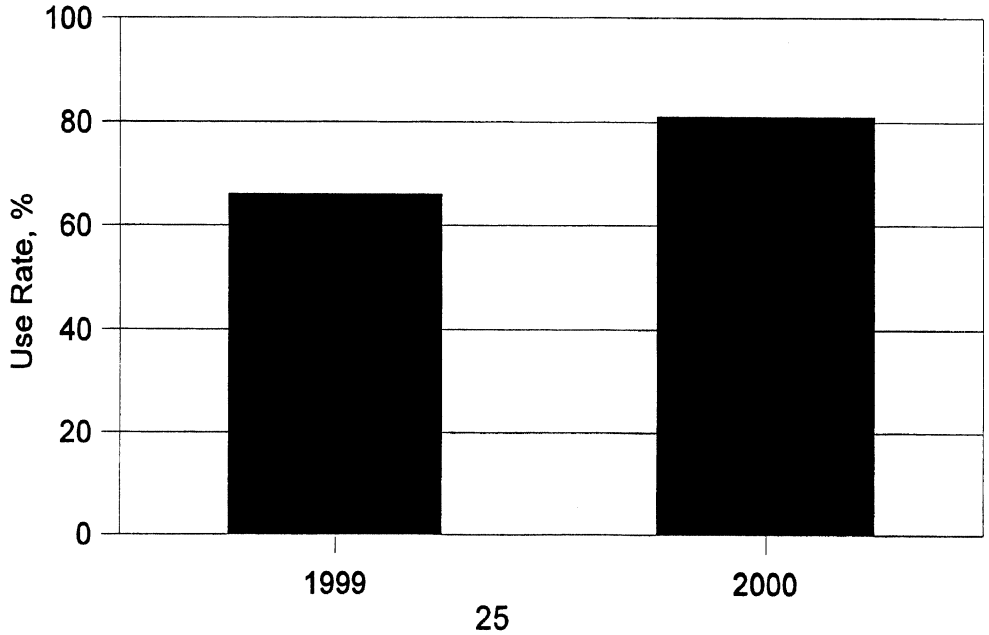
TRENDS

The current study of child occupant restraint use is the second of two direct observation surveys of child restraint use in Michigan. Both the current survey, and the previous survey, conducted in April, 1999, utilized the same sampling design and data collection procedures. Thus, it is possible to compare the results of the two surveys to investigate trends in child restraint use, to examine the effectiveness of Operation ABC, and to determine the impact that the introduction of standard enforcement legislation for adult belt use has had on child restraint use.

Overall Child Occupant Restraint Use by Year

Figure 10 shows the statewide child occupant restraint use rate by year. As can be clearly seen, the use rate has increased 15 percentage points over the last year. This increase is most likely due to a combination of factors. Undoubtedly, the introduction of standard enforcement legislation has had an effect. The increase in child restraint use is similar to the 13 percentage point increase in adult safety belt use after Michigan's safety belt law was upgraded to standard enforcement (Eby, Vivoda, & Fordyce, 1999; Eby, Fordyce, & Vivoda, 2000). Operation ABC, which was responsible for an increased awareness of child passenger safety, and zero tolerance enforcement of these laws is very likely another factor contributing to the increase in child restraint use.

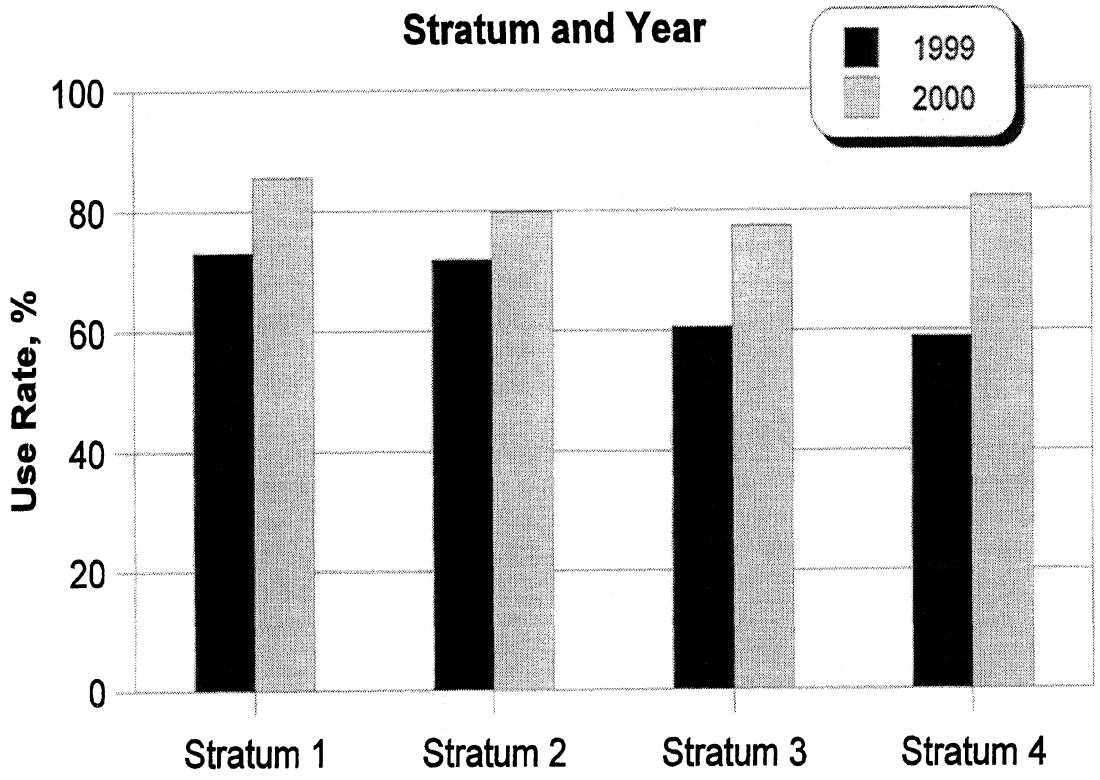
Figure 10: Child Occupant Restraint Use by Year



Child Occupant Restraint Use by Stratum and Year

Figure 11 shows the child occupant restraint use rate by stratum and year. Restraint use has increased in all strata, with the greatest gains seen in Stratum 3 and Stratum 4, showing 16.8 and 23.2 percentage point increases, respectively. Similar increases were reported in the statewide surveys of adult safety belt use conducted before and after standard enforcement legislation was implemented (Eby, Vivoda, & Fordyce,1999; Eby, Fordyce, & Vivoda, 2000).

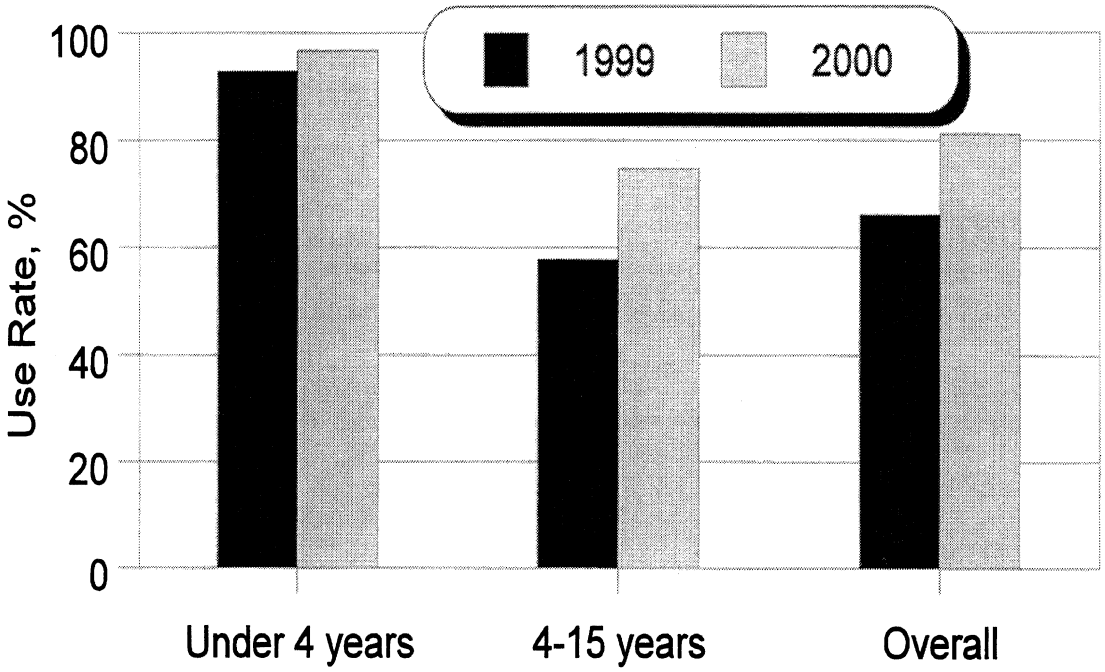
Figure 11: Child Occupant Restraint Use Rate by Stratum and Year



Child Occupant Restraint Use by Age Group and Year

Figure 12 shows child occupant restraint use by age group and year. While restraint use has increased for all children, children aged 4 to 15 show a greater increase than children under 4 years of age. This difference can be explained by the existence of a ceiling effect; almost all children under the age of 4 were found to be restrained in both the 1999 and 2000 child restraint use studies.

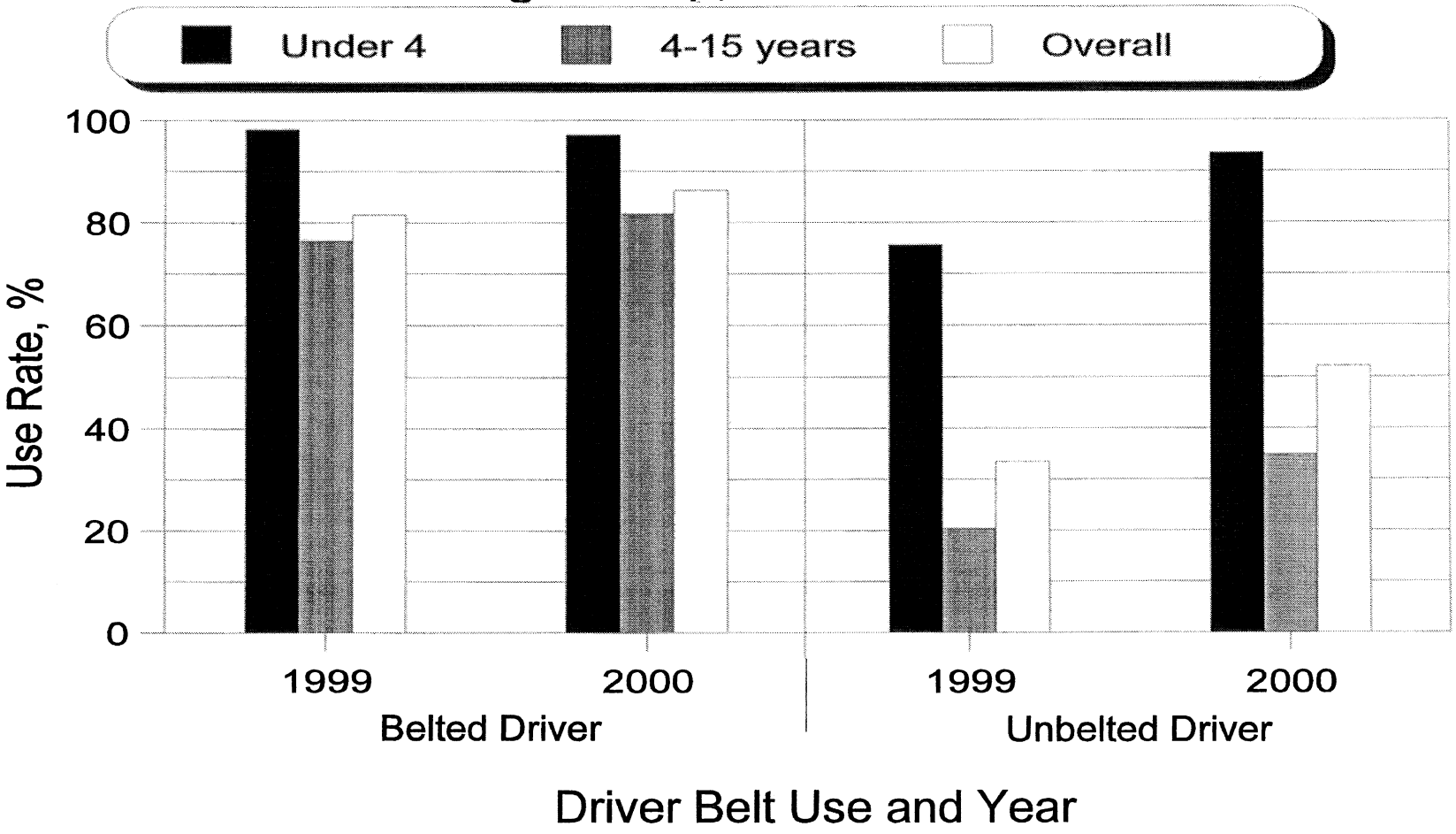
Figure 12: Child Occupant Restraint Use by Age Group and Year



Child Occupant Restraint Use by Age, Driver Belt Use, and Year

Figure 13 shows statewide child occupant restraint use rates by age, driver belt use, and year. The figure shows that restraint use rates have not changed significantly for children in motor vehicles with belted drivers for either age group or overall. Restraint use rates for children aged 3 and under appear to have increased by about 18 percentage points for children riding with unbelted drivers. However, the samples from both studies consisted of a small number of observations, resulting in large confidence bands that limit the certainty with which we can measure the increase. The restraint use rates for children aged 4 to 15, and for all children riding with an unbelted driver have increased significantly, by around 14 and 19 percentage points, respectively. These findings indicate Operation ABC, aimed to increase public awareness of child passenger safety laws and their effectiveness, may have succeeded in encouraging drivers to restrain their child passengers, though they themselves remained unrestrained.

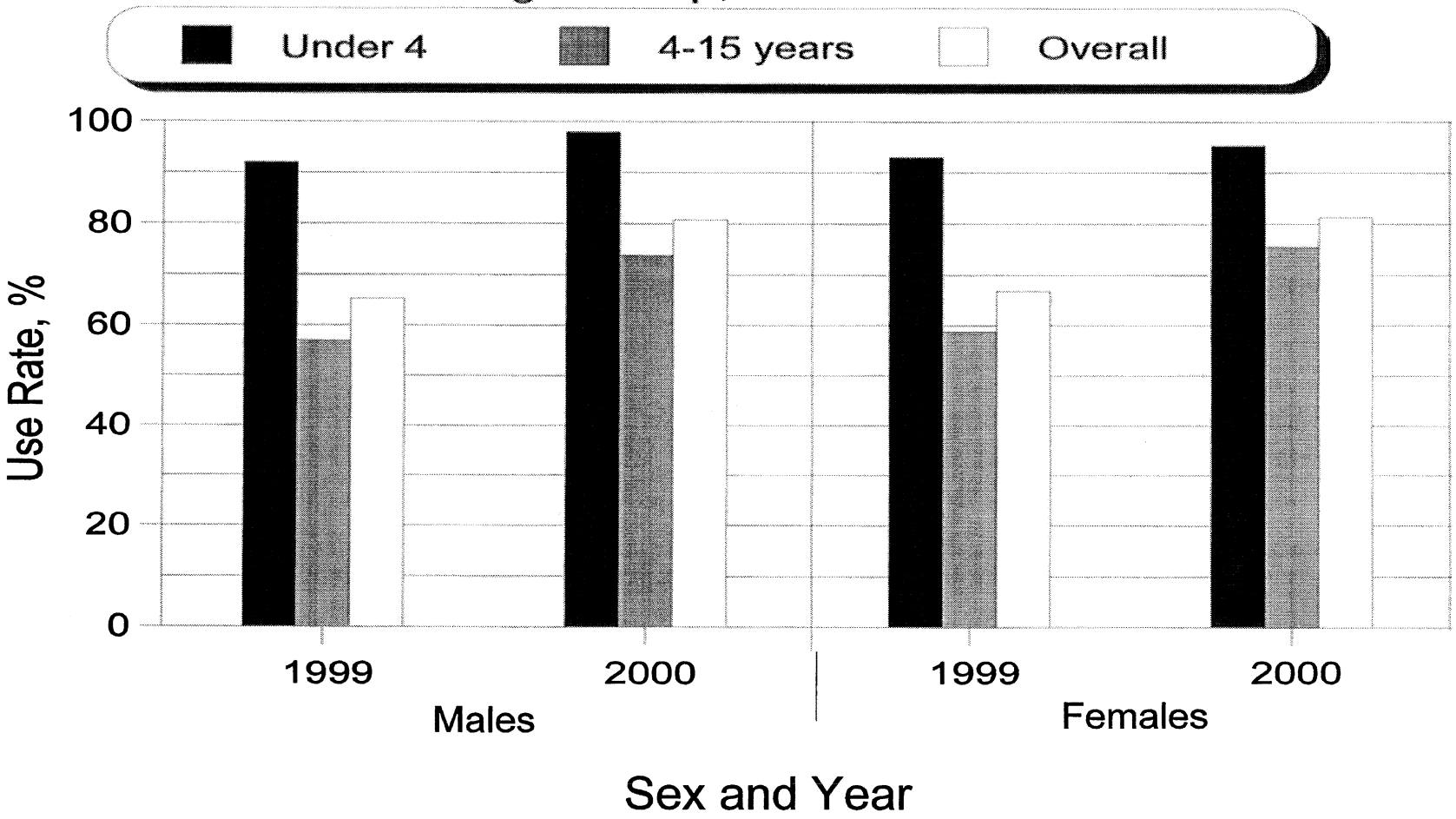
Figure 13: Child Occupant Restraint Use by Driver Belt Use, Age Group, and Year



Child Occupant Restraint Use by Child Sex, Age, and Year

Figure 14 shows child occupant restraint use rates by child sex, age, and year. Restraint use has not increased significantly for either males or females aged 3 and under. However, for child passengers aged 4 to 15, significant increases in restraint use were evidenced for both males and females. Overall belt use also increased significantly for both sexes. Restraint use for both males and females increased by about 15 percentage points each, indicating there are still no gender differences in restraint use among children.

Figure 14: Child Occupant Restraint Use by Sex, Age Group, and Year



Child Occupant Restraint Use by Age Group , Vehicle Type, and Year

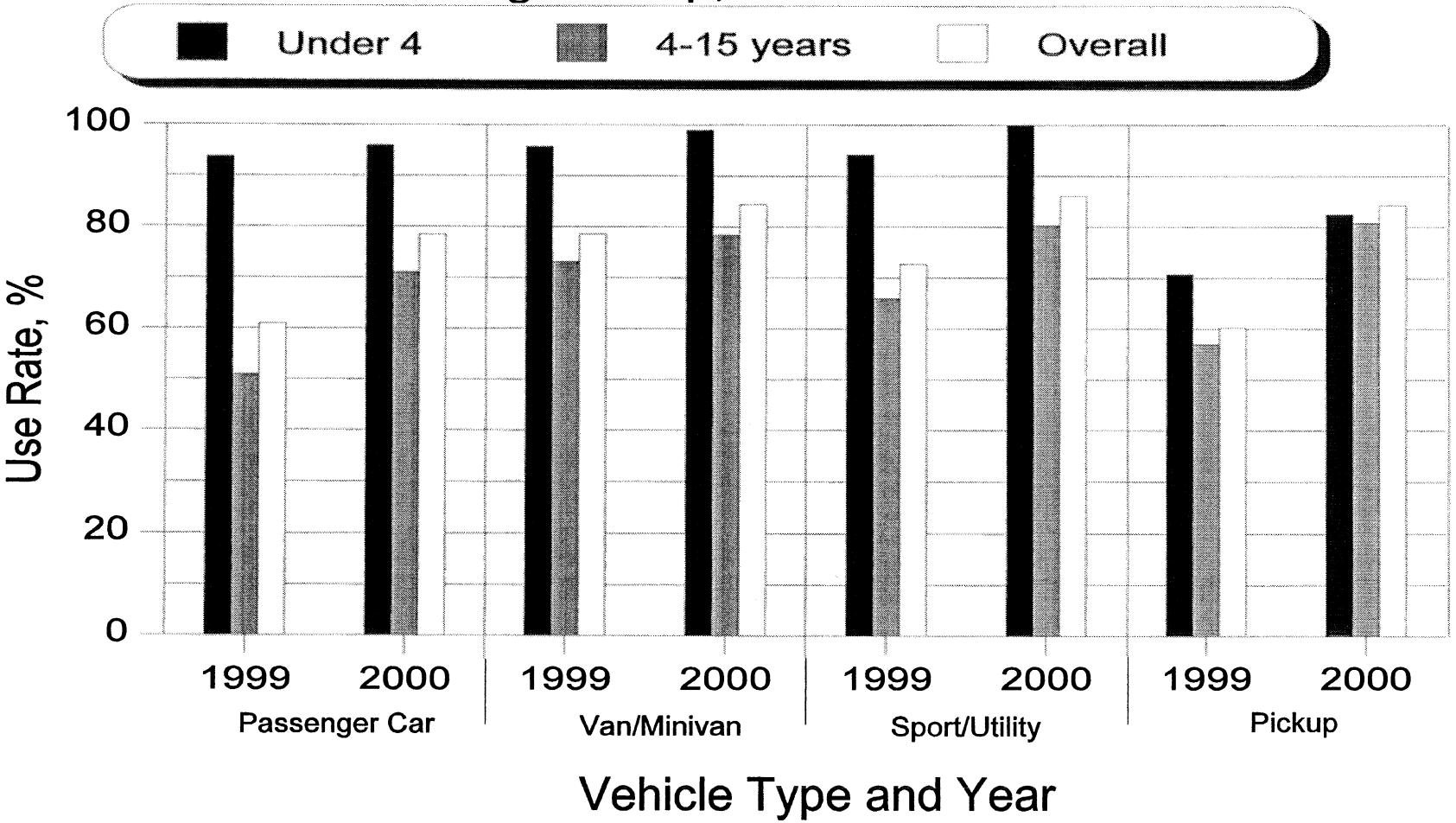
Figure 15 shows child occupant restraint use by age group, vehicle type and year. As the figure shows, there was not a significant difference in use rates for children aged 3 and under riding in passenger cars. However, there was a 20 percentage point increase in the use rate for children aged 4 to 15, and an overall increase of 17 percentage points for children in passenger cars.

Figure 15 also shows the child occupant restraint use rate for vans/minivans. There was no significant change for either age group, or for the age groups combined. The restraint use rate for child passengers in vans/minivans most likely remained stable because the rate for children observed in vans/minivans in 1999 was already relatively high, higher than the rate for children in other vehicle types.

As was observed for passenger cars and vans/minivans, the restraint use rate remained unchanged for children under the age of 4 in sport utility vehicles. The use rate for children aged 4 to 15 increased by more than 14 percentage points, and there was an overall increase of about 13 percentage points.

As seen in the other vehicle types, for child occupants in pickup trucks, there was no difference in the rates for younger children, while the rates for older children and overall increased by about 24 percentage points each. The largest increase in child occupant restraint use was observed for pickup trucks. Studies of adult safety belt use conducted prior to, and immediately following implementation of standard enforcement, also show that adult occupants of pickup trucks had the greatest increase in safety belt use. This suggests that standard enforcement legislation may be very effective in increasing both child and adult restraint use for pickup truck occupants, whose restraint use typically tends to be lower than restraint use by occupants in other vehicle types. Results from both surveys of child occupant restraint use indicate that children traveling in vans/minivans and sport utility vehicles are restrained at higher rates than children traveling in passenger cars and pickup trucks, although this difference is becoming much less pronounced.

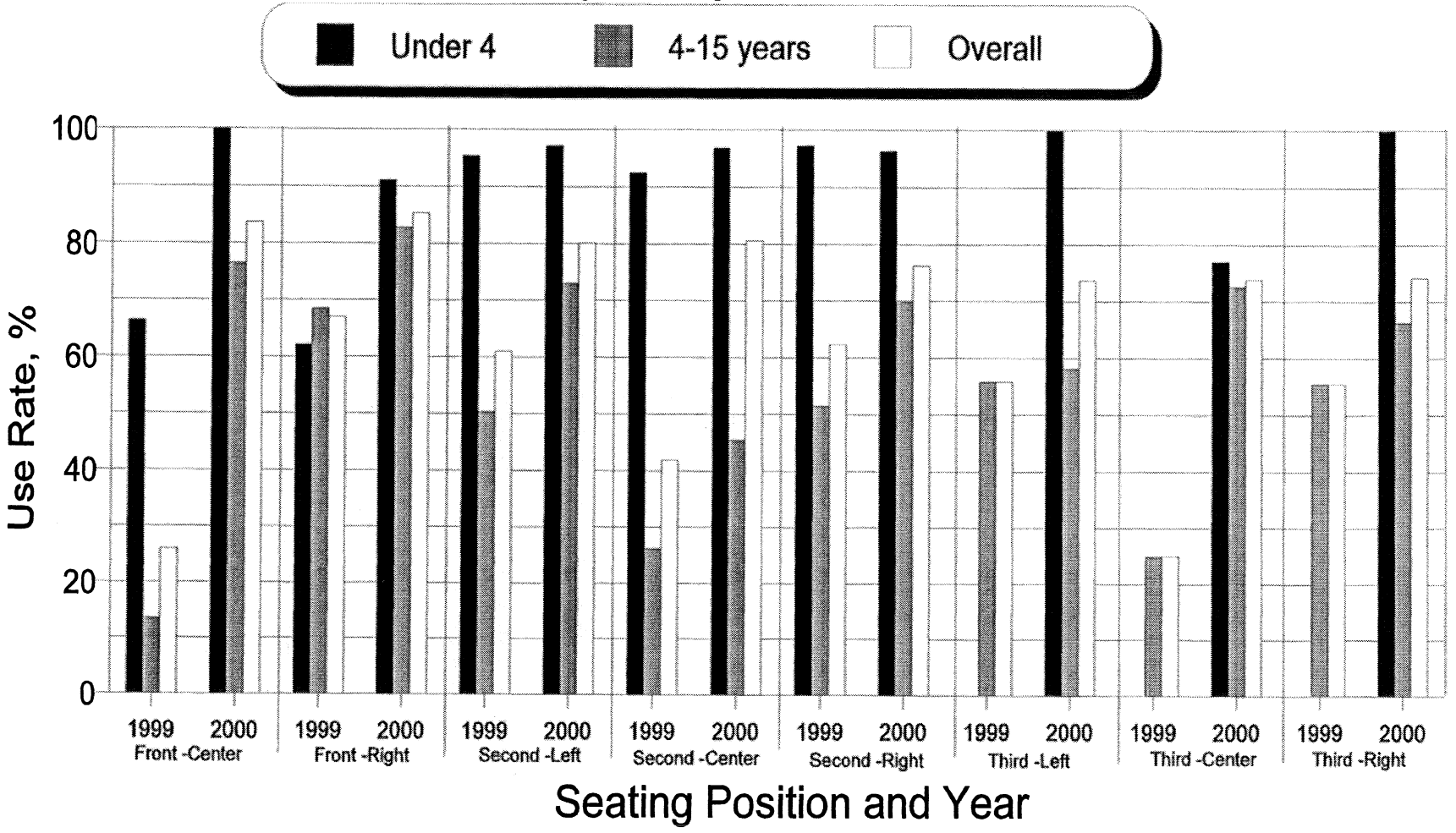
Figure 15: Child Occupant Restraint Use by Vehicle Type, Age Group, and Year



Child Occupant Restraint Use by Seating Position, Age Group, and Year

Figure16 shows child occupant restraint use by seating position, age group, and year. An examination of the front row center seating position reveals an increase in restraint use for each age group, and for both age groups. However, the small number of observations and the resulting large confidence bands limit the certainty of this finding. The figure also shows the rates for the front row right seating position. Again, due to the small number of children under the age of 4 in this seating position, it is difficult to ascertain the actual increase. For children in the 4 to 15 year old age group, and both age groups combined, significant increases were observed in this seating position over the last year. Restraint use for children under the age of 4 in the second row left, center, and right positions has not increased significantly. The rates for children in the 4 to 15 year old age group have increased significantly for all seating positions in the second row. Because the majority of the children (about 71 percent) in this row were in the 4 to 15 year old age group, there was an increase in the overall restraint use rates for each seating position. Across all three seating positions in the third row there appears to be an increase in restraint use for all three seating positions. However, the small numbers of observations in each group limit the strength with which we can assert that there was an increase. It is not surprising that there were few children seated in the third row as this row is only found in large vehicles such as vans/minivans and sport utility vehicles. It is interesting to note that in the 1999 child occupant restraint use survey, there were no children under 4 observed in the third row of seats, while in the current study, 15 children of this age group were observed in the third row, across all three seating positions.

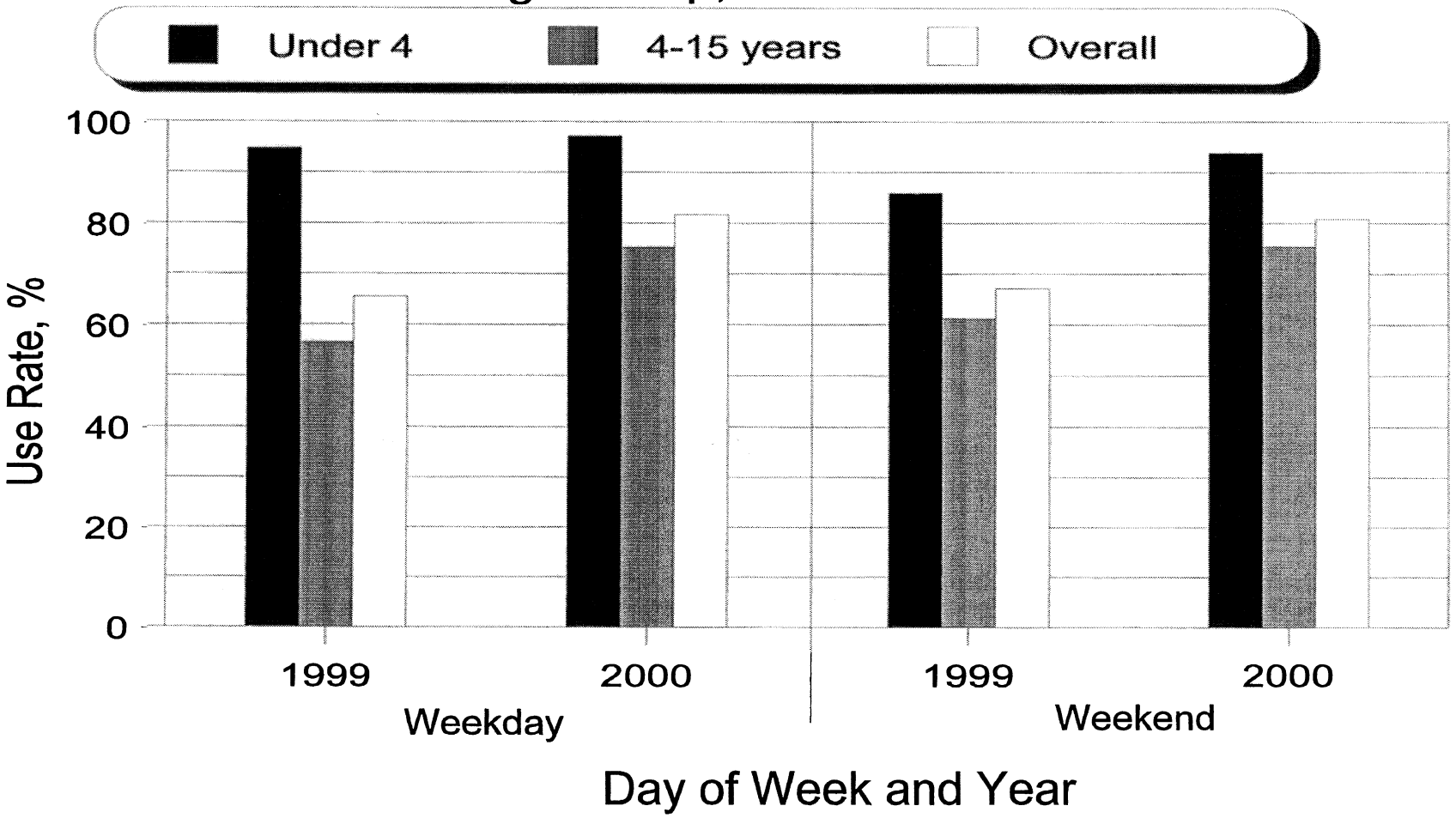
Figure 16: Child Occupant Restraint Use by Seating Position, Age Group, and Year



Child Occupant Restraint Use Rates by Age, Day of Week, and Year

Figure 17 shows child occupant restraint use rates by age, day of week, and year. For both weekdays and weekends, there have been significant increases in restraint use for both age groups combined. There was also a significant increase in weekday restraint use for children in the 4 to 15 year old age group. However, there were no other significant increases for the other age groups by day of week.

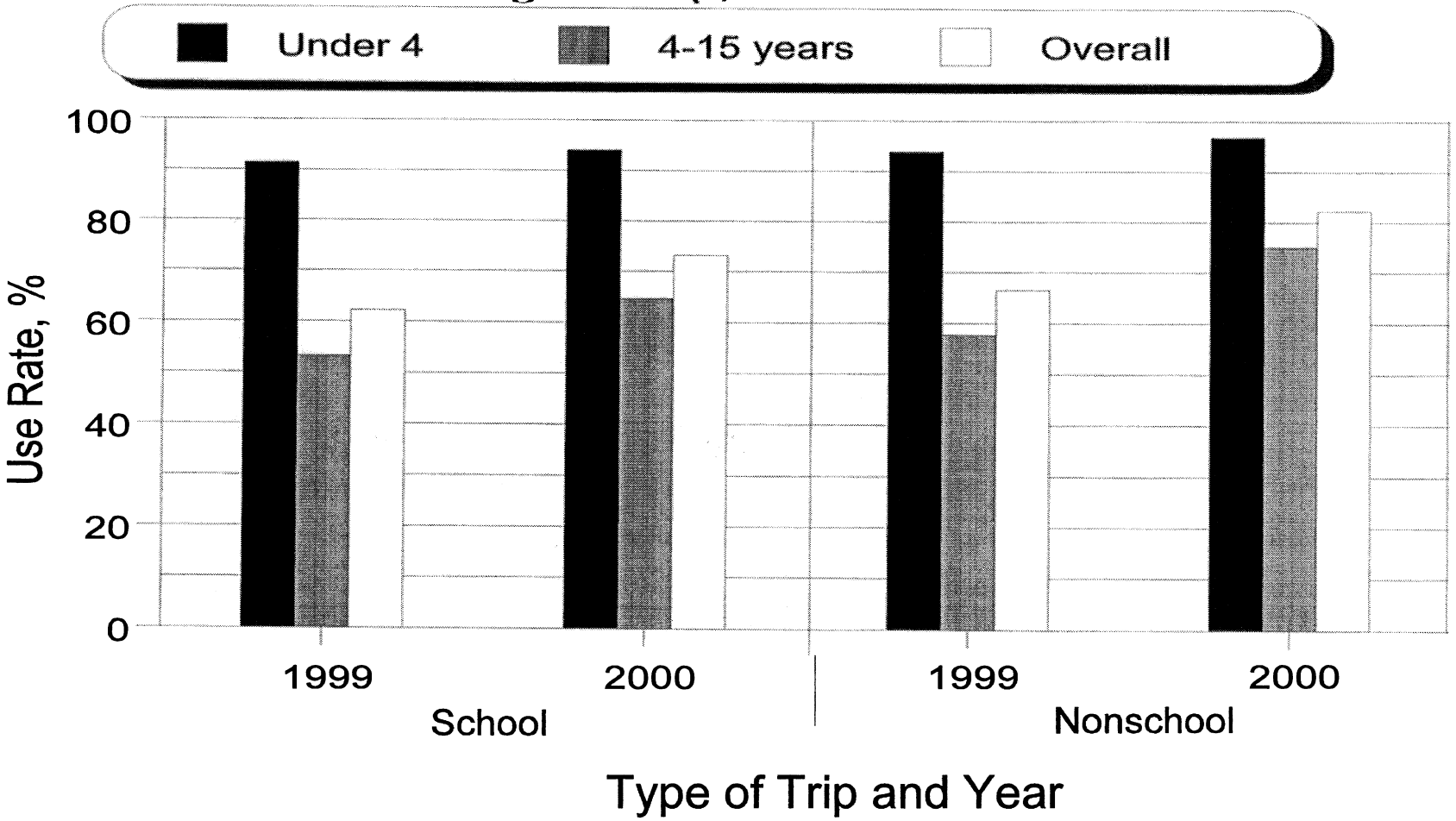
Figure 17: Child Occupant Restraint Use by Day of Week, Age Group, and Year



Child Occupant Restraint Use by Age, Type of Trip, and Year

Figure 18 shows child occupant restraint use by age, type of trip, and year. Although increases can be seen across both age groups in the use rates for school trips, these changes are not significant. Significant increases in restraint use were seen in the 4 to 15 year old age group and among both age groups combined for nonschool trips, which include trips to fast food restaurants, movie theaters, shopping malls, rinks, and recreation centers.

Figure 18: Child Occupant Restraint Use by Type of Trip, Age Group, and Year



DISCUSSION

The estimated statewide child occupant restraint use rate in Michigan for children under 16 years of age was 81.1 ± 1.8 percent. When compared with last year's rate of 66.1 ± 3.5 percent, the current rate shows that child occupant restraint use in Michigan has increased significantly over the past year; however, a segment of Michigan's child population is still riding unrestrained in vehicles. The significant increase in child occupant restraint use can be partly attributed to the implementation of standard enforcement legislation in Michigan on March 10, 2000 and an extensive PI&E program, the Operation ABC campaign.

A study of adult safety belt use in Michigan immediately following the introduction of standard enforcement showed an increase in safety belt use among adults, corresponding to that observed in children. As previously mentioned, the single most important factor in child occupant restraint use is adult safety belt use. When the driver is belted, many studies have established that child occupants are much more likely to be restrained (see, e.g., Bolen & Bland, 1999; Eby & Kostyniuk, 1999; Eby, Kostyniuk, & Christoff, 1997; Eby, Kostyniuk, & Vivoda, 1999; Edwards & Sullivan, 1997; Ferguson, Wells, & Williams, 1999; Miller, Spicer, & Lestina, 1998). In the current study, this trend was especially evident in the 4 to 15 year old age group. When the driver was using a safety belt, child occupants in Michigan were restrained more than 82 percent of the time, compared with only about 35 percent of the time when the driver was not using a safety belt. An effective means to further increase child occupant restraint use may be to focus highly publicized and visible enforcement efforts on the adult drivers of vehicles in violation of Michigan's safety belt use law, while continuing zero tolerance enforcement of child restraint use laws.

While the belt use of the driver does have an effect on the restraint use of child occupants, the sex of the driver does not seem to effect the use of occupant restraints by children. It could be argued that since children are much more likely to be restrained in vehicles in which the adult driver is also belted, and females use safety belts at a higher rate than males, children may be restrained at a higher rate in vehicles driven by females. However, in the current survey, no significant difference was found in child passenger

restraint use as a function of driver sex. This finding suggests that the belt use of the driver is a much better predictor of child passengers' restraint use than is driver sex.

Another important factor most likely affecting child restraint use is Operation ABC. In the past year, Michigan has expended a considerable amount of money and effort in this PI&E program designed to increase public awareness of child safety belt and safety seat use laws, and passenger safety. The goal of Operation ABC was to increase child restraint use across the nation and throughout Michigan. Operation ABC was the first nationally coordinated effort to attempt to enforce child passenger safety laws. Michigan law enforcement received $390,000 to help publicize their efforts, and more than half of the law enforcement agencies in Michigan participated. This program, along with the change to standard enforcement, likely contributed to the increase in child occupant restraint use in all strata. Other local PI&E programs such as Children Buckle U.P., based in Michigan's Upper Peninsula, and Stay in the Game, based in Wayne County, also appear to have had an effect.

The greatest increases in child restraint use were seen in Stratum 3, which contains the Upper Peninsula, and Stratum 4 which is comprised of Wayne County. Click It or Ticket, a program designed to increase public awareness of the new standard enforcement law, was also focused in Wayne County and may have helped to increase both adult and child restraint use in this area. These findings show that efforts to increase both adult belt use and child occupant restraint use in Michigan have been effective and should be continued to address the remaining 18.9 percent of child occupants that are not restrained.

When comparing the child restraint use rates by vehicle type from the study conducted in 1999 and the current study, it is evident that restraint use followed the same basic patterns, but increased for all vehicles types, with the largest increase for occupants in pickup trucks. For the youngest age group, use was high in all vehicle types. The use rates for older children were the lowest for children riding in passenger cars. This finding was surprising because passenger car safety belt use in Michigan is usually about the same as use in vans/minivans and sport utility vehicles (see e.g., Eby, Fordyce, & Vivoda, 2000; Eby & Olk, 1998; Eby, Vivoda, & Fordyce, 1999). It was also interesting that the rate of

restraint use for older children in pickup trucks was not significantly different from the rate for children riding in sport utility vehicles and vans/minivans. Safety belt use of pickup truck occupants in Michigan has previously been significantly lower than the other vehicle types (see e.g., Eby, Fordyce, & Vivoda, 2000; Eby & Olk, 1998; Eby, Vivoda, & Fordyce, 1999). The overall child occupant restraint use rates by vehicle type followed a similar trend as the rates for older children, with the lowest rates found for passenger cars. It may be the case that the higher overall restraint use rate in sport utility vehicles and minivans is due to the fact they are newer vehicles, as restraint use is lower in older vehicles (Agran, Anderson, & Winn, 1997). However, these results cannot be definitively explained without further research.

For children under the age of 4, restraint use rates remained the same, at a rate of 90 percent or higher, across all seating positions and rows. The only seating position where this high restraint use was not observed was in the third row center, however there were only 5 children observed in this position. While there has been a steady decline in the number of young children riding in the front row in recent years (Glass & Graham, 1999), more than 5 percent of children under the age of 4 in our sample were observed in the front row, although numerous studies have reported that in the event of a crash children of all ages are much safer in the rear seat (Braver, Whitfield, & Ferguson, 1997; Ferguson, Wells, & Williams, 1999; Glass & Graham, 1999; IIHS, 2000; NHTSA, 1996; Williams, Wells, & Ferguson, 1997). This issue is especially relevant as most new cars are equipped with passenger side air bags. According to NHTSA, by 1999, a total of 73 children had been killed in low severity crashes as a result of passenger side airbag deployments (Ferguson, Wells, & Williams, 1999). The National Transportation Safety Board has recommended that state legislatures amend their child restraint use laws and require children aged 13 and under to be seated in the rear seat, provided a position is available (Glass & Graham, 1999). Delaware, Louisiana, and Rhode Island have already passed such legislation (Ferguson, Wells, & Williams, 1999). Fortunately, the vast majority of children in our sample aged 3 and under were seated in the second row. For children aged 4 to 15, restraint use varied depending upon the row of seats, regardless of seating position within each row. Children aged 4 to 15 seated in the front row were restrained more frequently than children of this age seated in any other row, regardless of seating position. Nearly half of the older children observed in this sample were seated in the front row. Almost all of the

rest of the older children were seated in the second row, with only a small percentage observed in the third row. Research has indicated that children are riding in the front seat of vehicles even when there are unoccupied rear seats available (Edwards & Sullivan, 1997; Ferguson, Wells, & Williams, 1999; Glass & Graham, 1999). Anecdotal evidence from the observers collecting data for this study suggest this was the case in our survey. PI&E programs should focus on increasing restraint use for older children regardless of seating position, while enforcing the idea that children are at much less risk of injury in a motor vehicle crash if they are seated in the rear (Braver, Whitfield & Ferguson, 1997).

An analysis of child occupant restraint use by type of trip reveals that older children are buckled less frequently on school trips than on nonschool trips. Anecdotal evidence from observers collecting study data suggest that there was usually a larger number of children observed in vehicles at school sites. Consequently, it may be very difficult for the driver to monitor restraint use. Additionally, it is likely that the driver is not the parent of all of the child passengers in these instances. It could be the case that the driver is less inclined to insist that an unrelated child passenger wear a safety belt. However, further research is needed to explain this finding.

Finally, analysis of use rates by several other important factors showed that child occupant use did not vary by the child's sex, or whether it was a weekend or weekday. The lack of a sex difference shows that parents or guardians are not discriminating by sex when they decide to restrain the child occupant. It is interesting to note that for occupants 16 years of age and older, who are more likely to be making the decision to use or not use safety belts themselves, clear sex differences in use are found, with use significantly lower for males (e.g., see Agent, 1996; Eby & Olk, 1998; Lange & Voas, 1998; Williams, Wells, & Lund, 1987).

In conclusion, this study provides a current rate of child occupant restraint use for the state of Michigan. This study, the second yearly survey of child restraint use in Michigan, enables us to identify emerging trends; to examine and measure changes resulting from standard enforcement legislation; and to assess the effects of PI&E programs. Additionally, several factors were identified that should prove beneficial in the design and targeting of new enforcement and PI&E programs.

REFERENCES

Agent, K.R. (1996). *1996 Safety Belt Usage Survey and Evaluation of Effectiveness in Kentucky.* (Report No. KTC-96-20). Lexington, KY: Kentucky Transportation Center.

Agran, P.F., Anderson, C.L., & Winn, D.G. (1997). Restraint use among children in fatal crashes. *Child Occupant Protection 2nd Symposium Proceedings* (pp. 55-60). Warrendale: Society of Automotive Engineers, Inc.

Bolen, J. & Bland, S. (1999). Changes in occupant restraint use among children aged 0-14 years: United States, 1993-1997. *Child Occupant Protection in Motor Vehicle Crashes* (pp. 169-170). London: Professional Engineering Publishing Limited.

Braver, E.R., Whitfield, R., & Ferguson, S.A. (1997). Restraint use among children in fatal crashes. *Child Occupant Protection 2nd Symposium Proceedings* (pp. 25-31). Warrendale: Society of Automotive Engineers, Inc.

Center for Disease Control. (1991). Effectiveness in disease and injury prevention child passenger restraint use and motor-vehicle-related fatalities among children – United States, 1982-1990. Morbidity and Mortality Weekly Report, 40(34), 600-602.

Eby, D. W. & Christoff, C. (1996). *Direct Observation of Safety Belt Use in Michigan: Fall 1996.* (Report No. UMTRI-96-34). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Eby, D.W., Fordyce, T.A., & Vivoda, J.M. (2000). *Michigan Safety Belt Use Immediately Following Implementation of Standard Enforcement.* (Report No. UMTRI-2000-25). Ann Arbor, MI: University of Michigan Transportation Research Institute.

Eby, D.W. & Hopp, M.L. (1997). *Direct Observation of Safety Belt Use in Michigan: Fall 1997.* (Report No. UMTRI-97-41). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Eby, D.W. & Kostyniuk, L.P. (1999). A statewide analysis of child safety seat use and misuse in Michigan. *Accident Analysis & Prevention, 31*, 555-566.

Eby, D.W., Kostyniuk, L.P., & Christoff, C. (1997). *Child Restraint Device Use and Misuse in Michigan.* (Report No. UMTRI-97-36). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Eby, D.W., Kostyniuk, L.P., & Vivoda, J.M. (1999). *An Analysis of Restraint Use by Children in Michigan.* (Report No. UMTRI-99-24). Ann Arbor, MI: University of Michigan Transportation Research Institute.

Eby, D.W., Kostyniuk, L.P., & Vivoda, J.M. (in press). Restraint use patterns for older child passengers in Michigan. *Accident Analysis and Prevention.*

Eby, D.W., Molnar, L.J., & Olk, M.L. (2000). Trends in driver and front-right passenger safety belt use in Michigan: 1984-1998. *Accident Analysis & Prevention, 32*, 837-843.

Eby, D.W. & Olk, M.L. (1998). *Direct Observation of Safety Belt Use in Michigan: Fall 1998.* (Report No. UMTRI-98-46). Ann Arbor, MI: University of Michigan Transportation Research Institute.

Eby, D.W., Vivoda, J.M., & Fordyce, T.A. (1999). *Direct Observation of Safety Belt Use in Michigan: Fall 1999.* (Report No. UMTRI-99-33). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Eby, D.W., Vivoda, J.M., & Fordyce, T.A. (2000). *A Study of Michigan Safety Belt Use Prior to Implementation of Standard Enforcement.* (Report No. UMTRI-2000-08). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Edwards, J. & Sullivan, K. (1997). *Where are all the Children Seated and When are They Restrained?* (Report No. 971550). Warrendale, PA: Society of Automotive Engineers, Inc.

Evans, W.N. & Graham, J.D. (1990). An estimate of the lifesaving benefit of child restraint use legislation. *Journal of Health Economics, 9*, 121-142.

Federal Highway Administration (1997). *1995 NPTS Data Files*. CD ROM. Washington, DC: US Department of Transportation.

Ferguson, S.A., Wells, J.K., & Williams, A.F. (1999). *Child Seating Position and Restraint Use in Three States.* Arlington, VA: Insurance Institute for Highway Safety.

Glass, R.J. & Graham, J.D. (1999). Kids at risk: Where American children site in passenger vehicles. *Journal of Safety Research, 30*(1), 17-24.

Insurance Institute for Highway Safety. (2000). Fatality Facts: Children. [On-line] Available: http://www.highwaysafety.org/safety_facts/fatality_facts/children.htm.

Lange, J.E. & Voas, R.B. (1998). Nighttime observations of safety belt use: An evaluation of California's primary Law. *American Journal of Public Health*, 88, 1718-1720.

Miller, T.R., Spicer, R.S., & Lestina, D.C. (1998). Who is driving when unrestrained children and teenagers are hurt? *Accident Analysis and Prevention, 30*(6), 839-849.

National Highway Traffic Safety Administration (1992). Guidelines for State Observational Surveys of Safety Belt and Motorcycle Helmet Use. *Federal Register*, 57(125), 28899-28904

National Highway Traffic Safety Administration. (1996). State legislative fact sheet (September 1996). Washington, DC: National Highway Traffic Safety Administration.

National Highway Traffic Safety Administration. (1999). Occupant protection program update (Fall 1999). Washington, DC: National Highway Traffic Safety Administration.

National Highway Traffic Safety Administration (2000). The Facts: The Effectiveness of Standard Seat Belt Use Laws. [On-line] Available: http://www.nhtsa.dot.gov/people /injury/airbags/seatbelt/effectiv.htm

National Safety Council. (1999). More than Half of Americans Now Protected by Primary Seat Belt Laws. [On-line] Available: http://nsc.org/news/nr013100.htm.

Research Triangle Institute (1997) *Nationwide Personal Transportation Survey: Users Guide for the Public Use Data Files.* (Report No. FHWA-PL-98-002). Washington, DC: US Department of Transportation.

Rock, S.M. (1996). Impact of the Illinois child passenger protection act: A retrospective look. *Accident Analysis and Prevention, 28*(4), 487-492.

Streff, F. M., Eby, D. W., Molnar, L. J., Joksch, H. C., & Wallace, R. R. (1993). *Direct Observation of Safety Belt and Motorcycle Helmet Use in Michigan: Fall 1993.* (Report No. UMTRI-93-44). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

U.S. Bureau of the Census (1992). *1990 Census of Population and Housing* (from University of Michigan UM-ULibrary Gopher-computer datafile).

Wagenaar, A. C., Molnar, L. J., & Businski, K. L. (1987a). *Direct Observation of Safety Belt Use in Michigan: December 1986.* (Report No. UMTRI-87-03). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Wagenaar, A. C., Molnar, L. J., & Businski, K. L. (1987b). *Direct Observation of Safety Belt Use in Michigan: April 1987.* (Report No. UMTRI-87-25). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Wagenaar, A. C., Molnar, L. J., & Businski, K. L. (1988). *Direct Observation of Safety Belt Use in Michigan: Spring 1988.* (Report No. UMTRI-88-24). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Wagenaar, A. C. & Molnar, L. J. (1989). *Direct Observation of Safety Belt Use in Michigan: Spring 1989.* (Report No. UMTRI-89-12). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Williams, A.F., Wells, J.K., & Ferguson, S.A. (1997). Development and evaluation of programs to increase proper child restraint use. *Journal of Safety Research, 28*(2), 69-73.

Williams, A.F., Wells, J.K., & Lund, A.K. (1987). Shoulder belt use in four states with belt use laws. *Accident Analysis & Prevention*, 19, 251-260.

Appendix A: Data Collection Forms

YOUTH SAFETY BELT STUDY - SITE DESCRIPTION FORM 2000

SITE # __ __ __ (1 2 3) SITE LOCATION _____

DATE (month/day): __ __/__ __/2 0 0 0 (4 5 6 7 8 9 10 11)

OBSERVER

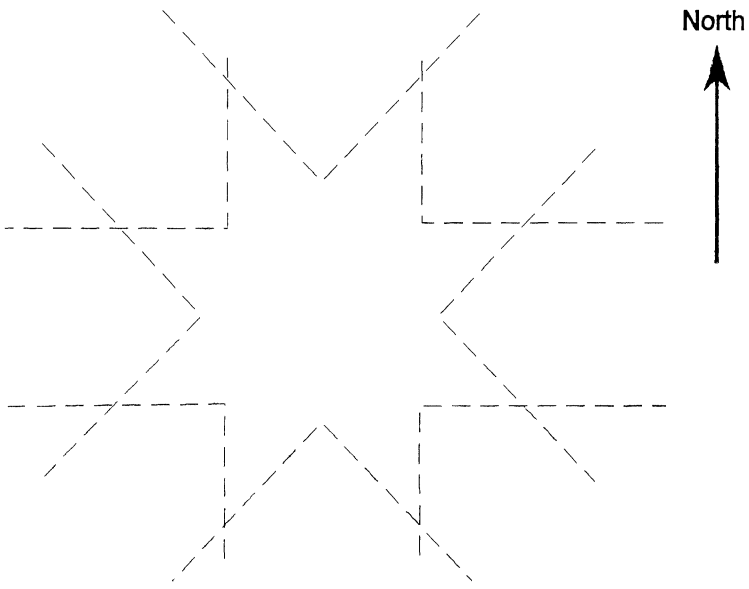
1☐ Marilyn
2☐ Jim
3☐ Amin
4☐ Steve
5☐ Jonathon
6☐ Tiffani
7☐ Dave
8☐ Lidia

12

SITE TYPE	**SITE CHOICE**	**DAY OF WEEK**	**WEATHER**
1☐ School	1☐ Primary	1☐ Monday	1☐ Mostly Sunny
2☐ Fast Food	2☐ Alternate	2☐ Tuesday	2☐ Mostly Cloudy
3☐ Other		3☐ Wednesday	3☐ Rain
		4☐ Thursday	4☐ Snow
		5☐ Friday	
		6☐ Saturday	
		7☐ Sunday	
13	14	15	16

START TIME: __ __:__ __ (17 18 19 20) (24 hour clock) END TIME: __ __:__ __ (21 22 23 24) (24 hour clock)

COMMENTS:



OBSERVATION FORM

SITE # ___ ___ ___ (1 2 3) OBSERVER NO. _____ (4) Team:_____

ATTENTION CODING: DUPLICATE COL 1 - 4 FOR EACH VEHICLE

PAGE #_____

VEHICLE NO. 1

1☐ Psngr car 2☐ Van 3☐ Utility 4☐ Pick-up (5)

DRIVER	CENTER	RIGHT
1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm (6)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (7)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (8)
1☐ Male 2☐ Female (9)	1☐ Male 2☐ Female (10)	1☐ Male 2☐ Female (11)
1☐ 16 - 29 2☐ 30 - 59 3☐ 60+ (12)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (13)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (14)

---2ND ROW---

LEFT	CENTER	RIGHT
1☐Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (15)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (16)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (17)
1☐ Male 2☐ Female (18)	1☐ Male 2☐ Female (19)	1☐ Male 2☐ Female (20)
1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (21)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (22)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (23)

---3RD ROW---

LEFT	CENTER	RIGHT
1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (24)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (25)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (26)
1☐ Male 2☐ Female (27)	1☐ Male 2☐ Female (28)	1☐ Male 2☐ Female (29)
1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (30)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (31)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (32)

VEHICLE NO.2

1☐ Psngr car 2☐ Van 3☐ Utility 4☐ Pick-up (5)

DRIVER	CENTER	RIGHT
1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm (6)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (7)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (8)
1☐ Male 2☐ Female (9)	1☐ Male 2☐ Female (10)	1☐ Male 2☐ Female (11)
1☐ 16 - 29 2☐ 30 - 59 3☐ 60+ (12)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (13)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (14)

---2ND ROW---

LEFT	CENTER	RIGHT
1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (15)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (16)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (17)
1☐ Male 2☐ Female (18)	1☐ Male 2☐ Female (19)	1☐ Male 2☐ Female (20)
1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (21)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (22)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (23)

---3RD ROW---

LEFT	CENTER	RIGHT
1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (24)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (25)	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD (26)
1☐ Male 2☐ Female (27)	1☐ Male 2☐ Female (28)	1☐ Male 2☐ Female (29)
1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (30)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (31)	1☐ 0 - 3 2☐ 4 - 9 3☐ 10-15 (32)

ote: Form is not shown at actual size.

Appendix B: Site Listing

SITE	NAME	ADDRESS	CITY	COUNTY	STR
1	MC DONALD'S	1630 HASLETT RD # 2	HASLETT	INGHAM	1
2	EDRU SKATING ARENA	1891 CEDAR ST	HOLT	INGHAM	1
3	MERIDIAN MALL	1982 W GRAND RIVER AVE	OKEMOS	INGHAM	1
4	TACO BELL	2030 W GRAND RIVER AVE	OKEMOS	INGHAM	1
5	MC DONALD'S	3477 OKEMOS RD	OKEMOS	INGHAM	1
6	MC DONALD'S	2120 N LARCH ST	LANSING	INGHAM	1
7	BURGER KING	523 S WAVERLY RD	LANSING	INGHAM	1
8	BURGER KING	4200 STADIUM DR	KALAMAZOO	KALAMAZOO	1
9	TACO BELL	3992 S WESTNEDGE AVE	KALAMAZOO	KALAMAZOO	1
10	KFC	24432 W 10 MILE	SOUTHFIELD	OAKLAND	1
11	MC DONALD'S	2829 W 14 MILE RD	ROYAL OAK	OAKLAND	1
12	ARBY'S	22729 PONTIAC TRL	SOUTH LYON	OAKLAND	1
13	TACO BELL	21350 GREENFIELD RD	OAK PARK	OAKLAND	1
14	CHUCK E CHEESE'S	201 E AUBURN RD	ROCHESTER HLS	OAKLAND	1
15	SUBURBAN SOFTBALL	2801 W HAMLIN RD	ROCHESTER HLS	OAKLAND	1
16	BURGER KING	2140 ORCHARD LAKE RD	SYLVAN LAKE	OAKLAND	1
17	U S BLADES	5700 DRAKE RD	W BLOOMFIELD	OAKLAND	1
18	TACO BELL	119 N TELEGRAPH RD	WATERFORD	OAKLAND	1
19	SUMMIT PLACE	315 N TELEGRAPH RD	WATERFORD	OAKLAND	1
20	MC DONALD'S	4772 DIXIE HWY	WATERFORD	OAKLAND	1
21	UNITED ARTISTS	30170 GRAND RIVER AVE	FARM. HILLS	OAKLAND	1
22	ARBY'S	2614 UNION LAKE RD	COMMERCE TWP	OAKLAND	1
23	VETERANS ICE ARENA	2150 JACKSON AVE	ANN ARBOR	WASHTENAW	1
24	TACO BELL	1590 S MAIN ST	CHELSEA	WASHTENAW	1
25	MC DONALD'S	1177 DEXTER ST	MILAN	WASHTENAW	1
26	ARBY'S	3015 WASHTENAW	YPSILANTI	WASHTENAW	1
27	MC DONALD'S	3825 CARPENTER RD	YPSILANTI	WASHTENAW	1
28	SHOWCASE CINEMAS	4100 CARPENTER RD	YPSILANTI	WASHTENAW	1
29	WENDY'S	1185 M 89	PLAINWELL	ALLEGAN	2
30	MC DONALD'S	1218 M 89	PLAINWELL	ALLEGAN	2
31	TACO BELL	1310 M 89	PLAINWELL	ALLEGAN	2
32	ARBY'S	905 N EUCLID AVE	BAY CITY	BAY	2
33	BURGER KING	6304 WESTSIDE SAGINAW RD	BAY CITY	BAY	2
34	BURGER KING	2504 N US HIGHWAY 31 N	TRAVERSE CITY	G TRAVERSE	2
35	ALLSKATE FUN CTR INC	1313 W NORTH ST	JACKSON	JACKSON	2
36	ARBY'S	952 N WEST AVE	JACKSON	JACKSON	2
37	WENDY'S	3306 E MICHIGAN AVE	JACKSON	JACKSON	2
38	WESTWOOD MALL	1850 W MICHIGAN AVE	JACKSON	JACKSON	2
39	WENDY'S	1300 S WEST AVE	JACKSON	JACKSON	2
40	BURGER KING	4080 PAGE AVE	MICHIGAN CTR	JACKSON	2
41	BURGER KING	13201 W MICHIGAN AVE	PARMA	JACKSON	2
42	SOUTHSIDE ICE CTR	500 100TH ST	BYRON CENTER	KENT	2
43	ARBY'S	850 28TH ST SE	GRAND RAPIDS	KENT	2
44	WOODLAND SPORT CTR	2100 28TH ST SE	KENTWOOD	KENT	2
45	MC DONALD'S	1110 28TH ST SW	GRAND RAPIDS	KENT	2
46	EASTBROOK MALL	3545 28TH ST SE	GRAND RAPIDS	KENT	2
47	MC DONALD'S	3757 PLAINFIELD AVE NE	GRAND RAPIDS	KENT	2
48	TACO BELL	22 44TH ST SW	GRAND RAPIDS	KENT	2
49	ARBY'S	3639 E GRAND RIVER AVE	HOWELL	LIVINGSTON	2
50	ARBY'S	15205 E 8 MILE RD	EASTPOINTE	MACOMB	2
51	KFC	67000 VAN DYKE	ROMEO	MACOMB	2
52	TACO BELL	28582 DEQUINDRE RD	WARREN	MACOMB	2
53	SHOWCASE CINEMA	35100 VAN DYKE AVE	STERLING HTS	MACOMB	2
54	ARBY'S	1510 S SAGINAW RD	MIDLAND	MIDLAND	2
55	MC DONALD'S	4989 LAKE MICHIGAN DR	ALLENDALE	OTTAWA	2
56	GRAND HAVEN RINK	219 N 7TH ST	GRAND HAVEN	OTTAWA	2
57	WENDY'S	1986 STATE ROUTE 139	BENTON HBR	BERRIEN	3
58	LOMA THEATER	221 PAW PAW ST	COLOMA	BERRIEN	3
59	WENDY'S	929 COLUMBIA AVE W	BATTLE CREEK	CALHOUN	3
60	MC DONALD'S	1260 W MICHIGAN AVE	MARSHALL	CALHOUN	3
61	MC DONALDS	1507 N EATON RD	ALBION	CALHOUN	3
62	TACO BELL	4337 W VIENNA RD	CLIO	GENESEE	3

63	GRAND MALL	12741 S SAGINAW ST	GRAND BLANC	GENESEE	3
64	BURGER KING	3625 S DORT HWY	FLINT	GENESEE	3
65	WENDY'S	3215 MILLER RD	FLINT	GENESEE	3
66	MC DONALD'S	5947 N LAPEER RD	NORTH BRANCH	LAPEER	3
67	ADRIAN CINEMAS INC	3150 N ADRIAN HWY	ADRIAN	LENAWEE	3
68	MC DONALD'S	1357 S MAIN ST	ADRIAN	LENAWEE	3
69	MC DONALD'S	503 S MERIDIAN RD	HUDSON	LENAWEE	3
70	KFC	1006 W CHICAGO BLVD	TECUMSEH	LENAWEE	3
71	BURGER KING	US HIGHWAY 41 W	ISHPEMING	MARQUETTE	3
72	TACO BELL	3062 US 41 WEST	MARQUETTE	MARQUETTE	3
73	TACO BELL	539 TECUMSEH ST	DUNDEE	MONROE	3
74	MC DONALD'S	14530 LAPLAISANCE RD	MONROE	MONROE	3
75	ARBY'S	1455 N TELEGRAPH RD	MONROE	MONROE	3
76	ARBY'S	2039 E APPLE AVE	MUSKEGON	MUSKEGON	3
77	MC DONALD'S	3038 HOLTON WHITEHALL RD	WHITEHALL	MUSKEGON	3
78	MC DONALD'S	3700 E GENESEE	SAGINAW	SAGINAW	3
79	TACO BELL	8030 GRATIOT RD	SAGINAW	SAGINAW	3
80	WENDY'S	7945 GRATIOT RD	SAGINAW	SAGINAW	3
81	MC DONALD'S	3077 LANSING RD	PERRY	SHIAWASSEE	3
82	BURGER KING	3100 GRATIOT BLVD	MARYSVILLE	ST CLAIR	3
83	WENDY'S	1011 24TH ST	PORT HURON	ST CLAIR	3
84	TACO BELL	1001 W MICHIGAN AVE	THREE RIVERS	ST JOSEPH	3
85	TACO BELL	10930 BELLEVILLE RD	BELLEVILLE	WAYNE	4
86	WENDY'S	5714 S TELEGRAPH RD	DEARBORN HTS	WAYNE	4
87	MC DONALD'S	7300 WYOMING ST	DEARBORN	WAYNE	4
88	CANFIELD ICE ARENA	2100 KINLOCH	DEARBORN HTS	WAYNE	4
89	MC DONALD'S	2205 MIDDLEBELT RD	GARDEN CITY	WAYNE	4
90	INKSTER ICE ARENA	27077 S RIVER PARK DR	INKSTER	WAYNE	4
91	KFC	556 SOUTHFIELD RD	LINCOLN PARK	WAYNE	4
92	TACO BELL	2306 DIX HWY	LINCOLN PARK	WAYNE	4
93	MC DONALD'S	2160 DIX HWY	LINCOLN PARK	WAYNE	4
94	MC DONALD'S	39555 6 MILE RD	NORTHVILLE	WAYNE	4
95	TACO BELL	409 N MAIN ST	PLYMOUTH	WAYNE	4
96	ARBY'S 1	0500 TELEGRAPH RD	TAYLOR	WAYNE	4
97	BURGER KING	7900 N MIDDLEBELT RD	WESTLAND	WAYNE	4
98	WENDY'S	41465 FORD RD	CANTON	WAYNE	4
99	WENDY'S	14791 EUREKA RD	SOUTHGATE	WAYNE	4
100	MC DONALD'S	1000 MACK AVE	DETROIT	WAYNE	4
101	TACO BELL	15170 GRATIOT AVE	DETROIT	WAYNE	4
102	DELRAY REC CTR	420 LEIGH ST	DETROIT	WAYNE	4
103	YMCA	1601 CLARK ST	DETROIT	WAYNE	4
104	KFC	6211 W WARREN AVE	DETROIT	WAYNE	4
105	BURGER KING	9239 GRATIOT AVE	DETROIT	WAYNE	4
106	KFC	13320 E JEFFERSON AVE	DETROIT	WAYNE	4
107	BURGER KING	16196 TELEGRAPH RD	DETROIT	WAYNE	4
108	CROWELL REC CTR	16630 LAHSER RD	DETROIT	WAYNE	4
109	YMCA	21755 W 7 MILE RD	DETROIT	WAYNE	4
110	WENDY'S	18430 FORD RD	DETROIT	WAYNE	4
111	MC DONALD'S	8000 W OUTER DR	DETROIT	WAYNE	4
112	TACO BELL	14257 TELEGRAPH RD	REDFORD	WAYNE	4
113	WILLIAMSTON MID SCH	845 VANNETER RD	WILLIAMSTON	INGHAM	1
114	FLANDERS ELEM SCHOOL	32600 FLANDERS ST	FARMINGTON	OAKLAND	1
115	LAKEWOOD ELEM SCH	1500 BOGIE LAKE RD	WHITE LAKE	OAKLAND	1
116	MARY H GUEST ELEM SCH	1655 DECKER RD	WALLED LAKE	OAKLAND	1
117	NORTH WARD ELEM SCH	440 RIVER ST	ALLEGAN	ALLEGAN	2
118	LONG LAKE ELEM SCH	7738 N LONG LAKE RD	TRAVERSE CITY	G TRAVERSE	2
119	BUSHNELL ELEM SCHOOL	700 ELIZABETH ST	LOWELL	KENT	2
120	SUGARBUSH ELEM SCH	48400 SUGARBUSH RD	NEW BALTIMORE	MACOMB	2
121	HULL SCHOOL	1716 TERRITORIAL RD	BENTON HBR	BERRIEN	3
122	WHITTIER MIDDLE SCH	701 CRAPO ST	FLINT	GENESEE	3
123	ONSTED MIDDLE SCHOOL	10109 SLEE RD	ONSTED	LENAWEE	3
124	HOLTON SCHOOLS	4TH	HOLTON	MUSKEGON	3
125	THOMAS SIMPSON SCH	24900 MEADOWS AVE	FLAT ROCK	WAYNE	4
126	ST CASIMIR'S GRADE SCH	3361 23RD ST	DETROIT	WAYNE	4
127	CHILDREN'S LEARN. CTR	18401 W MCNICHOLS RD	DETROIT	WAYNE	4
128	BROWNELL MIDDLE SCH	260 CHALFONTE AVE	GROSSE PTE	WAYNE	4

Appendix C: Estimation of Child Occupant Restraint Use Rates, Variances, and Confidence Bands

The statewide child occupant restraint use rate was estimated from observations at a stratified random sample of sites in Michigan known to be visited by children between the ages of 4 and 15 years, based upon results of the National Personal Transportation Survey (NPTS; Research Triangle Institute, 1997). (Children under 4 years of age were included in the sample when they appeared, but the sample was designed for older children.) The sites used in the sample were schools, restaurants (fast food), and entertainment centers (movie theaters, skating rinks, and recreation centers). Because of possible differences in the child occupant restraint use rates at schools and other sites, separate estimates were obtained for schools and nonschool sites and combined to obtain a statewide child occupant use rate.

For each stratum, there were N_s possible school sites and N_o possible other sites of which n_s school sites and n_o other sites were sampled. For school sites in stratum *i* at sample *j*, y_{sij} children were observed, of which x_{sij} were restrained. Similarly, for nonschool sites in stratum *i* at sample *j*, y_{oij} children were observed of which x_{oij} were restrained. The restraint use rate estimate for school sites in stratum *i* was calculated using Equation 1:

$$P_{si} = \frac{\sum_{j=1}^{n_{si}} x_{sij}}{\sum_{j=1}^{n_{si}} y_{sij}} \qquad (1)$$

The restraint use rate estimate for nonschool sites in stratum *i* was calculated using Equation 2:

$$P_{oi} = \frac{\sum_{j=1}^{n_{oi}} x_{oij}}{\sum_{j=1}^{n_{oi}} y_{oij}} \qquad (2)$$

The estimate of the variance for school sites in stratum *i* was calculated using Equation 3:

$$v_{si}=\frac{n_{si}}{n_{si}-1}\sum_{j=1}^{n_{si}}\left[\left(\frac{y_{sij}}{\sum_{j=1}^{n_{si}}y_{sij}}\right)^2(p_{sij}-p_{si})^2\right] \quad (3)$$

The estimate of the variance for nonschool sites in stratum *i* was calculated using Equation 4:

$$v_{oi}=\frac{n_{oi}}{n_{oi}-1}\sum_{j=1}^{n_{oi}}\left[\left(\frac{y_{oij}}{\sum_{j=1}^{n_{oi}}y_{oij}}\right)^2(p_{oij}-p_{oi})^2\right] \quad (4)$$

When combining school trips (school sites) and nonschool trips (other sites) in a stratum, school-age children were distinguished from the preschool age children because the sampling of school and nonschool sites was based on the relative frequencies of these trips by school age children and not by preschool aged children. The ratio of the number of trips to nonschool sites to the number of trips to school sites by private automobile by school aged children was defined as *t*. Because according to NPTS data, school age children make about one school trip for every seven nonschool trips in Michigan, *t* was seven for these analyses. It was assumed that *t* was constant across all strata. Combining the child occupant use rate estimates by their relative proportions yielded an overall average child occupant restraint use rate for school age children in stratum *i*. This calculation was done using Equation 5, where the prime (') indicates school age children:

$$P_i'=\frac{P_{si}'+tP_{oi}'}{1+t} \quad (5)$$

The variances for school aged children was calculated using Equation 6:

$$V_i' = \frac{V_{si}' + t^2 V_{oi}'}{(1+t)^2} \tag{6}$$

School trips by preschool children in this analysis were considered to be equivalent to nonschool (other) trips. Therefore, the population of possible sites for this age group in each stratum was $N = N_s + N_o$, and the number of sites that are sampled was $n = n_s + n_o$. At each site *j* in stratum *i*, y''_{ij} preschool children are observed and x''_{ij} of them are restrained, where the double-prime (") indicates preschool age children. The child occupant restraint use estimate for preschool age children was calculated using Equation 7:

$$P_i'' = \frac{\sum_{j=1}^{n_i} x_{ij}''}{\sum_{j=1}^{n_i} y_{ij}''} \tag{7}$$

The variance estimate for preschool age children was calculated using Equation 8:

$$V_i'' = \frac{n_i}{n_i - 1} \sum_{j=1}^{n_i} \left[\left(\frac{y_{ij}''}{\sum_{j=1}^{n_i} y_{ij}''} \right)^2 (p_{ij}'' - p_i'')^2 \right] \tag{8}$$

The child occupant restraint use rate estimate for each stratum was determined by combining the use rate estimates for both age groups and weighting the analyses by the population of children in each age group for each stratum. This calculation was done using Equation 9 where m'_i was the number of school age children in stratum *i* and m''_i was the number of preschool age children in stratum *i*:

$$P_i = \frac{m_i' P_i' + m_i'' P_i''}{m_i' + m_i''} \quad (9)$$

The variance was calculated using Equation 10:

$$V_i = \frac{(m_i')^2 V_i' + (m_i'')^2 V_i''}{(m_i' + m_i'')^2} \quad (10)$$

The overall child occupant restraint use rate, combined across the strata, was determined using Equation 11:

$$P = \frac{\sum_{i=1}^{4} m_i' P_i' + \sum_{i=1}^{4} m_i'' P_i''}{\sum_{i=1}^{4} (m_i' + m_i'')} \quad (11)$$

The variance for the overall child occupant use rate for Michigan was calculated using Equation 12:

$$V = \frac{\sum_{i=1}^{4} (m_i')^2 V_i' + \sum_{i=1}^{4} (m_i'')^2 V_i''}{\left(\sum_{i=1}^{4} (m_i' + m_i'') \right)^2} \quad (12)$$

The 95 percent confidence band for the statewide estimate were calculated with Equation 13:

$$95\,Percent\,Confidence\,Band = P \pm 1.96\sqrt{V} \quad (13)$$

Finally, the relative error or precision of the use rate estimates was computed using Equation 14:

$$RelErr = \frac{\sqrt{V}}{P} \tag{14}$$

The overall statewide child occupant restraint use rate estimate for Michigan has a relative error of 2.7 percent which was well below the 5 percent relative error allowed by NHTSA (1992; 1998) for statewide surveys of safety belt use.

Appendix D: Child Occupant Restraint Use Rates, 95% Confidence Bands, and Unweighted Numbers of Observations (N)

Table 5: Child Occupant Restraint Use Rates and Unweighted Ns by Age Group		
Age	**Rate (%)**	**N**
0-3	96.7 ± 1.6	618
4-14	74.6 ± 2.5	2750
Overall	81.1 ± 1.8	3368

Table 6: Child Occupant Restraint Use Rates and Unweighted Ns by Driver Safety Belt Use and Age Group				
	Driver Belted		**Driver Not Belted**	
Age	**Rate (%)**	**N**	**Rate (%)**	**N**
0-3	97.1 ± 1.5	525	93.5 ± 7.6	93
4-15	81.7 ± 2.7	2288	34.8 ± 6.6	462
Overall	86.3 ± 2.0	2813	52.1 ± 5.1	555

Table 7: Child Occupant Restraint Use Rates and Unweighted Ns by Driver Sex and Age Group				
	Male (Driver)		**Female (Driver)**	
Age	**Rate (%)**	**N**	**Rate (%)**	**N**
0-3	97.8 ± 1.9	210	96.3 ± 2.1	408
4-15	77.7 ± 3.6	877	72.9 ± 3.9	1873
Overall	83.6 ± 2.6	1087	79.8 ± 2.8	2281

Table 8: Child Occupant Restraint Use Rates and Unweighted Ns by Child Sex and Age Group				
	Male (Child)		Female (Child)	
Age	Rate (%)	N	Rate (%)	N
0-3	98.0 ± 1.7	318	95.3 ± 3.2	300
4-15	73.7 ± 2.8	1358	75.5 ± 3.1	1392
Overall	80.8 ± 2.0	1676	81.3 ± 2.4	1692

Table 9: Child Occupant Restraint Use Rates and Unweighted Ns by Vehicle Type and Age Group								
	Passenger Car		Van/ Minivan		Sport Utility Vehicle		Pickup Truck	
Age	Rate (%)	N	Rate (%)	N	Rate (%)	N	Rate (%)	N
0-3	95.9 ± 2.5	361	99.0 ± 1.3	167	100.0 ± 0.0	66	92.5 ± 10.3	25
4-15	71.0 ± 3.3	1474	78.3 ± 4.6	749	80.3 ± 5.7	340	80.8 ± 7.3	187
Overall	78.4 ± 2.4	1835	84.4 ± 3.3	916	86.1 ± 4.0	406	84.3 ± 6.0	212

Table 10: Child Occupant Restraint Use Rates and Unweighted Ns in Front Row by Seating Position and Age Group				
	Center		Right	
Age	Rate (%)	N	Rate (%)	N
0-3	100.0 ± 0.0	11	91.1 ± 17.4	22
4-15	76.5 ± 27.2	15	82.8 ± 4.4	1249
Overall	83.7 ± 19.0	26	85.3 ± 6.0	1271

Table 11: Child Occupant Restraint Use Rates and Unweighted Ns in Second Row by Seating Position and Age Group						
	Left		Middle		Right	
Age	Rate (%)	N	Rate (%)	N	Rate (%)	N
0-3	97.1 ± 2.3	212	96.8 ± 7.1	195	98.3 ± 2.0	165
4-15	73.0 ± 3.9	605	45.5 ± 9.8	152	70.0 ± 4.2	617
Overall	80.1 ± 2.8	817	60.9 ± 7.2	347	78.3 ± 3.1	782

Table 12: Child Occupant Restraint Use Rates and Unweighted Ns in Third Row by Seating Position and Age Group						
	Left		Middle		Right	
Age	Rate (%)	N	Rate (%)	N	Rate (%)	N
0-3	100.0 ± 0.0	3	77.0 ± 45.1	5	100.0 ± 0.0	5
4-15	68.1 ± 21.1	57	72.6 ± 36.1	10	66.3 ± 15.1	42
Overall	73.7 ± 17.4	60	73.9 ± 28.7	15	74.2 ± 11.5	47

Table 13: Child Occupant Restraint Use Rates and Unweighted Ns Day of Week and Age Group				
	Weekday		Weekend	
Age	Rate (%)	N	Rate (%)	N
0-3	97.1 ± 1.4	408	93.8 ± 6.2	210
4-15	75.2 ± 3.6	1770	75.4 ± 4.5	980
Overall	81.7 ± 2.6	2178	80.9 ± 3.7	1190

Table 14: Child Occupant Restraint Use Rates and Unweighted Ns by Type of Trip and Age Group				
	Nonschool		School	
Age	Rate (%)	N	Rate (%)	N
0-3	96.9 ± 1.6	458	94.1 ± 6.1	47
4-15	76.1 ± 2.7	1917	64.6 ± 5.8	833
Overall	82.2 ± 2.0	2375	73.2 ± 4.5	880