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Safety Belt Use in Michigan's Upper Peninsula

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16. Abstract

Reported here are the results of a direct observation survey of safety belt use in Michigan's Upper Peninsula (UP), conducted in the fall of 2000. In this study, 3,814 occupants traveling in four vehicle types (passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks) were surveyed during October 17 to October 29, 2000. Belt use was estimated for all commercial/noncommercial vehicle types combined and separately for each vehicle type. Belt use by stratum, seating position, sex, prevailing weather conditions, and age was also calculated. Overall belt use was 78.6 percent. Belt use was 83.7 percent for vans/minivans, 83.3 percent for passenger cars, 82.3 percent for sport-utility vehicles, and 66.4 percent for pickup trucks. Overall belt use was higher for females than for males, and higher for drivers than for passengers. Overall, belt use was similar for the 16-to-29 and 30-to-59 year old age groups, and was higher in the 60-and-up age group. Safety belt use rates did not significantly differ by stratum or weather conditions. These findings enable us to obtain a baseline safety belt use rate for Michigan's UP, with which to examine and measure safety belt use trends in the UP. This study also provides information for the creation of Public Information and Education programs specific to the unique characteristics of UP residents.

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INTRODUCTION

The state of Michigan is unique by virtue of its varied physical characteristics. Michigan is divided into two large land segments, the Upper and Lower Peninsulas, which are surrounded by four of the five great lakes. The two peninsulas are connected only by the 5 mile long Mackinac Bridge (Brunner, 1999). Michigan is a highly urbanized and industrialized state, however, the Upper Peninsula (UP) represents a unique part of Michigan. The UP is primarily rural, with a population density of only 19 people per square mile, considerably lower than the population density of 223 people per square mile found in the Lower Peninsula (US Bureau of the Census, 2000). The 16,500 square miles of land that constitute the UP consist of wilderness and farmland, interspersed with isolated pockets of population (Lindenberger, 2000). While the UP represents about 30 percent of Michigan's land mass, only 3.4 percent of Michigan's 9,295,297 inhabitants reside in the UP (US Bureau of the Census, 2000).

Unlike the Lower Peninsula, the UP road network consists primarily of rural roads and two-lane highways, with only a short section of interstate connecting two counties. Rural communities depend heavily on these roads for transportation related to commerce and recreation (National Sheriff's Association, 1992). Research on safety belt use rates in rural versus urban areas outside of Michigan has yielded inconclusive results. Some studies of safety belt use have found that use rates are lower in rural areas than in urban areas (see e.g. Bureau of Transportation Statistics, BTS, 2000; Hennepin County Community Health Department, 1998; National Highway Traffic Safety Administration, NHTSA, 1996; Survey Research Center, 1997; Williams, Reinfurt, & Wells, 1996). Other studies have shown that there is little or no difference in safety belt use rates between rural and urban areas (see e.g. Alabama Department of Public Health, 1999; Block, 2000; Matthews, 1982; New Jersey Department of Highway Traffic Safety, 1999). While rural versus urban safety belt use rates were not examined, past research on safety belt use rates in Michigan has shown that the UP tends to have lower restraint use rates than the Lower Peninsula. The eastern half of the UP has consistently been observed to have the lowest restraint use rate in the state of Michigan (Streff & Molnar, 1990; Wagenaar & Maybee, 1986; Wagenaar & Molnar, 1989; Wagenaar, Molnar, & Businski, 1988; Wagenaar & Webster, 1985).

Additionally, it has been established that even though rural areas have a lower number of vehicle miles of travel (VMT) than urban areas, they experience a disproportionally high number of motor vehicle fatalities (NHTSA, 1996). In 1996, more than half of all motor vehicle crashes that resulted in fatalities occurred in rural areas (NHTSA, 1996). In fatal crashes for which restraint use is known, a higher percentage of drivers involved in rural area crashes were not restrained by a safety belt (NHTSA, 1996). Research on motor vehicle fatalities in Minnesota has shown that in rural areas, where the majority of these fatalities occur, safety belt use is significantly lower than in urban areas, by a difference of ten percentage points (Hennepin County Community Health Department, 1998). Because much of the travel in Michigan's UP occurs in rural areas, it is important to fully understand safety belt use in these areas of the UP.

The UP economy is dominated by mining, extractive industries, logging, and tourism. Layoffs and cutbacks are common, and a large segment of the population lives near or below the poverty level (Lindenberger, 2000). According to 1990 census data, 14.1 percent of UP residents were living below the poverty level (US Bureau of Census, 2000). Socio-economic status has also been shown to be a factor contributing to differences in safety belt use rates. Income has been shown to positively correlate with safety belt use; people with higher income and education levels use safety belts more than those with less education and lower income levels (see e.g., Block, 2000; Lund, 1986; Reinfurt, Williams, Wells, & Rodgman, 1995; Shinar, 1993; Wagenaar, Streff, Molnar, Businski, & Schultz, 1987). Similarly, research has also shown that people with white collar jobs use safety belts more often than people with blue collar jobs (Reinfurt et al., 1995; Shinar, 1993). Again, this evidence demonstrates the need to evaluate safety belt use in the UP in order to obtain baseline information.

Another unique characteristic of Michigan's UP is the large population of American Indian residents. According to the 1990 Census, Michigan had the tenth largest American Indian population in the United States (Michigan Department of Community Health, 2000). A large proportion of Michigan's American Indian population reside in the UP, about 19 percent (US Bureau of the Census, 2000). The risk for motor vehicle related injury is higher among American Indians than among the total US population (Centers for Disease Control, CDC, 1992). The 1997 Behavioral Risk Factor Surveillance System found that the median percentage of adults who reported not always wearing a safety belt while driving or riding in a car was 40.9 percent for American Indians, the highest of any group (Bolen, Rhodes, Powell-Griner, Bland, & Holtzman, 2000). This unique demographic may be important in understanding the UP's population characteristics and in targeting programs to increase safety belt use in the UP.

Collectively, these factors suggest that understanding the distinct attributes of the UP and its residents may be crucial in order to understand the trends in safety belt use for Michigan's UP. The purpose of this study was to conduct a direct observation survey of safety belt use in Michigan's UP. The results from this survey will be used to determine a baseline safety belt use rate for the UP, and provide valuable information to allow for evaluation of programs designed to promote belt use in the UP.

METHODS

Sample Design

The sample design for the present survey was based upon the one used by Streff, Eby, Molnar, Joksch, and Wallace (1993). While the entire sampling procedure is presented in the previous report, it is repeated here for completeness, with the modifications noted.

The goal of this sample design was to select observation sites that accurately represent front-outboard vehicle occupants in eligible commercial and noncommercial vehicles (i.e., passenger cars, vans/minivans, sport-utility vehicles, and pickup trucks) in Michigan's UP. An ideal sample minimizes total survey error while providing sites which can be surveyed efficiently and economically. To achieve this goal, the following sampling procedure was used.

The 15 counties that comprise Michigan's UP were separated into three strata (see Figure 1). The strata were constructed by first obtaining VMT information from 1999 for each Michigan county (Transportation Data Center, 2000). The stratum boundaries were adjusted until the total VMT was roughly equal within each stratum, making sure that the counties within each stratum were contiguous. As shown in Figure 1, this breakdown resulted in a geographic division of the UP into Western, Central, and Eastern Strata. Islands were not included in the divisions, even if they were part of one of the counties.

Because total VMT within each stratum was roughly equal (see Figure 1), observation sites were evenly divided among the strata (35 each). Since the UP road network consists primarily of rural roads and two-lane highways, with only a short section of interstate connecting two counties in the Eastern Stratum, only two freeway exit ramp sites were selected.

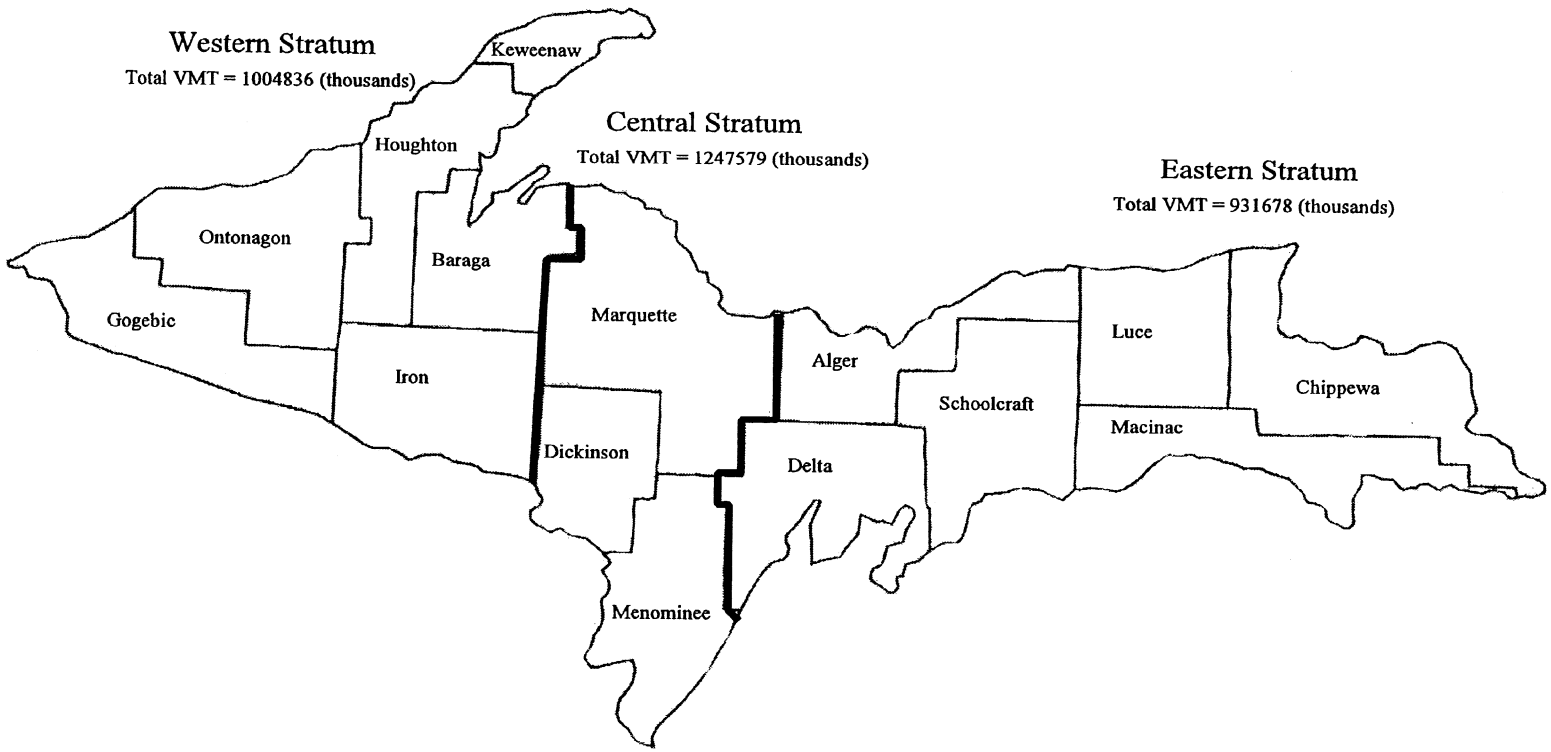

Figure 1. Stratum Boundaries for Michigan's UP.

Within each stratum, observation sites were randomly assigned to a location using a method that ensured each intersection within a stratum an equal probability of selection. Detailed, equal-scale road maps for each county were obtained and connected to form each stratum. A grid pattern was inscribed upon the maps. The lines of the grid were separated by 3/8 inch. With the *3/8 inch:mile* scale of the maps, this created grid squares that were each 1 square mile. Within each stratum, each grid square was uniquely identified by two numbers, a horizontal (x) coordinate and a vertical (y) coordinate.

The 35 sites for each stratum were sampled sequentially. The sites were chosen by first randomly selecting an x and a y coordinate to identify the corresponding grid square. If an intersection was contained within the square, that intersection was chosen as an observation site. Thus, every intersection within the stratum had an equal probability of selection. If the square did not fall within the stratum or there was no intersection within the square, then new x and y coordinates were selected randomly. For each primary site, an alternate site was also selected. The alternate sites were chosen by picking the closest available intersection to the primary site, making sure that it was not already selected as a primary or alternate site.

Given the large distance between sites, and limited time and resources to collect data, the day of week and time of day for site observation were assigned to enable the observers to finish data collection within a two week time period. The sites were observed using a clustering procedure. That is, sites that were located spatially adjacent to each other were considered to be a cluster. Within each cluster, the shortest route between all of the sites was decided (essentially a loop). An observer watched traffic at all sites in the cluster during a single day. The clusters were assigned to be observed in such a way that observations could begin at the geographic middle of the southern part of the UP, near Escanaba. From day to day, one observer traveled in a loop covering the eastern part of the UP and one covering the western part of the UP, with observations concluding in the geographic middle of the northern part of the UP, near Marquette. This process allowed sites and clusters from different strata to be observed on the same day, thereby eliminating any possible sequencing effects. The time of day that sites were to be observed was also assigned to logistically enable the observers to reach each site and return to the hotel at the end of the day within a reasonable time period. Using maps and atlases, field supervisors estimated the amount of time that it would take to travel to the first site of the day and to travel between all of the sites in the cluster. Using this estimate, approximate times for the sites to be observed were assigned, ensuring that observations were conducted during all daylight hours.

The particular street and direction of traffic flow to be observed was determined in the field by highly trained observers, following a carefully prescribed procedure. For each intersection, all possible combinations of street and traffic flow were considered. Due to the very low volume of traffic in many areas of the UP, observers were instructed to observe vehicles on the street that contained the highest volume of traffic, preferably with a traffic control device, still ensuring that accurate data could be collected given the speed at which vehicles were traveling. If the observer judged both streets to have an equal volume of traffic, a coin flip first determined which street to be observed, and a further coin flip determined the direction of traffic flow that would be observed. The observer location at the alternate intersection was determined in the same way as at the primary site.[1]

The sample design was constructed so that each observation site was self-weighted by VMT within each stratum. This was accomplished by selecting sites with equal probability and by setting the observation interval to a constant duration (50 minutes) for each site. Thus the number of vehicles observed at an observation site reflected safety belt use by VMT; that is, the higher the VMT at a site, the greater the number of vehicles that would pass during the 50-minute observation period. However, since all vehicles passing an observer could not be surveyed, a vehicle count of all eligible vehicles (i.e., passenger cars, vans/minivans, sport-utility vehicles, and pickup trucks) on the traffic leg under observation was conducted for a set duration (5 minutes) immediately prior to and immediately following the observation period (10 minutes total).

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[1] For those interested in designing a safety belt survey for their county or region, a guidebook and software for selecting and surveying sites for safety belt use is available (Eby, 2000) by contacting UMTRI -SBA, 2901 Baxter Rd., Ann Arbor, MI 48109-2150, or accessing http://www-personal.umich.edu/~eby/sbs.html/.

Table 1 shows descriptive statistics for the 105 observation sites. As shown in this table, the observations were distributed over day of week and time of day. Note that an observation session was included in the time slot that represented the majority of the observation period. If the observation period was evenly distributed between two time slots, then it was included in the later time slot. This table shows that nearly every site observed was the primary site and the majority of observations were conducted during cloudy weather conditions.

Table 1. Descriptive Statistics for the 105 Observation Sites

Day of Week		Observation Period		Site Choice		Weather	
Monday	9.5%	7-9 a.m.	6.7%	Primary	99.0%	Sunny	40.0%
Tuesday	9.5%	9-11 a.m.	15.2%	Alternate	1.0%	Cloudy	53.3%
Wednesday	17.2%	11-1 p.m.	20.0%			Rain	6.7%
Thursday	18.1%	1-3 p.m.	24.8%			Snow	0.0%
Friday	19.0%	3-5 p.m.	19.0%				
Saturday	9.6%	5-7 p.m.	14.3%				
Sunday	17.1%						
TOTALS	100%		100%		100%		100%

Data Collection

Data collection for the study involved direct observation of shoulder belt use, estimated age and sex of occupants, along with vehicle type, and whether it was a commercial or noncommercial vehicle. Trained field staff observed shoulder belt use of drivers and front-right passengers traveling in passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks during daylight hours from October 17 through October 29, 2000.

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 (freeway exit ramp or intersection), site choice (primary or alternate), observer number, date, day of week, time of day, weather, and a count of eligible vehicles traveling on the proper traffic leg. A place on the form was also furnished for observers to sketch the intersection 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 (e.g., school, shopping mall) and to discuss problems or issues relevant to the site or study.

The second form, the observation form, was used to record safety belt use, passenger information, and vehicle information (see Appendix A). Each observation form was divided into four boxes with each box having room for the survey of a single vehicle. For each vehicle surveyed, shoulder belt use, sex, and estimated age for the driver as well as vehicle type were recorded on the upper half of the box. The same information for the front-outboard passenger could be recorded in the lower half of the box, if there was a front-outboard passenger present. Occupants observed with their shoulder belt worn under the arm or behind the back were noted but considered as belted in the analysis. The observer also recorded whether the vehicle was commercial or noncommercial. A commercial vehicle is defined as a vehicle that is used for business purposes and may or may not contain company logos. This classification includes vehicles marked with commercial lettering or logos, or vehicles with ladders or other tools on them. At each site, observers carried several data collection forms and completed as many as were necessary during the observation period.

Procedures at Each Site

All sites in the sample were visited by one observer for a period of 1 hour. Upon arrival at a site, observers determined whether observations were possible at the site. If observations were not possible (e.g., due to construction), observers proceeded to the alternate site. Otherwise, observers completed the site description form and determined their observation position.

At each site, observers conducted a 5-minute count of all eligible vehicles on the designated traffic leg before beginning safety belt observations. Observations began immediately after completion of the count and continued for 50 minutes. During the observation period, observers recorded data for as many eligible vehicles as they could observe. 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. At the end of the observation period, a second 5-minute vehicle count was conducted.

Observer Training

Data for this study was collected by two highly trained observers. Both observers had extensive experience with data collection from previous studies, and both had trained and supervised other staff on safety belt data collection in the past. Both observers had prepared 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 list that identified the location of each site (see Appendix B for a listing of the sites). The observers have also practiced recording safety belt use, sex, age, and vehicle information until an interobserver reliability of at least 85 percent for all measures on drivers and front-right passengers had been achieved. Both observers were provided with two atlases of Michigan, several detailed maps of specific areas in the UP, and all necessary field supplies.

Data Processing and Estimation Procedures

The site description form and observation form data 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, the data from randomly selected sites were reviewed for accuracy by a second party and all site data were checked for inconsistent codes (e.g., the observation end time occurring before the start time). Errors were corrected after consultation with the original data forms.

For each site, computer analysis programs determined the number of observed vehicles, belted and unbelted drivers, and belted and unbelted passengers. Separate counts were made for each independent variable in the survey (i.e., site type, time of day,

day of week, weather, sex, age, seating position, and vehicle type). This information was combined with the site information to create a file used for generating study results.

As mentioned earlier, our goal in this safety belt survey was to estimate belt use for the UP of Michigan based on VMT. As also discussed, the self-weighting-by-VMT scheme employed is limited by the number of vehicles for which an observer can accurately record information. To correct for this limitation, the vehicle count information was used to weight the observed traffic volumes so they would more accurately reflect VMT.

This weighting was done by first adding each of the two 5-minute counts and then multiplying this number by five so that it would represent a 50-minute duration. The resulting number was the estimated number of vehicles passing the site if all eligible vehicles had been included in the survey during the observation period at that site. The estimated count for each site is divided by the actual number of vehicles observed there to obtain a volume weighting factor for that site. These weights are then applied to the number of actual vehicles of each type observed at each site to yield the weighted N for the total number of drivers and passengers, and total number of belted drivers and passengers for each vehicle type. Unless otherwise indicated, all analyses reported are based upon the weighted values.

The overall estimate of belt use per VMT in Michigan's UP was determined by first calculating the belt use rate within each stratum for observed vehicle occupants in all vehicle types using the following formula:

$$r_i = \frac{\textit{Total Number of Belted Occupants, weighted}}{\textit{Total Number of Occupants, weighted}}$$

where r_i refers to the belt use rate within any of the three strata. The totals are the sums across all 35 sites within the stratum after weighting, and occupants refers to only front-outboard occupants. The overall estimate of belt use was computed by averaging the belt use rates for each stratum. The overall belt use rate was determined by the following formula:

$$r_{all}=\frac{r_1+r_2+r_3}{3}$$

where r_i is the belt use rate for a certain vehicle type within each stratum.

The estimates of variance and the calculation of the confidence bands for the belt use estimates are complex. See Appendix C for a detailed description of the formulas and procedures. The same use rate and variance equations were utilized for the calculation of use rates for each vehicle type separately.

RESULTS

Overall Safety Belt Use

As shown in Figure 2, 78.6 ± 2.1 percent of all front-outboard occupants traveling in commercial/noncommercial passenger cars, sport utility vehicles, vans/minivans, or pickup trucks on local roads in Michigan's UP during October 2000 were restrained with shoulder belts. 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 safety belt use rate falls somewhere between 76.5 percent and 80.7 percent.

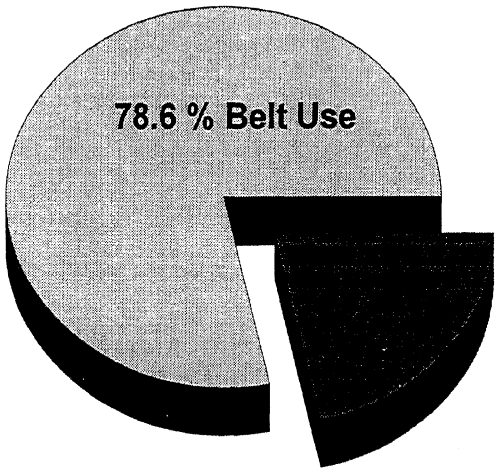

Figure 2. Front-Outboard Shoulder Belt Use in Michigan's UP.

Table 2 shows the shoulder belt use rates and unweighted number of occupants by vehicle type in Michigan's UP. Analysis revealed that belt use was not statistically different between occupants of passenger cars, vans/minivans, and sport-utility vehicles. The safety belt use rate for pickup trucks, 66.4 ± 3.4, was significantly lower than the use rate for the other three vehicle types. A separate section of the results calculates individual safety belt use rates by vehicle type for subcategories. The following results are presented with all vehicle types combined.

Table 2. Percent Shoulder Belt Use and Unweighted Number of Occupants by Vehicle Type in Michigan's UP		
Vehicle Type	**Percent Use**	**Unweighted N**
Passenger Car	83.3 ± 2.2 %	1,688
Van/Minivan	83.7 ± 5.0 %	477
Sport Utility	82.3 ± 4.7 %	516
Pickup Truck	66.4 ± 3.4 %	1,133
All Vehicles Combined	**78.6 ± 2.1 %**	3,814

Estimated Safety Belt Use by Seating Position

Estimated safety belt use rates by seating position are shown in Figure 3. As is typically found in Michigan (Eby, Fordyce, & Vivoda, 2000; Eby, Molnar, & Olk, 2000), driver belt use was significantly higher than passenger belt use. For 95 percent confidence bands and unweighted N for each of the following figures, see Appendix D.

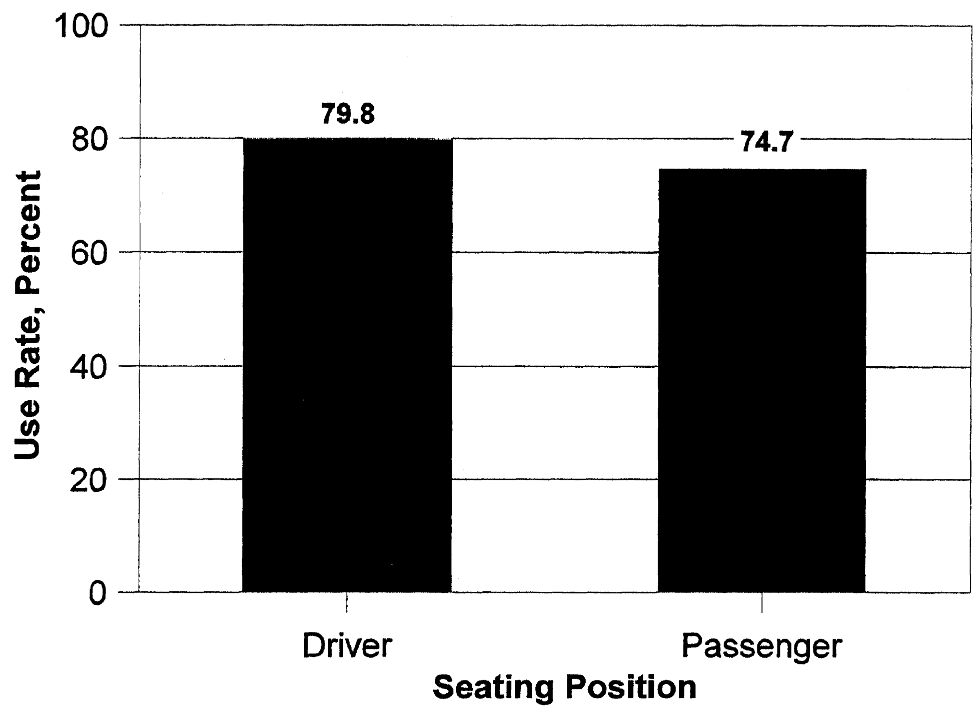

Figure 3. Front-Outboard Shoulder Belt Use by Seating Position in Michigan's UP.

Estimated Safety Belt Use by Sex

The estimated safety belt use rates by sex for Michigan's UP, are shown in Figure 4. Female belt use was significantly higher than male belt use, a difference of 10.8 percentage points. This finding is consistent with a large body of research on safety belt use by sex (see Eby, Molnar, & Olk, 2000, for a review).

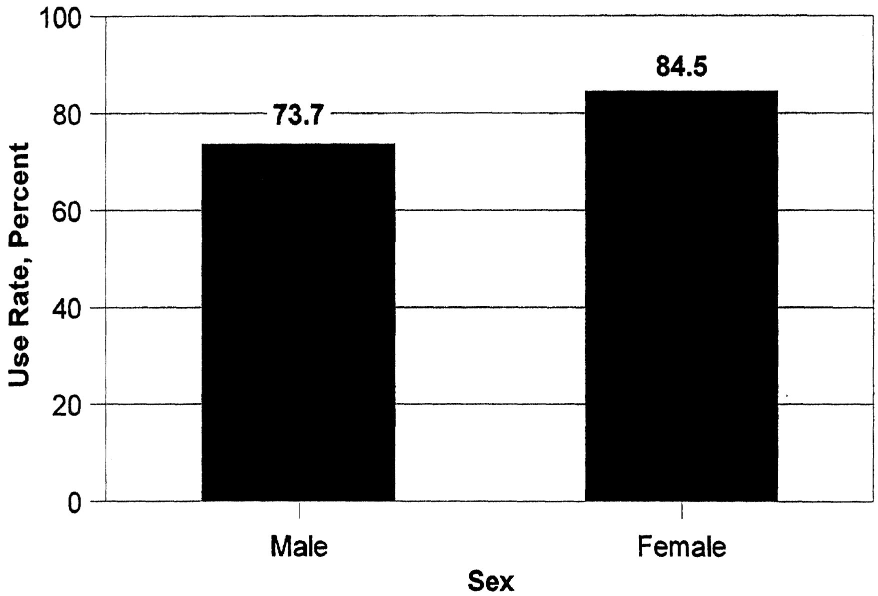

Figure 4. Front-Outboard Shoulder Belt Use by Sex in Michigan's UP.

Estimated Safety Belt Use by Weather

The estimated safety belt use rates in Michigan's UP, by prevailing weather condition are shown in Figure 5. Analysis revealed that safety belt use did not statistically differ by weather condition.

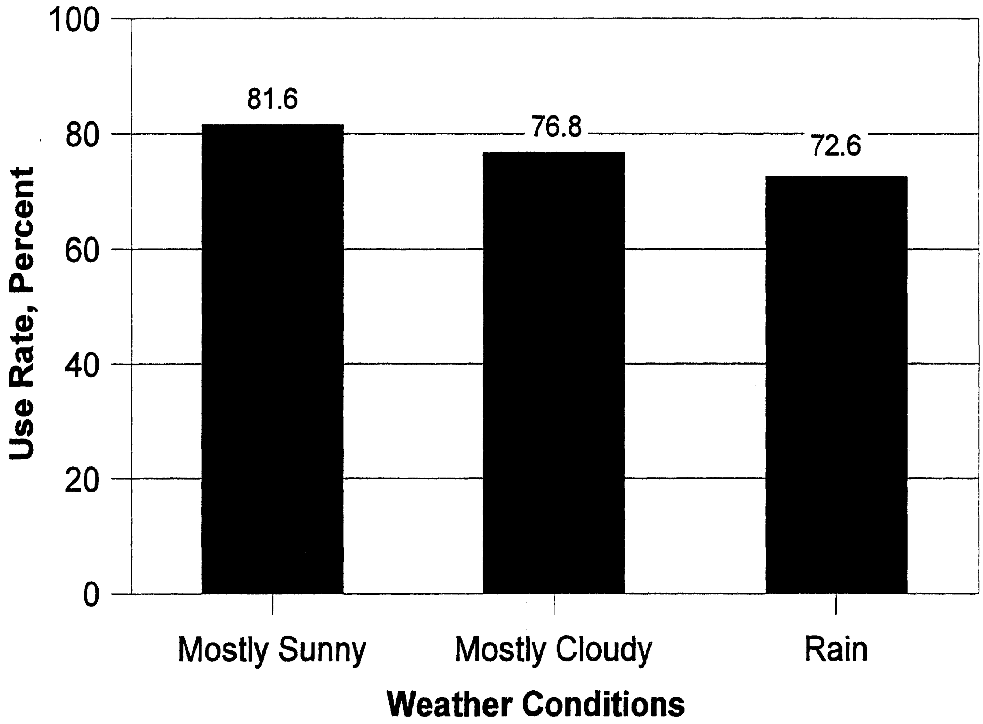

Figure 5. Front-Outboard Shoulder Belt Use by Weather in Michigan's UP.

Estimated Safety Belt Use by Age Group

Estimated safety belt use rates by age are shown in Figure 6. Only three children in the 0-to-3 year old age group were observed in the study. Additionally, there were only 102 children in the 4-to-15 year old age group observed in the front-outboard position. Therefore, the rates calculated for these age groups should be interpreted with great caution. Excluding these age groups, we find that there was no significant difference between the belt use rates for the 16-to-29 year old age group and the 30-to-59 year old age group. However, the safety belt use observed for the 60-and-up age group was significantly higher than the two younger age groups. The 60-and-up age group has consistently been observed to have the highest safety belt use of any age group in Michigan (see eg., Eby, Fordyce, & Vivoda, 2000; Eby, Molnar, & Olk, 2000).

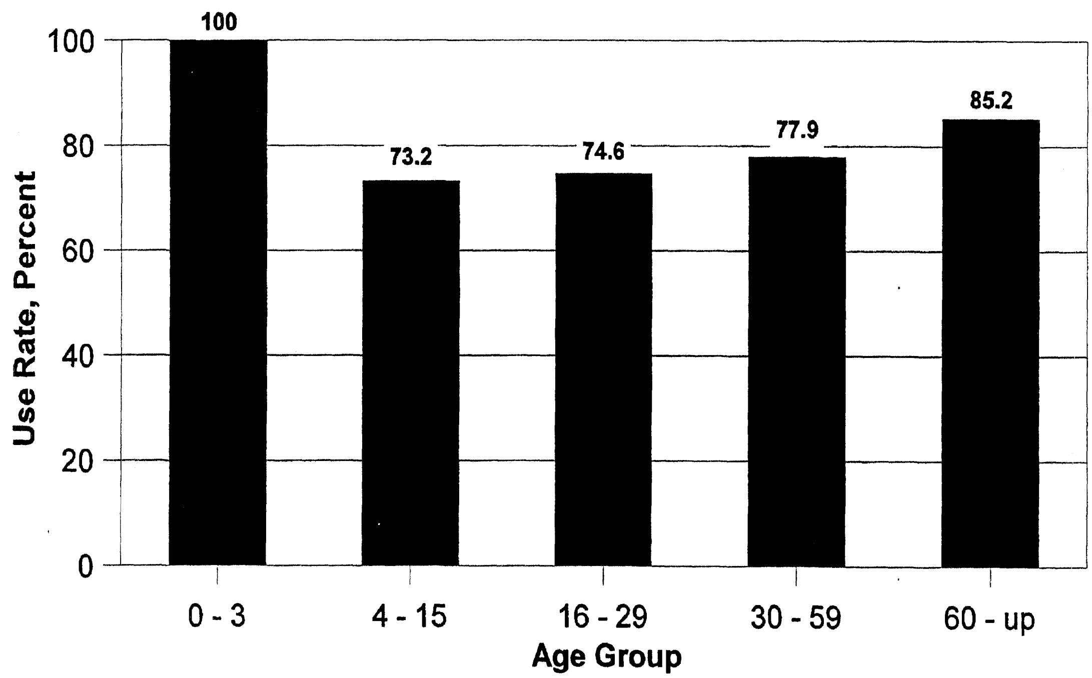

Figure 6. Front-Outboard Shoulder Belt Use by Age Group in Michigan's UP.

Estimated Safety Belt Use by Stratum

In order to obtain a baseline safety belt use rate that would be useful in the measurement of the effects of belt use programs that are stratum specific, we have calculated safety belt use rates for all vehicle types combined, for each stratum separately. Analysis shows that there were no significant differences in the safety belt use rates by stratum.

Table 3. Percent Shoulder Belt Use and Unweighted Number of Occupants by Stratum in Michigan's UP

Stratum	Percent Use	Unweighted N
Western	80.6 ± 4.4 %	1440
Central	76.3 ± 3.3 %	841
Eastern	77.5 ± 3.0 %	1533

Estimated Safety Belt by Stratum and Vehicle Type

Tables 4a - 4d show safety belt use rates and unweighted number of occupants by vehicle type and stratum. Within each stratum, there were no significant differences in safety belt use rates for either passenger cars, sport-utility vehicles, or vans/minivans. However, in all three strata, the safety belt use rates for pickup truck occupants are significantly lower than the safety belt use rates for occupants of other vehicle types. Across strata, there were no significant differences in safety belt use within each vehicle type.

Table 4a. Percent Shoulder Belt Use by Stratum (Passenger Cars)		
	Percent Use	Unweighted N
Western	83.8 ± 3.6	693
Central	84.2 ± 3.7	365
Eastern	81.5 ± 4.1	630

Table 4b. Percent Shoulder Belt Use by Stratum (Sport-Utility Vehicles)		
	Percent Use	Unweighted N
Western	82.9 ± 7.1	194
Central	81.0 ± 10.1	104
Eastern	82.5 ± 6.5	218

Table 4c. Percent Shoulder Belt Use by Stratum (Vans/Minivans)		
	Percent Use	Unweighted N
Western	84.4 ± 8.6	194
Central	81.7 ± 9.9	92
Eastern	84.0 ± 7.0	191

Table 4d. Percent Shoulder Belt Use by Stratum (Pickup Trucks)		
	Percent Use	Unweighted N
Western	69.7 ± 7.6	359
Central	62.3 ± 5.2	280
Eastern	66.6 ± 4.4	494

Estimated Safety Belt Use by Stratum and Seating Position

Estimated safety belt use rates by stratum and seating position are shown in Figure 7. For each stratum, safety belt use rates were lower for passengers than for drivers, a trend that is typically found in Michigan (Eby, Fordyce, & Vivoda 2000; Eby, Molnar, & Olk, 2000). However, a statistical analysis revealed that within each stratum, this observed difference was not significant. This lack of a significant difference was most likely due to the small number of passengers observed in each stratum (n=350, n=171, and n=464 for the Western, Central, and Eastern Strata, respectively), which resulted in large variance. Belt use by seating position was also examined across strata, and no significant differences were noted.

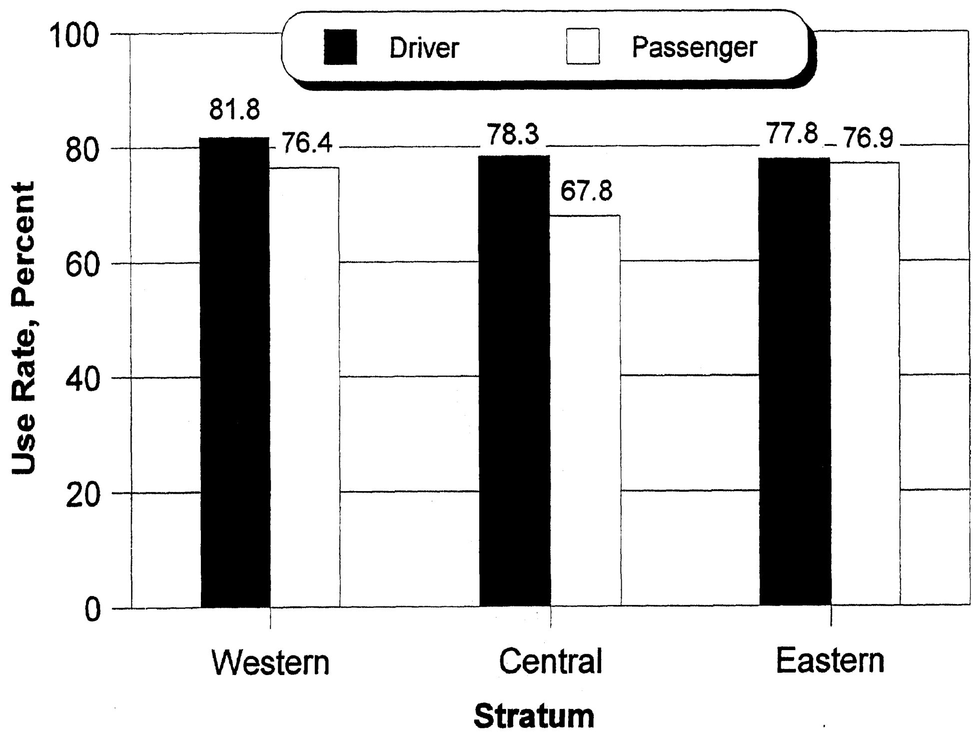

Figure 7. Front-Outboard Shoulder Belt Use by Stratum and Seating Position in Michigan's UP.

Estimated Safety Belt Use by Stratum and Sex

Estimated safety belt use rates by stratum and sex are shown in Figure 8. Belt use did not vary significantly across stratum by sex. However, as is typically found in Michigan, safety belt use rates were higher for females than males within every stratum (Eby, Fordyce, & Vivoda, 2000; Eby, Molnar, & Olk, 2000). It is interesting to note that a statistical analysis reveals that this difference is only significant in the Central and Eastern Strata. This suggests that in the Western Stratum, males and females are using safety belts at about the same rate. This finding cannot be explained by a low number of observations in the Western Stratum. Therefore, further research is necessary to fully understand what separates the Western Stratum with regard to this difference.

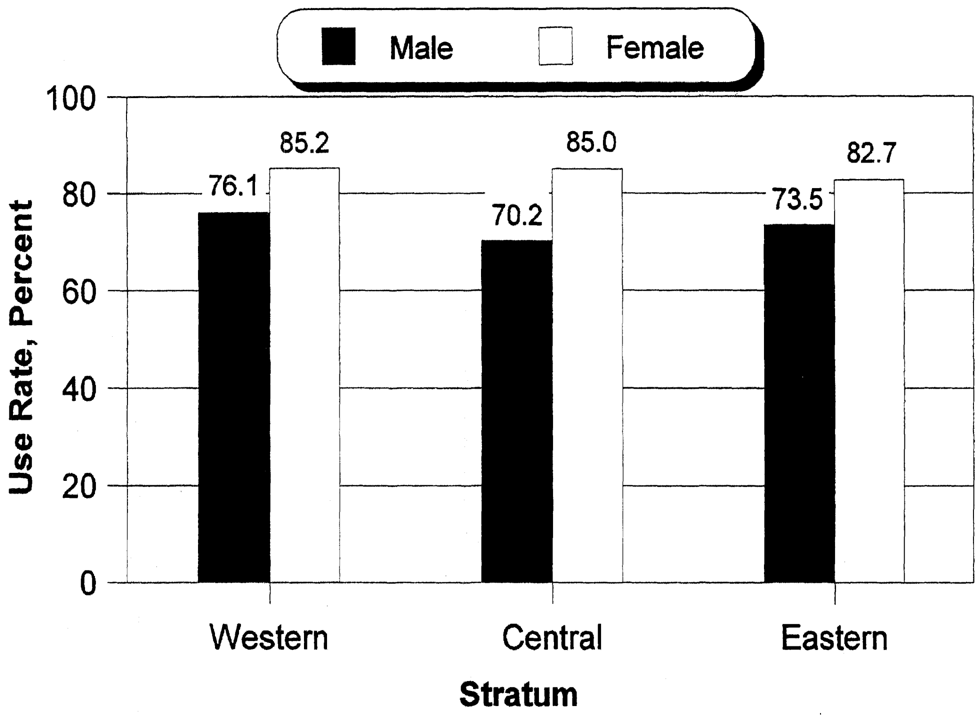

Figure 8. Front-Outboard Shoulder Belt Use by Stratum and Sex in Michigan's UP.

Estimated Safety Belt Use by Stratum and Age Group

Estimated safety belt use by stratum and age group is shown in Figure 9. Within each age group, there were no significant differences across strata. Given the low number of observations and resulting large variance within each age group when divided into strata, many of the differences shown in Figure 9 are not statistically significant. However, in the Western Stratum, safety belt use is significantly higher for people age 60 and over, than for people between the ages of 30 and 59. None of the other rates in the Western Stratum are significantly different from one another. In the Central Stratum, belt use for 16-to-29 year olds was significantly lower than both the 30-to-59 year old age group, and the 60-and-older age groups. There are no other significant differences in this stratum. In the Eastern Stratum, there are no significant differences between the age groups.

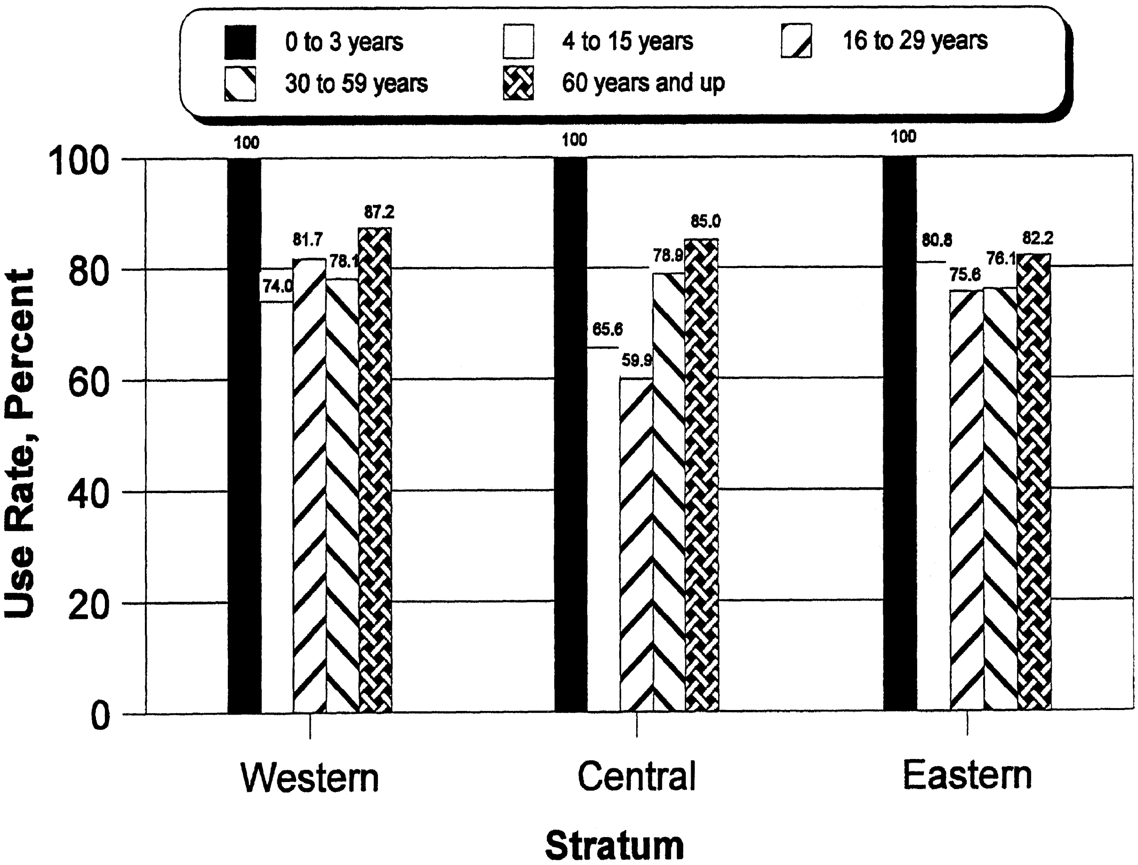

Figure 9. Front-Outboard Shoulder Belt Use by Stratum and Age Group in Michigan's UP.

Estimated Safety Belt Use by Stratum and Weather Conditions

Figure 10 shows estimated safety belt use by stratum and weather condition. No observations were conducted during rainy conditions in the Western Stratum. In the Central Stratum, there were only 25 observations conducted during rainy conditions, and only 88 observations were conducted during rain in the Eastern Stratum. Therefore, no meaningful conclusions can be drawn about safety belt use during rainy conditions either within or across strata. In addition, there were no significant differences in safety belt use observations either between or across strata during sunny and cloudy weather conditions.

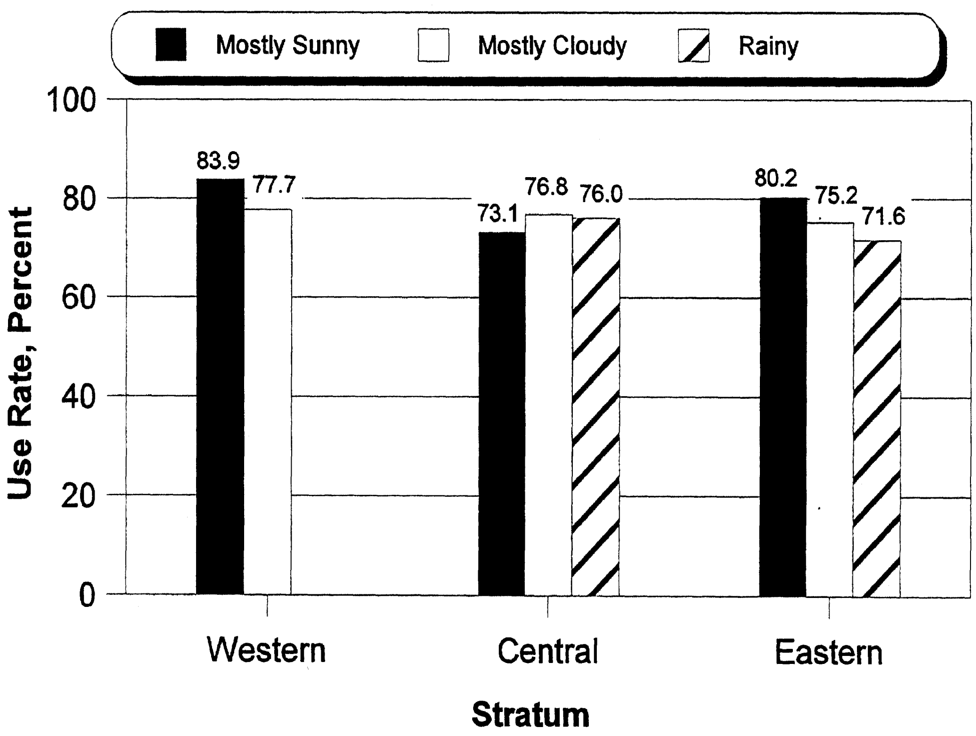

Figure 10. Front-Outboard Shoulder Belt Use by Stratum and Weather Conditions in Michigan's UP.

DISCUSSION

The estimated safety belt use rate for front-outboard occupants of passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks combined in Michigan's UP was 78.6 ± 2.1 percent. When compared with this year's rate for the entire state of Michigan, 81.9 ± 1.4 (Eby, Fordyce, & Vivoda, 2000), we find that the rate from the current survey did not differ from the statewide use rate.

An examination of safety belt use patterns in the current study showed many of the trends that are often observed in Michigan (Eby, Fordyce, & Vivoda, 2000; Eby, Molnar, & Olk, 2000). The analysis of safety belt use by vehicle type showed that occupants in passenger cars, sport-utility vehicles, and vans/minivans used safety belts at a rate above 80 percent (see Table 2). Unfortunately, the use rate for pickup truck occupants was significantly lower, both overall and within each stratum. This problematic trend has been consistently observed in every statewide survey of Michigan's safety belt use (see eg., Eby, Fordyce, & Vivoda, 2000). Research has shown that the main demographic differences between the driver/owners of pickup trucks and passenger cars are that driver/owners of pickup trucks are more likely to be male, have higher household incomes, and lower educational levels (Anderson, Winn, & Agran, 1999). This information provides a starting point for the development of programs designed to influence pickup truck occupant safety belt use, as continued efforts to encourage belt use by occupants of pickup trucks are warranted. Pickup trucks made up 29.7 percent of all vehicle types in the survey of Michigan's UP, while in this year's statewide survey, pickup trucks only represented 17.6 percent of the total vehicles observed. The higher ratio of pickup trucks to other vehicle types in the UP makes this effort even more important. It is essential that efforts to encourage belt use by occupants of pickup trucks in Michigan's UP be developed and implemented.

To target this population, the Michigan Office of Highway Safety Planning (OHSP) enlisted the help of Ted Nugent, a rock star and well-know hunter. This program consisted of radio Public Service Announcements, billboards, bumper stickers, hats, and posters featuring Nugent with his bow and the slogan "Don't be road kill - buckle up and live."

Getting information out to a rural audience can be difficult, with large areas of land to cover without abundant media outlets. Use of the radio is an excellent source of information dissemination (NHTSA, 2000), and may be one of the reasons that the Nugent program was so successful. Another contributing factor could be the wide availability of program paraphernalia at sporting goods stores in conjunction with the deer hunting season. This is particularly noteworthy, as hunting season attracts many visitors to the UP. Programs of this type are essential to reach UP residents because of the large rural areas with isolated pockets of population that must be addressed.

The present study showed that the belt use rate for drivers was consistently higher than for passengers. Our analysis indicates that new efforts should be made to encourage passengers to use safety belts. Further research is essential to better understand the dynamics of passenger belt use in order to develop appropriate and effective Public Information and Education (PI&E) programs. Of particular interest would be a study to determine the age difference and relationship between the driver and passenger to determine which combinations are at higher risk for safety belt nonuse. For example, front-outboard passengers may be less likely to use safety belts if they are a friend of the driver rather than a family member. Such information would be invaluable for constructing effective PI&E programs to promote safety belt use.

Belt use was also higher for females than for males. Again, this finding is consistent with years of safety belt research both in Michigan (Eby, Molnar, & Olk, 2000) and elsewhere (e.g., Lange & Voas, 1998; Williams, Wells, & Lund, 1987). While not surprising, this finding highlights the need for traffic safety professionals to focus efforts directed towards increasing belt use for the male population. However, females should not be ignored in these efforts, as their current safety belt use rate of 84.5 percent does not reflect total compliance with Michigan's safety belt use law.

When the two youngest age groups are excluded because of low representation in the sample, safety belt use for vehicle occupants age 60 and above was the highest of any age group. There was no significant difference between the 16-to-29 year old age group and the 30-to-59 year old age group. This finding indicates that programs designed to increase safety belt use of UP residents should focus on vehicle occupants in both the 16-to-29 and 30-to-59 year old age groups. This finding is in marked contrast to findings in the statewide survey of safety belt use, where safety belt use rates in the 30-to-59 year old age group are consistently observed to be higher than use rates for 16-to-29 year olds. This suggests that in addition to programs aimed at increasing belt use among 16-to-29 year olds, special programs must be focused on 30-to-59 year olds.

This study was designed to measure safety belt use across the UP of Michigan, and also within each stratum of the UP. Analysis reveals that overall belt use does not significantly vary between strata in the UP. Additionally, belt use was examined as a function of stratum by vehicle type, seating position, sex, age group, and weather. No significant differences were observed in any of these analyses. These findings suggest that belt use trends do not vary across the UP; for example, belt use by 30-to-59 year olds is about the same in the Western Stratum as it is in the Central or Eastern Strata.

Past research has identified factors that could be useful in attempts to increase safety belt use among UP residents. Studies have found that people in rural areas report not wearing safety belts because they will not be going far or driving fast (see e.g., OHSP, 2000). This erroneous reasoning could be addressed in programs highlighting the fact that everyday driving poses the greatest danger. Most crashes occur within 25 miles of home at speeds of less than 40 mph (OHSP, 2000). Additionally, surveys and focus groups have found that drivers in rural areas may not see a need for wearing safety belts (Graham, 1997). Perceptions by drivers in rural areas of decreased crash risk and decreased police enforcement of the safety belt law results in decreased safety belt use (Campbell, Stewart, & Campbell, 1987; Marchetti, Hall, Hunter, & Stewart, 1992; Thompson & Russell, 1994). It has been suggested that the perception of enforcement may be more important than the actual enforcement level (Campbell, 1987). Thus, there must be adequate publicity concerning enforcement efforts related to Michigan's standard enforcement safety belt use law, so UP residents feel there is a risk of being pulled over for safety belt use violations. However, further research is necessary to develop PI&E programs and messages to appeal to the unique characteristics of UP residents.

The baseline safety belt use rate obtained in this study enables us to measure safety belt use rates in Michigan's UP; it also allows us to identify emerging trends; and to measure the effects of future PI&E programs in this area. The current study reports safety belt use rates separated into several demographic categories. These categorical belt use rates suggest that PI&E programs targeted at specific groups within the UP could be of a particular benefit, especially programs aimed at pickup truck occupants, passengers, males, and 16-to-59 year olds. By targeting programs designed to increase safety belt use toward those populations most likely to benefit, safety belt use increases can be maximized in the UP.

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APPENDIX A

Data Collection Forms

SITE DESCRIPTION 2000

SITE # __ __ __ SITE LOCATION ______________________________
1 2 3

SITE TYPE
1☐ Intersection
2☐ Freeway
4
Exit No. ________

SITE CHOICE
1☐ Primary
2☐ Alternate
5

TRAFFIC CONTROL
1☐ Traffic Light
2☐ Stop sign
3☐ None
4☐ Other ______________
6

DATE (month/day): __ __/__ __/2000
7 8 9 10

OBSERVER
1☐ Tiffani
2☐ Jonathon
11

DAY OF WEEK
1☐ Monday
2☐ Tuesday
3☐ Wednesday
4☐ Thursday
5☐ Friday
6☐ Saturday
7☐ Sunday
12

WEATHER
1☐ Mostly Sunny
2☐ Mostly Cloudy
3☐ Rain
4☐ Snow
13

START TIME: __ __:__ __ (24 hour clock)
14 15 16 17

END TIME: __ __:__ __ (24 hour clock)
18 19 20 21

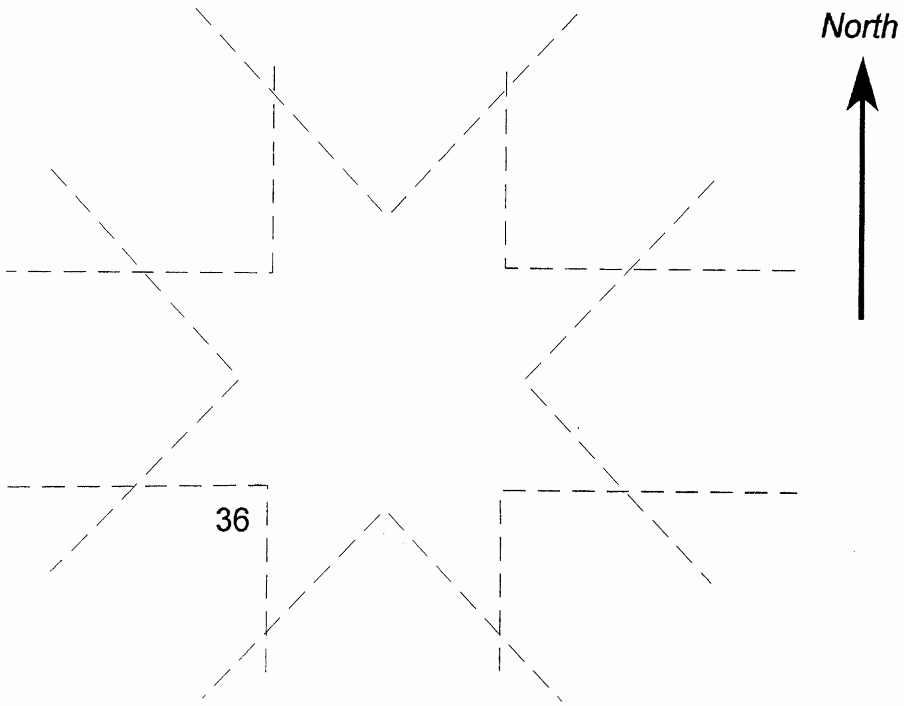
INTERRUPTION (total number of minutes during observation period): __ __
22 23

MEDIAN: 1☐ Yes
2☐ No
24

TRAFFIC COUNT 1: __ __ __
25 26 27

TRAFFIC COUNT 2: __ __ __
28 29 30

COMMENTS::



SITE # ___ ___ ___ PAGE #______

1 2 3

ATTENTION CODING: DUPLICATE COL 1 - 3 FOR ALL VEHICLES **2000**

DRIVER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 4	1☐ Male 2☐ Female 5	2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 6	VEHICLE TYPE 1☐ Passenger car 2☐ Van 3☐ Utility 4☐ Pick-up 7	
FRONT-RIGHT PASSENGER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD 8	1☐ Male 2☐ Female 9	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 10	Office Use Only: ___ ___ ___ 11 12 13	COMM. VEHICLE 1☐No 2☐Yes 14

DRIVER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 4	1☐ Male 2☐ Female 5	2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 6	VEHICLE TYPE 1☐ Passenger car 2☐ Van 3☐ Utility 4☐ Pick-up 7	
FRONT-RIGHT PASSENGER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD 8	1☐ Male 2☐ Female 9	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 10	Office Use Only: ___ ___ ___ 11 12 13	COMM. VEHICLE 1☐No 2☐Yes 14

DRIVER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 4	1☐ Male 2☐ Female 5	2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 6	VEHICLE TYPE 1☐ Passenger car 2☐ Van 3☐ Utility 4☐ Pick-up 7	
FRONT-RIGHT PASSENGER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD 8	1☐ Male 2☐ Female 9	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 10	Office Use Only: ___ ___ ___ 11 12 13	COMM. VEHICLE 1☐No 2☐Yes 14

DRIVER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 4	1☐ Male 2☐ Female 5	2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 6	VEHICLE TYPE 1☐ Passenger car 2☐ Van 3☐ Utility 4☐ Pick-up 7	
FRONT-RIGHT PASSENGER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD 8	1☐ Male 2☐ Female 9	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 10	Office Use Only: ___ ___ ___ 11 12 13	COMM. VEHICLE 1☐No 2☐Yes 14

APPENDIX B

Site Listing

Survey Sites by Number

Site #	Stratum	Site Location
001	Western Stratum	NWB Emily Lane Rd. & M-26
002	Western Stratum	SB CO-523 & US-2
003	Western Stratum	SB US-141 & US-2
004	Western Stratum	NEB US-141/M-28 & US-41/M-28
005	Western Stratum	WB CO-210/Indian Village & US-45
006	Western Stratum	SB USFS-16 & CO-436
007	Western Stratum	EB US-2 & M-28
008	Western Stratum	NWB M-26 & US-41
009	Western Stratum	NB M-95 & Turner Rd.
010	Western Stratum	SB Jack Spur & M-28
011	Western Stratum	SB M-26 & US-41
012	Western Stratum	EB Chicago Mine Rd. & M-28
013	Western Stratum	NB M-38 & M-26
014	Western Stratum	WB Herman & US-41
015	Western Stratum	SB M-64 & M-28
016	Western Stratum	SB Herman & US-41/M-28
017	Western Stratum	WB Cloverland/US-2 & Hemlock
018	Western Stratum	NB Newberry & M-38
019	Western Stratum	SB Norwich & M-28
020	Western Stratum	NB CO-569/G-69 & CO-69
021	Western Stratum	WB M-26 & Fourth St.
022	Western Stratum	EB M-38 & US-41
023	Western Stratum	NEB US-41/M-26/Mohawk St. & Stanton Ave.
024	Western Stratum	WB US-2 & Cedar
025	Western Stratum	SB US-2/US-141/M-95 & M-95/Ludington
026	Western Stratum	NB Wasas & M-38
027	Western Stratum	SB N. Bessemer Rd./CO-513 & CO-513
028	Western Stratum	WB M-69 & M-95
029	Western Stratum	NB US-45 & CO-206/ Sucker Lake Rd.
030	Western Stratum	NEB M-26 & Hubbard Ave.
031	Western Stratum	WB Pierce & US-2.

032	Western Stratum	SWB CO-581/G-67 & CO-569
033	Western Stratum	EB Canal & M-26
034	Western Stratum	EB Jackson & Lake/CO-505
035	Western Stratum	NB M-95/Carpenter & Woodward
036	Central Stratum	EB CO-374 & CO-551
037	Central Stratum	NWB CO-497 & US-2
038	Central Stratum	EB PG & CO-476
039	Central Stratum	EB US-41/M-28 & Main
040	Central Stratum	NEB Middle Island Pt & CO-550
041	Central Stratum	NB Ogontz Rd/County 503CC Rd & CO-550
042	Central Stratum	NB Goldmine Rd & CO-550
043	Central Stratum	SE CO-550 & Prosen
044	Central Stratum	EB CO-478 & CO
045	Central Stratum	SEB A-35 & M-35
046	Central Stratum	NB North/Baldwin & Kivela
047	Central Stratum	WB CO-519/I Rd. & CO-523/Boney Falls/H Rd.
048	Central Stratum	EB Perch Lake & CO-581
049	Central Stratum	EB CO-338 & M-35
050	Central Stratum	NB CO-510 & CO-550
051	Central Stratum	SB Wolf Lake/FX & US-41/M-28
052	Central Stratum	WB MU & M-35
053	Central Stratum	NB CO-533/Dukes & M-94
054	Central Stratum	NB IB/Brown Rd. & US-41/M-28
055	Central Stratum	WB Ingalls & US-41
056	Central Stratum	NB Lake Shore Blvd & Pine
057	Central Stratum	EB US-2 & US-41
058	Central Stratum	NB M-183 & US-2
059	Central Stratum	SWB SA & CO-426
060	Central Stratum	SB M-35 & CO-492/M-35
061	Central Stratum	SB CO-557 & CO-426/G-38
062	Central Stratum	EB CO-338 & CO-571/Range Line Dr./M-1
063	Central Stratum	WB N-18/CO-436 & M-183
064	Central Stratum	WB CO-601 & M-95
065	Central Stratum	WB CO-601 & M-95
066	Central Stratum	EB G-12/CO-352 & CO-577

067	Central Stratum	WB No. 2 Rd. & Hwy. 577
068	Central Stratum	EB 48th Ave. & US-41
069	Central Stratum	NB M-35 & US-2/US-41/M-35
070	Central Stratum	SEB CO-426 & US-2/US-41
071	Eastern Stratum	WB Curly Lewis Memorial Hwy. & M-123
072	Eastern Stratum	EB H-44/CO-98 & H-33/CO-135
073	Eastern Stratum	SB M-48 & M-134
074	Eastern Stratum	EB CO-433 & US-2
075	Eastern Stratum	EB M-48 & M-48/M-129
076	Eastern Stratum	WB H-58 & M-28
077	Eastern Stratum	NBD I-75 & M-48/19 Mile Rd.
078	Eastern Stratum	SB N. Raber & M-48
079	Eastern Stratum	NWB H-40/Trout Lake Rd. & M-123
080	Eastern Stratum	SB Borgstrom Rd. & Hiawatha Trail/H-40
081	Eastern Stratum	SB Kinross Rd. & Mackinac Trail/H-63
082	Eastern Stratum	NB Strongs Rd./Salt Point Rd./USFS 3159 & M-28
083	Eastern Stratum	SB M-129 & 3 Mile Rd.
084	Eastern Stratum	SB M-77 & M-28
085	Eastern Stratum	EB M-123 & M-123
086	Eastern Stratum	EB Worth Rd. & M-123
087	Eastern Stratum	EB 3 Mile Rd. & Riverside Dr.
088	Eastern Stratum	EB McKelvey Rd. & M-117
089	Eastern Stratum	SBP I-75 & West US-2
090	Eastern Stratum	WB Cheeseman & US-2
091	Eastern Stratum	NB Ashmun/Business Loop I-75 & Easterday Ave.
092	Eastern Stratum	WB Prospect Rd. & M-28
093	Eastern Stratum	SB Tannery Rd. P-439 & US-2
094	Eastern Stratum	SW M-94/Maple Street & US-2
095	Eastern Stratum	SB M-117 & US-2
096	Eastern Stratum	NB M-117 & M-28
097	Eastern Stratum	WB Carpenter Rd. & M-77
098	Eastern Stratum	WB Lakeshore Rd. & S. Ranger Rd.
099	Eastern Stratum	SB H-15 & M-28

100	Eastern Stratum	SB Trout lake Rd./H-40 & Hiawatha Trail
101	Eastern Stratum	NB M-123 & CO-407/H-47/Deer Park Rd.
102	Eastern Stratum	EB W. 6 Mile Rd. & S. Mackinac Trail/H-63
103	Eastern Stratum	SB CO-413 & CO-436
104	Eastern Stratum	SB CO-403 & M-28
105	Eastern Stratum	EB Rockview & M-129

APPENDIX C

Calculation of Variances, Confidence Bands, and Relative Error

The variances for the belt use estimates were calculated using an equation derived from Cochran's (1977) equation 11.30 from section 11.8. The resulting formula was:

$$var \approx \frac{n}{n-1}\sum_i \left(\frac{g_i}{\sum_i g_i}\right)^2 (r_i - r)^2 + \frac{n}{N}\sum_i \left(\frac{g_i}{\sum_i g_i}\right)^2 \frac{s_i^2}{g_i}$$

where *var* equals the variance for a stratum, n is the number of observed intersections, g_i is the weighted number of vehicle occupants at intersection i, $\sum g_i$ is the total weighted number of occupants at all sites, r_i is the weighted belt use rate at intersection i, r is the belt use rate, N is the total number of intersections, and $s_i = r_i(1-r_i)$. In the actual calculation of the variance, the second term of this equation is negligible. If we conservatively estimate N to be 2000, the second term only adds 2.1×10^{-6} units. This additional variance does not significantly add to the variance captured in the first term. Therefore, since N was not known exactly, the second term was dropped in the variance calculations.

$$Variance_{total} = \frac{V_{WesternStratum} + V_{CentralStratum} + V_{EasternStratum}}{9}$$

The 95 percent confidence bands were calculated using the formula:

$$95\%\ Confidence\ Band = r \pm 1.96 \times \sqrt{Variance}$$

where r is the belt use of interest. This formula is used for the calculation of confidence bands for each each vehicle type and for the overall belt use estimate.

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

$$RelativeError = \frac{StandardError}{r}$$

APPENDIX D

Confidence Bands and Unweighted N's

Table 5. Percent Shoulder Belt Use, 95% Confidence Band, and Unweighted Number of Occupants by Seating Position in Michigan's UP		
Seating Position	**Percent Use**	**Unweighted N**
Driver	79.8 ± 2.2 %	2829
Passenger	74.7 ± 3.6 %	985

Table 6. Percent Shoulder Belt Use, 95% Confidence Band, and Unweighted Number of Occupants by Sex in Michigan's UP		
Sex	**Percent Use**	**Unweighted N**
Male	73.7 ± 2.7 %	2167
Female	84.5 ± 2.0 %	1647

Table 7. Percent Shoulder Belt Use, 95% Confidence Band, and Unweighted Number of Occupants by Weather in Michigan's UP		
Weather	**Percent Use**	**Unweighted N**
Mostly Sunny	81.6 ± 3.9 %	1517
Mostly Cloudy	76.8 ± 2.8 %	2184
Rainy	72.6 ± N/A %	113

Table 8. Percent Shoulder Belt Use, 95% Confidence Band, and Unweighted Number of Occupants by Age Group in Michigan's UP		
Age Group	**Percent Use**	**Unweighted N**
0-to-3	100.0 ± N/A %	3
4-to-15	73.2 ± 1.0 %	102
16-to-29	74.6 ± 3.3 %	695
30-to-59	77.9 ± 2.7 %	2268
60-up	85.2 ± 2.6 %	746

Table 9. Percent Shoulder Belt Use, 95% Confidence Band, and Unweighted Number of Occupants by Stratum and Seating Position in Michigan's UP				
	Driver		Passenger	
Stratum	Rate (%)	N	Rate (%)	N
Western	81.8 ± 5.1 %	1090	76.4 ± 5.3 %	350
Central	78.3 ± 3.2 %	670	67.8 ± 7.8 %	171
Eastern	77.8 ± 2.4 %	1069	76.9 ± 5.2 %	464

Table 10. Percent Shoulder Belt Use, 95% Confidence Band, and Unweighted Number of Occupants by Stratum and Sex in Michigan's UP				
	Male		Female	
Stratum	Rate (%)	N	Rate (%)	N
Western	76.1 ± 5.4 %	768	85.2 ± 4.1 %	672
Central	70.2 ± 4.6 %	513	85.0 ± 3.1 %	328
Eastern	73.5 ± 3.7 %	886	82.7 ± 3.2 %	647

Table 11. Percent Shoulder Belt Use, 95% Confidence Band, and Unweighted Number of Occupants by Stratum and Age Group in Michigan's UP										
	0-to-3		4-to-15		16-to-29		30-to-59		60-up	
Stratum	Rate (%)	N	Rate (%)	N	Rate (%)	N	Rate (%)	N	Rate (%)	N
Western	100.0± N/A %	1	74.0 ± 12.1 %	40	81.7 ± 7.0 %	240	78.1 ± 4.4 %	891	87.2 ± 4.3 %	268
Central	100.0± N/A %	1	65.6 ± 26.6 %	17	59.9 ± 5.7 %	116	78.9 ± 3.8 %	562	85.0 ± 4.3 %	145
Eastern	100.0± N/A %	1	80.8 ± 10.1 %	45	75.6 ± 4.0 %	339	76.1 ± 5.5 %	815	82.2 ± 4.8 %	333

Table 12. Percent Shoulder Belt Use, 95% Confidence Band, and Unweighted Number of Occupants by Stratum and Weather in Michigan's UP

	Mostly Sunny		Mostly Cloudy		Rainy	
Stratum	**Rate (%)**	**N**	**Rate (%)**	**N**	**Rate (%)**	**N**
Western	83.9 ± 3.8 %	510	77.7 ± 6.8 %	930	-----	0
Central	73.1 ± 10.4 %	139	76.8 ± 3.3 %	677	76.0 ± N/A %	25
Eastern	80.2 ± 4.2 %	868	75.2 ± 3.6 %	577	71.6 ± N/A %	88