UMTRI-88-12

REAR SEAT BELT EFFECTIVENESS IN MICHIGAN

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March 1988

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UMTRI-88-12		

4. Title and Subtitle	5. Report Date
REAR SEAT BELT EFFECTIVENESS IN MICHIGAN	March 1988
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Kenneth L. Campbell	UMTRI-88-12

9. Performing Organization Name and Address	10. Work Unit No.
The University of Michigan Transportation Research Institute 2901 Baxter Road Ann Arbor, Michigan 48109-2150	11. Contract or Grant No. DTNH22-87-P-07129
	13. Type of Report and Period Covered

12. Sponsoring Agency Name and Address	
National Highway Traffic Safety Administration U. S. Department of Transportation Washington, D. C. 20590	Special Report 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

In July 1985, a seat belt use law went into effect in Michigan. Although, the law does not apply to rear seat occupants, it was anticipated that seat belt use would increase among these occupants also. Thus, the new seat belt law was expected to produce increased restraint use in the rear seat, and provide a basis to estimate the effectiveness of seat belts in preventing injury to rear seat occupants. An initial examination of the data comparing belt use among rear seat occupants involved in accidents and those observed in roadside surveys showed that belt use was substantially overstated in the accident reports following implementation of the seat belt use law. This bias is sufficient to render the belt use information in the accident data unsuitable for analysis under the seat belt law. Accident data from the period prior to Michigan's seat belt law is used to estimate the effectiveness of rear seat restraints in preventing injury. Based on 1984 data, rear seat restraints are shown to reduce the probability of fatal and incapacitating injury among injured occupants. While the accuracy of the coding of seat belt use is still open, this analysis provides no evidence that seat belt use by rear seat occupants might increase the probability of injury. Limited sample sizes prevent multivariate analysis of factors such as collision type, car size, and occupant age, that one would expect to influence the effectiveness.

17. Key Words	18. Distribution Statement
Rear seat belt effectiveness, Michigan accident data	Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
None	None	13	

Rear Seat Belt Effectiveness in Michigan

Text of a presentation made in a session on
Occupant Protection in Rear Seats
at the
1987 SAE International Congress
in Detroit, Michigan
February 26, 1987

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The work described in this paper was an effort to estimate the effectiveness of restraint use for rear seat occupants of passenger cars involved in accidents reported in Michigan. Belt use among rear seat occupants was expected to increase as a result of a belt use law for front seat occupants that was passed in February 1985 and went into effect in July 1985 in Michigan. Increased belt use would provide a larger sample size for estimation of the effectiveness of rear seat restraints. Information coded from the traffic accidents reported in 1985 was provided by the Michigan State Police.

The analysis was initially restricted to occupants of late model (1973 and newer) passenger cars. All of these vehicles should have been equipped with lap belts in the rear outboard positions. To eliminate small children that may have been in child restraint devices, occupants of age 5 or younger were omitted. There were a total of 701,763 occupants over age 5 in late model passenger cars involved in police-reported accidents in Michigan in 1985. Nearly 84 percent of these occupants were not injured, 16 percent were injured, and only 0.12 percent (846) were killed. Only 9.4 percent (61,489 occupants) were in the outboard rear seat locations, 5.4 percent in the right rear and 4.0 percent in the left rear. The overall probability of injury was lower for rear seat occupants. Eighty-nine percent received no injury, 10.5 percent were injured, and 0.08 percent (49 occupants) were killed.

Table 1 shows the belt use for these rear seat occupants versus the severity of their injuries. The last column shows an effectiveness for belt use calculated as the percent reduction in the probability of injury for restrained occupants as compared to unrestrained. These figures indicate a substantial effectiveness for rear seat belt use. However, the accuracy of these estimates rests on the accuracy of the coding of belt use in the data. The next section compares belt use rates in the accident data with the results of observational surveys of belt use in Michigan.

Comparison with Observed Belt Use

In order to assess compliance with Michigan's seat belt law, the University of Michigan Transportation Research Institute has been conducting direct observation surveys of seat belt use throughout the state under the sponsorship of the Michigan Office of Highway Safety Planning (References 1-4). Before the law went into effect, surveys were conducted in December 1984 and April 1985. After the law went into effect, surveys were conducted in July and December 1985. Trained staff observe belt use at 240 intersections throughout Michigan. The information recorded includes restraint use, seat position, estimated age, and sex for occupants in all seating positions in each sampled vehicle. The size and type of vehicle is also recorded. Observations were made while the vehicles were stopped at the intersection. No more than three vehicles were selected for observation during any one signal cycle. This procedure was adopted in the July 1985 survey when it was noticed that occupants in long traffic queues buckled up after noticing the observer examining vehicles ahead of them in the queue. The survey design calls for observation of up to 51 vehicles at each site over about a 45 minute period. In all, restraint use for all occupants of about 12,000 vehicles is recorded in each survey wave.

Table 2 compares belt use in the accident data and belt use from the observation surveys. Only drivers were used for this comparison. The top half of the table shows restraint use among accident-involved drivers by the severity of injury and quarter of the year. Restraint use is lower among more seriously injured drivers, and is substantially higher in the last two quarters when the belt use law took effect. Across the bottom of the table are the results of the four waves of the observation survey of belt use in Michigan. The observations are taken during a one-week period in the month indicated. The time periods for the observations are not exactly matched with the quarterly accident data. For example, a December 1984 observation period is shown in the column with accident data from January through March 1985. In the next two quarters, the observation survey was conducted during the first month of the quarter, and during the last month of the last quarter. Thus, the time periods are not exactly comparable. However, the differences in the belt use rates are substantial.

In general, much higher belt use rates are shown in the accident data. This result does not seem plausible. If any difference were to be expected, it would be that belt users were more cautious, and possibly less likely to be involved in an accident. In addition, the expectation that belt use reduces the probability of injury would also suggest that belt use would be lower among occupants injured in an accident than in the general driving public. In general, one would not expect accident-involved occupants to have higher rates of belt

use than the general driving public. The more likely explanation is that belt use is overestimated in the accident data. Unless an occupant is seriously injured and has not moved when the officer arrives on the scene, the investigating officer does not usually have the opportunity to actually observe whether belts were worn or not. Frequently, the occupant must be relied on to correctly report restraint use. Particularly after the belt use law, occupants may have a tendency to report that the restraint was used when it was not. The trend in belt use is consistent with this explanation, since the highest use is among uninjured occupants, and the lowest for fatally injured occupants where belt use was presumably obtained from rescue personnel. It appears that belt use is overstated among uninjured occupants in the Michigan accident data.

There are some other problems with the coding for uninjured occupants. Occupant age is missing for 37 percent of the uninjured occupants of late model passenger cars. Among injured occupants in this group, age is missing for only 1.6 percent. For occupant sex, the miscoding is less obvious. For injured occupants, 50.3 percent are coded male and 49.7 percent are coded female. However, among uninjured occupants, 74 percent are coded male and 26 percent female. The convention in Michigan is to code sex as "male" when it is unknown, rather than leave it blank. These problems further limit the usefulness of the data on uninjured occupants, and are a general indication of the lower priority of this subset for the investigating officer. Getting medical treatment for the injured, directing traffic and removal of the vehicles, and determining whether any traffic laws have been violated are of much greater importance.

These problems with the data prompted omission of uninjured occupants from the remainder of the analysis. Belt use among injured occupants compares more favorably with belt use from observation surveys. Table 3 focuses on rear seat occupants by quarter in 1985. Although none of the rear seat occupants are included in the belt use law that went into effect in July 1985, its influence is evident. Looking at the belt use rates from observation surveys, belt use increased among rear seat occupants in the July 1985 survey, and then dropped back to the levels of the December 1984 and April 1985 surveys in the December 1985 survey. Before the belt law was effective, the belt use rates for injured adults in the accident data are about twice the observed rate. The rates for injured children in the accident data are actually lower than the observed rate. After the law was effective, belt use rates are somewhat higher for injured children and substantially higher for injured adults.

Rear Seat Belt Effectiveness

Table 4 presents estimates of belt use and effectiveness for injured rear seat occupants. For the remaining tables, effectiveness has been calculated as the percent reduction in the probability of a fatal or incapacitating injury, given that the occupant was injured. The effectiveness has been estimated separately for children (ages 4 through 15) and adults (ages 16 and over). In addition, data from 1984 has been added for comparison. Belt use rates in the 1984 accident data are lower than those in the first quarter of 1985. Based on the 1984 accident data for injured occupants, belt use reduced the probability of a fatal or incapacitating injury by 38 percent for children and 26 percent for adults. Except for children in the first six months of 1985, the effectiveness estimates are all higher in the 1985 data. This apparent increase in the effectiveness of belts could be a consequence of bias in the coding of belt use.

The last table (Table 5) presents belt effectiveness estimates derived from 1984 Michigan accident data. The tabulation was restricted to injured rear seat occupants of late model (1973 or newer) passenger cars. The older data should be less likely to be contaminated with bias in the coding of belt use. The overall effectiveness of belts in reducing fatal and incapacitating injuries among injured occupants of late model passenger cars is 27 percent. The remainder of the table shows the variation in this estimate for various subsets of the data based on collision type, occupant sex, model year, month, and car size. Some of these factors would be expected to influence belt effectiveness, while others would not. With regard to collision type, the belts appear most effective in frontal impacts. One would have expected belts to be effective in rollover accidents by eliminating ejection. However, the sample size is small for this cell, with only 21 restrained rear seat occupants. Other subsets indicate that rear seat belts are less effective for adult males and less effective in the first six months of 1984. The belts were more effective in older model year cars, and more effective in the rear of large cars. These finding are somewhat mixed, and sample sizes are inadequate is some subsets. However, none of the tabulations have indicated a net negative effectiveness for rear seat lap belt use.

Summary

Perhaps the most important finding from this exercise is the apparent tendency in the Michigan accident data for belt use to be coded when the restraints were not actually worn. This paper presents no direct proof of this bias, such as subsequent investigations showing that the restraints were not actually used, but the inferential evidence seems compelling. Belt use rates from the observation surveys of the driving public were

substantially lower. The sites for the observations were selected to represent all travel in Michigan. For example, the number of sites observing traffic entering or exiting freeways matched the proportion of freeway travel in Michigan. The sample sizes were more than adequate, and the observations were made by impartial trained observers. Finally, the results are consistent with similar observations in other states. Belt use rates of 88 percent, as shown in the accident data for drivers in the last six months of 1985, are simply too high to be credible.

The apparent bias in the coding of belt use seemed to inflate the estimates of belt effectiveness. If there was a tendency for officers to code belt use when there were no injuries or minor injuries, and to code restraints as not used for occupants with serious injuries, then belt effectiveness would indeed be over-stated. Again, there is no direct evidence to establish the nature or source of this bias.

The analysis was directed to 1984 Michigan data in the hope that the coding of belt use would be more accurate before belt use laws became imminent. Overall, belts appeared to be 26 percent effective in reducing the probability of fatal or serious injury among rear seat, injured, adult occupants of passenger cars. The effectiveness varied substantially across various subsets of the data defined by factors that may influence the resulting effectiveness. However, no evidence of a net negative effectiveness was found. While the accuracy of the coding of seat belt use is still open to question, this analysis provides no evidence that seat belt use by rear seat occupants might increase the probability of injury.

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Table 1
1985 Michigan Accidents-Rear Seat Occupants

Injury Severity by Belt Use

Injury Level	Belted		Unbelted		Belt Effectiveness*
	N	P(Injury)	N	P(Injury)	
Fatal (F)	15	0.0005	34	0.0012	62%
Incapactating (A)	152	0.0046	550	0.0193	76
Non-incapacitating (B)	569	0.0172	1,163	0.0409	58
Possible (C)	1,616	0.0489	2,426	0.0852	43
None	30,670	0.9288	24,294	0.8534	
Total	33,022	100.0000	28,467	100.0000	

*Percent reduction in the probability of injury

Table 2
Comparison of Belt Use in Accident Data with Belt Use from Observation Surveys Drivers Only

1985 Michigan Accidents-Drivers Belt Use by Injury Severity–Quarterly				
Injury Level	Jan-Mar	Apr-June	July-Sept	Oct-Dec
Fatal (F)	13.9%	14.4%	32.0%	31.4%
Incapacitating (A)	19.5	20.4	59.5	57.4
Non-incapacitating (B)	21.2	26.0	71.2	66.0
Possible (C)	34.0	38.0	86.5	84.6
None	35.6	40.5	90.3	89.4
ALL	34.5%	39.0%	88.3%	87.4%
N	116,796	97,947	102,178	149,392
Observed Belt Use in Michigan*				
	Dec 84	Apr 85	July 85	Dec 85
Drivers	19.5%	26.0%	61.3%	45.4%
N	11,906	12,345	12,263	12,106

*References 1-4

Table 3
Comparison of Belt Use in Accident Data with Belt Use from Observation Surveys Rear Seat Occupants by Age

1985 Michigan Accidents-Quarterly Rear Seat Injured Occupants				
Age	Jan-Mar	Apr-June	July-Sept	Oct-Dec
Child (4-15)	28.7%	33.9%	59.5%	55.0%
N	696	707	743	893
Adults (16+)	14.0%	17.3%	46.3%	43.1%
N	965	1034	1065	1185
Observed Belt Use in Michigan*				
Age	Dec 84	Apr 85	July 85	Dec 85
Child (4-15)	28.0%	36.5%	50.3%	36.8%
N	468	586	1006	483
Adults (16+)	7.2%	9.7%	18.6%	6.9%
N	423	532	688	429

*References 1-4

Table 4
Belt Use and Effectiveness by Accident Year and Occupant Age
Rear Seat Injured Occupants in Michigan Accidents

Category	Belt Use	P(F+A)		Effect.*	N
		Belted	Unbelted		
1984					
Child (4–15)	19.3%	0.068	0.110	38.0%	2,356
Adult (16+)	10.2	0.093	0.126	26.2	4,104
January–June 1985					
Child (4–15)	31.4%	0.068	0.092	26.2%	1,403
Adult (16+)	15.7	0.057	0.146	60.7	1,999
July–December 1985					
Child (4–15)	57.0%	0.060	0.131	54.1%	1,636
Adult (16+)	44.6	0.080	0.171	53.4	2,250

*Percent reduction in the probability of fatal and incapacitating injury among injured occupants.

Table 5
Belt Effectiveness for Various Subsets

1984 Michigan Accidents
Injured Rear Seat Adult Occupants
of Late Model Passenger Cars

Category	Belt Use	P(F+A)		Effect.*	N
		Belted	Unbelted		
Overall					
All	11%	0.093	0.128	27%	3763
Collision Type					
Frontal	10%	0.083	0.132	37%	1718
Near-Side	9	0.200	0.199	0	336
Far-Side	8	0.150	0.164	9	245
Rollover	10	0.227	0.229	1	214
Sex					
Male	9%	0.130	0.140	7%	1521
Female	12	0.076	0.120	37	2242
Model Year					
73-79	8%	0.058	0.120	51%	2044
80-85	15	0.115	0.139	18	1719
Month					
Jan-June	10%	0.097	0.113	14%	1629
July-Dec	12	0.091	0.140	35	2134
Car Size					
Small	13%	0.118	0.141	16%	694
Medium	12	0.103	0.129	20	1493
Large	9	0.069	0.121	43	1464

*Percent reduction in the probability of fatal and incapacitating injury among injured occupants.