



CODES

Crash Outcome Data Evaluation System

INJURIES AND COSTS ASSOCIATED WITH NON-SEATBELT USE FOR MOTOR VEHICLE CRASHES IN WISCONSIN, 2010

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Summary

We utilized Wisconsin CODES linked crash/hospital/ED data to evaluate injuries and costs associated with non-seatbelt use among persons for whom seat belt use is most likely to be reported correctly. Those cases were persons who died, were hospitalized, or had incapacitating or non-incapacitating injuries as reported by police. There were 13,854 crash victims included in the analysis. Highlights:

- Persons not wearing seat belts were 5.4 times as likely to die as those wearing belts.
- Persons not wearing seat belts were 1.9 times as likely to be hospitalized as those wearing belts.
- Persons not wearing seat belts had total costs \$268,000 higher than for persons wearing belts.

Background

One of the issues relating to any analysis of the health and cost outcomes related to seat belt use centers on the issue of over-reporting of seat belt use by police. This over-reporting is caused both by crash victims not being “truthful” concerning seat belt use and by police making assumptions concerning seat belt use in light of whether an occupant was or wasn’t injured. This issue has been known to be a problem for over 20 years. An analysis which used data from the National Accident Sampling System Crashworthiness Data System (CDS) investigated this issue. In the article, investigators assessed how police reported seat belt use vs. whether CDS investigators determined belts were used (Schiff et al, 2004) . The authors drew two major conclusions. First, police usually correctly classify crash victims as belted when they actually were belted. Second, they tend to misclassify unbelted occupants as belted. They do suggest, however, that the more severe the injury, the less likely it is that police will misclassify unbelted occupants as belted.

In our analysis we select patients who police classify as being injured, or who are hospitalized, in order to obtain injury and cost estimates for vehicle occupants for whom police are more likely to be correct in reporting seat belt usage. These estimates cover injuries and costs for occupants for whom seat belt (non)use is directly relevant. We do not, however, attempt to analyze whether the nonuse of seatbelts leads to injury. We are only concerned with the population that is injured and for whom injury severity, type of injury and costs are directly relevant.

Population Selection

The initial selection of motor vehicle crash occupants was limited to:

- Include only passenger vehicles and utility vehicles
- Exclude persons in child seats
- Exclude crashes occurring in parking lots or on private property
- Use data from 2010

Below (Table 1) shows (reported) belted vs. non-belted by injury severity and for hospitalized patients. It also has reported seat belt use, for cases where injury severity was coded as an A, B, K or for individuals who were hospitalized. For patients who died (K), only 41% are reported to have worn seat belts. For patients who were reported to have an incapacitating injury, 75% were reported to have worn a seat belt (A). For patients who were reported to have a non-incapacitating injury (B), 83% were reported to have worn a seat belt. The results for “possible injury” (C) and no injury have

reported seat belt use at 93% and 97%, respectively. For patients who were hospitalized, only 67% were wearing seat belts.

These results suggest that police officers do pay attention to seat belt use if they believe that an injury has occurred. And that is reflected not just for Ks and As, but for Bs (with seatbelt use at 83%). By including cases with injury types A/B/K or who were hospitalized, we end up with an overall seatbelt use rate of 79% for 2010. This rate is reasonably close to seatbelt use rates derived from observational studies performed for WDOT.

Table 1. Seat Belt Use by Injury Severity and Hospitalization

	<u>Not Belted - #</u>	<u>Not Belted - %</u>	<u>Belted - #</u>	<u>Belted - %</u>
K – Died	218	59%	147	41%
A – Incapacitating Injury	800	25%	1,769	75%
B – Non-Incapacitating Injury	1,849	17%	8,725	83%
C - Potential Injury	1,535	7%	19,185	93%
Unknown/No Injury	4,977	3%	146,619	97%
Hospitalized	695	34%	1,359	66%
All K, A, B and Hospitalized	2,933	21%	10,921	79%

The study population will thus include all hospitalized cases, as well as cases for which the police reported injury severity is “K”, “A”, or “B”.

Table 2 (next page) provides basic information on crashes and crash outcomes for our selected population (A/B/K/Hospitalized) for 2010. There are 13,854 cases. Of these crash victims, an average of about 66% per year had an emergency transport. About 15% were hospitalized during the period. And 2.7% died as a result of the crash they were in. Overall, 79% were reported as having worn belts, and 21% were not wearing seat belts.

TABLE 2
BASIC INFORMATION ON PASSENGER VEHICLE
CRASHES IN WISCONSIN (included in the Analysis) for 2010

	2010
Number of Occupants	13,854
<u>Crash Outcomes</u>	
Number of Occupants Transported	9,128
% of Occupants	66.1%
Number of Occupants Hospitalized	2,054
% of Occupants	14.8%
Number of Occupants Who Died	370
% of Occupants	2.7%
<u>Restraint Use</u>	
Belted	10,921
% of Total	78.8%
Not Belted	2,933
% of Total	21.2%

Only includes occupants of passenger vehicles with a reported injury severity of Died, Incapacitating Injury, Non-Incapacitating Injury (A/B/K), or who were hospitalized. Only includes occupants of passenger or utility vehicles in crashes occurring on public right of way. Occupants with missing information on seatbelt use are excluded.

Health/Cost Outcomes

In evaluating health related outcomes for belted vs. non-belted drivers, we utilized classification and estimation techniques not intrinsic to CODES linked data proper.

Injury Scores:

We used the Maximum Abbreviated Injury Score (MAIS) to evaluate how serious the injuries were. The MAIS ranges from 1 (minor) to 6 (critical) based on the highest AIS for any body region injured (there may be several body parts injured in a crash). The MAIS is a cardinal measure of injury severity. These measure was originally developed by the AAAM in conjunction with NHTSA and injury researchers in the 1960s. The version we use is the most recent version, last updated for the International Classification of Disease Version 9 for 1990 and implemented in ICDMAP90 software (which was developed and is maintained at John Hopkins University). MAIS scores couldn't be calculated for about 7.5% of our hospital records.

Estimates of Cost:

We provide information on both hospital charges and on estimated Medical Costs, Other Direct Costs and Quality of Life Costs. Hospital charges are the usual "cost" information provided in CODES related analysis. However, hospital charges may bear little, if any, relation to true costs for individual patients due to cost shifting within hospital billing practices.

In an attempt to more fully and correctly capture the costs associated with seat belt use in passenger vehicle related crashes in Wisconsin, we utilized diagnostic code based cost estimates outlined in a paper published in 2003: "*Crash costs by body part injured, fracture involvement and threat-to-life severity, United States, 2000*" (Zaloshnja et al., 2003). This paper is an elaboration of analysis the authors performed while working on a major NHTSA study: "*The Economic Impact of Motor Vehicle Crashes, 2000*" (Blincoe et al., 2002) published in 2002. This study used the methods employed in the US Consumer Product Safety Commission's injury cost model, and utilized nationally representative samples of hospitalized patients over several years to derive detailed cost estimates for medical and other costs based on specific types of injuries. These cost estimates were adjusted annually based on the Consumer Price Index and the Bureau of Labor Statistics estimate of medical cost inflation.

The studies identified three broad types of cost, which we employ here.

Medical Costs: Ambulance, ER, physician/specialists, inpatient hospital, rehabilitation, prescription, medical equipment and related special treatment costs.

Other Costs: Police/Fire services, household work, wage work/human capital losses, insurance administration, legal/court costs and property damage.

Quality of Life (QOL): Costs related to suffering caused by injury and death to the victim and their families. These costs are estimated utilizing quality adjusted life years (QALYs) where perfect health is assigned a value of 1 while death is 0. Estimates of age/sex and diagnostic specific QALY loss values were developed by Miller et al. (1995) and the average value of a year of life came from a meta-analytic review by Miller (1990) and discounted over time at 3%. The discount factor is important insofar as

QOL costs often occur over the remainder of a lifetime in the event of disability. For the 2000 NHTSA study, the monetary value of a QALY was \$91,752.

Combined, the medical costs and other costs equal the “Human Capital” model costs typically utilized at NHTSA and at the National Safety Council (NSC). When the “quality of life” costs are included, the total amount equals the “Comprehensive” or “Willingness to Pay” model costs sometimes used by the NSC.

For cases for which no MAIS (required to determine which diagnostic group a case falls in) was available, we utilized costs based on the KABC scale – developed using NHTSA’s CVS cost estimation software. Estimated costs were adjusted for Wisconsin specific cost of living differences, and adjusted for medical inflation (medical care costs) or for CPI inflation (other costs and QOL costs).

Diagnostic Grouping:

We utilized the single level Classification System developed by the Agency for Healthcare Research and Quality for its Healthcare Cost and Utilization Project to combine diagnostic codes together. We selected specific types of injuries particularly relevant to motor vehicle crashes. The injury groups were:

- Spinal Cord Injury
- Traumatic Brain Injury
- Skull/Face Fractures
- Crushing Internal Injury
- Hip Fracture
- Lower Limb Fracture
- Upper Limb Fracture
- Other Fracture

Results

Table 3 (next page) shows the percentage of persons with various health related services or outcomes by reported seat belt use status. It also provides a variety of information regarding persons who were hospitalized by seat belt use status. It is important to note that all of the reported odds ratios or differences in Table 3, between those not wearing a seat belt vs. those wearing a seat belt, are statistically significant at the .001 level (meaning that there is only one chance in a thousand that the direction of the differences are incorrect).

For all indicators reported, persons not wearing seat belts were more likely to have more health related services than those wearing seat belts. Those not wearing seat belts are:

- 14% more likely to have EMS transport
- 5.4 times more likely to die
- 91% more likely to be hospitalized.

TABLE 3.
Number, Percent, Odds Ratios and Differences for Injury Outcomes and Costs
for Belted and Unbelted Passengers, Wisconsin, 2010

	Belted	Not Belted	Belted Percent	Not Belted Percent	Odds Ratio or Difference
Transported from Crash Scene	6,989	2,139	64.2%	73.0%	1.14
Emergency Dept. Visit	6,437	1,529	52.1%	58.9%	1.13
Hospitalized	1,359	695	13.3%	23.7%	1.91
Died	150	220	1.4%	7.5%	5.36
<u>For Hospitalizations Only</u>					
Maximum Abbreviated Injury Score					
Minor	203	63	16.3%	9.5%	.58
Moderate	466	220	37.5%	32.3%	.86
Serious	359	215	28.9%	32.2%	1.11
Severe	187	134	15.1%	20.1%	1.33
Critical	27	35	2.2%	5.3%	2.41
<u>For Entire Study Population</u>					
Hospital & ED Charges	\$4,882	\$12,325			\$7,443
Estimated Medical Costs	\$15,800	\$33,815			\$18,015
Estimated Other Costs	\$55,787	\$1676,546			\$111,759
Estimated Quality of Life Costs	\$54,742	\$193,162			\$146,624
Total Estimated Costs	\$126,326	\$394,528			\$268,202
Total Number Crash Victims	10,921	2,933			

Looking only at crash occupants who were hospitalized, persons not wearing seat belts are:

- 33% more likely to have a Severe Injury Score
- 2.4 times more likely to have a Critical Injury Score

Cost differentials are quite large. Crash victims not wearing seat belts have:

- Hospital and ED charges which are \$7,400 higher
- Estimated Medical Costs which are \$18,000 higher for hospitalized persons
- Estimated Other Costs which are \$111,000 higher for hospitalized persons
- Quality of Life Costs which are \$146,000 higher for hospitalized persons
- Total Costs which are \$268,000 higher for hospitalized persons

Given the higher level of hospitalization (91% higher) and higher charges/costs for persons not wearing a seat belt, the total economic impact of not wearing a seat belt is very large even if we only look at hospitalized occupants. Table 4 (next page) estimates the total economic impact of not wearing a seat belt by comparing the total estimated medical costs for those without a belt, to what their number and cost would have been had they all worn a seat belt. If persons not wearing a seat belt HAD been belted:

- There would have been 331 fewer hospitalizations
- Hospital charges would have been \$5.5 million dollars less
- Medical Costs would have been 12 million lower
- Other Costs would have been 77 million lower
- Quality of Life Costs would have been \$ 96 million less
- Total Costs would have been almost \$ 186 million lower

Injuries Sustained

There are also differences with respect to the types of injuries sustained by crash occupants wearing seat belts and those not wearing seat belts. Table 5 (second next page) provides a breakdown, by seat belt status, for nine different types of injuries. Injuries for which there is a significant difference at the .01 level between persons not wearing and wearing seat belts are underlined in the tables. Persons not wearing seat belts are:

- 3.0 times more likely to have a Spinal Cord Injury
- 2.2 times more likely to have an Internal Brain Injury
- 4.4 times more likely to have a Hip Fracture.
- 2.6 times more likely to have a Crushing Internal Injury

One of the major reasons for increased Medical and other costs for crash occupants not wearing seat belts is revealed in Table 5. Spinal Cord and Brain Injuries are the most expensive type of injuries evaluated in the article outlining costs by diagnostic code (Zaloshnja et al., 2003).

**Table 4.
Additional Hospitalizations and Hospital / Emergency Department Charges/Costs
Associated with Occupants Not Wearing Seat Belts, Wisconsin, 2010**

		Hospital Charges	Estimated Medical Costs	Estimated Other Costs	Quality of Life Costs	Total All Costs
Average Cost Per Hospitalized Occupant Not Wearing a Seat Belt		\$12,325	\$33,815	\$167,546	\$193,162	\$394,523
Average Cost Per Hospitalized Occupant Wearing a Seat Belt		\$4,822	\$15,800	\$55,787	\$54,742	\$126,329
Number Hospitalizations/Total Charges or Costs for Occupants Not Wearing Seat Belts	695	\$8,565,875	\$23,501,425	\$116,444,470	\$134,247,590	\$274,193,485
Number Hospitalizations/Total Charges or Costs If Occupants had Worn Seat Belts	364	\$3,392,990	\$10,981,000	\$38,771,965	\$38,045,690	\$87,798,655
Additional Hospitalizations and Costs Due to Not Wearing a Seat Belt	331	\$5,172,885	\$12,520,425	\$77,672,505	\$96,201,900	\$186,394,830

Table 5.
Number, Percent and Likelihood Odds Ratios for Specific Types of Injuries,
For Belted and Unbelted Hospitalized Passenger Vehicle Occupants, Wisconsin, 2010
 (underlined odds ratios are significant at the .01 level)

	NOT BELTED Number	BELTED Number	NOT BELTED Percent	BELTED Percent	ODDS RATIO
Spinal Cord Injury	8	10	.27%	.09%	<u>3.0</u>
Brain Injury	64	109	2.18%	1.00%	<u>2.2</u>
Skull/Face Fracture	52	44	1.77%	.40%	<u>4.4</u>
Crushing Internal Injury	72	107	2.45%	.98%	<u>2.5</u>
Hip Fracture	4	5	.14%	.05%	<u>2.8</u>
Lower Limb Fracture	68	136	2.32%	1.25%	<u>1.9</u>
Upper Limb Fracture	47	100	1.60%	.92%	<u>1.7</u>
Other Fracture	296	547	10.09%	5.01%	<u>2.0</u>
Total Hospitalized Occupants	695	1,359			

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