

The Impact of Helmet Use and Alcohol on
Traumatic Brain Injury Related
Hospitalizations for Motorcycle Crashes in
Wisconsin, 1991-1998

Wayne Bigelow, M.S.

Center for Health Systems Research and Analysis
University of Wisconsin - Madison

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Motor Vehicle related injuries are a major cause of morbidity and mortality in the United States and Wisconsin. Motorcycle crashes in particular lead to more severe injuries and outcomes than do other types of motor vehicle crashes.

For Crashes in Wisconsin During 1996-1997	Hospitalization Rate per 100,000 Occupants	Fatalities per 100,000 Occupants
Motorcycles	164.1	26.0
Passenger Vehicles	10.6	1.9
Relative Risk Ratio	15.5	13.7

In our study we evaluate the impact of helmet use and alcohol on the likelihood of Traumatic Brain Injury (TBI) related hospitalization among motorcycle operators involved in crashes in Wisconsin from 1991-1998.

We evaluate the impact of helmet use and the involvement of alcohol on TBI related outcomes measures in the context of other factors which may influence the likelihood of TBI, including:

- Demographic Factors
- Crash Characteristics

Goals

- Ascertain the extent of motorcycle crash related Traumatic Brain Injury (TBI) in Wisconsin.
- Evaluate the impact of helmet use and alcohol involvement on the likelihood of TBI hospitalizations across a range of factors (e.g. age, sex, rural/urban).
- Evaluate the impact of helmet use and alcohol on TBI related health outcomes controlling for a variety of factors which may also impact TBI outcomes in motorcycle crashes.

Data

- ❑ Wisconsin CODES (Crash Outcome Data Evaluation System) data was used in this analysis. CODES is a national level project developed by and funded in part by the National Highway Transportation Safety Administration in the U.S..
- ❑ CODES data links together crash data with health outcomes data (e.g. hospital inpatient, Emergency Department, and death certificate data)
- ❑ It links these data together utilizing “Probabilistic Linkage.”

Case Selection

- Time Period is for crashes occurring in 1991-1998.
- Only Motorcycles were included, mopeds/scooters were excluded
- For analyses involving alcohol involvement in the crash, only motorcycle operators were selected since information on alcohol being involved in the crash is only collected for operators.
- Only cases with a primary or secondary diagnosis of Traumatic Brain Injury were included. The CDC definition of Traumatic Brain Injury was used. Traumatic Brain Injury includes cases where an ICD-9-CM code was in the following ranges:
 - **800.00 – 801.99**
 - **801.00 – 803.99**
 - **850.20 – 850.49**
 - **851.00 – 850.49**

OUTCOMES

Likelihood of Traumatic Brain Injury
Related Hospitalization.

For those hospitalized with TBI:

- Abbreviated Injury Score
- Injury Severity Score
- Hospital Charges
- Hospital Length of Stay

Methods/Statistics

- ❖ For the impact of helmet use and the involvement of alcohol on the likelihood of TBI hospitalization across a range of factors, relative risk ratios and chi square statistics were used.
- ❖ For evaluating the impact of helmet use and alcohol involvement and other factors on the likelihood of TBI hospitalizations, logistic regression was used.
- ❖ For evaluating the impact of helmet use on other outcomes (charges, AIS,ISS, days), simple T-Tests were used.

INDEPENDENT VARIABLES USED IN LOGISTIC REGRESSION

- Helmet Use (Yes/No)
 - Alcohol Involved in Crash (Yes/No)
 - Rural /Urban
 - Speed Limit (0-25, 26-35, 36-45, 46-55, 55+)
 - Age (0-19, 19-24, 25-34, 35-44, 45-54, 55-64, 65+)
- Crash Type
 - Multiple Vehicle Crash:
 - Rear End (comparison)
 - Side Swipe
 - Head On Collision
 - Motorcycle Only Crash:
 - Hit Fixed Object
 - Hit Movable Object
 - Other Type of Crash

Basic Statistics On Key Variables

Total Number	20,819	100.0%
Not Helmeted	13,038	62.6%
Helmeted	5,967	28.7%
Helmet Info Missing	1,814	8.7%
Hospitalized	3,584	17.2%
Hospitalized w/ TBI	933	4.5%
FOR TBI CASES	<i>Mean</i>	<i>St.Dev</i>
Charges	\$30,370	\$23,175
Length of Stay	10.7	7.9
Maximum AIS	3.6	.6
Inj.Severity Score	18.4	5.1

Chart 1.
**Percent of Motorcycle Riders Involved in a Crash with a Traumatic Brain Injury
Related Hospitalization, by Helmet Status, Wisconsin, 1991-1998**

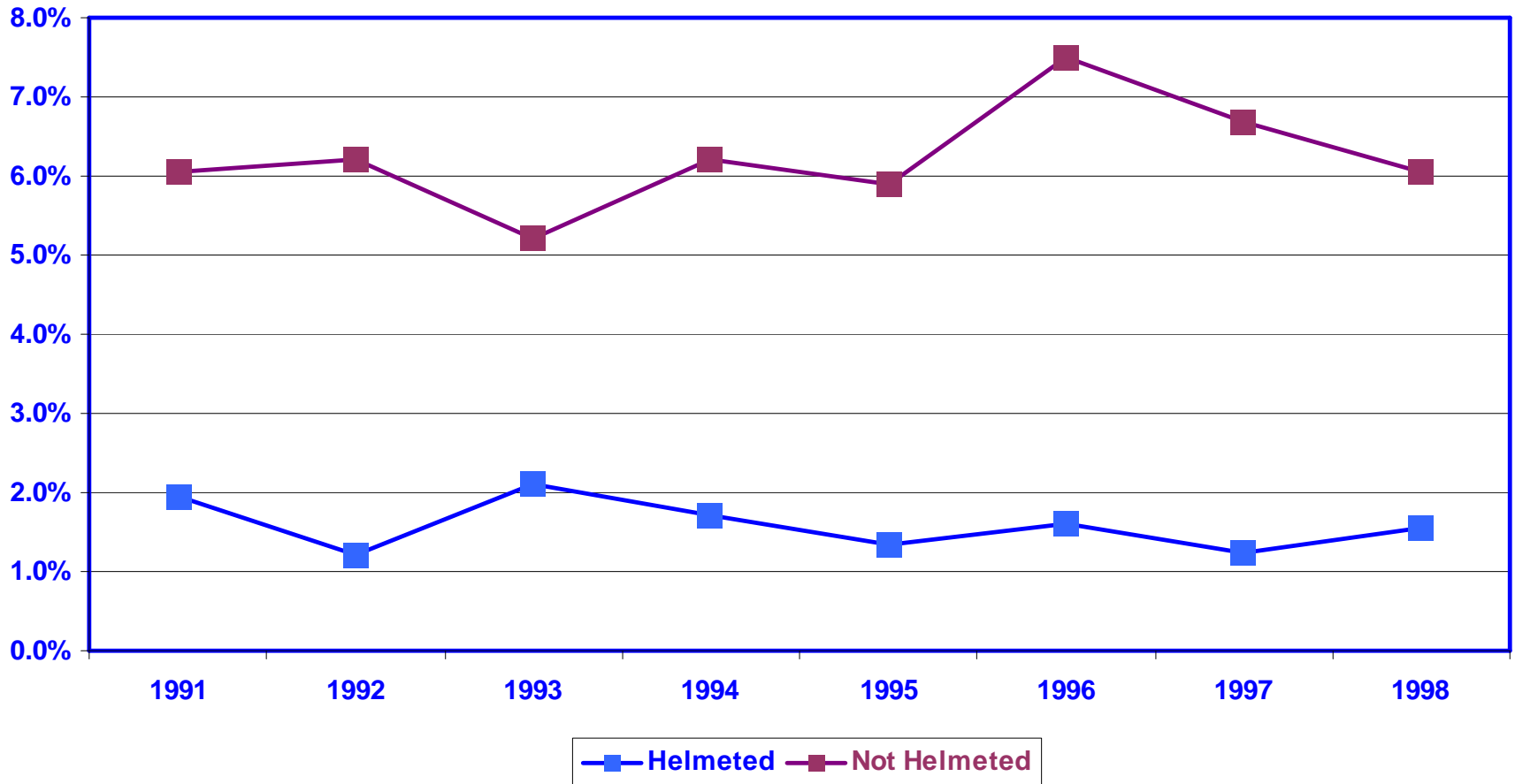
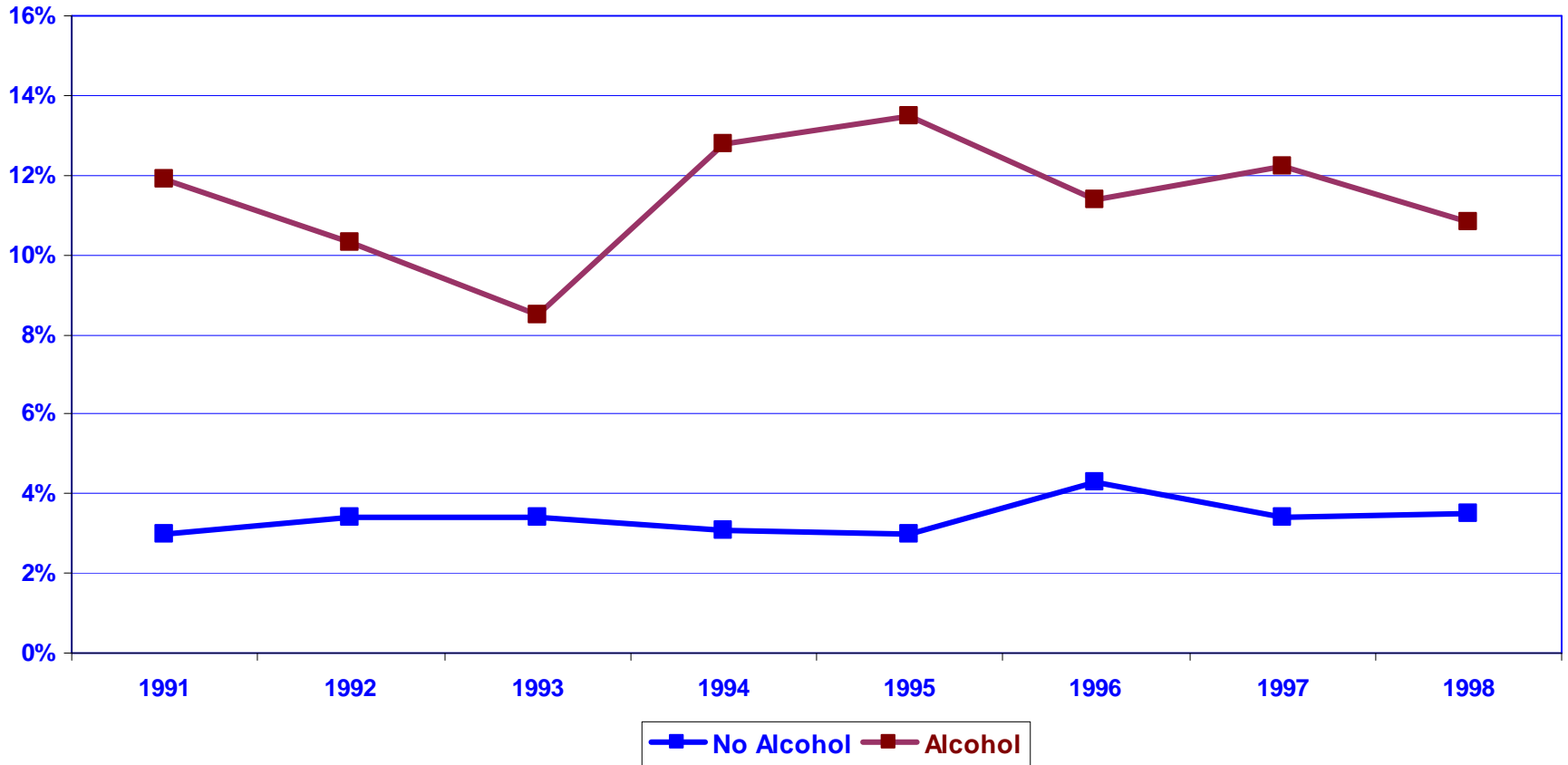


Chart 2.
Percent of Motorcycle Operators Involved in Crashes with a Traumatic Brain Injuries, by Alcohol Involvement, Wisconsin, 1991-1998



Relative Risk Ratios for Those Not Wearing a Helmet – Age & Sex

Overall	3.66	*
Male	3.12	*
Female	2.51	*
<19 years	4.95	*
20-24 years	3.72	*
25-34 years	4.24	*
35-44 years	3.50	*
45-54 years	3.29	*
55-64 years	3.82	*
65+ years	2.18	

* Significant at .05 level.

Relative Risk Ratios for Those Not Wearing a Helmet for Crash Characteristics

2+ Vehicle, Rear End	5.37	*
2+ Vehicle, Head On	3.04	*
2+ Vehicle, Side Impact	2.78	*
One Vehicle, Fixed Object	5.84	*
One Vehicle, Movable Object	2.30	*
Other Crash Configuration	3.47	*

* Significant at .05 level.

Relative Risk Ratios for Those Not Wearing a Helmet – Other Factors

Alcohol “Related”	2.56 *
Not Alcohol Related	3.09 *
Urban	3.99 *
Rural	3.51 *
0-25 mph	3.72 *
26-35 mph	4.00 *
36-45 mph	5.30 *
46-55 mph	3.70 *
55+ mph	6.34 *

* Significant at .05 level.

Relative Risk Ratios for Those With Alcohol Involvement – Age & Sex

Overall	3.41	*
Male	2.56	*
Female	3.45	*
<19 years	2.61	*
20-24 years	3.77	*
25-34 years	3.15	*
35-44 years	3.49	*
45-54 years	2.85	*
55-64 years	4.39	*
65+ years	4.21	*

* Significant at .05 level.

Relative Risk Ratios for Those With Alcohol Involvement – Crash Characteristics

2+ Vehicle, Rear End	6.06	*
2+ Vehicle, Head On	2.07	*
2+ Vehicle, Side Impact	3.32	*
One Vehicle, Fixed Object	2.47	*
One Vehicle, Movable Object	4.19	*
Other Crash Configuration	3.14	*

* Significant at .05 level.

Relative Risk Ratios for Those With Alcohol Involvement – Other Factors

Not Helmeted	2.64 *
Helmeted	3.36 *
Urban	3.97 *
Rural	2.84 *
0-25 mph	4.45 *
26-35 mph	4.31 *
36-45 mph	3.27 *
46-55 mph	2.44 *
55+ mph	8.43 *

* Significant at .05 level.

Variable Selection for the Logistic Model

- ❖ In order to select a parsimonious model for evaluating the impact of helmet use on TBI in the context of other factors, logistic regression was run for specific blocks of variables (e.g. age) separately.
- ❖ Initial results indicated that the demographic variables, age and sex, were not significant in predicting the likelihood of TBI. Thus, they were excluded from the final logistic model.
- ❖ Only motorcycle operators were included in the analysis since the “alcohol” variable only applies to operators.

Results from Full Model for Likelihood of Traumatic Brain Injury for Motorcycle Operators, Wisconsin, 1991-1998 (1)				
		Odds Ratio		95% Wald Confidence Interval
No Helmet		3.29 *		2.61 , 4.15)
Alcohol Involved		2.67 *		2.22 , 3.06)
26-35 mph		1.63 *	(	1.31 , 2.03)
36-45 mph		1.89 *	(	1.42 , 2.52)
46-55 mph		2.50 *	(	1.97 , 3.16)
56+ mph		2.34 *	(	1.22 , 4.46)
Rural		1.16	(	0.96 , 1.42)
2+ Vehicles, Side Impact		1.04	(	0.65 , 1.68)
2+ Vehicles, Head On		2.49 *	(	1.44 , 4.33)
1 Vehicle, Fixed Object		2.33 *	(	1.65 , 3.29)
1 Vehicle, Movable Object		0.95 *	(	0.90 , 1.00)
Other Crash Configuration		2.07 *	(	1.51 , 2.85)
* Indicates that the difference between the comparison group and the model variable is significant at the .05 level.				

**Results from Full Model for Likelihood of Traumatic Brain Injury
for Motorcycle Riders, Wisconsin, 1991-1998 (2)**

	Odds Ratio	95% Wald Confidence Interval
No Helmet, No Alcohol	3.15 *	1.75 , 5.67)
Helmeted, Alcohol Present	3.40 *	2.64 , 4.39)
No Helmet, Alcohol Present	8.75 *	6.71 , 11.41)
26-35 mph	1.63 *	(1.31 , 2.03)
36-45 mph	1.89 *	(1.42 , 2.52)
46-55 mph	2.49 *	(1.98 , 3.16)
56+ mph	2.34 *	(1.23 , 4.47)
Rural	1.16	(0.96 , 1.42)
2+ Vehicles, Side Impact	1.04	(0.65 , 1.68)
2+ Vehicles, Head On	2.49 *	(1.44 , 4.33)
1 Vehicle, Fixed Object	2.33 *	(1.65 , 3.29)
1 Vehicle, Movable Object	0.95 *	(0.90 , 1.00)
Other Crash Configuration	2.08 *	(1.51 , 2.85)
* Indicates that the difference between the comparison group and the model variable is significant at the .05 level.		

**Mean and Standard Deviation for Hospital Charges,
Hospital Length of Stay, Maximum AIS Score, and
Injury Severity Score, for all Traumatic Brain Injury
Cases, by Helmet Use, Wisconsin, 1991-1998**

	Hospital Charges	Hospital LOS	Maximum AIS Score	Injury Severity Score
<u>All TBI Cases</u>				
No Helmet	\$ 29,279	10.40	3.59	18.95
Number=760	\$ (36,529)	(13.69)	(1.05)	(9.90)
Helmet Worn	\$ 25,693	9.21	3.44	18.93
Number=95	\$ (35,739)	(10.57)	(1.19)	(11.44)
Standard deviations are in parentheses.				
There were no significant differences in the four outcomes with respect to helmet use category				

**Mean and Standard Deviation for Hospital Charges,
Hospital Length of Stay, Maximum AIS Score, and
Injury Severity Score, for all Traumatic Brain Injury
Cases, by Alcohol Involvement, Wisconsin, 1991-1998**

	Hospital Charges	Hospital LOS	Maximum AIS Score	Injury Severity Score
<u>All TBI Cases</u>				
Alcohol Involved	\$ 31,364	10.95	3.55	18.31
Number=760	(26,683)	(8.68)	(.65)	(5.66)
Alcohol Not Involved	\$ 29,821	10.56	3.51	18.55
Number=95	(36,772)	(12.78)	(.86)	(8.20)
Standard deviations are in parentheses.				
There were no significant differences in the four outcomes with respect to alcohol involvement				

Results

- Helmet use has a major protective effect against TBI related hospitalizations in motorcycle crashes in all situations. The effect is significant and robust.
- Alcohol being used by operators has a significant negative effect on TBI related hospitalizations. The effect is significant and robust.

Results

- Helmet use has no significant impact on hospital days, charges, or on injury severity for persons with TBI hospitalizations.
- Alcohol Involvement has no significant impact on hospital days, charges, or on injury severity for persons with TBI hospitalizations.
- The impact of helmet use and alcohol involvement on TBI related outcomes is primarily to reduce or to increase the risk of initial hospitalization, rather than on subsequent outcomes.