U.S. Department
of Transportation
**National Highway
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Administration**

Research Note

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Further Analysis of Motorcycle Helmet Effectiveness Using CODES Linked Data

Background

Linked data from the Crash Outcome Data Evaluation System (CODES) in seven states were used by the National Highway Traffic Safety Administration as the basis of a 1996 *Report to Congress on the Benefits of Safety Belts and Motorcycle Helmets* (DOT HS 808 347). This study measured motorcycle helmet effectiveness using mortality, morbidity, severity and costs. The CODES data showed that motorcycle helmets are effective in preventing injuries or death in general, but even more effective in preventing brain injuries in particular. This was to be expected given that the helmet protects only the head. But, for the first time, linkages between police crash files and hospital discharge files were used to substantiate these expectations.

This Research Note expands the CODES analyses to include consideration of the effect of helmet legislation in the CODES states.

Distribution of the Helmet Cases in Six of the Seven CODES States

Helmet data, obtained from six (Hawaii, Maine, Missouri, New York, Pennsylvania, Wisconsin) of the seven CODES states and updated with new data since the Report to Congress to include an additional 137 cases, consisted of a total of 10,490 motorcycle riders involved in crashes for whom helmet use was known. Presence of helmet legislation was not a funding criterion for CODES.

The three largest CODES states (Missouri, New York, and Pennsylvania) had universal helmet legislation during the year their data, subsequently used for CODES, were collected. These three states generated 61 percent (6,453) of the total 10,490 cases in the analysis. The majority of the motorcycle cases from these states were helmeted, a total of 6,188 cases or 96 percent of the total 6,453. The three states without the universal helmet law (Hawaii, Maine, Wisconsin) generated 4,037 cases of which only 34 percent (1,384) were helmeted. Thus, the CODES results were generated from a case mix in which 72 percent or 7,572 of the total 10,490 motorcyclists were helmeted. The seventh CODES state, Utah, was excluded because it was not possible to distinguish between helmet use unknown and non-helmet use.

As expected, universal helmet use legislation has a strong effect on actual helmet use. Table 1 shows the differences in reported motorcycle helmet use rates for riders involved in crashes in the CODES states with and without helmet legislation.

Table 1
Reported Helmet Use Rate for Six CODES States With and Without Universal Helmet Use Law

With Law	**Missouri**	**New York**	**Pennsylvania**
All Riders	94%	98%	80%
Without Law	**Hawaii**	**Maine**	**Wisconsin**
All Riders	30%	49%	33%

Helmets Shown to be 65 percent Effective in Preventing Brain Injuries in the Six CODES States

Motorcycle riders experiencing head injuries requiring inpatient treatment were classified into three groups using the following International Classification of Diseases, 9th revision, Clinical Modification codes: brain injury (800.1-801.99, 803.1-804.99, 850.2-850.89, 851.0-854.99 excluding those cases without intracranial injury), concussion (only skull fractures with no intracranial injury 800.00-800.09, 800.50-800.59, 801.00-801.09, 801.50-801.59, 803.00-803.09, 803.50-803.59, 804.00-804.09, 804.50-804.59), and simple skull fracture (includes cases with no or brief loss of consciousness 850.00-850.19, 850.50-850.59, 850.90-850.99).

The results of the analysis showed that although helmets are only 36 percent effective in preventing death, they are 65 percent effective in preventing brain injuries. So if all motorcyclists had been wearing helmets, 65 percent of those unhelmeted motorcyclists who received inpatient care for a brain injury would not have sustained the brain injury. In other words, unhelmeted injured motorcyclists are three times as likely to suffer a brain injury compared to helmeted injured motorcyclists.

What do these results mean to the CODES motorcycle population? Of the total 10,490 motorcycle riders with known helmet use, 132 unhelmeted riders died. If all of these riders had used a helmet, 48 of them would be expected to have survived. A total of 134 unhelmeted riders were admitted as inpatients with brain injuries. If these riders had used a helmet, it is expected that 87 of them would not have had a brain injury. These 87 brain injury cases represent a large health care expense.

Helmets Dramatically Reduce Health Care Charges By Preventing Unhelmeted Brain Injuries From Occurring

The average charge for inpatient care for a motorcyclist who sustained a brain injury is about $27,000, more than twice the average $12,000 charge for non-brain injured motorcyclists receiving inpatient care for other injuries. Thus, on average, each brain-injured motorcyclist who would not have suffered a brain injury if he or she had been helmeted, would save the difference between these two average charges ($15,000). Consequently, a total of $1,305,000 (87 brain injuries prevented x $15,000 per prevention) would have been **saved** in the year in which the injury occurred, just in the six CODES states alone. This expense does not begin to cover the long-term charges associated with brain injuries, many of which are experienced by youthful motorcyclists who live a normal life span after the injury.

Estimating the Benefits of Helmets if None of the CODES States had Universal Helmet Legislation.

Without the high helmet use rate, even greater cost would have been incurred. A review of the brain injury cases in the six CODES states identified 302 cases (helmeted, unhelmeted and unknown use). The three states without the law, also the smallest states, generated a total of 3,284 injured riders of which 147 were brain injury cases. The three states with a law, the largest states, generated a total of 6,653 injured riders of which 155 were brain injury cases. These cases represent a rate of 448 brain injuries per 10,000 injured riders in the three states without universal helmet legislation compared to only 233 brain injuries per 10,000 injured riders in the three states with the legislation.

The increase in brain injuries which would have occurred, if helmet use were not as high as reported in the three states currently with a helmet use law, can be estimated. This estimate was obtained by assuming a 95 percent use rate for the three helmet law states and using a conservative estimate of 50 percent

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as the use rate for states without a helmet use law (Refer to Table 1 for actual use rates). In addition, the estimate acknowledges that 35 percent of the brain injuries are not prevented by the helmet. The estimated increase in the number of brain injuries was calculated using the following. Let N be the number of cyclists in crashes and let p be the proportion of these cyclists who would be brain-injured if all were unhelmeted. Then:

With Law:

$(.05p + .95(.35)p)N$ = expected number of brain injuries

Without Law:

$(.50p + .50(.35)p)\ N$ = expected number of brain injuries

Thus to determine the increase in brain injuries if the laws were repealed:

$$\frac{(.5) + (.5).35 - [.05 + (.95)(.35)]}{.05 + (.95)(.35)} = 76\%$$

(The p's cancel each other out and therefore do not appear in the calculation.)

So, instead of 155 brain injuries occurring in the three states with the universal helmet law, the expected number would have been 273 if those states had not had the law.

Table 2
Adjusted Extra Inpatient Charges for Brain Injury in Missouri, New York, and Pennsylvania by Helmet Legislation Status

Helmet Legislation Status	Total Brain Injured Cases	Total Extra Inpatient Charges for Riders with Brain Injury ($15,000 per Brain Injury)
With Helmet Legislation	155	$2,325,000
Adjusted to No Helmet Legislation	273	$4,095,000

As indicated in Table 2, total inpatient charges for motorcycle riders with brain injuries are high. Without the law, the total extra inpatient charges due to brain injury would have almost doubled from $2,325,000 to $4,095,000.

Conclusion

Total inpatient charges were lower than they could have been because of the high helmet use rate in the CODES case mix. The high helmet use rate was associated with the presence of universal helmet legislation in the three largest CODES states. Expanding the CODES analyses to consider the absence of universal helmet legislation and the predicted resulting lower helmet use rate revealed that brain injuries would have increased 76 percent and the extra inpatient charges for these additional brain injuries would have almost doubled.

For additional copies of this research note, the CODES Report to Congress on the Benefits of Safety Belts and Motorcycle Helmets *and the* CODES Technical Report *please call (202) 366-4198 or fax your request to (202) 366-7078. For questions regarding the data reported in this research, contact Sandy Johnson (202)366-5364 of the National Center for Statistics and Analysis or Jonathan Walker (202) 366-8571 of the Office of Research and Traffic Records. This research note and other general information on highway traffic safety may be accessed by Internet users at*

http://www.nhtsa.dot.gov/people/ncsa

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