



# Research Note

Revised

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

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## Crash Outcome Data Evaluation System (CODES) Project Safety Belt and Helmet Analyses

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Analyses of the benefits of safety belt and helmet use were undertaken in response to Section 1031(b) of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) for a Report that was sent to Congress February, 1996. NHTSA awarded grants to entities in Hawaii, Maine, Missouri, New York, Pennsylvania, Utah, and Wisconsin to link crash and injury state data and perform the analyses upon which the report was based. The individual state estimates are reported in the *CODES Technical Report* which describes the linkage and analytical processes used in the CODES project.

### Data Collection Methodology

The study employed probabilistic linkage methods whereby statewide data from police crash reports, emergency medical services, hospital emergency departments, hospital discharge files, claims, and other sources were linked so that those people injured in motor vehicle crashes could be followed through the health care system. Linkage of population-based state data enabled information for both the injured and uninjured to be used to determine the benefits of safety belts and helmets in motor vehicle crashes. It also provided access to financial information; inpatient charges (acute care, rehabilitation, long-term care) and estimates of actual costs using a charge-to-cost ratio. Inpatient charges represent about 60 percent of the total direct medical expenses. The remaining 40 percent include physician charges, emergency room charges, EMS charges, and other charges. Through the cooperation of the highway safety and medical communities, this was the first time these databases were linked using a probabilistic computer algorithm.

The study population consisted of 879,670 drivers for the safety belt analyses and

10,353 motorcycle riders for the helmet analyses.

### Outcome Measures

NHTSA measured effectiveness to determine the benefits of safety belts and helmets. Effectiveness is defined as the percentage reduction in the likelihood of injury or death for people wearing safety belts or helmets compared to people not wearing safety belts or helmets as appropriate. For example, if the effectiveness of some device in reducing injuries is 35 percent, then 35 percent of those people who were injured while not using the device would not have been injured had they used it. The effectiveness of safety belts and helmets was measured using four outcome measures:

1. Died
2. Died or admitted as an inpatient
3. Died, admitted as an inpatient, or transported by EMS/treated in the emergency department
4. Any injury (died, inpatient, transported, or slightly injured)

To measure the effectiveness in reducing **mortality** (outcome measure 1) the group of crash victims (passenger vehicle drivers for belt effectiveness and all motorcycle riders for helmets) who died was compared with all other crash-involved victims.

To assess the effectiveness in reducing **morbidity** (outcome measure 4), the group of crash victims experiencing any injury, i.e., slightly injured, transported, inpatient, or died, was compared with those not injured.

To assess the benefits in reducing **injury severity**, the effectiveness for all outcome

measures was analyzed (outcome measures 1-4).

To provide the input for computing effectiveness, each CODES grantee was required to perform a series of regression analyses on its linked data using the outcome measures listed above.

To estimate the effect of safety belt and motorcycle helmet use on **medical costs**, costs were limited to total inpatient charges found on hospital, rehabilitative, and long-term care patient records.

To provide the input for comparing average charges, each grantee computed average inpatient charges for passenger vehicle drivers and for motorcycle riders. Averages were calculated based on the victims' belt or helmet use and for various payers.

### Contributing Factors

CODES controlled for type of crash, rural/urban, age, male/female, posted speed limit, wet/dry, night/day, intersection related, vehicle type, and seating position in the safety belt analyses; only helmet use was included in the helmet analysis because of the need to prevent cases from being excluded because of missing data.

### Aggregated Results

The results were statistically combined by NHTSA staff from the individual state data provided by the grantees. To obtain overall estimates of effectiveness, state estimates were weighted by the inverse of their standard errors. For overall estimates of average charges, each state estimate was weighted by the number of observations which contributed to it.

The results presented in this report reflect only the data from the seven CODES states, and the case selection criteria for the safety belt and motorcycle helmet analyses. They are not intended to be nationally representative. In addition, except as noted, the financial results were based only on data from the linked inpatient records. These linked records represent a sub-population of

all occupants who were injured and required inpatient care as the result of a motor vehicle crash.

### Benefits of Safety Belt Use

The results of the study revealed that safety belts are highly effective in reducing morbidity (the occurrence of any injury) and mortality. They also indicate that safety belts cause a downward shift in the severity of injuries. However, these effectiveness estimates may be inflated because of over-reporting of belt use in police crash reports. Table 1 presents the estimates of safety belt effectiveness. The estimates adjusted for over-reporting of belt use are consistent with results from earlier NHTSA analyses.

Table 1. Safety Belt Effectiveness by Outcome for Crash-Involved Drivers in the CODES States		
Outcome	Effectiveness Estimates	
	Belt Use as Reported by Police	Belt Use Adjusted for Overreporting
Died	89%	60%
Died or Inpatient	75%	45%
Died, Inpatient, or Transported	54%	30%
Any Injury	52%	20%

The CODES results showed that the average inpatient charge for unbelted passenger vehicle drivers admitted to an inpatient facility as a result of a crash injury was more than 55 percent greater than the average charge for those who were belted, \$13,937 and \$9,004, respectively. Private insurance accounted for 69 percent of the inpatient charges compared to 16 percent for public and 15 percent for other sources. In all cases, the average inpatient charge was greater for drivers who were unbelted.

**Table 2.**  
Average and Total Inpatient Charges  
by Source of Payment and Safety Belt Use  
for Crash Involved Drivers in the CODES States

Source of Payment	Average Charge		Total Charges
	Safety Belt Use		
	Used	Not Used	
Public <sup>1</sup>	\$13,322	\$18,922	\$26,498,675
Private <sup>2</sup>	\$8,581	\$14,058	\$113,156,421
Other <sup>3</sup>	\$8,180	\$10,534	\$24,788,922
All Sources	\$9,004	\$13,937	\$164,444,018

<sup>1</sup>Includes Medicaid, Medicare, etc.

<sup>2</sup>Includes Worker's Compensation

<sup>3</sup>Usually Self Payment

### Benefits of Helmets

The study results also showed that motorcycle helmet effectiveness ranged from 9 percent in preventing any kind of injury to 34 percent in preventing a fatality. These results confirm previous NHTSA estimates.

**Table 3.**  
Effectiveness of Motorcycle Helmets  
by Outcome  
for Crash-Involved Motorcycle Riders  
in CODES States\*

Outcome Measure	Effectiveness
Died	35%
Died or Inpatient	26%
Died, Inpatient, or Transported	26%
Any Injury	9%
Brain Injury	67%

\*Excludes Utah.

The average inpatient charge for motorcycle crash victims receiving inpatient care was \$14,377 for those who used helmets, and \$15,578 for those who did not, an 8 percent increase in charges for those electing to not wear a helmet. Private insurance sources accounted for 63 percent of inpatient charges compared to 23 percent for public and 14 percent for other sources. For the private and public sources, average inpatient

charges for motorcycle crash victims were 15 percent and 5 percent higher, respectively, for the unhelmeted.

**Table 4.**  
Average and Total Inpatient Charges  
by Source of Payment and Motorcycle Helmet  
Use for Crash Involved Motorcycle Riders in the  
CODES States\*

Source of Payment	Average Charge		Total Charges
	Helmet Use		
	Used	Not Used	
Public <sup>1</sup>	\$23,793	\$24,925	\$5,364,759
Private Insurance <sup>2</sup>	\$13,617	\$15,687	\$14,764,706
Other <sup>3</sup>	\$10,565	\$8,913	\$3,403,183
All Sources	\$14,377	\$15,578	\$23,532,648

\*Excludes Utah

<sup>1</sup>Includes Medicaid, Medicare, etc.

<sup>2</sup>Includes Worker's Compensation

<sup>3</sup>Usually Self Payment

Helmets cannot protect the rider from most types of injuries. But further analysis of the CODES data, possible because of the linked medical outcome, showed that motorcycle helmets are 67 percent effective in preventing brain injuries. Thus, if all motorcyclists had been wearing helmets, 67 percent of those unhelmeted motorcyclists who received inpatient care for a brain injury would not have sustained the brain injury. In other words, unhelmeted motorcyclists were over three times as likely to suffer a brain injury as were helmeted motorcyclists.

Examination of the average inpatient charges revealed that the average charge for inpatient care for a motorcyclist who sustained a brain injury is more than twice the average charge for motorcyclists receiving inpatient care for other injuries. On average, approximately \$15,000 in inpatient costs would be saved during the first 12 months for every injured motorcycle rider not sustaining a brain injury. Therefore, if all injured motorcycle riders wore helmets, fewer victims would incur the high cost of inpatient care associated with brain injury.

### Significance

CODES demonstrated that linked, comparable data could be generated to evaluate the benefits of belts and helmets in terms of medical and financial outcome. Linkage enabled injury severity to be standardized among the CODES states. The linked data represent a permanent data file. Besides the belt and helmet study, these data were used to generate state-specific analyses and will continue to be used in the future. The CODES states learned new linkage skills that can be applied to the linkage of other types of records and also can be shared with other states interested in linkage. Of even more

importance is the fact that linkage identified previously unknown problems with missing and inaccurate data. Correcting these problems for the study improved the quality of the data in the permanent files, making the state data (linked or unlinked) even more valuable for future uses.

Copies of the CODES Report to Congress on the Benefits of Safety Belts and Motorcycle Helmets and the CODES Technical Report may be obtained from the National Center for Statistics and Analysis, National Highway Traffic Safety Administration, 400 7th Street, SW, Room 6125, Washington, DC 20590 or send a FAX request to 202-366-7078.

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