# Head Injuries to Helmeted and Unhelmeted Motorcyclists in US Trauma Data

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## I. INTRODUCTION

Motorcyclist fatalities are increasing even as fatalities among vehicle occupants in crashes are falling in the US [1-2]. A large proportion of serious and more severe injuries in US motorcycle crashes are head injuries [3]. In order to understand where there may be opportunity for improvement of motorcyclist head protection, it is necessary to understand which injuries are reduced by helmets and which are less well mitigated by helmets.

## II. METHODS

Motorcycle riders and passengers in the National Trauma Data Bank (NTDB) National Sample Program (2003-2009) were sorted by helmet use. Cases from 2007 were excluded because the very small number of helmeted cases suggested errors in the data. In order to isolate helmeted and unhelmeted cases of similar crash severity in the absence of explicit crash severity variables in NTDB, only cases that included a serious below-neck injury were included in the study dataset. Without such a limitation, helmeted cases might be of higher severity on average than unhelmeted cases given that a helmeted occupant might be less likely to be admitted to a trauma center and included in NTDB as a result of head injury in a lower-severity crash. Motorcyclists with serious (AIS 3+) head injuries were broadly grouped by head injury type. Injuries involving concussion, diffuse axonal injury, or loss of consciousness not attributed to other injury were categorized as closed head injury. Injury rates, and odds ratios (OR) from logistic regression analysis of each head injury type controlling for age and helmet use, were calculated using NTDB-weighted data and survey analysis methods.

## III. INITIAL FINDINGS

The NTDB dataset included 37,791 cases with known helmet use representing a weighted total of 142,598, 20% (27,885) of whom had serious below-neck injury. Among the weighted included cases with below-neck injury, 77% (21,444) were helmeted. Fifteen percent of those helmeted cases and 32% of unhelmeted cases included serious head injury.

***Injury rate (Figure 1):*** For all broad AIS 3+ head injury types considered, the injury rate (percentage of included motorcyclists with at least one injury of that type) was lower with helmet use than without. ***Odds Ratios (Figure 2):*** For all head injury groups except brainstem, the entire 95% confidence interval (CI) is greater than 1 indicating that the odds of injury without a helmet are significantly greater than with a helmet. Injuries such as epidural hematoma have the highest odds ratios indicating the largest reduction in injury odds with a helmet, while other injuries, including subdural hematoma and subarachnoid hemorrhage, showed more modest reductions in injury odds with a helmet.

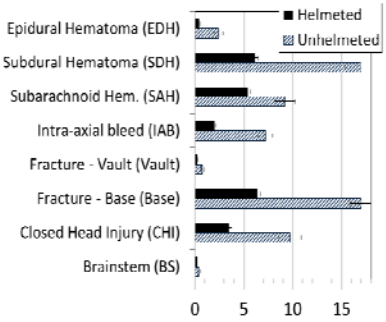


Figure 1. Rate (%) of AIS 3+ head injury among cases with serious body injury (95% CI)

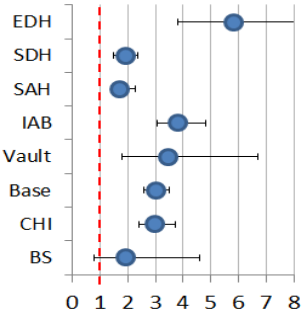


Figure 2. Serious head injury OR without helmet relative to with helmet (95% CI)

## IV. DISCUSSION

In this preliminary analysis, injury rate was lower among helmeted motorcyclists than among unhelmeted for all broad types of head injury considered, including those typically associated with rotation such as subdural hematoma and the broad closed head injury category that included concussion and diffuse axonal injury. The ratio of injury odds for unhelmeted versus helmeted cases varied by type of injury, with the most improvement with a helmet for epidural hematoma which is typically attributed to linear forces associated with skull fracture. Although NTDB contains limited crash information and no indication on the type of helmet used and whether it was compliant with US standards, these results show that helmets decrease injury for all types of serious head injury. Further investigation is needed to understand the potential for further improvement of helmet protection relative to injuries typically associated with rotational loading.

## V. REFERENCES

[1] Sivak & Schoettle, TIP, 2010. [2] NHTSA, DOT HS 811 765, 2013. [3] Hanna & Austin, DOT HS 810 982, 2008.

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