



## Effects of repealing the motorcycle helmet law in Michigan



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### ABSTRACT

**Background:** In 2012, Michigan repealed its universal helmet law. Our study assessed the clinical impact of this repeal.

**Methods:** Our trauma database was queried retrospectively for 2 motorcycle riding seasons before and 3 seasons after repeal. On-scene death data was obtained from the Medical Examiner.

**Results:** Helmet use in hospitalized patients decreased after the helmet law repeal. Non-helmeted patients had a significant increased rate of head injury. Non-helmeted patients were more likely to die during hospitalization. While, helmet use and drugs/alcohol status significantly affected the risk for head injury, only drug/alcohol had a significant effect on overall mortality.

**Conclusions:** Following helmet law repeal, helmet use has decreased. Helmet status and drug/alcohol use was found to significantly increase risk of head injury. Although overall mortality was only affected by drug/alcohol use, non-helmeted patients did have a higher inpatient mortality. These findings deserve furthermore study and may provide a basis for reinstating the universal helmet law.

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## 1. Introduction

The repeal of Michigan's 35-year universal helmet law occurred on April 13th, 2012 despite advocacy efforts of the healthcare community, American College of Surgeons, public safety members, and data from national highway safety administration supporting the safety benefit of motorcycle helmets. Currently only 19 states, including the District of Columbia, enforce a universal helmet law while 28 states have a partial-requirement law in place as in Michigan. These partial laws mandate helmet use for certain riders, usually based on age (younger than 18 or 21 years) and medical coverage. Three states, Illinois, Iowa and New Hampshire, currently do not have any helmet laws in place.<sup>1</sup>

Michigan's partial helmet law now states that helmet use is optional for persons at least 21 years of age, who have at least \$20,000 in first-party medical benefits, and have either had a motorcycle endorsement for at least 2 years or have passed an approved motorcycle safety course. The option to not wear a helmet also extends to motorcycle passengers with similar stipulations. It has long been thought that non-helmeted motorcyclists have higher mortality rates, higher incidence of both lethal and non-lethal head injuries, and a consistently higher financial healthcare burden.<sup>2</sup> This study examined the clinical impact of helmet use following the repeal of Michigan's universal helmet law in Oakland County, a population of 1.2 million, through a high volume Level 1 trauma center.

## 2. Methods

### 2.1. Study design

Beaumont Health in Royal Oak is the only Level 1 trauma center in Oakland County, Michigan. Our institutional trauma database was queried retrospectively for 2 seasons before the repeal and 3 seasons after (April 2010 – November 2014) for all patients involved in motorcycle crashes. Our definition of motorcycle season

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was included admissions between April 1st and November 30th D, which was chosen to avoid unpredictable weather patterns during the winter months. These dates also incorporated the vast majority of our motorcycle crash patients with only a few outliers outside these seasons. Data was analyzed for 249 motorcyclists including 210 patients admitted to the trauma service and 39 patients who died on-scene. Overall data includes 84 motorcyclists before repeal of the universal helmet law and 165 after. Data collected includes: age, gender, date of accident, presence of helmet, estimated speed at time of accident, cause of death, head injury, Glasgow Coma Scale (GCS) on admission, drug and alcohol use, length of hospital stay, length of ICU stay, and discharge disposition. Our criteria for head injury were defined as clinical evidence of neurological dysfunction by clinical examination (GCS < 15) and/or radiographic evidence of trauma to the head/face. Evaluation of motorcyclist's speed at the time of crash was obtained from the patient or EMS/Police documents and categorized into high speed or low speed. To allow similar distributions into high and low speed cohorts, high speed was determined to be > 50 mph.

## 2.2. Statistical analysis

Continuous variables were summarized using mean and standard deviation or median and range, as appropriate, and were compared between subgroups using Welch's *t* or Wilcoxon rank-sum tests. Categorical variables were summarized by count and percentage, and compared using chi-squared tests or Fisher's exact test. The Cochran-Mantel-Haenszel test (hereafter CMH) was used to assess the association between helmet use and variables of interest while stratifying by time (before and after repeal), with Woolf's test used to test the assumption of homogeneity of odds ratios.

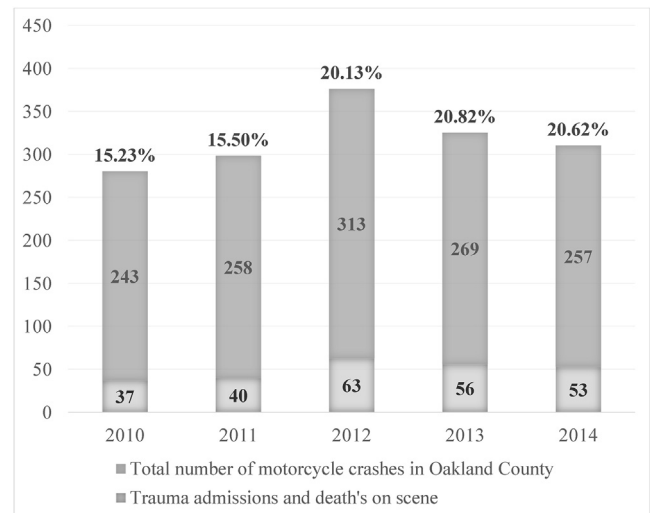
A multivariable logistic regression model was fit to examine the relationship between head injury and helmet status, drug and/or alcohol use, and time. A similar model was fit with mortality as the dependent variable. Assumptions were checked for both models, and the selected variables were tested for interactions. All statistical analysis was performed using R (version 3.2.3) and RStudio (version 0.99.891).

## 3. Results

A total of 210 trauma patients involved in motorcycle crashes were admitted following trauma evaluation from 2010 until 2014. In addition, data from 39 individuals from the Oakland County Medical Examiner's office who died at the scene of an accident during the same time frame was also reviewed, for a total cohort of 249 patients. There was no significant difference in age ( $43.3 \pm 14.9$  years before vs  $43.0 \pm 16.3$  years after) or male gender (90.5% before vs 87.9% after) of motorcyclists before or after the repeal.

In our cohort of 249 total patients, 84 motorcycle crashes occurred before the repeal of the helmet law and 165 after. Using data from the National Highway Traffic Safety Administration (NHTSA) database we compared our cohort to the total number of motorcycle crashes in Oakland county (see Fig. 1).<sup>3</sup> In 2010 and 2011 our cohort of motorcyclists involved in crashes who either died or were admitted to out trauma service represented 15.23% and 15.50% of the total number of motorcycle crashes in Oakland county. This increased to 20.13%, 20.82%, and 20.62% in the 3 seasons following repeal, however, this was not statistically significant ( $P$ -value = 0.24).

Prior to the repeal, 93.9% of those studied wore helmets while only 69.5% were helmeted in the 3 years after repeal ( $X^2 = 18.6$ ;  $P$ -value < 0.001; estimated odds ratio (OR) 0.15, 95% CI [0.06, 0.39]).



**Fig. 1.** Percentage motorcyclists Involved in Crashes that were admitted or died on scene compared to overall number of motorcycle crashes in Oakland county.<sup>3</sup> There was no statistical difference in number of motorcyclists that died on scene or were admitted to our trauma center following repeal ( $P$ -value = 0.24).

Further analysis revealed that helmet use decreased following repeal of helmet law, regardless of drug and/or alcohol use ( $P < 0.001$ ).

There was no significant difference in overall mortality before and after helmet law repeal with 15.5% mortality before and 19.4% mortality after ( $X^2 = 0.6$ ;  $P$ -value = 0.45; OR 1.31, 95% CI [0.65, 2.66]). While mortality did not significantly differ before and after repeal, there was a significant increase in rates of head injury following repeal, from 26.2% before to 45.1% after the repeal ( $P$ -value = 0.01) as seen in Table 1.

As predicted, helmet use decreased following repeal of Michigan's helmet law, we therefore focused our analysis on the clinical impact of helmet use of those involved in motorcycle crashes (Table 1). When looking at the effects of helmet use, only 24.4% of helmeted patients suffered head injuries, compared to 35.6% of non-helmeted individuals ( $X^2 = 26.1$ ;  $P$ -value < 0.001). There were higher numbers of non-helmeted patients with Glasgow Coma Scale (GCS) score  $\leq 8$  (21.9% vs. 12.5%) and non-helmeted patients were less likely to have a GCS of 15 (58.5% vs. 82.7%). Overall the GCS was typically lower in the non-helmeted patients ( $Z = -2.82$ ,  $P$ -value = 0.005; see Fig. 2). The non-helmeted patients who made it to the hospital had a significantly higher New Injury Severity Score (NISS) compared to those wearing helmets (22.8 for non-helmeted vs 16.1 for those helmeted;  $P$ -value = 0.01).

Helmet use did not significantly effect hospital length of stay, with median 9.5 [1, 61] days for helmeted patients and median 8 [1, 54] days for non-helmeted patients ( $P=0.84$ ). ICU length of stay was also not significantly different, with median 5 [1, 59] days seen in helmeted patients and median 4 [1, 54] days seen in non-helmeted patients ( $P$ -value of 0.78).

When looking at all hospitalized patients and their eventual disposition placement, more helmeted patients went to another location, such as rehabilitation center or nursing facility (37.2% helmeted vs 28.6% non-helmeted). Overall mortality was not significantly different between helmeted (16.3%) and non-helmeted (26.9%) patients ( $P$ -value = 0.08). Interestingly, more of the non-helmeted patients who were admitted ultimately died during their hospitalization (9.5% non-helmeted vs 1.3% helmeted;  $P$ -value = 0.031) as shown in Table 2.

Further analysis was performed on other contributing factors to clinical outcomes (specifically rates of head injury and mortality)

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