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ANALYSIS OF MOTORCYCLE CRASHES IN MICHIGAN 2009-2013

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16. Abstract

The goal of this analysis is to assess the consequences of the modification to the motorcycle helmet law that took effect on April 13, 2012, based on crash data from 2009-2013. The key areas of interest include: 1) changes in fatality and injury rates due to helmet non-use; 2) helmet use rates among crash-involved riders, especially those under 21; 3) out-of-state ridership, as it is seen in the crash data; 4) risk-taking behavior such as alcohol use and recklessness, as it relates to injury and fatality outcomes; and 5) motorcycle endorsements among crash-involved riders

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Analysis of Motorcycle Crashes in Michigan

2009-2013

Overview

The goal of this analysis is to assess the consequences of the modification to the motorcycle helmet law that took effect on April 13, 2012, based on crash data from 2009-2013. The key areas of interest include: 1) changes in fatality and injury rates due to helmet non-use; 2) helmet use rates among crash-involved riders, especially those under 21; 3) out-of-state ridership, as it is seen in the crash data; 4) risk-taking behavior such as alcohol use and recklessness, as it relates to injury and fatality outcomes; and 5) motorcycle endorsements among crash-involved riders.

Key results:

- In the crash population, helmet use dropped from 98% in 2008-2011 to 74% in 2012 and 2013 after modification of the helmet law. The pattern of helmet use seems to have stabilized, with some seasonal variation ranging between 70% in summer and 80% in fall/spring.
- Before and after the modification, the percentage of out-of-state riders who were involved in Michigan crashes has remained stable at 5%. This is one way of estimating whether there has been any change in out-of-state ridership after the modification.
- Helmet use rates for crash-involved riders age 16-20 dropped from 97% before the modification to 86% afterwards.
- Riders without motorcycle endorsements are somewhat less likely to wear a helmet, compared those with endorsements. Those with endorsements made up 58% of the crash population prior to 2012 and 50% of the crash population in 2012-13.
- Risk of fatality is 2.8 times higher for motorcycle riders who are not wearing a helmet. Risk of incapacitating injury is 1.4 times higher for motorcycle riders who are not wearing a helmet.
- The fatality rate in 2013 is the highest in 5 years at 3.6% of crash-involved riders. The overall rate since the modification is 8% higher than the overall rate for the three previous years.
- Regression models were used to estimate the number of fatalities and serious injuries attributable to changes in helmet use since the modification. Based on these models, 20% (24 per year) of fatalities and 10% (71 per year) of serious injuries were estimated to have resulted from reduced helmet use after the helmet-law modification.

Analysis Details

Analysis Approach

In the previous analysis using 2012 data, we compared only the time period from April 13-Dec 31 of each year to account for the timing of the helmet modification in 2012. With an additional year of data, we will use all of the data and categorize 2012 data as before- or after-modification. Although the comparison to other years will not mirror this exactly, we expect that there will be little effect on the analysis.

Crashes are the combined result of exposure (e.g., miles of riding) and risk. As a result, the data can be used to give indications of changes in certain exposure variables, such as out-of-state ridership, helmet use, and endorsements. For example, a large increase in out-of-state ridership resulting from the helmet-law modification would be expected to result in an increase in out-of-state drivers in the crash data, even if they are no more or less risky than Michigan drivers. In addition, crash data are readily used to look at injury outcome as a function of variables such as alcohol use and helmet use. The following results indicate changes in the pattern of crashes and injuries since the helmet law modification.

Overall Crashes and Fatalities

Table 1 shows the number of motorcycle riders involved in crashes and the number of fatalities each year from 2009-2013. In 2012, totals before and after the modification are indicated. Total crashes, total fatalities and percent fatal per year have not changed systematically over time.

Table 1

Total motorcycle riders involved in crashes and total fatalities for 2009-2013

Riders	Year				
	2009	2010	2011	2012 (before/after) *	2013
All Involved	3,812	3,741	3,509	3,948 (368/3,580)	3,504
Fatalities	103	125	109	129 (12/117)	128
Percent Fatal	2.7%	3.3%	3.1%	3.3%	3.6%

*Note: 2012 is subdivided into the time period before the modification took effect (Jan 1-April 12) and the time period after it took effect (April 13-Dec 31)

Helmet Use Patterns

Helmet use rates in the crashing population may or may not be equal to those in the riding population. However, the crash population both gives an indication of how helmet use patterns have changed and it is relevant to those at risk of injury because of a crash. Helmet use among crashing motorcycle riders was substantially lower after the modification than in previous years. Table 2 shows the number of riders with known helmet use for each year. Prior to the modification, from 2009 through early 2012, the crash-involved helmet use rate was

approximately 98%, but in 2012, it fell to 74% overall and stayed there through 2013.

Table 2
Helmet Use Among Riders Involved in Motorcycle Crashes by Year

Helmet Use	Year					
	2009	2010	2011	2012 (before)	2012 (after)	2013
No	89	75	74	13	850	836
Yes	2,990	3,158	3,115	330	2,431	2,381
Total	3,079	3,233	3,189	343	3,281	3,217
Percent Use	97.1%	97.7%	97.7%	96.2%	74.1%	74.0%

The pattern of helmet use is shown in more detail in Figure 1, which shows helmet use rate by month for 2012 and 2013. During the winter months, especially December-February, there are very few crashes, so there is wide monthly variability in helmet use rates. However, from April through October, and interesting and stable pattern seems to emerge for both 2012 and 2013 in which helmet use rates drop throughout the warmer months and then increase again as the weather gets colder. Rates reach a low point near 70% in the summer and rise to near 80% in the fall/spring. With ridership greatest in summer, the crash-involved helmet use rate averages to 74% across both 2012 and 2013. The cyclical pattern and average rate is surprisingly consistent over the two years of transition since the modification and thus is expected to continue in the future.

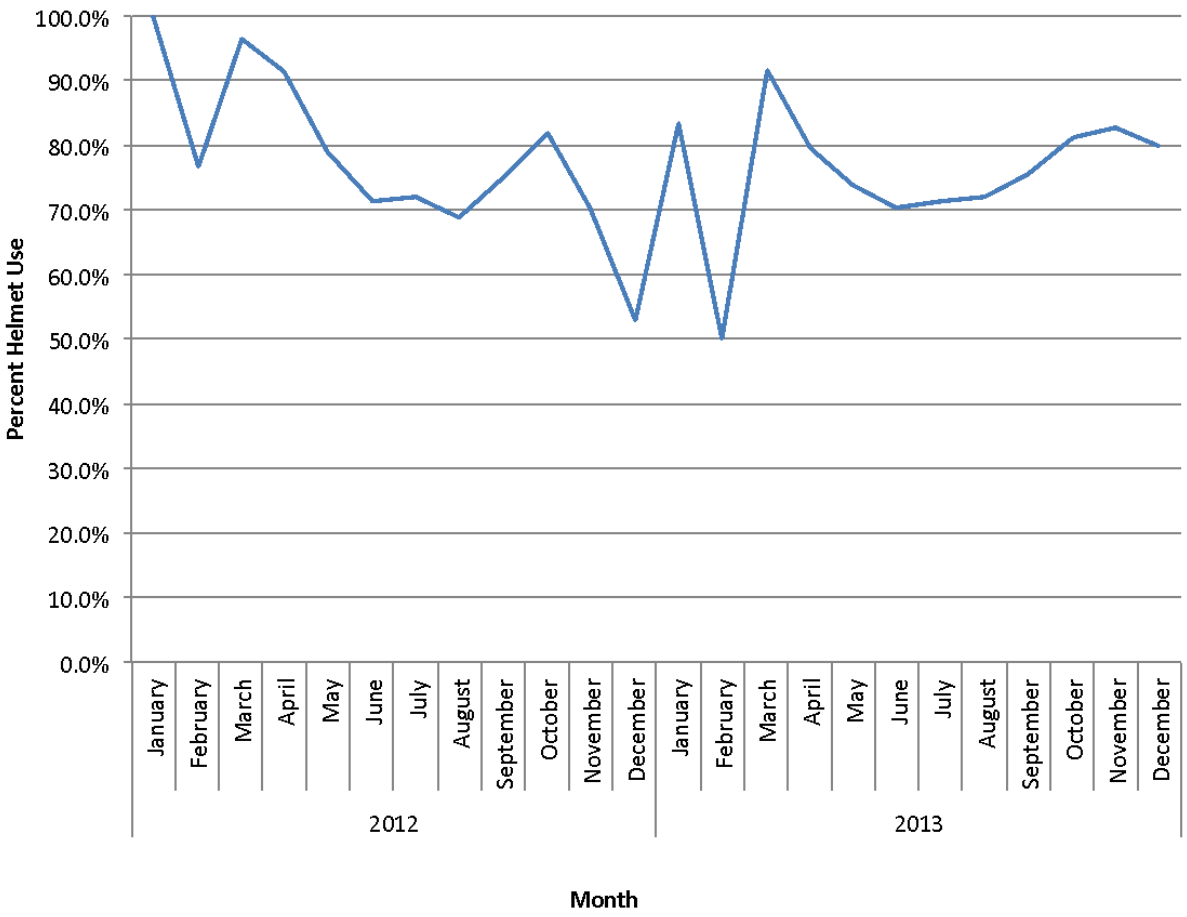

Figure 1. Monthly helmet use rates among crash-involved riders in 2012-2013, encompassing a period before and after the modification. Note that sample sizes in winter months are very low, leading to substantial variability in helmet use rates during that time.

Helmet use rates also vary with demographic variables. Table 3 summarizes these relationships and how they have changed in the post-modification period. Prior to the modification, crash-involved male and female riders both used helmets 97.5% of the time. However, after modification, both male and female use rates dropped, but females use helmets at a significantly higher rate than males (now that there is a choice). Use rate as a function of seat position does not vary. Before and after modification, both groups use helmets at the average rate.

Helmet use rates as a function of rider age also differ significantly. After the modification, use rates among all age groups dropped, even though the law requires helmets for riders under 21. The youngest riders (who make up less than 1% of the crash population) use a helmet less than 83% of the time, riders age 16-20 (who make up just under 6% of the crash population) use a helmet 86% of the time, and riders 21 and over use a helmet 73% of the time.

Prior to the modification, 5.0% of crash-involved riders rode vehicles registered out of state. Their helmet use rate was 97.3%, similar to those with vehicles registered in Michigan. After the

modification, 5.1% of crash-involved riders had vehicles registered out of state, and their helmet use rate was 69.6% compared to in-state riders' use rate of 74.4%. Riders with motorcycle endorsements made up 58% of the crash population prior to the modification and they wore helmets slightly (but significantly) more often than those without endorsements. After the modification, endorsed riders dropped to 50% of the crash population, and they continued to wear helmets at a significantly higher rate, compared to unendorsed riders.

Finally, motorcyclists who were drunk showed the largest change in helmet use rates of all groups. Prior to the modification, crash-involved operators who had been drinking wore a helmet 89% of the time. However, after the modification, this rate fell below 50%.

Table 3
Helmet Use as a Function of Demographic Variables

Group		Time Period	
		Before Modification (Jan 1, 2009-April 12, 2012)	After Modification (April 13, 2012-Dec 31, 2013)
Gender*(after only)	Males	97.5%	73.6%
	Females	97.5%	77.2%
Age (yrs)*	<16	92.0%	82.7%
	16-20	96.6%	86.2%
	21+	97.6%	73.3%
Seat Position	Driver	97.4%	74.1%
	Passenger	97.6%	74.2%
Vehicle Registration State*	Michigan	97.8%	74.4%
	Other	97.3%	69.6%
License Endorsement*	Yes	98.6%	75.9%
	No	96.3%	72.4%
Alcohol Involvement*	Yes	89.1%	46.8%
	No	98.1%	76.1%

*Indicates significantly different helmet use rates among demographic groups ($p<0.05$). All differences between the periods before and after modification are significant.

Helmet Use and Fatalities

Table 4 shows the percent of motorcycle fatalities by helmet use and year. Here, the raw fatality risk for helmeted riders decreased after the modification, whereas risk for non-helmeted riders is similar to previous years. Across the five-year period, the fatality rate for non-helmeted riders is 2.3 times higher than for helmeted riders, and since the modification, that risk ratio has risen to 2.7 times higher. The last row in Table 4 shows the proportion of fatally injured riders who were wearing a helmet. With the decrease in overall helmet use rates, the fatality burden since the

modification is primarily carried by unhelmeted riders, who make up 26% of the crash-involved rider population, but 51% of the fatalities.

Table 4
Fatality Rate as a Function of Helmet Use and Year

Helmet Used	Year				
	2009	2010	2011	2012 (4/13-12/31 only)	2013
No	7.1%	5.3%	6.8%	6.5%	7.1%
Yes	3.0%	3.6%	3.2%	2.3%	2.7%
Percent Helmet Use Among Fatalities	93.7%	96.6%	95.1%	50.5%	51.6%

One puzzle presented by the results in Tables 1 and 4 is that although fatality rate is almost 3 times higher for unhelmeted riders and that population has risen substantially, the overall fatality rate has not risen substantially. The reason for this is in the correlation between choosing not to wear a helmet and other risky behaviors among motorcyclists. For example, as Table 3 shows, drinking riders dropped from 89% to 47% helmet use rates after the modification. Drinking riders are more likely to be involved in severe crashes, which are, in turn, more likely to result in fatalities with or without a helmet. Prior to the modification, most drinking riders fell into the helmeted group, but their high-severity crashes drove up fatality rates among helmeted riders (see Table 4). After the modification, drinking riders were more likely to be counted among unhelmeted riders.

To separate risky behavior from helmet use as contributors to fatality risk, we developed a regression model to account for the effects of alcohol use and other factors that are not related to the law modification itself. The model indicates that after controlling for other risk factors, helmet non-use doubles fatality risk. We then used the model to estimate the number of fatalities that would have occurred if helmet use rates were at 2011 levels (98%). We estimate that fatalities would have been reduced by 20%, or 25 riders per year.

Injuries

Injuries are coded on the KABCO scale, where K is Killed, A is incapacitating injury, B is probable injury, C is possible injury, and O is no injury. Table 5 shows the number of A and B injuries as a function of helmet use by year. Table 6 shows the rate of A injuries for helmeted and unhelmeted riders by year. In the post-modification period (4/13/12-12/31/13), the serious injury rate was 1.5 times greater for crash-involved riders who did not wear a helmet, compared to those who did wear a helmet. The probable-injury rate was the same for helmeted and unhelmeted riders.

Table 5
Number of Injuries by Injury Level and Helmet Use

Helmet Use	Injury Level	Year				
		2009	2010	2011	2012 (4/13-12/31 only)	2013
Helmet Not Worn	A	31	20	23	194	194
	B	23	27	21	280	277
Helmet Worn	A	601	556	519	390	350
	B	929	1029	1088	846	780

Table 6
Serious Injury Rate (A) as a Function of Helmet Use

Helmet Use	Year					
	2009	2010	2011	2012 (4/13-12/31 only)	2013	
Helmet Not Worn	37%	27%	32%	23%	23%	
Helmet Worn	20%	18%	17%	16%	15%	

The regression modeling approach was repeated for A injuries to estimate the reduction in A injuries if helmet use were the same as in previous years. Adjusting for risk factors other than helmet use, we estimate that if helmet use were at 2011 levels (98%), the reduction in serious injuries would be 10%, or 71 fewer seriously-injured riders annually.