Motorcycle-Involved Crashes in Michigan: 2014-2018

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Contents

1.0 Executive Summary

This report utilizes police-reported crash data in Michigan from 2014 through 2018 to study motorcycle-involved crash trends. Data back to 2010 will be used to explore motorcyclist helmet trends before and after the helmet law repeal in Michigan. Major findings include:

- In the crash population, helmet use dropped from 97.7% in 2011 to 74.0% in 2012 after modification of the helmet law. The rate was 69.0% in 2018. In general, the helmet use rate observed in crashes has been decreasing very slowly since the initial large decrease after the modification.
- Helmet use rates for crash-involved motorcyclists age 16-20 dropped from 97.3% before the modification to 84.0% after, even though helmet use is mandatory for the motorcyclists in this age group.
- Motorcycle operators without motorcycle endorsements (CY endorsements) involved in crashes are somewhat less likely to wear a helmet, compared to those with CY endorsements. Among motorcycle operators involved in crashes where helmet use and CY endorsement status were known, 72.4% of CY endorsed operators wore helmets compared to 67.8% of unendorsed operators.
- Crash-involved motorcycle operators with CY endorsements made up 54.8% before the modification and 57.9% after the modification. Starting in 2017, the CY endorsed percentage of operators has risen drastically.
- After accounting for other risk factors (e.g., alcohol involvement), the risk of fatality for non-helmeted motorcyclists was 1.7 times the risk for helmeted motorcyclists.
- The overall rate of fatalities and suspected serious injuries (per crash-involved motorcyclist) increased from 20.7% before the modification to 22.5% after. The fatality rate per crash-involved motorcyclist increased from 3.6% in 2010 to 4.7% in 2018.
- Regression models were used to estimate the number of fatalities and suspected serious injuries attributable to changes in helmet use since the modification. Based on these models, 14.7% (19 per year) of fatalities and 9.2% (55 per year) of serious injuries were estimated to have resulted from reduced helmet use after the helmet-law modification.

2.0 Introduction

This report analyzes police-reported motor vehicle crashes involving motorcyclists on public roadways in Michigan from 2014 through 2018. Michigan traffic crashes are defined as taking place on public roadways in Michigan, involving at least one motor vehicle in transport, and resulting in death, injury, or property damage of $1,000 or more. For the purposes of this report, motorcyclists will be grouped into three categories:

- Motorcycle operators: motorcycle drivers
- Motorcycle passengers: non-operators of motorcycles riding on the motorcycle
- Motorcyclists: all motorcycle occupants, including both operators and passengers

The key areas of interest include: 1) fatality and injury rates for helmeted and unhelmeted motorcyclists; 2) helmet use rates among crash-involved motorcyclists, 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 (CY endorsements) among crash-involved operators. A particular focus is on changes in helmet use after the modification to the motorcycle helmet law that took effect in Michigan on April 13, 2012, so data back to 2010 will be used for that section of the report.

3.0 Methods

The helmet use section of this analysis covers the period from January 1, 2010 to December 31, 2018. The helmet-law modification took effect on April 13, 2012, resulting in just over two years of data prior to the modification and over six years of data after the modification. (Since ridership in the winter months is low, the majority of 2012 motorcycle-involved crashes occurred after the modified helmet law went into effect.) To evaluate changes in crash and injury patterns, we compare crashes before the modification (1/1/10-4/12/12) to those that occurred after the modification (4/13/12-12/31/18).

Crashes are the combined result of exposure (e.g., miles of riding) and risk. As a result, the data can be used to indicate changes in certain exposure variables, such as out-of-state ridership, helmet use, and CY 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 motorcycle operators in the crash data, even if they are no more or less risky than Michigan motorcycle operators. In addition, crash datasets 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.

4.0 Overall Crash Trends

Table 1 shows the number of motorcyclists involved in any crash and the number of motorcyclist fatalities from 2014-2018, while Figure 1 shows the patterns graphically (note: overall count and fatality count are plotted on different axes). With the exception of a spike in 2016, the total number of

motorcyclists involved in crashes has remained steady. In 2014, there was a relatively small number of motorcyclist fatalities, but all other years from 2015 to 2018 have been steady, although elevated from the 2014 count.

Table 1. Number of Fatalities among Crash-Involved Motorcyclists from 2014-2018

	Year				
	2014	**2015**	**2016**	**2017**	**2018**
Fatalities	107	138	141	137	134
All Involved	3,258	3,376	3,711	3,237	3,012
Percent Fatal	3.3%	4.1%	3.8%	4.2%	4.5%

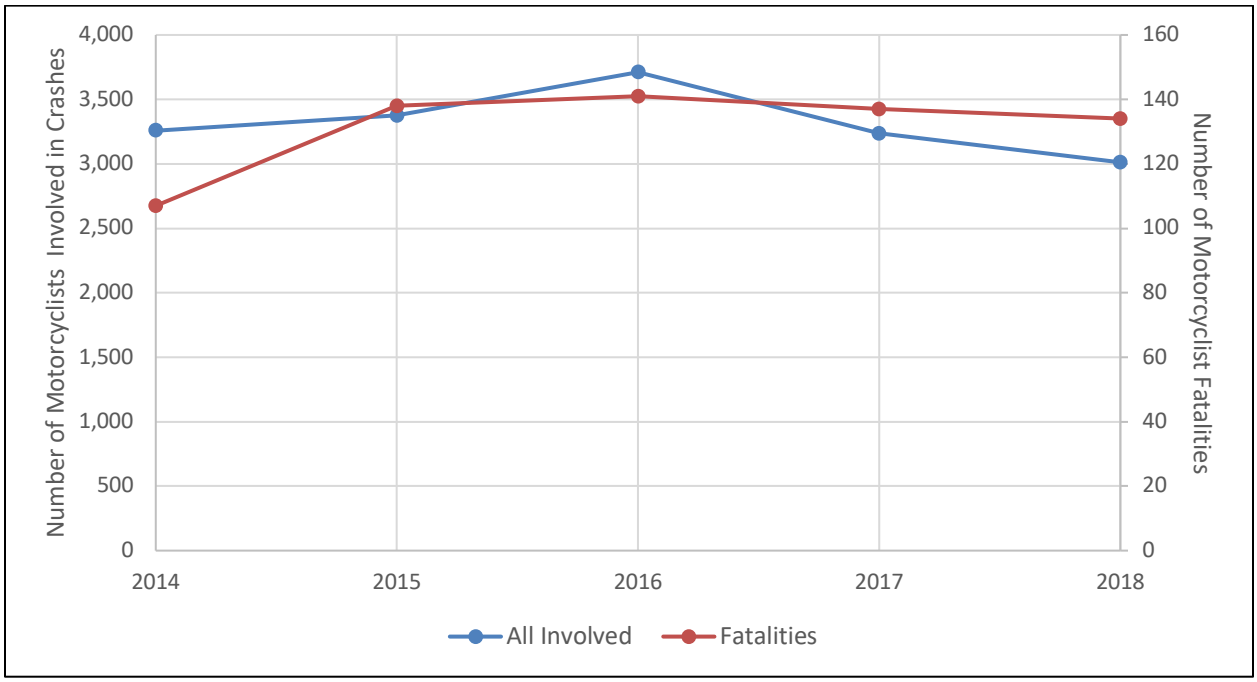

Figure 1 – Motorcyclists Involved in Crashes (left axis) and Fatalities (right axis) from 2014-2018

5.0 Crash Characteristics

5.1 Crash Type

In this section, we look at a variety of characteristics of motorcycle-involved crashes. For context, these are compared to patterns in non-motorcycle-involved crashes. Head-on includes head-on and head-on/left turn crashes; rear-end includes rear-end, rear-end/left turn, and rear-end/right-turn; and sideswipe crashes include both same and opposite direction sideswipe crashes. The distribution of crash types is shown in Figure 2. Single-vehicle crashes (run off road etc.) account for 47.0% of motorcycle-involved crashes, followed by rear-end and angle crashes. Single-vehicle and head-on crashes are overrepresented for motorcycle-involved crashes compared to non-motorcycle-involved crashes. Of the motorcycle head-on crashes, 78.0% are head-on/left turn crashes.

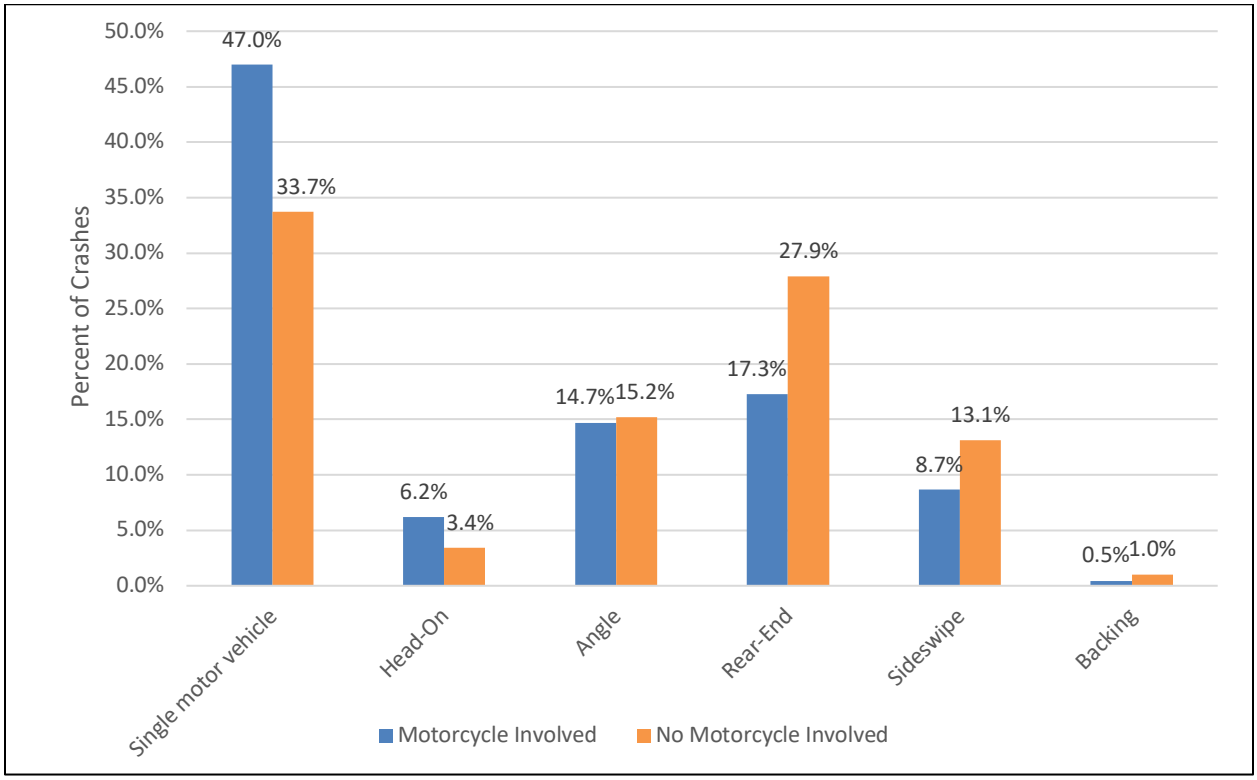

Figure 2 – Distribution of Crashes With and Without a Motorcycle Involved by Crash Type

5.2 Light Condition

The distribution of crashes by light condition is shown in Figure 3 for crashes with and without motorcycles. While all crashes are more likely to occur in light than dark conditions, motorcycle-involved crashes are somewhat more likely than other vehicle crashes to occur during daylight. This most likely reflects motorcyclists' riding patterns, which may favor daytime travel.

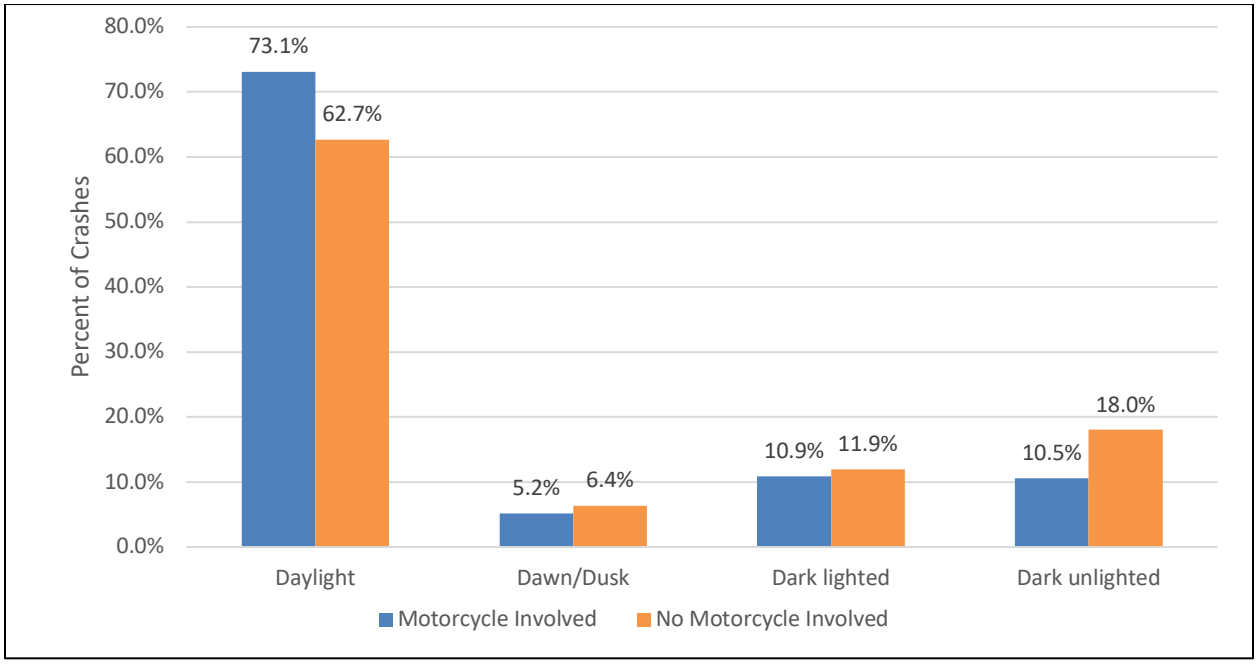

Figure 3 – Distribution of Crashes With and Without a Motorcycle Involved by Light Condition

5.3 Weather Condition

Figure 4 plots the distribution of crashes by weather condition for crashes with and without motorcyclists. The bars labeled “poor conditions” include fog, rain, snow, severe crosswinds, sleet/hail, blowing snow, blowing sand, dirt, and smoke. Motorcycle-involved crashes are substantially more likely to occur in clear conditions compared to non-motorcycle-involved crashes. Motorcyclists may choose to avoid riding in inclement weather, which may reduce the number of events that occur in these conditions.

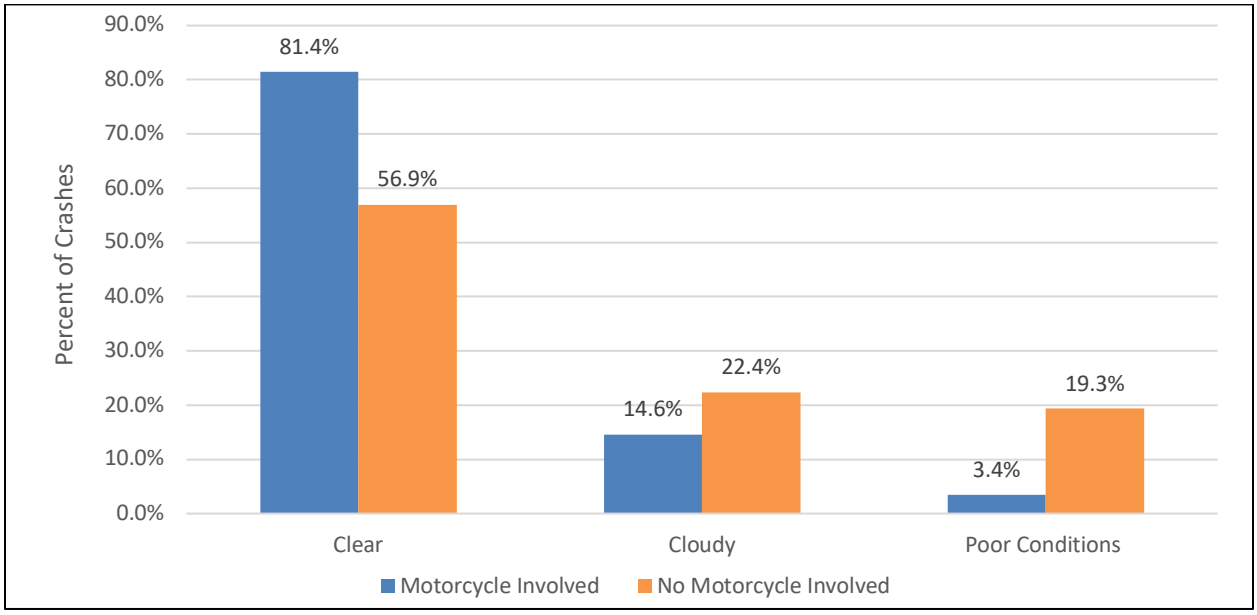

Figure 4 – Distribution of Crashes With and Without a Motorcycle Involved by Weather Condition

5.4 Road Factors

Figure 5 shows the proportion of crashes with and without a motorcyclist by number of lanes, while the distribution of crashes with and without motorcyclists by speed limit is shown in Figure 6. Motorcycle-involved crashes are slightly more likely to take place on two-lane, 55-mph speed limit roads, with 35.9% of motorcyclist-involved crashes happening on roads with a speed limit of 50-60 mph as compared to 31.4% of crashes with no motorcycles. Motorcycle-involved crashes are also slightly more likely to occur in speed limits of 30-45 mph. In comparison, non-motorcycle-involved crashes are more likely than motorcycle-involved crashes to occur on roads with more than two lanes and ≥65-mph speed limits.

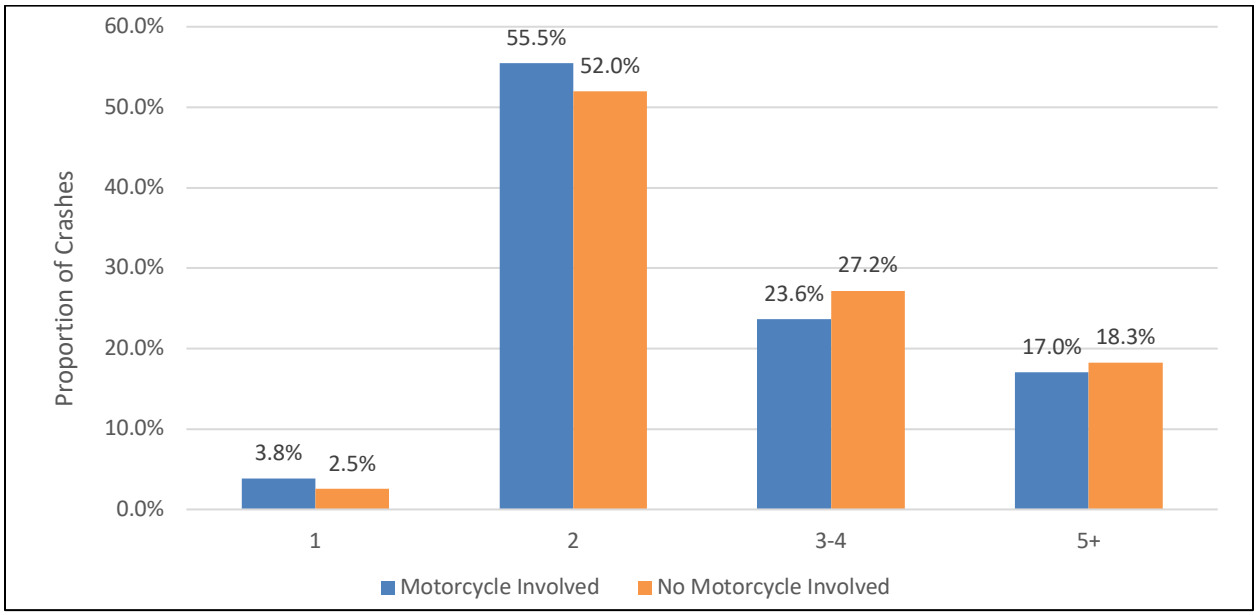

Figure 5 – Distribution of Crashes With and Without a Motorcycle Involved by Number of Lanes

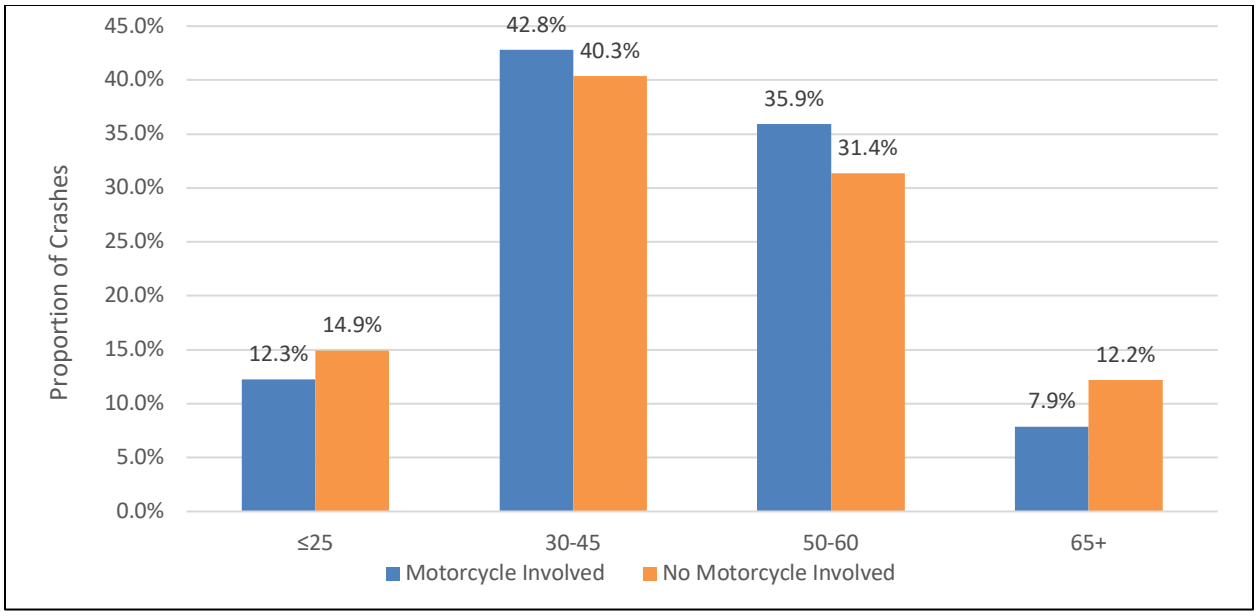

Figure 6 – Distribution of Crashes With and Without a Motorcycle Involved by Speed Limit

6.0 Temporal Variables

6.1 Month of Year

The distribution of crashes with and without motorcyclists by month of year is shown in Figure 7. As expected, motorcycle-involved crashes are much more frequent during the months from April to October than during the winter. As with weather and light conditions, this difference likely reflects the exposure of motorcyclists rather than a higher risk of crashing during that time.

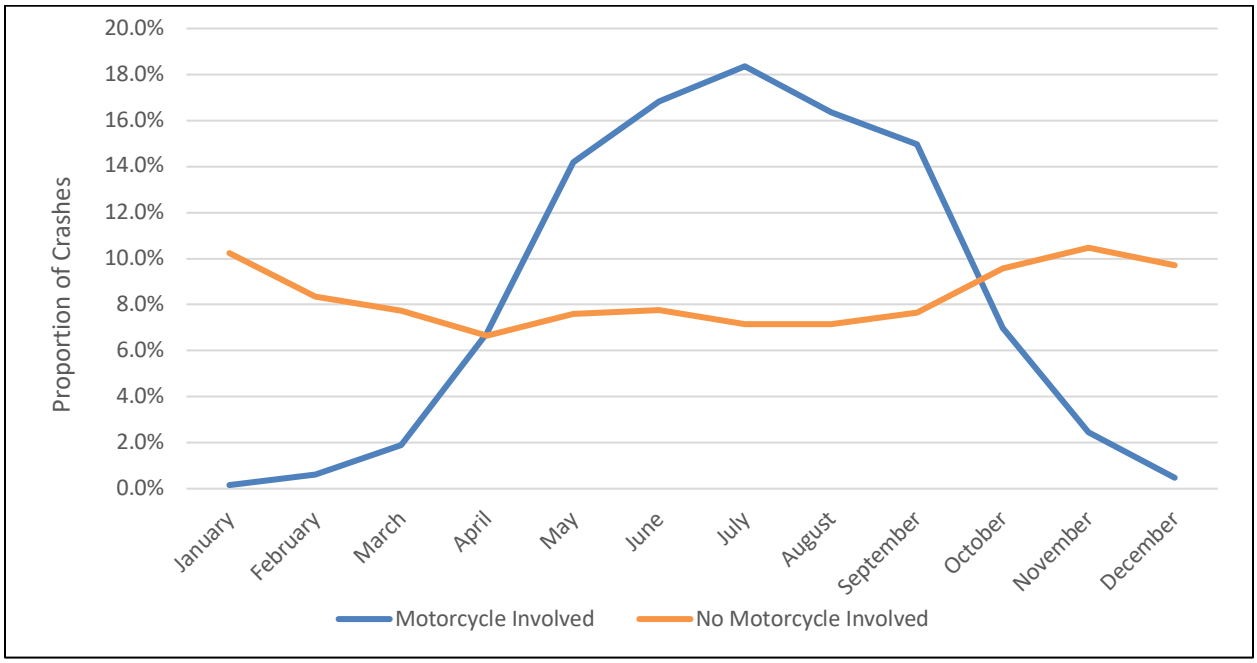

Figure 7 – Distribution of Crashes With and Without a Motorcycle Involved by Month

6.2 Day of Week

Figure 8 shows the variation in crashes with and without a motorcyclist by day of week. Motorcycle-involved crashes are more likely to happen on the weekend than during weekdays, in contrast to non-motorcycle-involved crashes which show the opposite pattern.

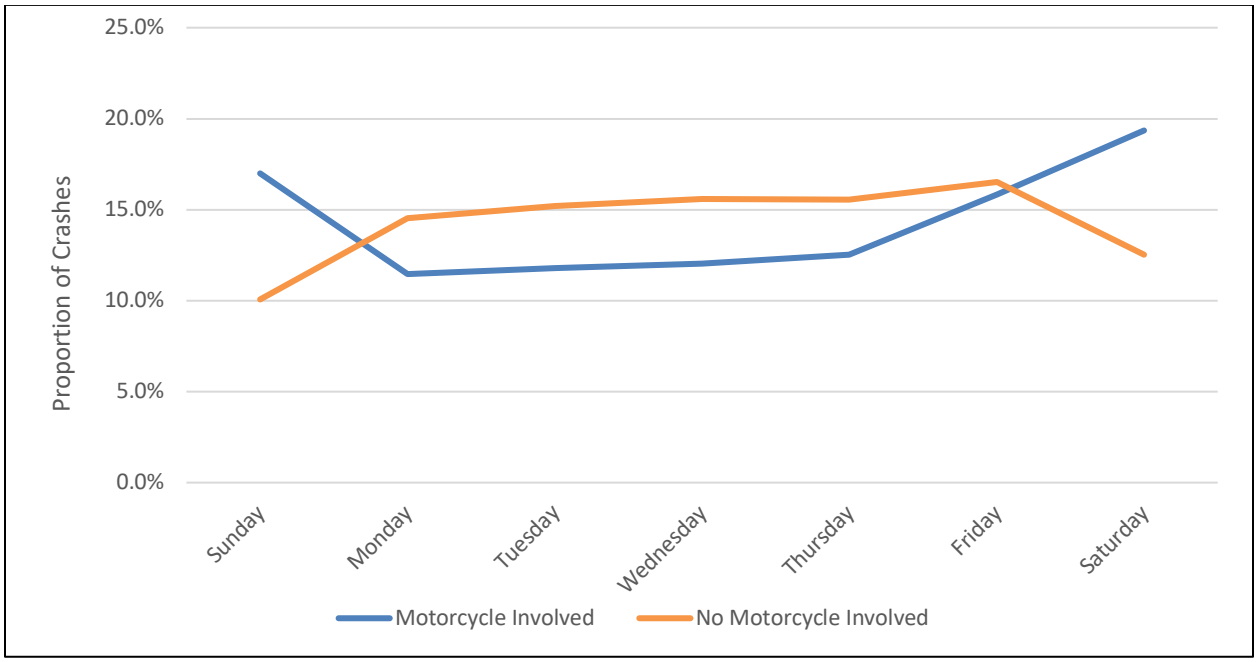

Figure 8 – Distribution of Crashes With and Without a Motorcycle Involved by Day of Week

6.3 Time of Day

The proportion of crashes with and without motorcyclists by time of day is shown in Figure 9. A greater proportion of motorcycle-involved crashes occur from 1 pm to midnight as compared to non-motorcycle-involved crashes. In addition, the morning peak seen for non-motorcycle-involved crashes is not present for motorcycle-involved crashes. This pattern, as well as the day-of-the-week pattern in Figure 8, most likely reflects the heavily recreational use of motorcycles as opposed to commuting patterns that dominate non-motorcycle travel.

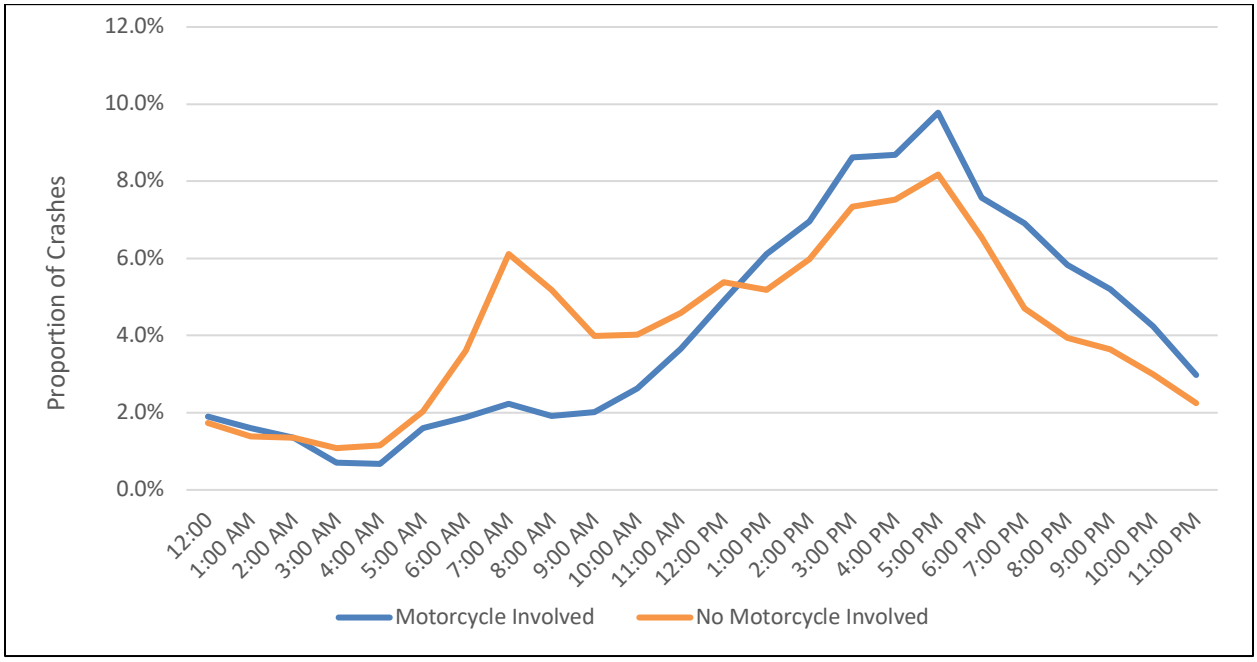

Figure 9 – Distribution of Crashes With and Without a Motorcycle Involved by Time of Day

7.0 Motorcycle Classification

Table 2 shows the distribution of motorcycle classification within motorcycles involved in crashes. This data was obtained by decoding the Vehicle Identification Number (VIN). There were 1,273 motorcycles involved in crashes from 2014 to 2018 with unavailable VIN data (8.4%). Cruisers are the predominant type with 37.1% of motorcycles involved in crashes, followed by touring at 28.6% and super sport at 14.9%. The year-to-year variation within each classification is fairly low. Table 3 displays motorcycle classification by fatal and non-fatal crashes. Super sport motorcycles occur at much higher rates in fatal crashes than in non-fatal crashes, with 19.0% in fatal crashes and 14.7% in non-fatal crashes.

Table 2. Motorcycles in Crashes by Motorcycle Classification and Year

Motorcycle Classification	Year					
	2014	2015	2016	2017	2018	Total
ATV	1	0	1	0	0	2
Autocycle	0	2	7	6	1	16
Chopper	6	7	6	9	9	37
Cruiser	961	1,042	1,204	1,003	918	5,128
Dual Purpose	57	60	72	52	69	310
Incomplete	1	0	0	0	0	1
Off Road	16	29	22	27	22	116
Scooter	44	42	43	34	36	199
Sport	204	207	230	219	189	1,049
Sport Touring	26	42	42	27	29	166
Standard	71	68	67	95	70	371
Super Sport	413	438	494	384	336	2,065
Touring	727	756	847	829	803	3,962
Unclad Sport	65	78	105	86	77	411
Total	2,592	2,771	3,140	2,771	2,559	13,833

Table 3. Motorcycles in All Crashes and Fatal Crashes by Motorcycle Classification from 2014-2018

Motorcycle Classification	Year	
	Fatal	Non-fatal
ATV	0 (0.0%)	2 (0.0%)
Autocycle	1 (0.2%)	15 (0.1%)
Chopper	2 (0.3%)	35 (0.3%)
Cruiser	221 (35.0%)	4,907 (37.2%)
Dual Purpose	8 (1.3%)	302 (2.3%)
Incomplete	0 (0.0%)	1 (0.0%)
Off Road	1 (0.2%)	115 (0.9%)
Scooter	12 (1.9%)	187 (1.4%)
Sport	46 (7.3%)	1,003 (7.6%)
Sport Touring	10 (1.6%)	156 (1.2%)
Standard	12 (1.9%)	359 (2.7%)
Super Sport	120 (19.0%)	1,945 (14.7%)
Touring	182 (28.8%)	3,962 (28.6%)
Unclad Sport	17 (2.7%)	394 (3.0%)
Total	632	13,201

8.0 Motorcycle Endorsement (CY Endorsement)

In order to legally operate a motorcycle on public roadways in the state of Michigan, a driver must obtain a motorcycle endorsement (CY endorsement) in addition to their Michigan driver's license. The overall CY endorsement rate in crashes from 2014 to 2018 was 61.3%. It is important to note that the crash population may not accurately reflect the total percentage of motorcycle operators who are CY endorsed in Michigan. Table 4 shows helmet use counts by CY endorsement status with 2014 through 2018 data combined. Unknown or miscoded helmet use values and unknown driver CY endorsement

status have been removed from the table for simplicity. Among CY endorsed motorcycle operators, the helmet use rate was 72.4% compared to operators with no CY endorsement at 67.8%.

Table 4. Helmet Use for Motorcycle Operators by CY Endorsement Status, 2014-2018

Helmet Use	Operator Endorsement	
	CY Endorsement	No CY Endorsement
Helmet Worn	5,944	3,450
Helmet Not Worn	2,267	1,639
Percent Helmet Use	72.4%	67.8%

9.0 Impairment

Figure 10 on the following page shows the proportion of motorcycle operators and non-motorcycle drivers who were drinking. The proportion of motorcycle operators who were impaired by alcohol is 3.8 times the proportion of non-motorcycle drivers who were impaired. The distribution of drug impairment for motorcycle operators and non-motorcycle drivers is shown in Figure 11. Although drug impairment is less common overall, the motorcycle operator drug impairment rate is 2.8 times higher than non-motorcycle drivers. About 6.8% of motorcycle operators were reported to be drinking, compared with 1.8% of other drivers. Similarly, 1.4% of motorcycle operators were suspected of using drugs, compared with 0.5% of other motor vehicle drivers.

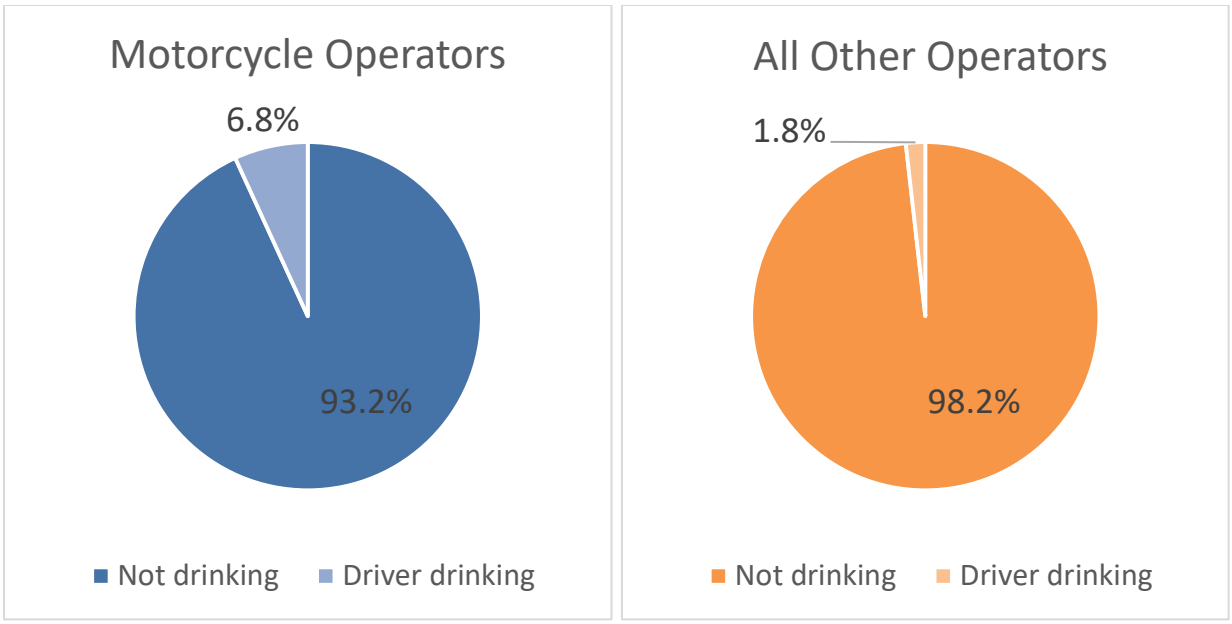

Figure 10 – Distribution of Motor Vehicle Operators by Alcohol Involvement

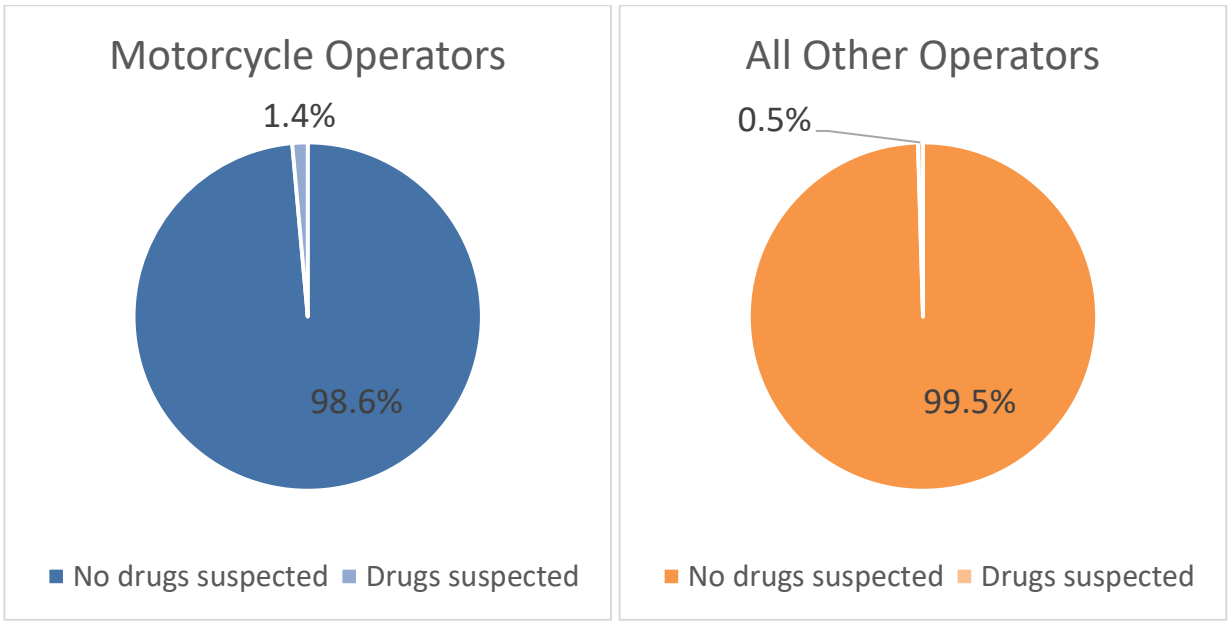

Figure 11 – Distribution of Motor Vehicle Operators by Drug Involvement

10.0 Helmet Use

10.1 Usage Rates

Helmet use rates in the crashing population may or may not be equal to those in the riding population. However, the crash population can indicate how helmet use patterns have changed and it is relevant to those at risk of injury because of a crash. Table 5 and Figure 12 show the number of motorcyclists with known helmet use for each year. Helmet use among crashing motorcyclists was substantially lower after the modification than in previous years. Prior to the modification, in 2010 and 2011, the crash-involved helmet use rate was 97.7%. In 2012, after the modification, it fell to 74.0%. Since then, the rate has decreased slowly but steadily to 69.0% in 2018.

Table 5. Helmet Use Among Motorcyclists in Crashes by Year

Helmet Use	Year									
	2010	2011	2012* (before)	2012* (after)	2013	2014	2015	2016	2017	2018
No	75	74	13	850	836	837	871	1,069	936	861
Yes	3,158	3,115	330	2,431	2,381	2,141	2,198	2,279	2,063	1,912
Total	3,233	3,189	343	3,281	3,217	2,978	3,069	3,348	2,999	2,773
Percent Use	97.7%	97.7%	96.2%	74.1%	74.0%	71.9%	71.6%	68.1%	68.8%	69.0%

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

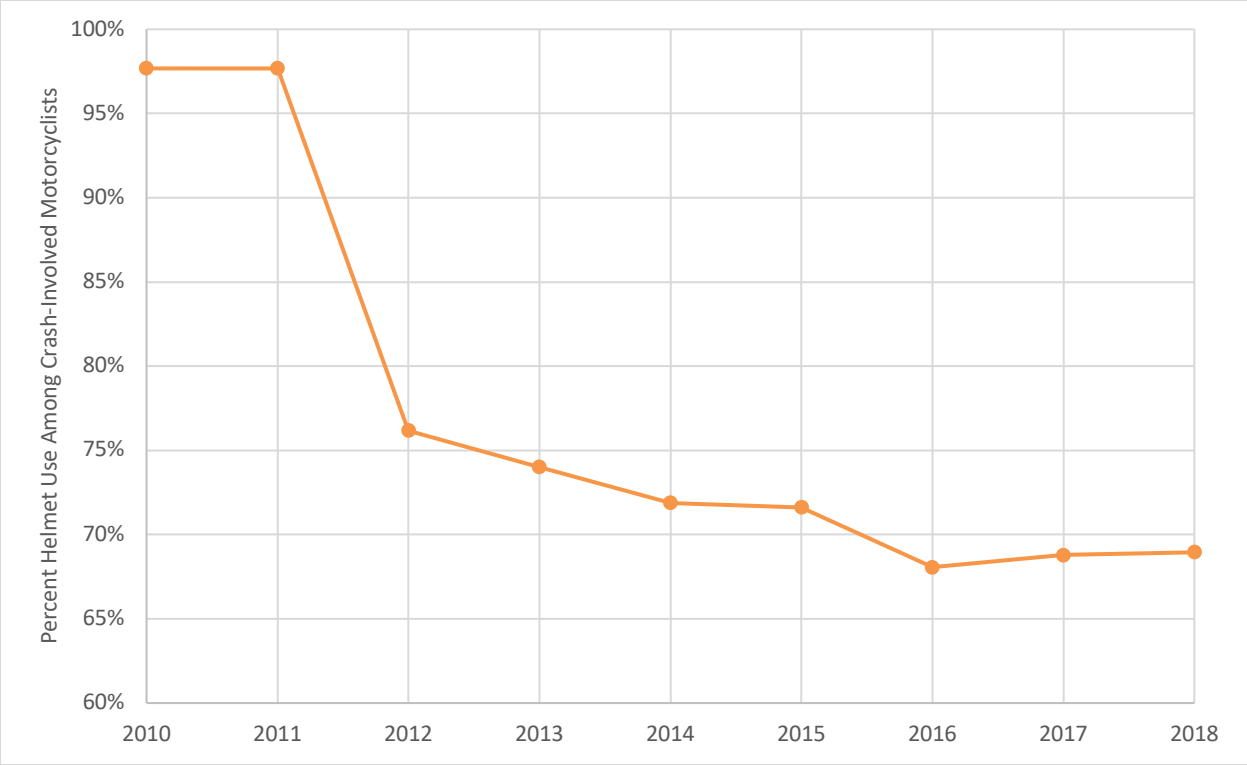

Figure 12 – Helmet Use Rates Among Crash-Involved Motorcyclists by Year

Helmet use rates also vary with demographic variables. Table 6 on the following page summarizes these relationships and how they have changed in the post-law modification period. Prior to the law modification, crash-involved male and female motorcyclists both used helmets at a similar rate, where the small difference is not significant. However, after the modification, both male and female use rates dropped, but females wear helmets at a significantly higher rate than males. Helmet-use rates as a function of seat position are marginally significantly different between operator and passenger seat position after the repeal. Before the law modification, both groups used helmets at a not significantly different rate, but afterwards, passengers' use rates became somewhat lower than that of operators.

Helmet use rates as a function of motorcyclist age also differ significantly after the repeal. After the modification, use rates among all age groups dropped, even though the law requires helmets for motorcyclists under 21. The youngest motorcyclists, under age 16 (who make up less than 1% of the crash population), use a helmet 77.8% of the time; motorcyclists age 16-20 (who make up about 5.5% of the crash population) use a helmet 84.0% of the time; and motorcyclists 21 and over use a helmet 70.3% of the time.

Table 6. Helmet Use in Crashes by Group

Group		Time Period	
		Before Law Modification (Jan 1, 2010- April 12, 2012)	**After Law Modification (April 13, 2012 -Dec 31, 2018)**
All Motorcyclists			
Gender*(after only)	Males	97.5%	70.7%
	Females	98.1%	73.8%
Age (Years)*(after only)	<16	93.8%	77.8%
	16-20	97.3%	84.0%
	21+	97.7%	70.3%
Seat Position†(after only)	Operator	97.6%	71.3%
	Passenger	98.1%	69.1%
Motorcycle Operators Only			
Vehicle Registration State*(after only)	Michigan	97.9%	71.6%
	Other	96.7%	66.1%
CY Endorsement*	Yes	98.7%	73.3%
	No	96.5%	69.5%
Alcohol Involvement*	Yes	89.2%	41.7%
	No	98.2%	73.5%

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

†Indicates marginally significant different helmet use rates among demographic groups ($0.05<p<0.10$)

Prior to the law modification, 4.6% of crash-involved motorcycle operators rode vehicles registered out of state. Their helmet use rate was 96.7%, which is not significantly lower than those with vehicles registered in Michigan with a rate of 97.9%. After the modification, 5.1% of crash-involved motorcycle operators had vehicles registered out of state. Their helmet use rate of 66.1% was significantly lower than operators of in-state vehicles at 71.6%. Motorcycle operators with CY endorsements made up 54.8% of the crash population prior to the law modification. They wore helmets slightly (but significantly) more often than those without CY endorsements. After the modification, the proportion of CY endorsed operators increased to 57.9% of the crash population. It is worth noting that in 2017, the CY endorsement rate jumped to 80.2%, but a change that big is unlikely to be due to a true increase in endorsements and may indicate a change in how the data are coded or collected. The 2018 CY endorsement rate was 78.6%.

Finally, motorcyclists who were coding as drinking at the time of the crash showed the largest change in helmet use rates of all groups. Prior to the law modification, crash-involved operators who had been drinking wore a helmet 89.2% of the time. However, after the modification, this rate fell to 41.7%. Drinking motorcycle operators make up 6.8% of all motorcycle operators involved in crashes.

10.2 Fatalities

Table 7 shows the percent of motorcyclist fatalities by helmet use and year for motorcyclists whose helmet use is known. Although there has been substantial variation in these rates over time, the current rates for 2018 are very similar to those prior to the law modification. The last row in Table 7 shows the proportion of fatally injured motorcyclists who were wearing a helmet. Helmeted motorcyclists made up 69.0% of the crash-involved motorcyclist population but 60.5% of the fatalities in 2018.

Table 7. Fatality Rate as a Function of Helmet Use and Year

	Year								
Category	**2010**	**2011**	**2012 (4/13-12/31)**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Helmet Not Worn	5.3%	6.8%	6.5%	7.1%	5.7%	6.4%	6.5%	6.3%	5.9%
Helmet Worn	3.6%	3.2%	2.3%	2.7%	2.3%	3.4%	2.8%	3.5%	4.1%
Overall	3.6%	3.2%	3.4%	3.8%	3.3%	4.2%	4.0%	4.4%	4.7%
Percent Helmet Use Among Fatalities	96.6%	95.1%	50.5%	51.6%	51.0%	56.9%	47.4%	55.0%	60.5%

As shown in Table 7, the overall fatality rate has risen less than expected, reaching a high of 4.7% in 2018. One likely reason for this is the relationship between choosing not to wear a helmet and other risky behaviors among motorcyclists. For example, as Table 6 shows, drinking operators dropped from 89.2% to 41.7% helmet use rates after the law modification. Drinking operators 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 law modification, most drinking operators fell into the helmeted group, but their high-severity crashes drove up fatality rates among helmeted motorcyclists. After the modification, drinking operators were more likely to be counted among unhelmeted motorcyclists.

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 multiplies the risk of a fatality by a factor of 1.7. We then used the model to estimate the number of fatalities that would have occurred if helmet use rates were at 2011 levels (97.7%). We estimate that fatalities would have been reduced by 14.7%, or about 19 motorcyclists per year.

10.3 Injuries

Injuries are coded on the KABCO scale, where K is Killed, A is suspected serious injury, B is suspected minor injury, C is possible injury, and O is no injury. Table 8 shows the count of motorcyclists who were

injured at each level broken down by year and helmet use. As expected, fatal injury rates are much higher for the no helmet use group than the group using helmets (5.6% vs. 3.4% before the law modification and 6.4% vs. 3.0% after). The overall rate of K+A injuries among motorcyclists has gone up slightly from 20.7% before the modification to 22.5% afterwards.

Table 8. Injury Outcome by Year and Helmet Use

Helmet Worn									
	2010	**2011**	**2012 Before/After**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
K	113	98	11/56	63	50	74	63	72	78
A	556	519	49/390	350	308	310	367	392	387
B	1,029	1,088	104/846	780	716	705	779	665	658
C	740	728	95/589	608	532	551	541	404	350
O	713	676	78/543	576	528	555	526	530	439
K+A	669	617	60/446	413	358	384	430	464	465
Helmet Not Worn									
	2010	**2011**	**2012 Before/After**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
K	4	5	0/55	59	48	56	70	59	51
A	20	23	2/194	194	172	178	263	261	241
B	27	21	4/280	277	273	288	344	301	306
C	13	15	6/173	171	182	172	182	131	122
O	11	9	2/146	134	160	177	209	184	141
K+A	24	28	2/249	253	220	234	333	320	292

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 (97.7%), the reduction in serious injuries would be 9.2%, or about 55 fewer A-injured motorcyclists annually.

11.0 Summary

Compared to crashes without motorcycles, motorcycle-involved crashes more commonly occur during daylight and clear weather conditions. Single-vehicle and head-on/left-turn crashes are overrepresented for motorcycle-involved crashes compared to non-motorcycle-involved crashes. In terms of temporal factors, crashes involving motorcyclists are more likely to take place from April through October, on the weekends, and from 1 pm to midnight, compared to crashes without motorcycles.

Motorcycle operators involved in crashes were more likely to be impaired than non-motorcycle drivers. About 6.8% of motorcycle operators were reported to be drinking, compared with 1.8% of other drivers.

Similarly, 1.4% of motorcycle operators were suspected of using drugs, compared with 0.5% of other motor vehicle drivers. Furthermore, before the helmet law modification about 89.2% of drinking motorcycle operators in crashes were wearing a helmet, but this dropped to about 41.7% after the partial repeal.

Since the partial repeal of Michigan's mandatory helmet law in 2012, the percent of fatally-injured motorcyclists has increased, reaching a high of 4.7% in 2018. The rate of K+A injuries among motorcyclists has gone up from 20.7% before the law modification to 22.5% after the law modification. Using a regression modeling approach and adjusting for risk factors other than helmet use, we estimate that if helmet use were at 2011 levels (97.7%), there would be about 19 fewer fatalities and 55 fewer A injuries annually.