Analysis Report: Motorcycle-Involved Crashes in Michigan (2018-2022)

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Contents

Special Note

The Michigan Office of Highway Safety Planning and the University of Michigan Transportation Research Institute acknowledge the differences in traffic and commuting patterns in 2020 and 2021 due to the COVID-19 pandemic. Travel restrictions from the "Stay Home, Stay Safe" Executive Order (EO 2020-21) were initially in place starting on March 24, 2020. That order was then extended through additional executive orders. The stay-at-home order was officially lifted June 1, 2020.

The total number of police-reported crashes on Michigan roadways decreased from 2019 to 2020 by 21.9%, declining from 314,376 in 2019 to 245,432 in 2020, and then in 2021 increased slightly to 282,640 crashes which is still 10.1% less than the 2019 crash total. There were 293,341 crashes in 2022, up 3.8% from 2021, but still 6.7% less than in 2019. Despite the lower amount of crashes since 2019, the fatality count increased from 985 in 2019, to 1,083 in 2020 (9.9% increase from 2019), 1,131 in 2021 (14.8% increase from 2019), and 1,123 in 2022 (14.0% increase from 2019). In 2020, there was a decrease in vehicle miles traveled, licensed drivers, and vehicle registrations: vehicle miles traveled decreased 15.5% to 86.31 billion, motor vehicle registrations were down 0.5% to 9.04 million, and the number of licensed drivers was down 1.9% to 7.12 million. The increased 2020 fatality count in combination with the reduction of the exposure factors contributed to a fatality rate of 1.25 per 100 million miles of travel, a 30.2% increase from 2019 (0.96 per 100 million miles). The 2020 fatality rate is also above the 10-year (2011-2020) average of 1.01 fatalities per 100 million miles. In 2021, vehicle miles traveled was still 5.3% less than 2019 at 96.74 billion miles, and the fatality rate was 1.17 fatalities per 100 million miles of travel – a slight decrease from the 2020 fatality rate but still much higher than the 2011-2020 average rate. In 2022, vehicle miles traveled decreased to 95.89, with the fatality rate the same as in 2021, at 1.17 fatalities per 100 million miles of travel.

1.0 Executive Summary

This report utilizes police-reported crash data in Michigan from 2018 through 2022 to study motorcycle-involved crash trends. Data back to 2010 were used to explore motorcyclist helmet trends before and after the helmet law modification in Michigan in April 2012 that abolished the motorcycle helmet requirement under certain circumstances. Major findings include:

- Motorcycle-involved crashes more commonly occur during daylight (71.1% vs. 60.9%) and clear weather conditions (84.3% vs. 61.4%) compared to crashes without motorcycles.
- Single-vehicle (46.2% vs. 36.3%) and head-on (6.4% vs. 3.5%) crashes are overrepresented for motorcycle-involved crashes compared to non-motorcycle-involved crashes.
- Crashes involving motorcyclists are more likely than crashes without motorcycles to take place from May through September (80.7% vs. 38.7%), on the weekends (36.2% vs. 23.4%), and between 1 PM and 3 AM (90.2% vs. 77.2%).
- Motorcycle operators involved in crashes were more likely to be impaired (7.1% using alcohol and 1.9% using drugs) than non-motorcycle drivers (1.9% using alcohol and 0.6% using drugs).
- The proportion of crash-involved motorcycle operators with motorcycle endorsements has fluctuated between a low of 37.7% in 2020 and a high of 75.2% in 2018 with the proportion of unknown endorsement status ranging from 4.4% in 2019 and 2021 to 8.0% in 2020.
- Among motorcycle operators involved in crashes between 2018-2022 where helmet use and motorcycle endorsement status were known, 69.5% of motorcycle endorsed operators wore helmets compared to 55.5% of unendorsed operators.
- In the motorcyclist crash population, helmet use dropped from 97.7% in 2011 to 76.2% in 2012 when the helmet law modification took place in April 2012. Since 2012, the percent of motorcyclists using helmets has generally gradually decreased with a low of 61.0% in 2021.
- Helmet usage for crash-involved motorcyclists age 16-20 dropped from 97.3% (prior to the April 2012 helmet law modification) to 82.7% (after April 2012), even though helmet use is still currently required by law for motorcyclists under the age of 21.
- The fatality rate per crash-involved motorcyclist ranged between 3.2% and 3.8% from 2010 to 2014, but from 2015-2022 has increased to range from 3.9% to 5.1%. The overall rate of fatalities and suspected serious injuries (per crash-involved motorcyclist) increased from 20.7% before the April 2012 helmet law modification to 24.8% (after April 2012).
- Accounting for other risk factors (e.g., alcohol involvement), the risk of fatality for non-helmeted motorcyclists was 1.6 times the risk for helmeted motorcyclists. The risk of a fatality was multiplied by a factor of 2.8 if the motorcycle operator was drinking and by a factor of 11.3 if the operator was using drugs.
- 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, 15.0% (21 per year) of fatalities and 10.4% (70 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 2018 through 2022. 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 primary areas of focus include: 1) fatality and injury rates and trends 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.

In this report, injury severity of people involved in crashes is frequently categorized according to the KABCO scale:

- K - Fatal Injury
- A - Suspected Serious Injury
- B - Suspected Minor Injury
- C - Possible Injury
- O - No Apparent Injury

Similarly, crashes are sometimes classified according to the most severe injury suffered by anyone involved in the crash. Again, the KABCO scale is used, but for O-level severity this refers to crashes with property damage only (PDO) instead of no injury or fatality.

3.0 Methods

The helmet use section of this analysis covers the period from 2010 through 2022. The helmet law modification that abolished the motorcycle helmet requirement under certain circumstances took effect on April 13, 2012.[1] Since motorcycle use in the winter months is low, the majority of 2012 motorcycle-involved crashes occurred after the helmet law modification went into effect. To evaluate changes in crash and injury patterns, we compare crashes before the modification (1/1/2010 - 4/12/2012) to those that occurred after the modification (4/13/2012 - 12/31/2022).

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 exposure variables, such as out-of-state ridership, helmet use, and motorcycle 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

[1] Michigan Legislature. Section 257.658(5). Senate Bill 0291 (2011). Public Act 98 of 2012.
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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.

4.0 Overall Crash Trends

Table 1 shows the number of motorcyclists involved in any crash as well as motorcyclist fatalities and percentages from 2018-2022, while Figure 1 provides a visualization of the injury severity trends. In general, these motorcyclist crash trends have shown normal variation over the past 5 years, with a high of 3,571 motorcyclists in crashes in 2021 and a low of 3,012 in 2018. Motorcyclist fatalities reached a high of 173 in 2022 and a low of 122 in 2019. Fatalities as a percent of all motorcyclists in crashes has ranged from 4.0% in 2019 to 4.9% in 2022 with an average of 4.5%.

Table 1. Number of Fatalities among Crash-Involved Motorcyclists

Year	Motorcyclist Fatalities	Motorcyclists in Crashes	Fatality Percent
2018	134	3,012	4.4%
2019	122	3,083	4.0%
2020	152	3,375	4.5%
2021	166	3,571	4.6%
2022	173	3,513	4.9%
Total	**747**	**16,554**	**4.5%**

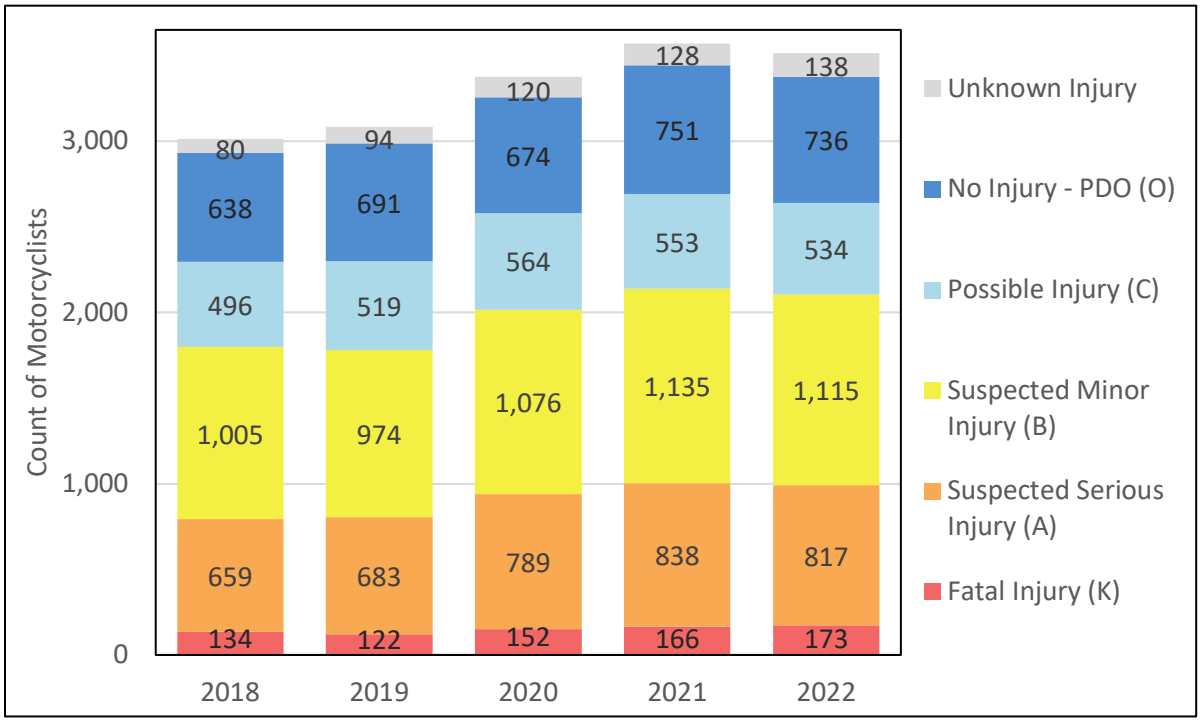

Figure 1 – Injury Severity of Motorcyclists Involved in Crashes

5.0 Crash Characteristics

In this section, we look at a variety of characteristics for motorcycle-involved crashes where motorcycle-involved crash patterns are compared to results for non-motorcycle-involved crashes.

5.1 Crash Type

The distribution of crash types by motorcycle involvement is shown in Figure 2. 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. Single-vehicle crashes (run off road, etc.) account for 46.2% of motorcycle-involved crashes, followed by angle crashes (16.2%) and rear-end (15.8%). Single-vehicle, head-on, and angle crashes are more common for motorcycle-involved crashes compared to non-motorcycle-involved crashes while rear-end, sideswipe, and backing crashes are less common for motorcycle-involved crashes. Of the motorcycle head-on category group crashes, 75.9% are head-on left turn crashes compared to 66.8% of the head-on crashes with no motorcycle involved.

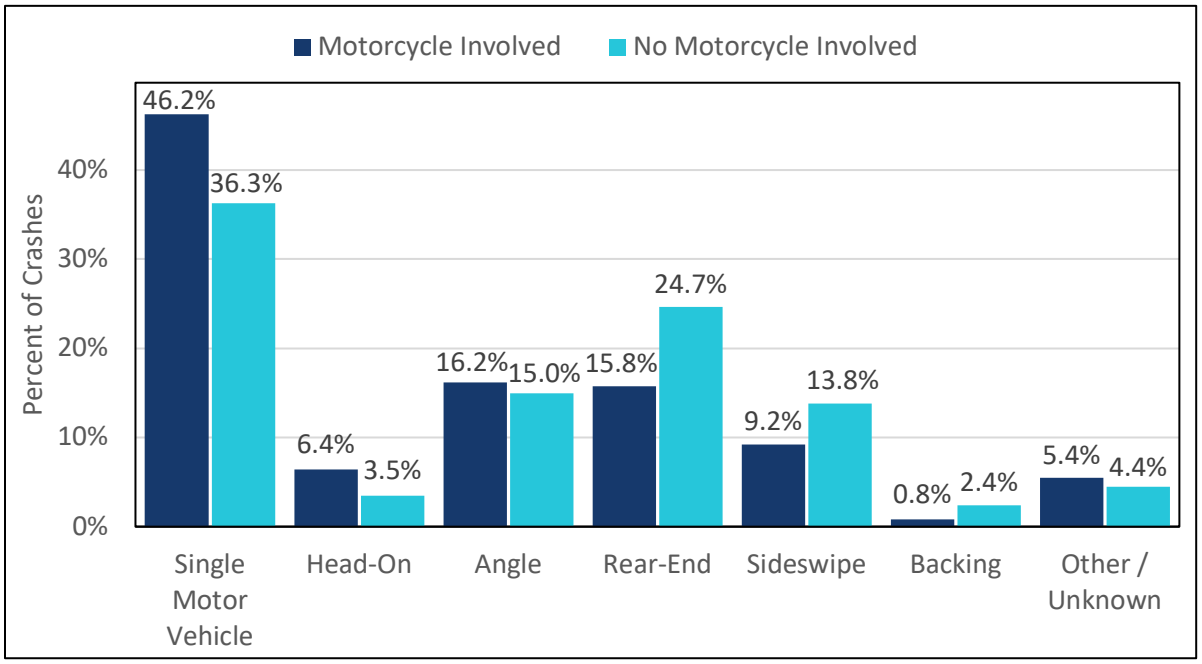

Figure 2 – Crash Type by Motorcycle Involvement, 2018-2022

5.2 Light Condition

Figure 3 highlights the distribution of crashes by light condition and motorcycle involvement. 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 (71.1% vs. 60.9%). This most likely reflects motorcyclists' riding patterns, which may favor daytime travel.

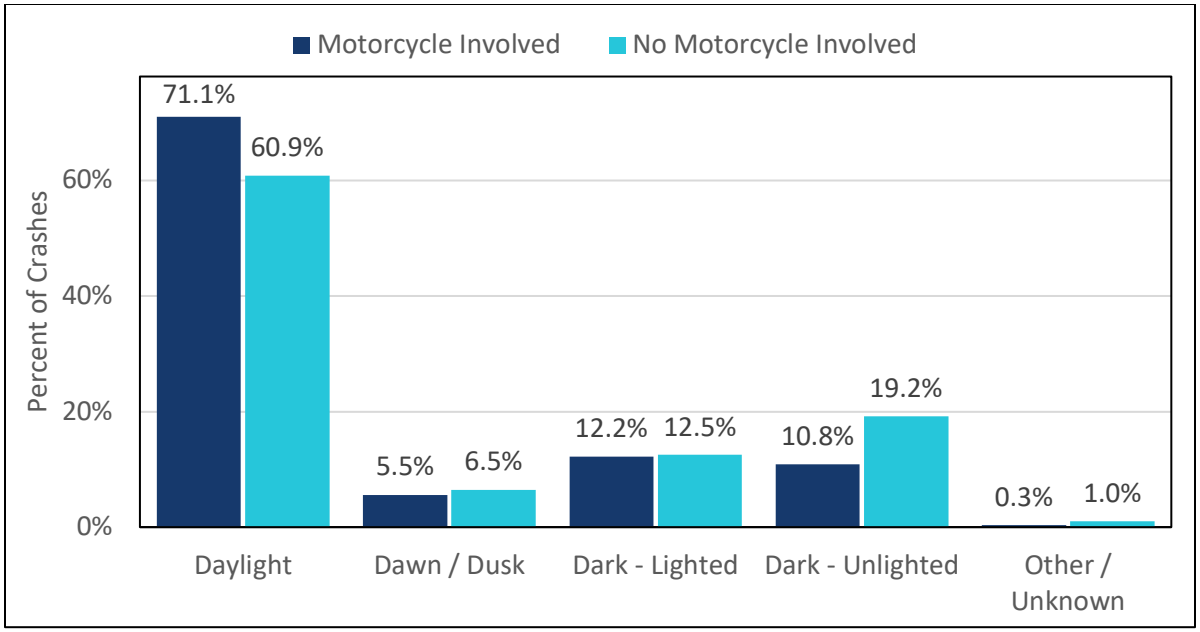

Figure 3 – Light Condition in Crashes by Motorcycle Involvement, 2018-2022

5.3 Weather Condition

A visualization of the distribution of crashes by weather condition for crashes with and without motorcyclists in shown in Figure 4. The condition of "other" includes fog, severe crosswinds, sleet/hail, blowing snow, blowing sand, and smoke. Motorcycle-involved crashes are substantially more likely to occur in clear conditions (84.3%) compared to non-motorcycle-involved crashes (61.4%). Motorcyclists likely choose to avoid riding in inclement weather, which would contribute to the relatively lower percentage of crashes the other non-clear weather categories.

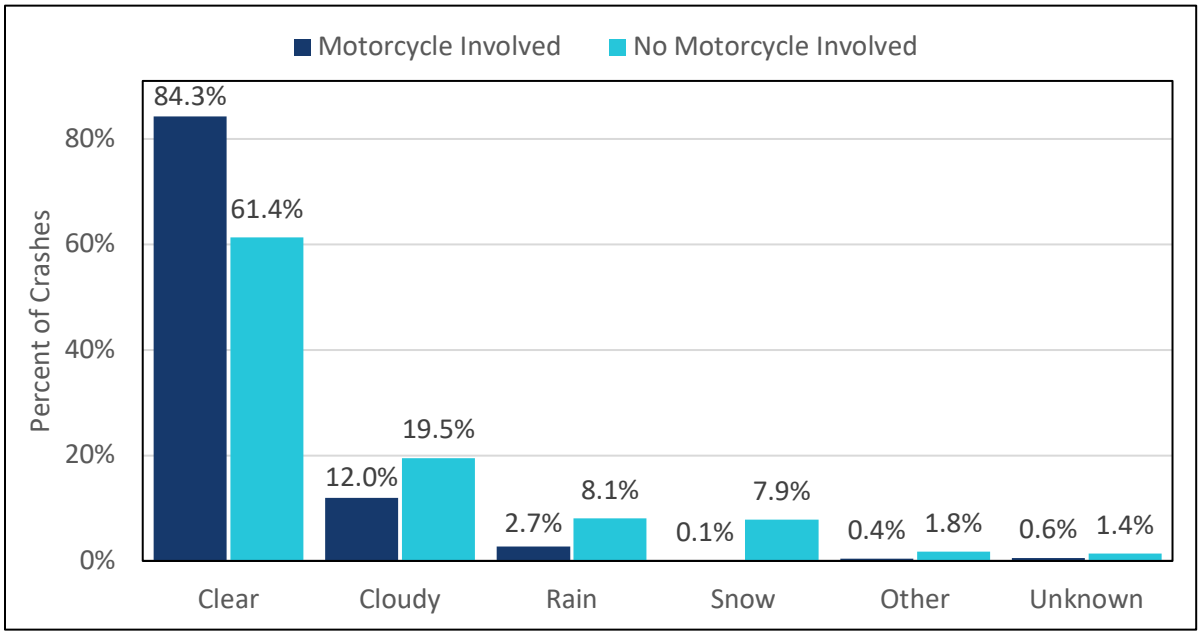

Figure 4 – Weather Condition in Crashes by Motorcycle Involvement, 2018-2022

5.4 Road Factors

Figure 5 shows the proportion of crashes with and without a motorcyclist by number of traffic lanes. Motorcycle-involved crashes are slightly more likely to take place on 1-2 lane roads (59.3% of motorcycle-involved crashes vs. 56.3% of non-motorcycle-involved crashes).

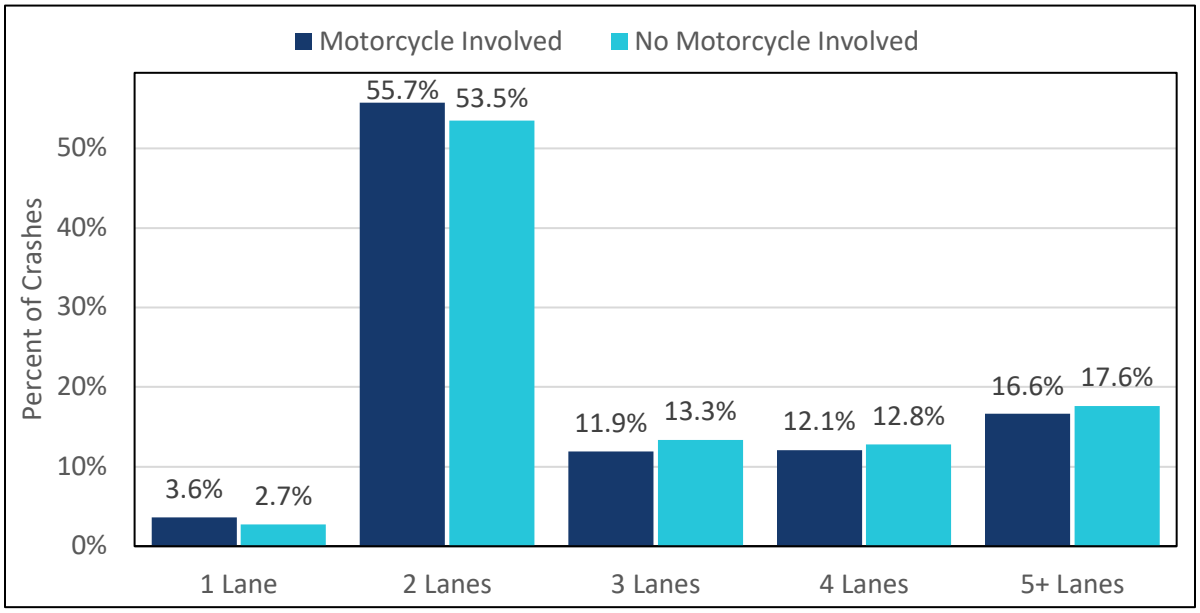

Figure 5 – Number of Traffic Lanes in Crashes by Motorcycle Involvement, 2018-2022

The distribution of crashes with and without motorcyclists by speed limit is shown in Figure 6. Motorcycle-involved crashes are slightly more likely to occur in posted speed limits of 30-35 mph (18.9% vs. 15.9%), 40-45 mph (24.8% vs. 24.2%), and 50-55 mph (36.2% vs. 32.9%).

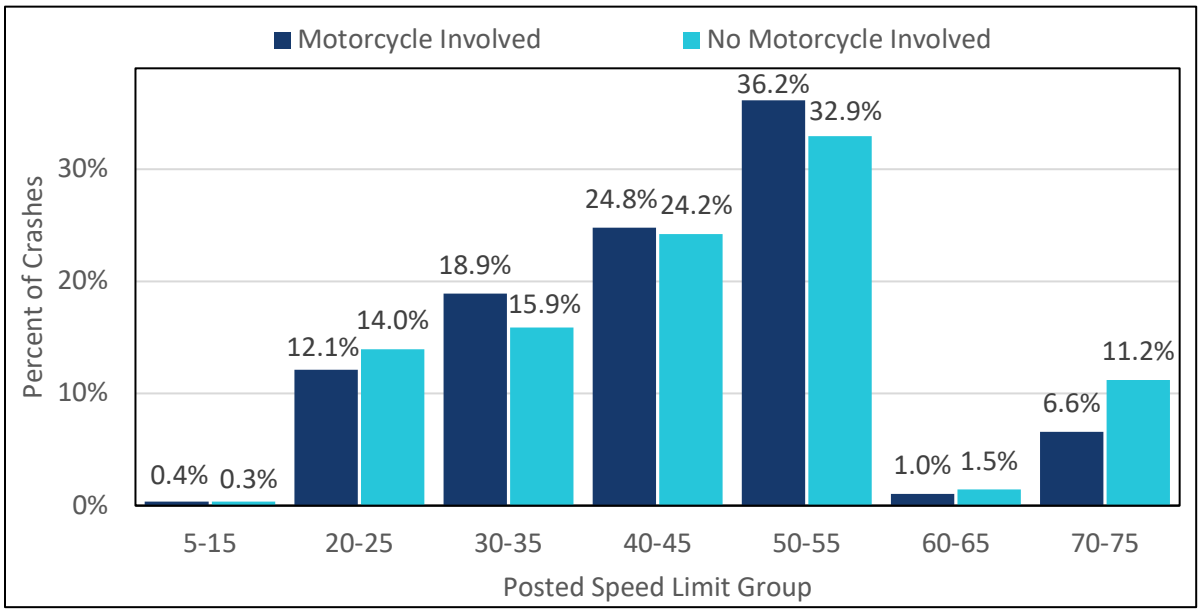

Figure 6 – Posted Speed Limit Crash Percentages by Motorcycle Involvement, 2018-2022

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. Motorcycle-involved crashes occur more frequently during the warmer months of the year from May through September (crashes during these months comprise 80.7% of motorcycle-involved crashes vs. 38.7% of non-motorcycle involved crashes). Motorcycle-involved crashes peak in July with 18.9% of the total motorcycle-involved crashes. As with weather and light conditions, this difference reflects the exposure of motorcyclists rather than a higher risk of crashing during that time.

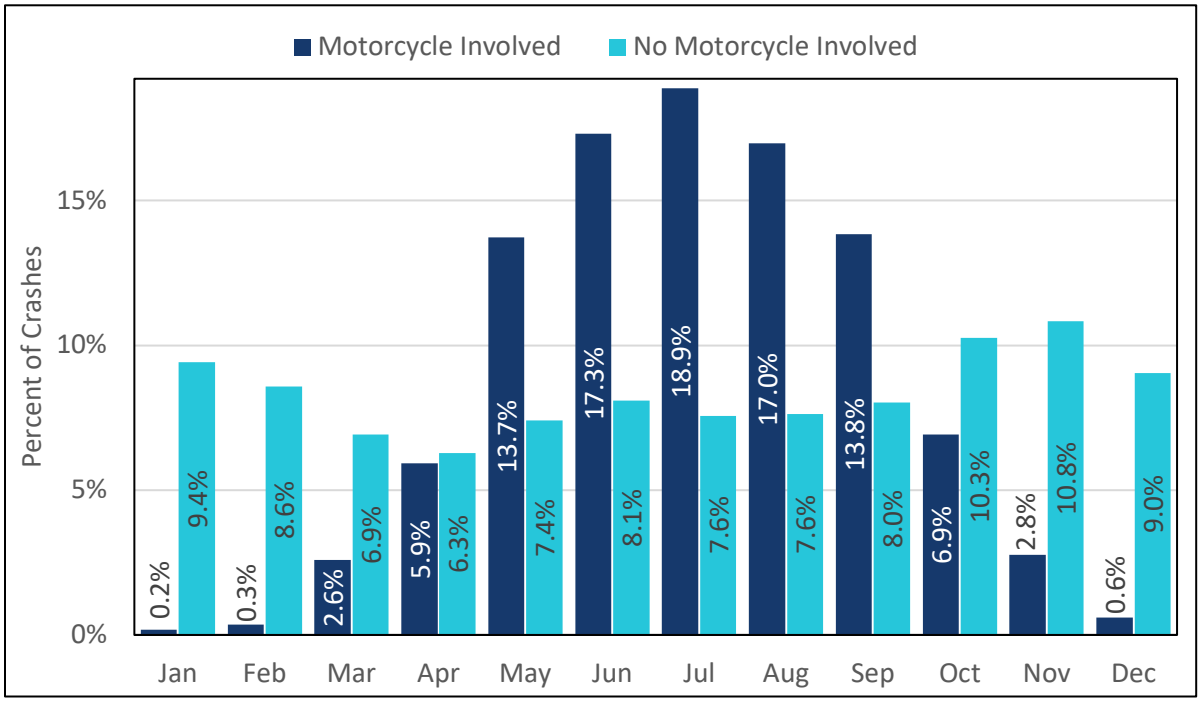

Figure 7 – Crashes by Month and Motorcycle Involvement, 2018-2022

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 than crashes without a motorcycle to happen on the weekends (36.2% vs. 23.4%), while non-motorcycle-involved crashes occur more frequently during weekdays. Saturdays account for the highest percentage of motorcycle-involved crashes at 19.5% followed by Sundays at 16.7%.

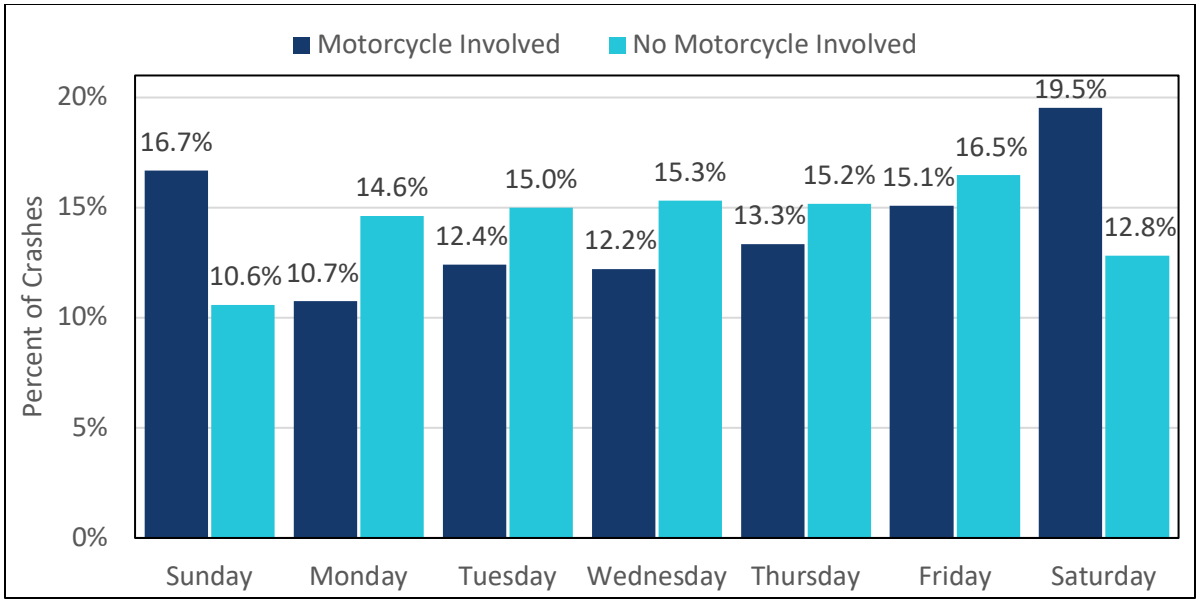

Figure 8 – Crashes by Day of Week and Motorcycle Involvement, 2018-2022

6.3 Time of Day

The proportion of crashes with and without motorcyclists by time of day is shown in Figure 9. The motorcycle-involved crash proportion is higher between 1 PM and 3 AM (90.2% vs. 77.2%). The peak time for motorcycle-involved crashes occurs at 5 PM (8.6%), similar to the peak time for non-motorcycle-involved crashes (7.7%). However, the secondary morning peak at 7 AM evident in 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 heavy recreational use of motorcycles compared to the typical commuting patterns of non-motorcycle travel.

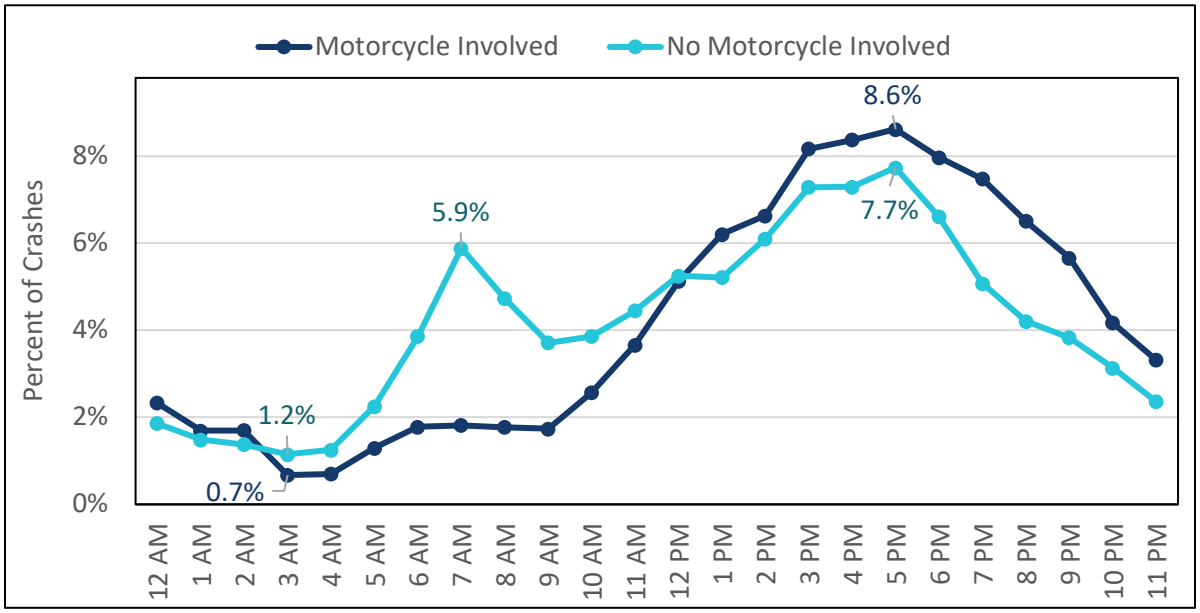

Figure 9 – Crashes by Time of Day and Motorcycle Involvement, 2018-2022

7.0 Motorcycle Classification

Table 2 shows the distribution of the motorcycle classification obtained by decoding the Vehicle Identification Number (VIN) among motorcycles involved in crashes. There were 919 (6.1%) motorcycles involved in crashes from 2018 to 2022 with unavailable VIN data that were excluded from Table 2. Cruisers were the predominant type of motorcycle in crashes with 34.7% of known motorcycles involved in crashes, followed by touring at 31.3% and super sport at 12.4%. The year-to-year variation within each classification is fairly low, although the number of touring motorcycles in crashes have been steadily increasing each year.

Table 2. Motorcycles in Crashes by Motorcycle Classification and Year

Motorcycle Classification	2018	2019	2020	2021	2022	Total	Percent of Total
Autocycle	1	5	7	12	19	44	0.3%
Chopper	9	5	6	3	3	26	0.2%
Cruiser	921	941	950	1,098	1,033	4,943	34.7%
Dual Purpose	69	63	73	81	92	378	2.7%
Incomplete	0	1	0	0	1	2	0.0%
Off Road	22	25	42	35	34	158	1.1%
Other	0	0	1	1	2	4	0.0%
Scooter	38	37	58	56	64	253	1.8%
Sport	189	173	219	233	251	1,065	7.5%
Sport Touring	29	32	54	38	53	206	1.4%
Standard	72	75	116	87	102	452	3.2%
Super Sport	336	335	408	382	306	1,767	12.4%
Touring	804	866	870	931	986	4,457	31.3%
Unclad Sport	77	94	87	105	130	493	3.5%
Total	**2,567**	**2,652**	**2,891**	**3,062**	**3,076**	**14,248**	**100.0%**

Table 3 displays motorcycle classification by fatal and non-fatal crashes. Most motorcycle types have similar proportions for fatal and non-fatal crashes, although there is a higher proportion of fatal crashes than non-fatal crashes for super sport motorcycles (17.8% vs. 12.1%), scooters (2.8% vs. 1.7%), choppers (0.3% vs. 0.2%), and touring motorcycles (32.2% vs. 31.2%).

Table 3. Motorcycles in Fatal and Non-Fatal Crashes by Motorcycle Classification, 2018-2022

Motorcycle Classification	Fatal Count	Fatal Percent	Non-Fatal Count	Non-Fatal Percent
Autocycle	2	0.3%	42	0.3%
Chopper	2	0.3%	24	0.2%
Cruiser	234	31.7%	4,709	34.9%
Dual Purpose	12	1.6%	366	2.7%
Incomplete	1	0.1%	1	0.0%
Off Road	3	0.4%	155	1.1%
Other	0	0.0%	4	0.0%
Scooter	21	2.8%	232	1.7%
Sport	48	6.5%	1,017	7.5%
Sport Touring	5	0.7%	201	1.5%
Standard	18	2.4%	434	3.2%
Super Sport	131	17.8%	1,636	12.1%
Touring	238	32.2%	4,219	31.2%
Unclad Sport	23	3.1%	470	3.5%
Total	**738**	**100.0%**	**13,510**	**100.0%**

8.0 Motorcycle Endorsements, Training, and Skills Tests

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. Typically, to receive a motorcycle endorsement a skills test is required. While training is not required for Michigan motorcycle operators over the age of 18 to receive a motorcycle endorsement, it is encouraged, and if training is completed and passed, the skills test required to receive an endorsement is waived. Table 4 shows the number of motorcycle operators who completed training, skills tests, and received motorcycle endorsements based on data from the Michigan Department of State.

Motorcycle operator endorsement counts were not collected in the same month each year, but these counts still provide an idea of changes over time if endorsements are kept current. The number of endorsements received has ranged from a low of 616,479 in 2021 to a high of 641,511 in 2019. Due to the COVID-19 pandemic, there was a sharp drop in completed trainings and skills tests in 2020 compared to other years. The number of completed trainings ranged between 9,185 in 2018 to 9,630 in 2022 excluding the outlier of 5,841 trainings in 2020. Similarly, the number of skills tests completed ranged between 4,459 in 2021 to 5,065 in 2018 excluding the outlier of 2,535 skills tests in 2020.

Table 4. Number of Motorcycle Operators Trained and Endorsed by Year

Year	Trainings Completed	Skills Tests Completed	Endorsements Received
2018	9,185	5,065	639,079
2019	9,589	4,496	641,511
2020	5,841	2,535	634,808
2021	9,626	4,459	616,479
2022	9,630	4,992	621,812
Average	**8,774**	**4,309**	**630,738**

From 2018 to 2022, the proportion of crash-involved motorcycle operators with motorcycle endorsements has shown large variation fluctuating between a low of 37.7% in 2020 and a high of 75.2% in 2018 as shown in Figure 10. The proportion of unknown endorsement status has ranged from 4.4% in 2019 and 2021 to 8.0% in 2020. It is important to note that the endorsement rate in the crash population may not be the same as in the overall riding population.

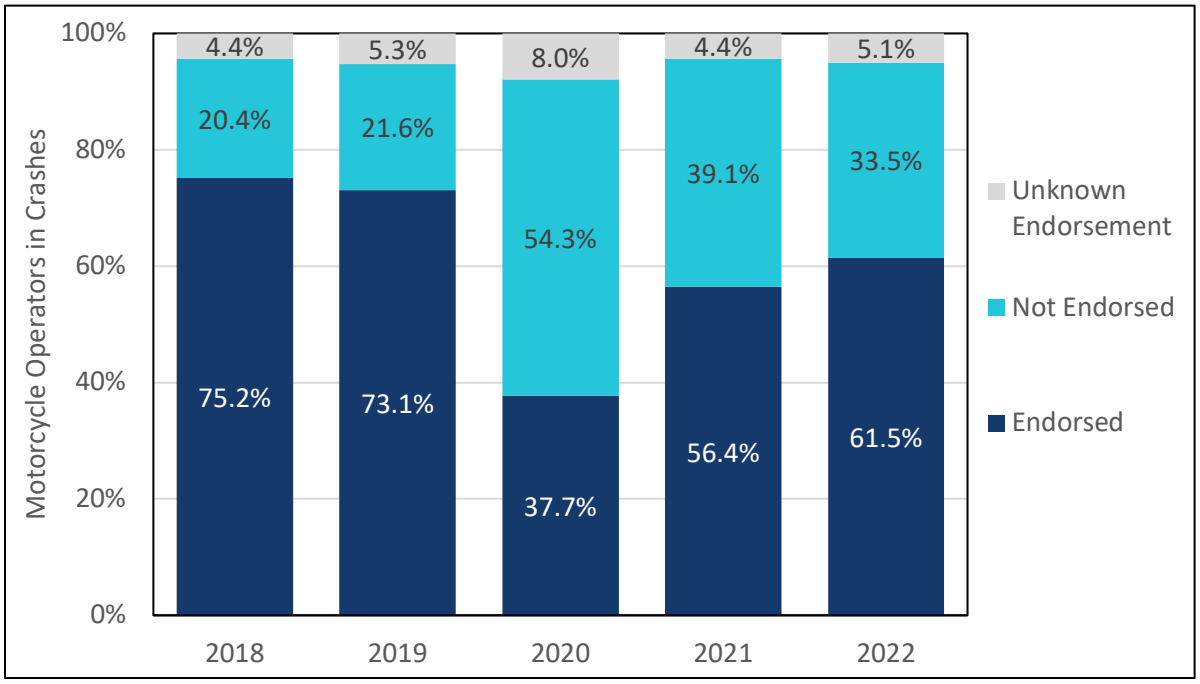

Figure 10 – Motorcycle Operators in Crashes by CY Endorsement Status and Rate

Table 5 shows helmet use counts in crashes by CY endorsement status from 2018 through 2022 where helmet use is known. Unknown or miscoded helmet use values and unknown endorsement status have been removed from the table. Among endorsed motorcycle operators in crashes, the helmet use rate was 69.5% compared to operators with no endorsement at 55.5%.

Table 5. Helmet Use for Motorcycle Operators by CY Endorsement Status, 2018-2022

CY Endorsement Status	Helmet Worn	Helmet Not Worn	Helmet Use Percent
Yes	5,985	2,623	69.5%
No	2,657	2,127	55.5%

9.0 Impairment

Figure 11 shows the proportion of motorcycle operators and non-motorcycle vehicle operators who were using alcohol at the time of the crash. The proportion of motorcycle operators who were impaired by alcohol is 3.7 times the proportion of non-motorcycle operators who were impaired. About 7.1% of motorcycle operators were reported to be drinking, compared with 1.9% of other drivers.

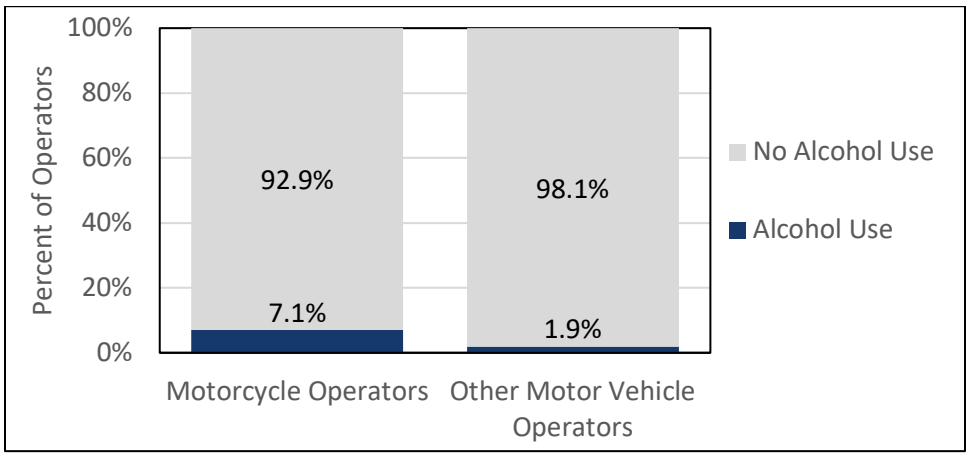

Figure 11 – Distribution of Motor Vehicle Operators by Alcohol Impairment, 2018-2022

The distribution of drug impairment for motorcycle operators and non-motorcycle vehicle operators is shown in Figure 12. Although drug impairment is less common overall, the motorcycle operator drug impairment rate is 3.3 times higher than non-motorcycle operators where 1.9% of motorcycle operators were suspected of using drugs, compared with 0.6% of other motor vehicle operators.

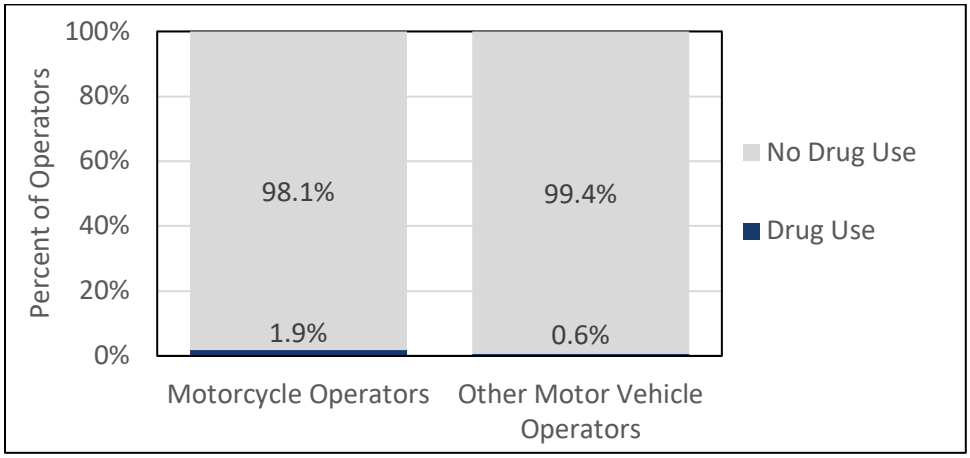

Figure 12 – Distribution of Motor Vehicle Operators by Drug Impairment, 2018-2022

Data collection for multiple drug classifications has improved in recent years. Starting in 2018, drug classification data for polydrug use has been included in the crash database. Polydrug impairment occurs when a driver is under the influence of more than one drug (including alcohol). In many cases a positive alcohol test result will lead to no further testing for drugs. Law enforcement has up to three years to add drug test results to existing police reports so it is possible that some of this data will be updated in the future. Utilizing these recent data collection improvements, this report includes analysis of the top three drug test results if they included a cannabinoid from 2018-2022. The eight drug test result codes related to cannabinoids are delta 9, hashish oil, hashish, marijuana/marihuana, marinol, tetrahydrocannabinols (THC), and "cannabinoid, type unknown." It is worth noting that medical marijuana facilities first opened in Michigan in 2016, and the first recreational marijuana facilities opened to the public in December 2019.

Table 6 shows the cannabinoid test results for motorcycle operators from 2018 to 2022 where an operator was using at least one cannabinoid drug. The most common cannabinoid drug codes with positive tests over the five-year period were THC (54.5%) and Delta 9 (35.5%). The count of motorcycle operators with a positive cannabinoid test result has been gradually increasing over the last 5 years with a low of 19 in 2018 and a high of 25 in 2022 while the five-year average percentage of operators testing positive is 0.73%.

Table 6. Motorcycle Operators in Crashes with Positive Cannabinoid Test by Year

Year	Operators with Positive Cannabinoid Test	Total Operators	Percent of All Operators
2018	19	2,728	0.70%
2019	20	2,809	0.71%
2020	22	3,092	0.71%
2021	24	3,271	0.73%
2022	25	3,267	0.77%
Total	**110**	**15,167**	**0.73%**

10.0 Helmet Use

10.1 Helmet Usage Percentage

Helmet use percentages in the crashing population are not necessarily equivalent to those in the overall riding population. However, the helmet use trends of motorcyclists in crashes may indicate how helmet use patterns are changing as well as impacting the risk of injury due to a crash. A direct observation survey of motorcycle helmet use for all motorcyclists on Michigan roadways was conducted in Michigan in 2017 by Michigan State University.[2] The study concluded that the motorcycle helmet usage was 71.4%, which is slightly higher than the crash-based 2017 motorcyclist helmet usage result of 68.8%.

Figure 13 shows the percentage of motorcyclists in crashes using helmets from 2010 to 2022 (excluding unknown helmet use). Helmet use among motorcyclists in crashes was substantially lower after the April

[2] Michigan State University. 2017 Direct Observation Survey of Motorcycle Helmet Use in Michigan. This survey research study was not federally funded. https://www.michigan.gov/-/media/Project/Websites/msp/ohsp/pdfs2/FINAL_REPORT__Michigan_Motorcycle_Helmet_Use.pdf

2012 helmet law modification than in previous years. Prior to the helmet law modification, in 2010 and 2011, the crash-involved helmet use percentage was 97.7%. Since 2011, the percentage has decreased steadily to a low of 61.0% in 2021 followed by a small increase to 61.5% in 2022.

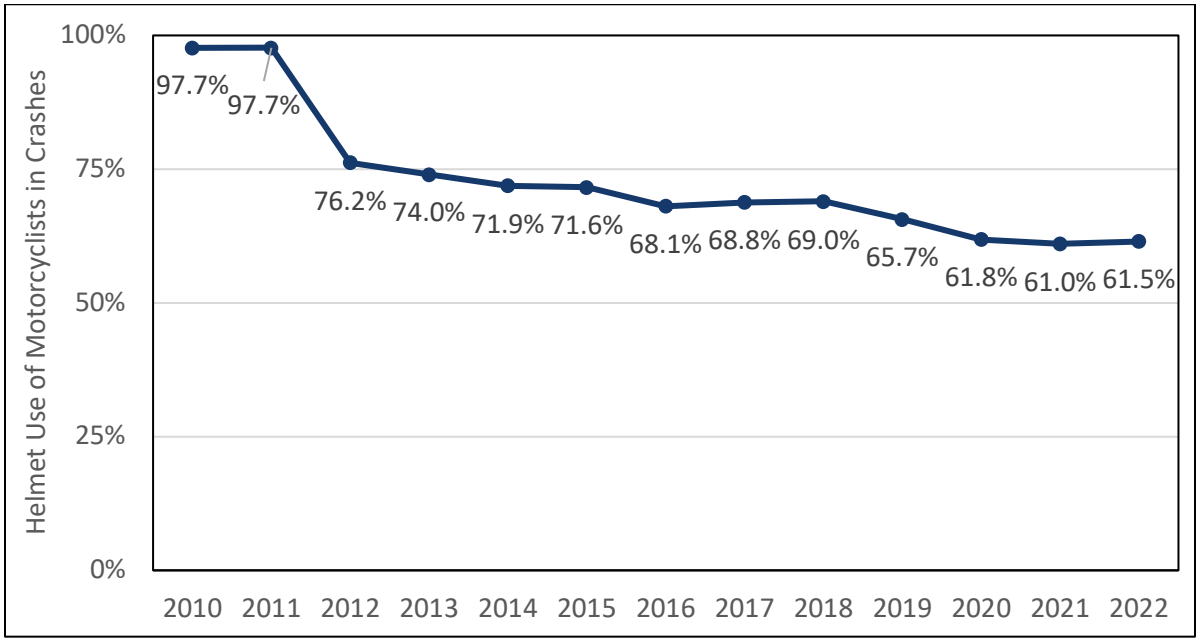

Figure 13 – Helmet Use Rates Among Motorcyclists in Crashes by Year

Table 7 summarizes helmet use percentages and how they have changed in the post helmet law modification period. All group percentage differences between the time periods before and after the helmet law modification are statistically significant ($p < 0.05$). Prior to the helmet law modification, crash-involved female (98.1%) and male (97.5%) motorcyclists helmet usage was not significantly different. After the helmet law modification, both male and female motorcyclist helmet usage decreased, but women (70.4%) wore helmets at a significantly higher percentage than men (67.6%).

Helmet use percentages as a function of motorcyclist age also differ significantly after the helmet law modification. After the helmet law modification, helmet usage among all motorcyclist age groups decreased sharply, even though the law still requires helmets for motorcyclists under the age of 21. Motorcyclists age 15 and under (0.9% of the crash population) have a helmet usage of 72.6%, motorcyclists age 16-20 (5.4% of the crash population) have a helmet usage of 82.7%, and motorcyclists 21 and over (93.7% of the crash population) have a helmet usage of 67.1%.

Helmet use percentages as a function of seat position are significantly different between operator and passenger seat position after the helmet law modification. Both groups used helmets about equally before the helmet law modification, but afterwards, passengers' usage (64.8%) became significantly lower than that of operators (68.3%).

Table 7. Helmet Use Among Motorcyclists in Crashes by Demographic Group, 2010-2022

Unit	Group		Before Helmet Law Modification (1/1/2010 - 4/12/2012)	After Helmet Law Modification (4/13/2012 - 12/31/2022)
All Motorcyclists	Gender* (sig. after only)	Male	97.5%	67.6%
		Female	98.1%	70.4%
	Age* (sig. after only)	≤ 15 years	93.8%	72.6%
		16-20 years	97.3%	82.7%
		21+ years	97.7%	67.1%
	Seat Position* (sig. after only)	Operator	97.6%	68.3%
		Passenger	98.1%	64.8%
Motorcycle Operators Only	Vehicle Registration State* (sig. after only)	Michigan	97.9%	68.6%
		Other	96.7%	63.2%
	CY Endorsement* (sig. before & after)	Yes	98.7%	71.6%
		No	96.5%	64.3%
	Alcohol Use* (sig. before & after)	Yes	89.2%	38.3%
		No	98.2%	70.6%

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

Prior to the helmet law modification, 4.6% of crash-involved motorcycle operators rode vehicles registered out of state. Their helmet usage was 96.7%, which is not significantly lower than those with vehicles registered in Michigan (97.9%). After the modification, 5.3% of crash-involved motorcycle operators had vehicles registered out of state. Their helmet usage was significantly lower than operators of in-state vehicles (63.2% vs. 68.6%). Motorcycle operators in crashes with motorcycle endorsements made up 55.2% of the crash population prior to the helmet law modification. They wore helmets slightly, but significantly, more often than those without motorcycle endorsements (98.7% vs. 96.5%). After the modification, the proportion of motorcycle endorsed operators increased to 58.8% of the crash population, and the endorsed motorcycle operators continued to have higher helmet usage (71.6% vs. 64.3%).

Finally, motorcyclists who were coded as drinking at the time of the crash showed the largest change in helmet usage of all groups. Prior to the helmet law modification, crash-involved operators who had been drinking wore a helmet 89.2% of the time. However, after the modification, this percentage fell to 38.3%. Drinking motorcycle operators made up 6.9% of all motorcycle operators involved in crashes from 2010 through 2022.

10.2 Helmet Usage and Fatalities

Figure 14 shows the percent of motorcyclist fatalities by helmet use and year for motorcyclists with known helmet usage (the 2012 data in this figure includes crashes both before and after the helmet law modification, but only a small proportion of motorcycle crashes occurred prior to April 13th in 2012). These fatality rates have generally shown normal variation over time, and the 13-year average fatality percent for motorcyclists not wearing helmets (6.3%) is almost double that of motorcyclists wearing

helmets (3.2%). The overall fatality rate has gradually risen, with a high in 2022 of 5.1% and a low of 3.2% in 2011. The fatality rate of motorcyclists without helmets also reached a high in 2022 of 7.5%.

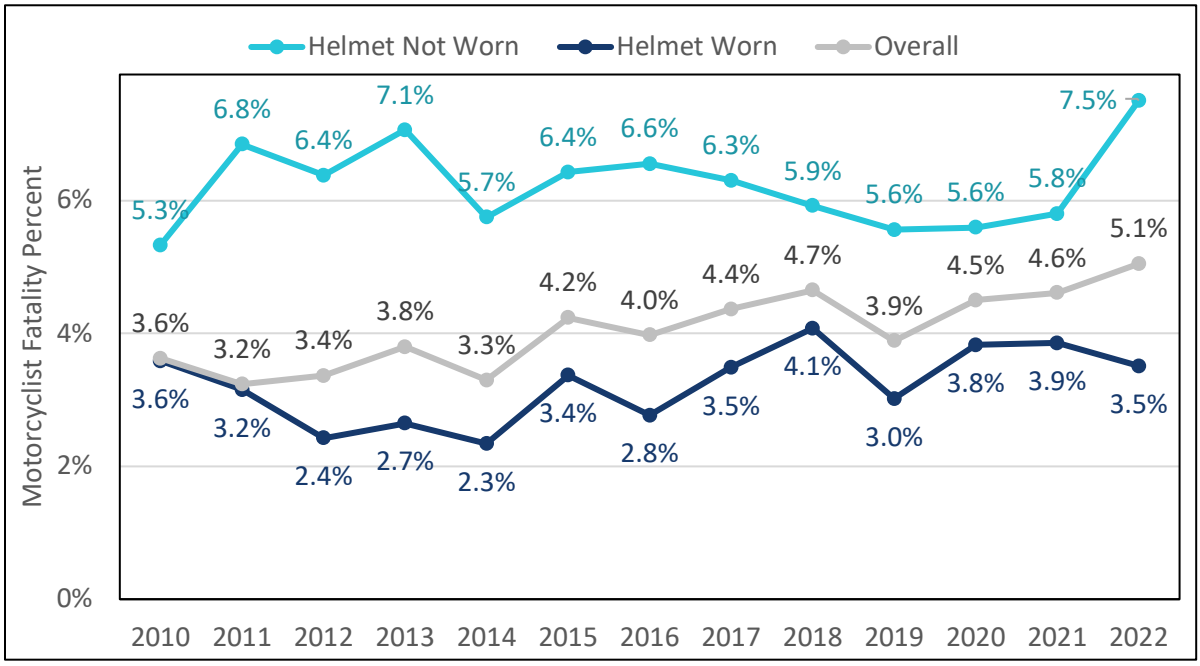

Figure 14 – Motorcyclist Fatality Percent by Helmet Use and Year

Figure 15 shows the helmet usage of fatally injured motorcyclists compared to non-fatally injured motorcyclists in crashes. Helmet usage in motorcyclist fatalities is consistently lower than non-fatally injured motorcyclists in crashes. Helmet use among fatalities decreased sharply from 95.1% in 2011 before the helmet law modification to 54.9% in 2012. The helmet usage rate among fatally injured motorcycle riders had shown low variation from 2012 through 2021, ranging from a low of 47.4% helmet usage in 2016 to a high of 60.5% in 2018, but in 2022, it reached a 13-year low of 42.8%.

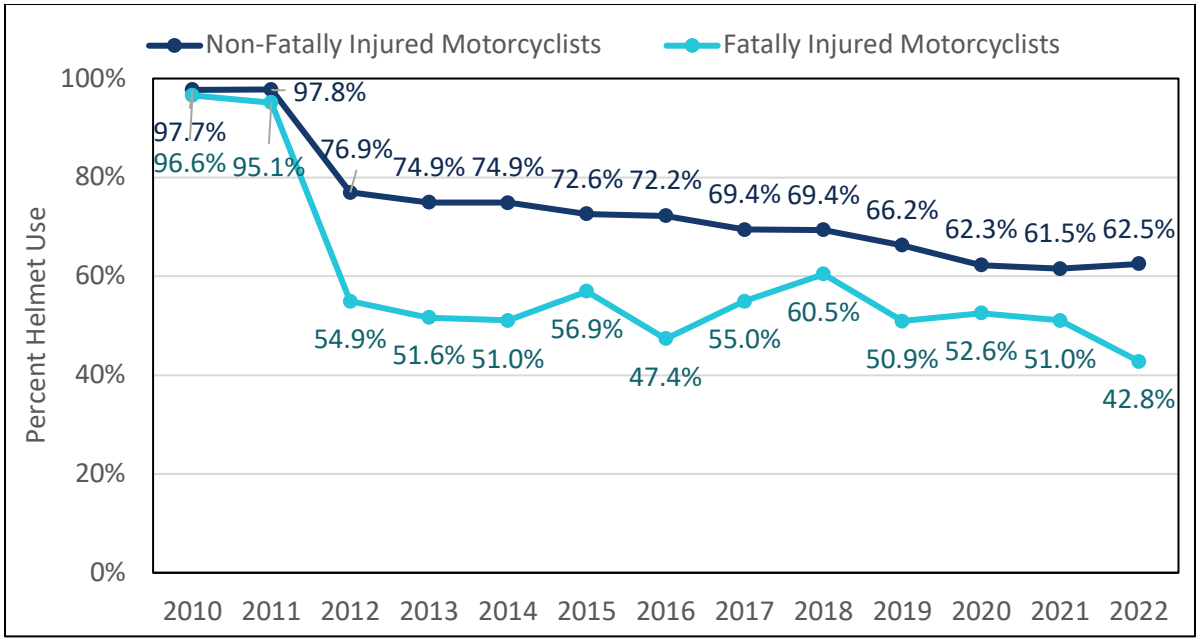

Figure 15 – Helmet Use Among Motorcyclists by Fatality Status and Year

10.3 Helmet Usage and Injuries

Table 8 shows the count of motorcyclists who were injured at each injury severity level by helmet use and year. Each row in Table 8 starting in the 2012 column has cells shaded on a scale of red (highest value) to blue (lowest value) within that row (injury status category). For motorcyclists wearing helmets, the less severe injury counts (C-level, and O-level) have generally decreased with 13-year lows in 2020 or 2021. However, for motorcyclists not wearing helmets, the counts of K-level, A-level, and B-level injuries appear to be gradually increasing with 13-year highs in 2022 of 91 K-level and 421 B-level injuries, and a 13-year high in 2021 of 367 A-level injuries. These trends are likely impacted by the general gradual decrease in helmet use among all motorcyclists over the last 11 years.

Table 8. Injury Severity Counts by Helmet Use and Year

Helmet Use	Injury Status	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Helmet Worn	Fatal Injury (K)	113	98	67	63	50	74	63	72	78	56	72	75	68
	Suspected Serious Injury (A)	556	519	439	350	308	310	367	392	387	366	409	418	442
	Suspected Minor Injury (B)	1,029	1,088	950	780	716	705	779	665	658	617	649	666	640
	Possible Injury (C)	740	728	684	608	532	551	541	404	350	354	351	336	341
	No Injury (O)	713	676	621	576	528	555	526	530	439	463	400	450	445
	K + A Injury Total	**669**	**617**	**506**	**413**	**358**	**384**	**430**	**464**	**465**	**422**	**481**	**493**	**510**
Helmet Not Worn	Fatal Injury (K)	4	5	55	59	48	56	70	59	51	54	65	72	91
	Suspected Serious Injury (A)	20	23	196	194	172	178	263	261	241	291	344	367	341
	Suspected Minor Injury (B)	27	21	284	277	273	288	344	301	306	309	378	404	421
	Possible Injury (C)	13	15	179	171	182	172	182	131	122	141	175	181	157
	No Injury (O)	11	9	148	134	160	177	209	184	141	176	199	217	202
	K + A Injury Total	**24**	**28**	**251**	**253**	**220**	**234**	**333**	**320**	**292**	**345**	**409**	**439**	**432**

Table 9 shows the proportion of motorcyclists within each injury severity level by helmet use status and year. Each row in Table 9 has cells shaded on a scale of red (highest value) to blue (lowest value) within that row (injury status category). The proportion of motorcyclists in crashes wearing helmets with A-level injuries was a 13-year high in 2022 at 22.8%. The proportion of motorcyclists in crashes not wearing helmets with K-level injuries was a 13-year high in 2022 at 7.5%.

Table 9. Injury Severity Percentages by Helmet Use and Year

Helmet Use	Injury Status	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Helmet Worn	Fatal Injury (K)	3.6%	3.2%	2.4%	2.7%	2.3%	3.4%	2.8%	3.5%	4.1%	3.0%	3.8%	3.9%	3.5%
	Suspected Serious Injury (A)	17.6%	16.7%	15.9%	14.7%	14.4%	14.1%	16.1%	19.0%	20.2%	19.7%	21.7%	21.5%	22.8%
	Suspected Minor Injury (B)	32.7%	35.0%	34.4%	32.8%	33.6%	32.1%	34.2%	32.2%	34.4%	33.2%	34.5%	34.2%	33.1%
	Possible Injury (C)	23.5%	23.4%	24.8%	25.6%	24.9%	25.1%	23.8%	19.6%	18.3%	19.1%	18.7%	17.3%	17.6%
	No Injury (O)	22.6%	21.7%	22.5%	24.2%	24.7%	25.3%	23.1%	25.7%	23.0%	24.9%	21.3%	23.1%	23.0%
	K + A Injury Total	**21.2%**	**19.8%**	**18.3%**	**17.4%**	**16.8%**	**17.5%**	**18.9%**	**22.5%**	**24.3%**	**22.7%**	**25.6%**	**25.3%**	**26.3%**
Helmet Not Worn	Fatal Injury (K)	5.3%	6.8%	6.4%	7.1%	5.7%	6.4%	6.6%	6.3%	5.9%	5.6%	5.6%	5.8%	7.5%
	Suspected Serious Injury (A)	26.7%	31.5%	22.7%	23.2%	20.6%	20.4%	24.6%	27.9%	28.0%	30.0%	29.6%	29.6%	28.1%
	Suspected Minor Injury (B)	36.0%	28.8%	32.9%	33.2%	32.7%	33.1%	32.2%	32.2%	35.5%	31.8%	32.6%	32.6%	34.7%
	Possible Injury (C)	17.3%	20.5%	20.8%	20.5%	21.8%	19.7%	17.0%	14.0%	14.2%	14.5%	15.1%	14.6%	13.0%
	No Injury (O)	14.7%	12.3%	17.2%	16.0%	19.2%	20.3%	19.6%	19.7%	16.4%	18.1%	17.1%	17.5%	16.7%
	K + A Injury Total	**32.0%**	**38.4%**	**29.1%**	**30.3%**	**26.3%**	**26.9%**	**31.2%**	**34.2%**	**33.9%**	**35.5%**	**35.2%**	**35.4%**	**35.6%**

10.4 Estimate of Lives Saved and Suspected Serious Injuries Reduced by Helmet Use

To separate other risky behavior from helmet use as contributors to fatality risk, we developed a regression model to account for the effects of alcohol use, drug use, posted speed limit, and other factors. The model indicates that after controlling for these other risk factors, helmet non-use multiplies the risk of a fatal injury (K) by a factor of 1.6 (i.e., a 60% increase in the risk of a fatality when not wearing a helmet). If the motorcycle operator is drinking, their risk of a fatality is multiplied by a factor of 2.8, and operator drug use multiplies the risk by 11.3.

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 15.0%, or about 21 motorcyclists per year. The regression modeling approach was repeated for A-level injuries to estimate the reduction in 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 A-level injuries would be 10.4%, or about 70 fewer A-level injured motorcyclists annually.

11.0 Summary

Compared to crashes without motorcycles, motorcycle-involved crashes more commonly occur during daylight (71.1% vs. 60.9%) and clear weather conditions (84.3% vs. 61.4%). Single-vehicle (46.2% vs. 36.3%) and head-on (6.4% vs. 3.5%) crashes are overrepresented for motorcycle-involved crashes compared to non-motorcycle-involved crashes. Crashes involving motorcyclists are more likely than crashes without motorcycles to take place from May through September (80.7% vs. 38.7%), on the weekends (36.2% vs. 23.4%), and between 1 PM and 3 AM (90.2% vs. 77.2%).

Motorcycle operators involved in crashes were more likely to be impaired than non-motorcycle drivers. About 7.3% of motorcycle operators were reported to be drinking, compared with 1.9% of other motor vehicle operators. Similarly, 1.9% of motorcycle operators were suspected of using drugs, compared with 0.6% of other motor vehicle operators. Before the helmet law modification in 2021, about 89.2% of drinking motorcycle operators in crashes were wearing a helmet, but this dropped to about 38.7% after the helmet law modification.

Since the modification of Michigan's mandatory helmet law in 2012, the percentage of fatally-injured motorcyclists has generally increased: from 2010-2014, percentages ranged between 3.2% and 3.8%, and since 2015, have ranged between 3.9% and 4.7%. The frequency of K-level or A-level injuries among motorcyclists has gone up from 20.7% before the helmet law modification to 24.3% after the helmet law modification. Using a regression modeling approach and adjusting for risk factors other than helmet use, we estimate that if helmet usage was at 2011 levels (97.7%), there would be about 21 fewer fatalities and 70 fewer A-level injuries annually.