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Motorcycle Crash Trends in Michigan: 2001 – 2005

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16. Abstract

Trends and patterns of motorcycle crashes in Michigan from 2001 through 2005 were examined in an effort to explain the large increase in motorcycle fatalities in Michigan between 2004 and 2005. Analysis of motorcycle registrations and license endorsements records showed continued increase in motorcycling activity, with a 32% increase in registered motorcycles, and a 9% increase in overall motorcycle endorsements. Analysis of crash patterns by age indicated that the increase in fatalities was most likely a consequence of the aging of the motorcyclists. Motorcycling endorsements in Michigan for those age 45 years and older increased by 23% between 2001 and 2005, and the percentage of this age group among all motorcyclists increased from 56% to 64%. The number of fatalities among motorcyclists age 45 and older increased from 13 to 47 between 2001 and 2005, while the percentage that these fatalities comprised among all motorcycle fatalities increased from 14% to 41%.

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1. INTRODUCTION

Motorcycling activity in Michigan, as in the rest of the United States, has been increasing noticeably. In the years between 1995 and 2005, motorcycle registrations in Michigan more than doubled, and the number of drivers with motorcycle endorsements increased by 15%. During this time, the numbers of motorcycle crashes and deaths from these crashes also increased. Between 1995 and 2005, the number of motorcycle crashes in Michigan increased by 32%, and the number of deaths from motorcycle crashes increased by 49%. Interestingly, the number of deaths from motorcycle crashes each year between 2002 and 2004 was relatively constant. However, from 2004 to 2005, the number of deaths from motorcycle crashes increased by 54% (from 79 to 122). The Michigan Office of Highway Safety Planning (OHSP), concerned with this large increase, asked the University of Michigan Transportation Research Institute (UMTRI) to investigate. This report examines trends in Michigan motorcycle crashes from 2001 through 2005, with the objective of identifying any changes that could help explain the large increase in fatalities between 2004 and 2005.

Data and methods of analysis are described in the next section. Trends in the number and severity of motorcycle crashes; crash rates; licensing; and the time, location, and environmental conditions of crashes are reported in the third section. Single vehicle and multi-vehicle motorcycle crashes are examined in the fourth section. Crashes in which the motorcyclist had been drinking alcohol are examined in the fifth section, and helmet use is reported in the sixth section. A summary and discussion of possible explanations for the increase in motorcycle fatalities are contained in the last section of the report.

2. DATA AND METHODS

Michigan vehicle crash data from 2001 through 2005 (UMTRI, Transportation Data Center 2002, 2003, 2004, 2005, 2006) are used for most of the analyses reported. These data cover all police-reported motor vehicle crashes in Michigan for the 5-year period (2001-2005), and come from information coded on police crash reports (UD-10 forms). Rates for crash occurrence are based on numbers of registered motorcycles and licensed motorcyclists. Data on motorcycle registrations and motorcycle licenses were obtained from the Michigan Department of State. Crashes in which one of the involved drivers was flagged for alcohol use are referred to as *had been drinking* (HBD) crashes.

Most of the analyses in this study examine changes in the distributions of key variables from the Michigan vehicle crash data files. The data files for each year contain three linked files: the crash file with descriptive information about the crash itself; the vehicle/driver file with information on the vehicle and the driver; and the person file with information on the occupants of the vehicles involved in the crash. Decisions about which files to use when similar information was contained in more than one file were based on the amount of missing data for the variables of interest in each file.

The Fatality Analysis Reporting System (FARS; NHTSA, 2004) data are a census of all fatal vehicle crashes in the United States, and include additional information not found in the Michigan crash data files. FARS data are used in this report to examine blood alcohol concentration (BAC) levels of motorcyclists involved in fatal crashes. Because FARS data for 2005 were not available at the time this report was prepared, BAC analyses are limited to the years 2001 through 2004.

3. ALL MOTORCYCLE CRASHES

Number and Severity

Table 1 shows the overall number of all police-reported crashes in Michigan from 2001 through 2005, and the number and percentage of crashes involving motorcycles. During this 5-year period, there was a 13% decline in the number of all police reported crashes. At the same time, crashes involving motorcycles increased by 9%. In each year from 2001 through 2005, motorcycle crashes represented about 1% of all motor-vehicle crashes.

Table 1. Number and Proportion of Vehicle Crashes Involving Motorcycles, 2001-2005

Year	All Crashes	Crashes Involving Motorcycles	
		Number	Percent of All
2001	400,813	3,216	0.8%
2002	395,515	3,051	0.8%
2003	391,485	3,261	0.8%
2004	373,028	3,321	0.9%
2005	350,838	3,504	1.0%
% Change 2001-2005	-12.5%	9.0%	0.2%

Table 2 shows the number and percentage of motorcycle crashes for fatal, non-fatal injury, and property-damage-only (i.e., no injury) severity levels. An increase in the severity of motorcycle crashes in 2005 compared to 2001 through 2004 is evident. The proportion of combined fatal and injury motorcycle crashes for each of the years 2001 through 2004 was about 76-77%, and the proportion of fatal crashes in that time period decreased from 2.8% to 2.3%. However, in 2005, the proportion of fatal and injury crashes among all motorcycle crashes increased to almost 79%, and the proportion of fatal crashes increased to 3.4%.

Table 2. Severity of Vehicle Crashes Involving Motorcycles, 2001-2005				
	Fatal	**Non-fatal Injury**	**Property- damage-only**	**Total**
2001	91 (2.8%)	2,399 (74.6%)	726 (22.6%)	3,216 (100%)
2002	80 (2.6%)	2,262 (74.1%)	709 (23.2%)	3,051 (100%)
2003	78 (2.4%)	2,389 (73.3%)	794 (24.3%)	3,261 (100%)
2004	78 (2.3%)	2,444 (73.6%)	799 (24.1%)	3,321 (100%)
2005	120 (3.4%)	2,632 (75.1%)	752 (21.5%)	3,504 (100%)

Table 3 shows the severity distribution of all vehicle crashes and the proportion of motorcycle crashes at each severity level. In each of the years 2001 through 2004, motorcycles were involved in about 7-8% of fatal vehicle crashes. In 2005, motorcycles were involved in close to 12% of all fatal vehicle crashes. The total number of all fatal vehicle crashes in Michigan decreased by 15% over the same time period. Between 2001 and 2005, the number of all non-fatal injury crashes in Michigan decreased by 18%, but the number of motorcycle crashes that resulted in a non-fatal injury increased by 11%. The number of all property-damage-only crashes deceased by 12% overall, but increased by 4% for motorcycles.

Table 3. Motorcycle Crashes as Proportion of All Vehicle Crashes by Severity, 2001-2005				
		Fatal	**Non-fatal Injury**	**Property-damage-only**
2001	All Crashes	1,206	80,922	318,685
	Motorcycle Crashes (% of all)	91 (7.6%)	2,369 (2.9%)	726 (0.2%)
2002	All Crashes	1,175	80,567	313,773
	Motorcycle Crashes (% of all)	80 (6.8%)	2,262 (2.8%)	709 (0.2%)
2003	All Crashes	1,172	76,598	313,715
	Motorcycle Crashes (% of all)	78 (6.7%)	2,389 (3.1%)	794 (0.3%)
2004	All Crashes	1,055	73,118	298,855
	Motorcycle Crashes (% of all)	78 (7.4%)	2,444 (3.3%)	799 (0.3%)
2005	All Crashes	1,030	66,729	283,079
	Motorcycle Crashes (% of all)	120 (11.7%)	2,632 (3.9%)	752 (0.3%)
% Change 2001-2005	All Crashes	-14.6%	-17.5%	-11.2%
	Motorcycle Crashes	31.9%	11.1%	3.6%

The number of people killed and injured in all motor vehicle crashes from 2001 through 2005, and the proportion among them killed and injured in motorcycle crashes are shown in Table 4.

Table 4. People Killed and Injured in All Vehicle Crashes and Motorcycle Crashes, 2001-2005.

		2001	2002	2003	2004	2005	% change 2001-2005
Number of Persons Killed	All crashes	1,328	1,279	1,283	1,159	1,129	-15.0%
	Motorcycle Crashes (% of all)	94 (7.1%)	82 (6.4%)	80 (6.2%)	79 (6.8%)	122 (10.8%)	29.8% (3.7%)
Number of Persons Injured	All Crashes	112,294	112,484	105,859	99,680	90,510	-19.4%
	Motorcycle Crashes (% of all)	2,767 (2.5%)	2,607 (2.3%)	2,891 (2.7%)	2,803 (2.8%)	3,053 (3.3%)	9.4% (0.8%)

In the 5-year period, the number of people killed in all motor vehicle crashes decreased by 15%, while the number of people killed in motorcycle crashes increased by almost 30%. The proportion of fatalities from motorcycle crashes relative to fatalities from all vehicle crashes increased from 7% to 11% over the 5-year period. While the number of people injured in all vehicle crashes in Michigan decreased by about 19%, the number of people injured in motorcycle crashes increased by 9%.

Table 5 shows the age distribution of motorcyclist killed and Table 6 shows the age distribution of motorcyclists injured in crashes each year from 2001 through 2005. While the number of fatalities among motorcyclists below age 45 decreased over the 5-year period, the number of fatalities among motorcyclists age 45 years and older increased. The number of motorcyclists age 45 and older killed in crashes in 2005 is almost four times greater than in 2001. Also, beginning in 2003, motorcyclists age 65 and older were among the fatalities. The number motorcyclists age 45 and older injured in motorcycle crashes increased by 61% from 2001 to 2005, and the proportion of this age group among all injured motorcyclists increased from 27% in 2001 to 41% in 2005 (Table 6).

Table 5. Number and Proportion By Age of Motorcyclists Killed In Crash					
	≤18	**19-29**	**30-44**	**45-64**	**65+**
2001	5 (5.6%)	33 (36.7%)	39 (43.3%)	13 (14.4%)	0 (0.0%)
2002	3 (3.9%)	22 (28.2%)	32 (41.0%)	21 (26.9%)	0 (0.0%)
2003	2 (2.7%)	18 (24.0%)	25 (33.3%)	29 (38.7%)	1 (1.3%)
2004	2 (2.6%)	21 (26.9%)	25 (32.1%)	28 (35.9%)	2 (2.6%)
2005	1 (0.9%)	28 (24.6%)	38 (33.3%)	39 (34.2%)	8 (7.0%)

Table 6. Number and Proportion By Age of Motorcyclists Injured In Crash					
	≤18	**19-29**	**30-44**	**45-64**	**65+**
2001	129 (5.8%)	674 (30.1%)	799 (35.7%)	592 (26.4%)	47 (2.1%)
2002	126 (6.0%)	546 (25.9%)	710 (33.6%)	693 (32.8%)	36 (1.7%)
2003	125 (5.4%)	577 (24.8%)	791 (34.0%)	782 (33.6%)	49 (2.1%)
2004	135 (5.6%)	634 (26.5%)	742 (31.0%)	828 (34.6%)	57 (2.4%)
2005	78 (3.0%)	689 (26.5%)	799 (30.8%)	956 (36.8%)	74 (2.9%)

Registrations, Licenses, and Crash Rates

Table 7 shows the number of motorcycles registered in Michigan from 2001 through 2005, and the crash rate per 1,000 registered motorcycles for each year.

Table 7. Registered Motorcycles and Crash Rate per 1,000 Motorcycles, 2001-2005			
	Motorcycle Registrations	**Number of Crashes**	**Crashes per 1,000 Registered Motorcycles**
2001	191,888	3,216	16.8
2002	197,735	3,051	15.4
2003	207,648	3,261	15.7
2004	219,478	3,321	15.1
2005	254,480	3,504	13.8
% Change 2001-2005	32.6%	9.0%	-17.9%

Between 2001 and 2005, the number of motorcycles registered in Michigan increased by about 33%, and their proportion of the state's registered vehicles increased from 2.0% to 2.9% (not in table; Michigan Department of State, 2005). Although the number of crashes increased by 9%, the even larger increase in the number of registered motorcycles contributed to an overall decrease in the vehicle crash rate. In 2001, the crash rate was about 17 crashes per 1,000 registered motorcycles, and in 2005, the crash rate was 14 crashes per 1,000 registered motorcycles, a decrease of approximately 18%.

A person must be at least 16 years of age, and have a motorcycle endorsement on a valid driver's license to legally operate a motorcycle in Michigan (Michigan Vehicle Code 257.312a). Drivers satisfying these conditions are referred to as licensed motorcyclists in this report (See Appendix A). Table 8 shows the number of licensed motorcyclists, the number of crashes, and the crash rate per 1,000 licensed motorcyclists in Michigan for each year from 2001 through 2005.

Table 8. Licensed Motorcycle Drivers and Crash Rate per 1,000 Motorcycle Drivers, 2001-2005

	Licensed Motorcyclists	Number of Crashes	Crashes per 1,000 Licensed Motorcyclists
2001	457,001	3,216	7.0
2002	465,786	3,051	6.6
2003	476,897	3,261	6.8
2004	487,519	3,321	6.8
2005	497,165	3,504	7.0
% Change 2001-2005	8.8%	9.0%	0.0%

In the 5 years between 2001 through 2005, the number of licensed motorcyclists increased by 9%, and the crash rate per 1,000 licensed motorcyclists remained at 7 crashes per 1,000 licensed motorcyclists.

Changes in the number of crashes, licensed motorcyclists, and crash rates were further examined by age. Table 9 shows the number of crashes, the number of licensed motorcyclists, and the crash rate per 1,000 licensed motorcyclists by age category for each year.

Table 9. Motorcycle Crashes, Licensed Motorcyclists, and Crash Rate by Age, 2001-2005							
Age		2001	2002	2003	2004	2005	% change 2001-2005
≤18	Crashes	169	157	157	155	99	-41.4%
	Licensed Motorcyclists	761	764	914	985	922	21.2%
	Crashes/1,000 Lic. Motorcyclists	222.1	205.5	171.8	157.4	107.4	-51.6%
19-29	Crashes	947	768	796	861	897	-5.3%
	Licensed Motorcyclists	31,513	31,179	31,957	32,362	32,879	4.3%
	Crashes/1,000 Lic. Motorcyclists	30.1	24.6	24.9	26.6	27.3	-9.2%
30-44	Crashes	1,111	1,005	1,109	1,025	1,098	-1.2%
	Licensed Motorcyclists	168,826	160,813	155,760	149,926	143,144	-15.2%
	Crashes/1,000 Lic. Motorcyclists	6.6	6.2	7.1	6.8	7.7	16.6%
45-64	Crashes	809	916	1,074	1,157	1,285	58.8%
	Licensed Motorcyclists	230,362	244,835	257,448	270,304	282,525	22.6%
	Crashes/1,000 Lic. Motorcyclists	3.5	3.7	4.2	4.3	4.5	29.5%
65+	Crashes	54	48	66	68	106	96.3%
	Licensed Motorcyclists	25,539	28,195	30,818	33,942	37,695	47.6%
	Crashes/1,000 Lic. Motorcyclists	2.1	1.7	2.1	2.0	2.8	33.0%

The aging of the population of licensed motorcyclists in Michigan can be seen in Table 9. The number of licensed motorcyclists in the 45-64 age group increased by 23% over the 5-years between 2001 and 2005, and this age group accounted for the largest number of licensed motorcyclists in each of the 5 years. However, the largest rate of growth in the number of licensed motorcyclists was among those over age 64, with an increase of 48%.

From 2001 through 2003, motorcyclists age 30-44 were involved in more crashes than motorcyclists in any other age group (Table 9). However, in 2004 and 2005, motorcyclists age 45-64 were involved in more crashes than any other age group. Although motorcyclists age 65 and older were involved in few crashes, the number of their crash involvements increased by 96% in the 5 years from 2001 to 2005.

Table 9 also shows the crash rate per licensed motorcyclist by age from 2001 through 2005. Motorcyclists younger than 19 years consistently had the highest crash rates. Although the number of crashes was small, the number of licensed motorcyclists in the youngest age group was also very small, yielding a high crash rate per licensed motorcyclist. It should be noted, however, that in the 5-years from 2001 through 2005, the crash rate per 1,000 licensed motorcyclists for this age group decreased by 52%. The crash rate for per 1,000 licensed motorcyclists also decreased for motorcyclists age 19-29, from 30 to 27 crashes per 1,000 licensed motorcyclists, a decrease of 9%.

Crash rates for motorcyclists age 30 and older increased from 2001 through 2005. The largest increase in crash rates was among motorcyclists age 65 and older. Crashes in this age group increased by 33% from 2.1 to 2.8 crashes per 1,000 licensed motorcyclists. Notable also was the 30% increase in crash rate for motorcyclists age 45-64, from 3.5 to 4.5 crashes per 1,000 licensed motorcyclists.

Because of the increase in the number of older motorcyclists, the data on licensed motorcyclists, crashes, and crash rates were further examined by partitioning at age 45. (Table 10).

Table 10. Licensed Motorcycle Drivers and Crash Rate per 1,000 Motorcycle Drivers Under Age 45 and Age 45 and Over, 2001-2005

	Licensed Motorcyclists < 45	Number of Crashes	Crashes per 1,000 Licensed Motorcyclists	Licensed Motorcyclists ≥ 45	Number of Crashes	Crashes per 1,000 Licensed Motorcyclists
2001	201,100 (44.0%)	2,227 (73.2%)	11.1	255,901 (56.0%)	863 (26.8%)	3.4
2002	192,756 (41.4%)	1,930 (68.4%)	10.0	273,030 (58.6%)	964 (31.6%)	3.5
2003	188,630 (39.6%)	2,062 (65.0%)	10.9	288,266 (60.4%)	1,140 (35.0%)	4.0
2004	183,273 (37.6%)	2,041 (63.1%)	11.1	304,246 (62.4%)	1,225 (36.9%)	4.0
2005	176,945 (35.6%)	2,094 (60.3%)	11.8	320,220 (64.4%)	1,391 (39.7%)	4.3
% Change 2001-2005	-12.0%	-6.0%	6.3%	25.1%	61.2%	26.5%

Table 10 shows that between 2001 and 2005, the number of licensed motorcyclists age 45 and older increased by 25%, while the number of those under 45 years decreased by 12%. During the same time, the proportion of all licensed motorcyclists comprised by

the age group 45 and older increased from 56% to 64%. The number of crashes involving motorcyclists age 45 and older increased by 61%, and their crash rate increased from 3.4 to 4.3 crashes per 1,000 licensed motorcyclists. The number of crashes involving motorcyclists younger than 45 years of age decreased by 6%, but their rate of crashes increased by 6% from 11.1 to 11.8 crashes per 1,000 licensed motorcyclists.

Table 11 shows the number of licensed motorcyclists and the crash rate per 1,000 licensed motorcyclists by sex for each year from 2001 through 2005. The table shows that during those 5 years, most licensed motorcyclists were men, and most motorcycle crashes involved male motorcyclists. The proportion of women among licensed motorcyclists remained relatively constant at 8-10% over the 5-year period from 2001 through 2005, and the proportion of crashes involving female motorcyclists was 4-5% each year. Although the number of both male and female licensed motorcyclists increased from 2001 through 2005, the growth rate for women was higher than that for men (25% compared to 7%) The crash rate for men was greater than for women, but the increase in crash rates was greater for women than for men (33% for women and 10% for men).

Table 11. Motorcycle Crashes, Licensed Motorcyclists, and Crash Rate by Sex, 2001-2005

	Male			Female		
	Motorcycle Crashes	**Licensed Motorcyclists**	**Crashes per 1000 Licensed Motorcyclists**	**Motorcycle Crashes**	**Licensed Motorcyclists**	**Crashes per 1000 Licensed Motorcyclists**
2001	2,997	418,334	7.2	165	38,667	4.3
2002	2,780	424,924	6.5	202	40,862	4.9
2003	2,983	433,468	6.9	238	43,429	5.5
2004	3,082	441,661	7.0	243	45,858	5.3
2005	3,308	448,925	7.4	220	48,240	4.6
% change 2001-2005	10.4%	7.3%	2.3%	33.3%	24.8%	6.1%

Unlicensed Motorcyclists

Table 12 shows the number and proportion of all crash-involved motorcyclists with a valid motorcycle endorsement (i.e., licensed motorcyclists) in each crash-severity level for each year from 2001 through 2005.

Table 12. Number and Proportion of Crash-Involved Motorcycle Drivers with a Valid Motorcycle Endorsement by Severity of Crash, 2001-2005				
	Fatal	**Non-fatal Injury**	**Property-damage only**	**Total**
2001	49 (53.8%)	1348 (56.9%)	418 (57.6%)	1,815 (57.0%)
2002	43 53.8%)	2262 (55.8%)	322 (52.5%)	1678 (55.0%)
2003	44 (56.4%)	2389 (58.4%)	413 (52.0%)	1,853 (56.8%)
2004	44 (56.4%)	2444 (58.3%)	461 (577%)	1,929 (58.1%)
2005	71 (59.2%)	2632 (63.7%)	413 (54.5%)	2,160 (61.6%)

The proportion of licensed motorcyclists in each crash severity level is similar and does not very substantially by crash outcome. Overall, 54-62% of crash-involved motorcyclists had valid motorcycle endorsements on their drivers' licenses. This indicates that each year from 2001 through 2005, a substantial proportion of crash-involved motorcyclists were not legally licensed to operate a motorcycle. However, it is not possible to calculate a precise percentage of unlicensed crash-involved motorcyclists because of the way endorsement data is coded in the crash data files in this 5-year period (i.e., for some years "no endorsement" and "unknown endorsement" are reported as one category). Table 12 also shows an increase in the proportion of crash-involved motorcyclists overall, with valid motorcycle licenses from 57% in 2001 to 62% in 2005.

Examining motorcycle license status by age (Table 13) shows that the youngest crash-involved motorcyclists had the fewest motorcycle endorsements, although the proportion of crash-involved motorcyclists in this group with an endorsement increased from 15% in 2001 to 34% in 2005.

Table 13. Number and Proportion of Crash-Involved Motorcycle Drivers with a Valid Motorcycle Endorsement by Age, 2001-2005						
	≤18	**19-29**	**30-44**	**45-64**	**65+**	**Total***
2001	26 (15.4%)	456 (48.2%)	661 (59.5%)	566 (70.0%)	40 (74.1%)	1,749 (56.6%)
2002	30 (19.1%)	356 (46.4%)	611 (60.8%)	643 (70.2%)	38 (79.2%)	1,678 (53.7%)
2003	28 (17.8%)	366 (46.0%)	636 (57.3%)	751 (69.9%)	43 (65.2%)	1,824 (57.0%)
2004	27 (17.8%)	414 (48.1%)	634 (61.9%)	794 (68.6%)	49 (72.1%)	1,918 (56.5%)
2005	34 (34.3%)	480 (53.5%)	656 (59.7%)	907 (70.6%)	76 (71.7%)	2,153 (61.8%)

* Because of missing data on age, total does not necessarily equal the sum of age groups

The proportion of crash-involved motorcyclists with valid licenses among those age 19-29 increased from 48% in 2001 to 54% in 2005. The proportion of licensed motorcyclists remained at 60% among crash-involved motorcyclists age 30-44, and at 70% for those age 45-64 over the 5-years from 2001 through 2005. The number of crash-involved motorcycle drivers age 65 and older was quite small, but the proportion with valid licenses in this group was at 72-79% for the years from 2001 through 2005. It should be noted that because motorcycle endorsements are more prevalent among older crash-involved motorcyclists and because their proportion is growing, the overall increase in motorcycle endorsements seen in Table 13 is most likely a result of the aging of the motorcyclist population.

Examining the license status of crash-involved motorcyclists by sex (Table 14), shows that the proportion of crash-involved male motorcyclists with a valid motorcycle endorsement increased from 56% to 61% over the 5-years from 2001 through 2005. The proportion of crash-involved female motorcyclists with a valid motorcycle license increased from 52% in 2001 to 63% in 2005.

Table 14. Number and Proportion of Crash-Involved Motorcycle Drivers with a Valid Motorcycle Endorsement by Sex, 2001-2005

	Male	Female
2001	1,694 (56.5%)	86 (52.1%)
2002	1,614 (58.1%)	112 (55.4%)
2003	1,681 (56.4%)	138 (58.0%)
2004	1,786 (57.9%)	142 (58.4%)
2005	2,021 (61.1%)	139 (63.2%)

Time, Location, and Environmental Conditions

The trends and patterns in the time, location, and environmental conditions of motorcycle crashes are next examined. The patterns reported here are very similar to those identified in an earlier analysis of motorcycle crash trends in Michigan (Kostyniuk and Miller, 2003a). Table 15 and Figure 1 show the number and distribution of motorcycle crashes by month for each year from 2001 through 2005. June, July, and August tended to be the peak months of crash occurrence, followed by May or

September. This is not unusual because these are the peak months for recreational travel in the state.

Table 15. Motorcycle Crashes by Month, 2001-2005												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
2001	3 (0.1)	8 (0.3)	90 (2.8)	289 (9.0)	388 (12.1)	551 (17.1)	570 (17.7)	560 (17.4)	386 (12.0)	193 (6.0)	135 (4.2)	43 (1.3)
2002	36 (1.2)	19 (0.6)	57 (1.9)	237 (7.8)	374 (12.3)	514 (16.9)	571 (18.7)	542 (17.8)	443 (14.5)	183 (6.0)	66 (2.2)	9 (0.3)
2003	4 (1.2)	5 (0.2)	80 (2.5)	270 (8.3)	343 (10.5)	562 (17.2)	616 (18.9)	570 (17.5)	450 (13.8)	288 (8.8)	59 (1.8)	14 (0.4)
2004	9 (0.3)	28 (0.8)	75 (2.3)	289 (8.7)	365 (11.0)	548 (16.5)	583 (17.6)	521 (15.7)	572 (17.2)	250 (7.5)	61 (1.8)	20 (0.6)
2005	5 (0.1)	6 (0.2)	56 (1.6)	326 (9.3)	412 (11.8)	582 (16.6)	599 (17.1)	570 (16.3)	542 (15.5)	306 (8.7)	96 (2.7)	4 (0.1)

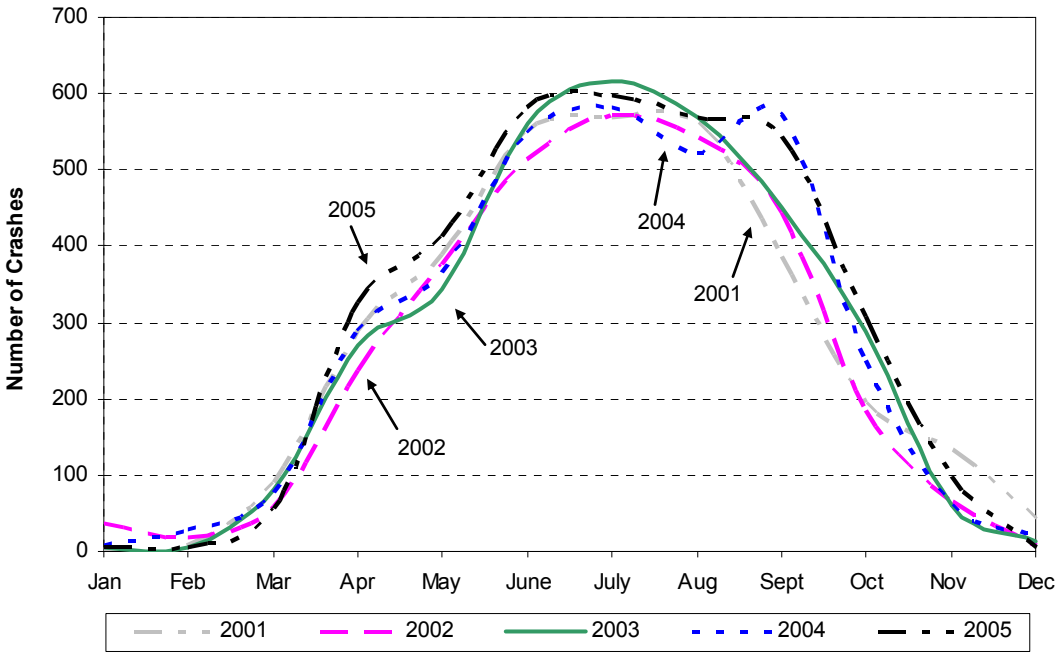

Figure 1. Motorcycle Crashes by Month, 2001-2005

Table 16 and Figure 2 show the number and distribution of motorcycle crashes by day of week.

Table 16. Motorcycle Crashes by Day of Week, 2001-2005							
	Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
2001	546 (17.0%)	348 (10.8%)	386 (12.0%)	435 (13.5%)	403 (12.5%)	489 (15.2%)	609 (18.9%)
2002	487 (16.0%)	323 (10.6%)	393 (12.9%)	388 (12.7%)	381 (12.5%)	466 (15.3%)	613 (20.1%)
2003	585 (17.9%)	377 (11.6%)	380 (11.7%)	406 (12.5%)	398 (12.2%)	493 (15.1%)	622 (19.1%)
2004	554 (16.7%)	392 (11.8%)	327 (9.9%)	391 (11.8%)	467 (14.1%)	515 (15.5%)	675 (20.3%)
2005	616 (17.6%)	386 (11.0%)	467 (13.3%)	445 (12.7%)	368 (10.5%)	528 (15.1%)	694 (19.8%)

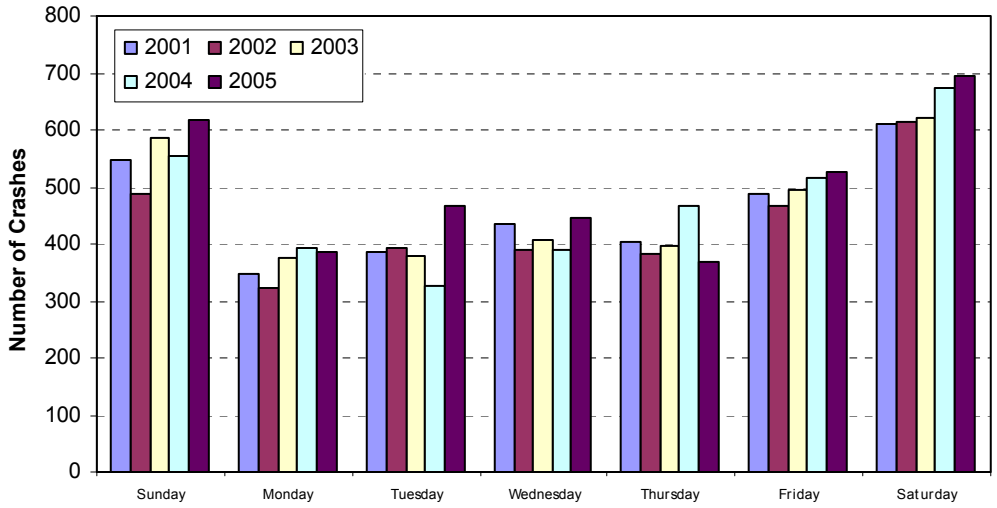

Figure 2. Motorcycle Crashes by Day of Week, 2001-2005

Saturdays remain peak days for motorcycle crashes, accounting for 19-20% of all motorcycle crashes. The day of week with the second highest number of crashes was Sunday, with about 16-18% of crashes.

Table 17 and Figure 3 show the number and distribution of motorcycle crashes by the time of day for each year.

Table 17. Motorcycle Crashes by Time of Day, 2001-2005

	12:01 am to 3:00 am	3:01 am to 6:00 am	6:01 am to 9:00 am	9:01 am to 12 pm	12:01 pm to 3:00 pm	3:01 pm to 6:00 pm	6:01 pm to 9:00 pm	9:01 pm to 12:00 am
2001	185 (6.2%)	85 (2.8%)	151 (5.0%)	211 (7.0%)	521 (17.3%)	759 (25.2%)	676 (22.5%)	421 (14.0%)
2002	175 (6.1%)	65 (2.3%)	136 (4.7%)	240 (8.4%)	501 (17.4%)	750 (26.1%)	633 (22.0%)	374 (13.0%)
2003	178 (5.7%)	55 (1.8%)	144 (4.6%)	243 (7.8%)	574 (18.5%)	798 (25.7%)	686 (22.1%)	426 (13.7%)
2004	169 (5.1%)	78 (2.4%)	161 (4.9%)	299 (9.1%)	560 (17.0%)	873 (26.4%)	762 (23.1%)	400 (12.1%)
2005	204 (5.9%)	94 (2.7%)	200 (5.7%)	303 (8.7%)	588 (16.9%)	916 (26.3%)	734 (21.1%)	447 (12.8%)

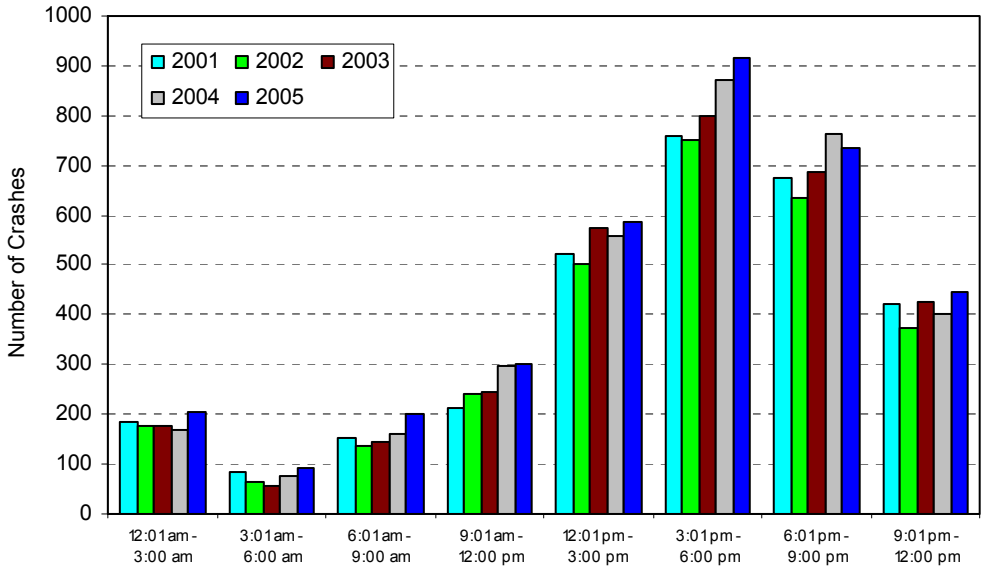

Figure 3. Motorcycle Crashes by Time of Day, 1997-2002

The pattern of motorcycle crashes by time of day did not change significantly from 2001 through 2005. Approximately one-quarter of motorcycle crashes (25-26%) occurred from 3:00 P.M. to 6:00 P.M., and close to one-half (48-50%) occurred between 3:00 P.M. and 9:00 P.M.

The location of crashes by traffic control was examined to identify the pattern of motorcycle crash location by intersection or road segment. Signals, stop signs, and yield signs indicate intersections, and no traffic control usually indicates a location away from

an intersection or a road segment. Table 18 shows the location of motorcycle crashes by traffic control for each year from 2001 through 2005.

Table18. Motorcycle Crashes by Traffic Control, 2001-2005

	Signal	Stop Sign	Yield Sign	None
2001	476 (15.7%)	365 (12.0%)	26 (0.9%)	2,166 (71.4%)
2002	393 (13.7%)	381 (13.3%)	37 (1.3%)	2,064 (71.8%)
2003	459 (15.0%)	334 (10.9%)	24 (0.8%)	2,248 (73.3%)
2004	443 (13.7%)	400 (12.4%)	28 (0.9%)	2,361 (73.1%)
2005	416 (12.1%)	403 (11.7%)	26 (0.8%)	2,587 (75.4%)

About 71-75% of motorcycle crashes occurred away from controlled intersections, and about 25-29% occurred at controlled intersections.

Tables 19-21 show the number and distribution of motorcycle crashes for each year from 2001 through 2005 by roadway condition, weather, and by light condition.

Table19. Motorcycle Crashes by Roadway Condition, 2001-2005

	Dry	Wet	Icy	Snowy	Muddy	Debris	Other Unknown
2001	2,892 (92.4%)	145 (4.6%)	4 (0.1%)	2 (0.1%)	8 (0.3%)	34 (1.1%)	45 (1.4%)
2002	2,782 (93.0%)	116 (3.9%)	3 (0.1%)	1 (0.1%)	2 (0.1%)	35 (1.2%)	53 (1.8%)
2003	2,982 (92.3%)	161 (5.0%)	2 (0.1%)	1 (0.0%)	6 (0.2%)	33 (1.0%)	47 (1.5%)
2004	2,964 (90.8%)	193 (5.9%)	2 (0.1%)	5 (0.2%)	5 (0.2%)	53 (1.6%)	44 (1.3%)
2005	3,246 (93.8%)	132 (3.8%)	3 (0.1%)	0 (0.0%)	3 (0.1%)	38 (1.1%)	39 (1.1%)

Table 20. Motorcycle Crashes by Weather, 2001-2005							
	Clear	**Cloudy**	**Fog, Smoke**	**Rain**	**Snow, Blowing Snow**	**Severe Wind**	**Other**
2001	2,408 (76.4%)	628 (19.9%)	12 (0.4%)	86 (2.7%)	4 (0.1%)	2 (0.1%)	14 (0.4%)
2002	2,443 (81.1%)	458 (15.2%)	10 (0.3%)	82 (2.7%)	1 (0.1%)	2 (0.1%)	15 (0.5%)
2003	2,447 (75.5%)	650 (20.1%)	9 (0.3%)	113 (3.5%)	1 (0.0%)	3 (0.1%)	16 (0.5%)
2004	2,466 (74.5%)	686 (20.7%)	11 (0.3%)	125 (3.8%)	5 (0.2%)	4 (0.1%)	13 (0.4%)
2005	2,752 (78.8%)	636 (18.2%)	7 (0.2%)	83 (2.4%)	0 (0.0%)	4 (0.1%)	9 (0.3%)

Table 21. Motorcycle Crashes by Light Condition, 2001-2005						
	Daylight	**Dawn**	**Dusk**	**Dark lighted**	**Dark unlighted**	**Other**
2001	2,201 (69.7%)	36 (1.1%)	135 (4.3%)	417 (13.2%)	365 (11.6%)	6 (0.2%)
2002	2,128 (70.8%)	41 (1.4%)	145 (4.8%)	358 (11.9%)	326 (10.9%)	7 (0.2%)
2003	2,310 (71.3%)	46 (1.4%)	131 (4.0%)	373 (11.5%)	376 (11.6%)	4 (0.1%)
2004	2,381 (71.9%)	51 (1.5%)	173 (5.2%)	353 (10.7%)	346 (10.5%)	7 (0.2%)
2005	2,488 (71.3%)	66 (1.9%)	142 (4.1%)	367 (10.5%)	420 (12.0%)	5 (0.1%)

The pattern of occurrence of motorcycle crashes by roadway condition, weather, and light condition was stable over the 5-years from 2001 through 2005. About 91-94% of crashes occurred on dry roads and 4-6% were on wet roads. About 75-81% of the crashes occurred in clear weather conditions, and 3-5% in rain. Each year about 70-72% of crashes were in daylight, 11-13% in dark, lighted conditions, and 11-12% in dark, unlighted conditions. These patterns indicate that from 2001 through 2005, most motorcycle crashes occurred on dry roads, in good weather, and during the day.

The patterns of time and location of motorcycle crash occurrence were also examined by whether the motorcyclist was under 45 years of age or 45 years and older. The results for both groups were not different from the overall patterns presented.

4. SINGLE-AND MULTI-VEHICLE MOTORCYCLE CRASHES

Number and Severity

In this section, crashes involving single motorcycles (single-vehicle) and crashes involving a motorcycle and other traffic units (multi-vehicle) are examined separately. Table 22 shows the number and proportion of motorcycle crashes that involved only a motorcycle, and crashes that involved a motorcycle with another vehicle(s) or pedestrian(s). Approximately one-half of motorcycle crashes were single-vehicle crashes and one-half involved other traffic units. This pattern was consistent over the 5 years from 2001 through 2005, and has not changed from earlier patterns and trends reported by Kostyniuk and Miller (2003a).

Table 22. Number and Proportion of Single- and Multi-Vehicle Motorcycle Crashes, 2001-2005

	Type of Motorcycle Crash	Number of Crashes	% of all Motorcycle Crashes
2001	Single	1,638	50.9%
	Multi-Vehicle	1,578	49.1%
2002	Single	1,480	48.5%
	Multi-Vehicle	1,571	51.5%
2003	Single	1,670	51.2%
	Multi-Vehicle	1,591	48.8%
2004	Single	1,608	48.4%
	Multi-Vehicle	1,713	51.6%
2005	Single	1,782	50.9%
	Multi-Vehicle	1,722	49.1%

Table 23 shows the distribution of other traffic units involved in collisions with motorcycles in multi-vehicle crashes from 2001 through 2005.

Table 23. Multi-Vehicle Motorcycle Crashes by Traffic Unit Mix, 2001-2005

	With Car	With Truck	With Motorcycle	With Pedestrians or Other	With 2+ Traffic Units	Total
2001	1,001 (66.6%)	343 (22.8%)	49 (3.3%)	18 (1.2%)	91 (6.1%)	1,502 (100%)
2002	1,001 (67.1%)	357 (23.9%)	50 (3.4%)	13 (0.9%)	71 (4.8%)	1,492 (100%)
2003	1,015 (67.0%)	330 (21.8%)	60 (4.0%)	15 (1.0%)	95 (6.3%)	1,515 (100%)
2004	1,113 (66.9%)	389 (23.4%)	48 (2.9%)	18 (1.1%)	95 (5.7%)	1,663 (100%)
2005	1,071 (63.6%)	421 (25.0%)	61 (3.6%)	33 (2.0%)	97 (5.8%)	1,683 (100%)

The distribution of traffic units involved in collisions with motorcycles did not change over the 5 years from 2001 through 2005. About two-thirds (64-67%) of the multi-vehicle crashes were with passenger cars, 22-25% with trucks, 5-6% with more than one other traffic unit, and about 1-2% with pedestrians and other units (bicycles, etc).

Severity of single- and multi-vehicle motorcycle crashes is examined in Table 24 by comparing the number and distribution of people killed or injured in each type of crash.

Table 24. Number and Proportion of People Killed and Injured in Single- and Multi-vehicle Motorcycle Crashes, 2001-2005

	Type of Motorcycle Crash	People Killed	% of All Motorcycle Fatalities	People Injured	% of all Motorcycle Crash Injuries
2001	Single	33	35.1%	1,317	48.7%
	Multi-Vehicle	61	64.9%	1,388	51.3%
2002	Single	30	36.6%	1,225	47.0%
	Multi-Vehicle	52	63.4%	1,379	53.0%
2003	Single	41	51.3%	1,390	48.8%
	Multi-Vehicle	39	48.8%	1,460	51.2%
2004	Single	27	34.2%	1,413	50.4%
	Multi-Vehicle	52	65.8%	1,391	49.6%
2005	Single	48	39.3%	1,568	51.4%
	Multi-Vehicle	74	60.7%	1,485	48.6%

With the exception of 2003, about 35-40% of all motorcycle fatalities and 47-51% of motorcycle injuries were sustained in single-vehicle crashes. In 2003, 51% of the persons killed in motorcycle crashes were killed in single motorcycle crashes. Each year from 2001 through 2005, approximately one-half of injuries sustained in motorcycle crashes were in single-vehicle crashes.

Distributions by Age, Sex

The distributions of motorcyclists by age in single- and multi-vehicle motorcycle crashes for each year from 2001 through 2005 are shown in Table 25.

Table 25. Number and Proportion of Single- and Multi-Vehicle Motorcycle Crashes by Age of Driver, 2001-2005

	Type of Motorcycle Crash	≤18	19-29	30-44	45-64	65+	Total
2001	Single	79 (5.1%)	470 (30.6%)	564 (36.7%)	394 (25.7%)	28 (1.8%)	1,535 (100%)
	Multi-Vehicle	90 (5.8%)	477 (30.7%)	547 (35.2%)	415 (26.7%)	26 (1.6%)	1,555 (100%)
2002	Single	66 (4.8%)	364 (26.3%)	447 (32.3%)	480 (34.7%)	25 (1.8%)	1,382 (100%)
	Multi-Vehicle	91 (6.0%)	404 (26.7%)	558 (36.9%)	436 (28.8%)	23 (1.5%)	1,512 (100%)
2003	Single	82 (5.1%)	373 (23.3%)	536 (33.4%)	571 (35.6%)	42 (2.6%)	1,604 (100%)
	Multi-Vehicle	75 (4.7%)	423 (26.5%)	573 (35.9%)	503 (31.5%)	24 (1.5%)	1,598 (100%)
2004	Single	68 (4.4%)	393 (25.4%)	485 (31.4%)	559 (36.2%)	39 (2.5%)	1,544 (100%)
	Multi-Vehicle	87 (5.0%)	468 (27.2%)	540 (31.4%)	598 (34.7%)	29 (1.7%)	1,722 (100%)
2005	Single	57 (3.3%)	409 (23.6%)	539 (31.1%)	670 (38.6%)	59 (3.4%)	1,734 (100%)
	Multi-Vehicle	42 (2.4%)	488 (27.9%)	559 (31.9%)	615 (35.1%)	47 (2.7%)	1,751 (100%)

Examining the age distributions of motorcyclists involved in both single- and multi-vehicle motorcycle crashes over the 5 years from 2001 through 2005 shows that they are similar to each other. An increase in the proportion of both single- and multi-vehicle crashes attributable to drivers age 45 and older is evident. This is a continuation of a trend reported by Kostyniuk and Miller (2003a).

Table 26 shows the distribution of crash-involved motorcyclists by sex for single- and multi-vehicle motorcycle crashes.

Table 26. Number and Proportion of Single- and Multi-Vehicle Motorcycle Crashes by Sex of Driver, 2001-2005

	Type of Motorcycle Crash	Male	Female
2001	Single	1,518 (95.2%)	77 (4.8%)
	Multi-Vehicle	1,479 (94.4%)	88 (5.6%)
2002	Single	1,449 (93.1%)	107 (6.7%)
	Multi-Vehicle	1,331 (93.3%)	95 (6.7%)
2003	Single	1,487 (92.6%)	118 (7.4%)
	Multi-Vehicle	1,496 (92.6%)	120 (7.4%)
2004	Single	1,451 (92.2%)	123 (7.8%)
	Multi-Vehicle	1,631 (93.2%)	120 (6.9%)
2005	Single	1,650 (94.0%)	105 (6.0%)
	Multi-Vehicle	1,658 (93.5%)	115 (6.5%)

The table reveals that women motorcyclists were involved in about 5-8% of the single-vehicle motorcycle crashes and 6-8% of the multi-vehicle motorcycle crashes. The pattern of motorcycle crash involvement by sex of driver did not vary by crash type and appears to have been stable over the 5 years from 2001 through 2005.

Other Drivers in Multi-vehicle Motorcycle Crashes

Table 27 shows the age distribution of the drivers of other vehicles involved in collisions with motorcycles.

Table 27. Age Distribution of Other Drivers Involved in Multi-Vehicle Motorcycle Crashes, 2001-2005

	≤18	19-29	30-44	45-64	65+	Total
2001	352 (21.5%)	419 (25.6%)	394 (24.1%)	312 (19.1%)	160 (9.8%)	1,637 (100%)
2002	342 (21.2%)	405 (25.1%)	368 (22.8%)	341 (21.1%)	161 (10.0%)	1,617 (100%)
2003	352 (21.4%)	392 (23.8%)	371 (22.6%)	371 (22.6%)	158 (9.6%)	1,644 (100%)
2004	365 (21.5%)	360 (21.2%)	413 (24.3%)	400 (23.6%)	160 (9.4%)	1,698 (100%)
2005	156 (9.8%)	380 (24.0%)	400 (26.9%)	420 (26.5%)	203 (12.8%)	1,585 (100%)

There were decreases in the number and proportion of younger (age 18 years and less) drivers (from about 22% to 10%), and increases in the number and proportion of drivers over age 44. The beginnings of this shift were reported in the investigation of motorcycle crash trends from 1997 through 2002 (Kostyniuk and Miller, 2003a), and should be monitored further.

Table 28 shows the distribution of the other drivers involved in motorcycle collisions by sex. Men comprised approximately 57% of other drivers involved in motorcycle crashes from 2001 through 2005. This proportion reflects the general composition by sex of drivers on the road (Eby et al, 2002).

Table 28. Sex Distribution of Other Drivers Involved in Multi-vehicle Motorcycle Crashes, 2001-2005

	Male	Female
2001	879 (57.4%)	652 (42.6%)
2002	859 (57.2%)	643 (42.8%)
2003	884 (57.4%)	657 (42.6%)
2004	921 (57.4%)	683 (42.6%)
2005	919 (56.7%)	701 (43.3%)

Hazardous Actions

The distributions of hazardous actions recorded by police for motorcycle drivers and other drivers in motorcycle crashes from 2001 through 2005 are examined in the next set of tables.

Single-vehicle crashes

Table 29 shows the distribution of hazardous actions recorded in single-vehicle motorcycle crashes.

Table 29. Hazardous Actions for Single-Vehicle Crash-Involved Motorcyclists, 2001-2005

Hazardous Action	2001	2002	2003	2004	2005
None	770 (49.2%)	747 (51.5%)	829 (50.7%)	710 (51.2%)	890 (52.0%)
Speed too Fast	226 (14.4%)	215 (14.8%)	225 (13.8%)	184 (13.3%)	196 (11.5%)
Speed too Slow	0 (0.0%)	1 (0.1%)	2 (0.1%)	1 (0.1%)	4 (0.2%)
Fail to Yield	48 (3.1%)	35 (2.4%)	41 (2.5%)	46 (3.3%)	41 (2.4%)
Traffic Control	16 (1.0%)	11 (0.9%)	16 (1.0%)	22 (1.6%)	8 (0.5%)
Wrong Way	6 (0.5%)	4 (0.3%)	1 (0.1%)	3 (0.2%)	2 (0.1%)
Left of Center	17 (1.1%)	5 (0.3%)	10 (0.6%)	17 (1.2%)	6 (0.5%)
Improper Passing	20 (1.3%)	19 (1.3%)	17 (1.0%)	15 (1.1%)	18 (1.1%)
Improper Lane Use	18 (1.2%)	17 (1.2%)	19 (1.2%)	11 (0.8%)	15 (0.9%)
Improper Turn	10 (0.6%)	8 (0.6%)	6 (0.4%)	7 (0.5%)	10 (0.6%)
Improper Signal	0 (0.0%)	1 (0.1%)	1 (0.1%)	3 (0.2%)	3 (0.2%)
Improper Backing	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	1 (0.1%)
Clear Distance	108 (6.9%)	127 (8.8%)	137 (8.4%)	139 (9.2%)	147 (8.6%)
Reckless Driving	27 (1.7%)	20 (1.4%)	32 (2.0%)	43 (3.1%)	35 (2.0%)
Careless/Negligent Driving	70 (4.5%)	66 (4.6%)	88 (5.4%)	93 (6.7%)	101 (5.9%)
Other	143 (9.1%)	103 (7.1%)	131 (8.0%)	136 (9.8%)	156 (9.1%)
Unknown	87 (5.6%)	73 (5.0%)	79 (4.8%)	83 (6.0%)	82 (4.8%)

The pattern of hazardous actions recorded for motorcyclists involved in single-vehicle crashes did not change significantly over the 5 years from 2001 through 2005. In about one-half (49-52%) of these crashes, no hazardous action was recorded. The most frequently recorded hazardous action for motorcyclists in single vehicle crashes was "speed too fast" (11-14%). The second most frequent was "(failing to maintain) clear distance" (7-9%). "Reckless driving" and "careless/negligent driving" together were recorded for about 6-10% of motorcyclists involved in single-vehicle crashes.

The distribution of hazardous actions in single-vehicle motorcycle crashes was further examined by whether the motorcyclist was younger than 45 years (Table 30) or 45 years and older (Table 31).

Table 30. Hazardous Actions for Single-Vehicle Crash-Involved Motorcyclists < Age 45, 2001-2005

Hazardous Action	2001	2002	2003	2004	2005
None	510 (46.9%)	447 (48.4%)	498 (47.6%)	402 (42.0%)	485 (46.9%)
Speed too Fast	173 (15.9%)	146 (15.8%)	164 (15.7%)	137 (14.3%)	139 (13.4%)
Speed too Slow	0 (0.0%)	0 (0.0%)	1 (0.1%)	0 (0.0%)	2 (0.2%)
Fail to Yield	36 (3.3%)	22 (2.4%)	28 (2.7%)	33 (3.4%)	27 (2.6%)
Traffic Control	7 (0.6%)	9 (1.0%)	14 (1.3%)	17 (1.8%)	6 (0.6%)
Wrong Way	5 (0.5%)	2 (0.2%)	1 (0.1%)	2 (0.2%)	2 (0.2%)
Left of Center	11 (1.0%)	5 (0.5%)	8 (0.8%)	10 (1.0%)	2 (0.2%)
Improper Passing	13 (1.2%)	8 (0.9%)	14 (1.3%)	10 (1.0%)	11 (1.1%)
Improper Lane Use	9 (0.8%)	11 (1.2%)	11 (1.1%)	6 (0.6%)	6 (0.6%)
Improper Turn	7 (0.6%)	5 (0.5%)	2 (0.2%)	2 (0.2%)	5 (0.5%)
Improper Signal	0 (0.0%)	0 (0.0%)	1 (0.1%)	2 (0.2%)	3 (0.3%)
Improper Backing	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	0 (0.0%)
Clear Distance	77 (7.1%)	78 (8.4%)	75 (7.2%)	85 (8.9%)	91 (8.8%)
Reckless Driving	23 (2.1%)	18 (1.9%)	27 (2.6%)	38 (4.0%)	32 (3.1%)
Careless/Negligent Driving	57 (5.2%)	51 (5.5%)	66 (6.3%)	71 (7.4%)	82 (7.9%)
Other	99 (9.1%)	75 (8.1%)	85 (8.1%)	90 (9.4%)	96 (9.3%)
Unknown	61 (5.6%)	47 (5.1%)	52 (5.0%)	52 (5.4%)	46 (4.4%)

Table 31. Hazardous Actions for Single-Vehicle Crash-Involved Motorcyclists ≥ Age 45, 2001-2005					
Hazardous Action	**2001**	**2002**	**2003**	**2004**	**2005**
None	230 (54.0%)	247 (57.0%)	313 (59.6%)	316 (56.5%)	398 (59.6%)
Speed too Fast	39 (9.2%)	58 (13.4%)	51 (9.7%)	50 (8.9%)	57 (8.5%)
Speed too Slow	0 (0.0%)	1 (0.2%)	1 (0.2%)	1 (0.2%)	2 (0.3%)
Fail to Yield	0 (0.0%)	13 (3.0%)	12 (2.3%)	9 (1.6%)	14 (2.1%)
Traffic Control	3 (0.7%)	1 (0.2%)	2 (0.4%)	3 (0.5%)	2 (0.3%)
Wrong Way	0 (0.0%)	1 (0.2%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Left of Center	4 (0.9%)	0 (0.0%)	2 (0.4%)	7 (1.3%)	4 (0.6%)
Improper Passing	5 (1.2%)	11 (2.5%)	3 (0.6%)	6 (1.1%)	7 (1.0%)
Improper Lane Use	9 (2.1%)	6 (1.4%)	4 (0.8%)	5 (0.9%)	8 (1.2%)
Improper Turn	3 (0.7%)	2 (0.5%)	4 (0.8%)	5 (0.9%)	5 (0.7%)
Improper Signal	0 (0.0%)	1 (0.2%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Improper Backing	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)
Clear Distance	25 (5.9%)	34 (7.9%)	51 (9.7%)	54 (9.7%)	56 (8.4%)
Reckless Driving	0 (0.0%)	1 (0.2%)	2 (0.4%)	5 (0.9%)	3 (0.4%)
Careless/Negligent Driving	11 (2.6%)	14 (3.2%)	19 (3.6%)	20 (3.6%)	22 (3.3%)
Other	33 (7.7%)	24 (5.5%)	35 (6.7%)	46 (8.2%)	58 (8.7%)
Unknown	20 (4.7%)	20 (4.6%)	26 (5.0%)	30 (5.4%)	31 (4.6%)

Comparison of Tables 30 and 31 shows that crash-involved motorcyclists 45 years and older were less likely to be flagged with a hazardous action than younger motorcyclists. In the 5-year period from 2001 through 2005, no hazardous actions were recorded for 54-60% of single motorcycle crashes involving motorcyclists age 45 years and older, and for 42-48% of single vehicle crashes involving motorcyclists under 45 years of age. Hazardous actions such as speeding and reckless, careless, or negligent driving were more likely to be recorded for crash-involved motorcyclists under age 45 than for older motorcyclists. Speeding was recorded for 13-16% and reckless, careless, or negligent driving was recorded for 7-11% of single motorcycle crashes motorcyclists under age 45. In contrast, speeding was recorded for 9-13%, and reckless, careless, or negligent driving was recorded for 3-5% of motorcyclists age 45 and older, involved in single-vehicle crashes. There was little difference between the two age groups in the proportion of (failure to maintain) clear distance. This hazardous action was recorded for

6-10% of single vehicle crashes of older motorcyclist, and for 7-9% of crashes of younger motorcyclists, in each of the years from 2001 through 2005.

Multi-vehicle crashes

The distribution of hazardous actions recorded for motorcyclists involved in multi-vehicle crashes for each year from 2001 through 2005 is shown in Table 32.

Table 32. Hazardous Actions for Multi-Vehicle Crash-Involved Motorcyclists, 2001-2005

Hazardous Action	2001	2002	2003	2004	2005
None	748 (46.7%)	728 (50.1%)	773 (49.0%)	848 (49.1%)	830 (49.3%)
Speed too Fast	277 (17.3%)	180 (12.4%)	242 (15.4%)	221 (12.8%)	222 (13.2%)
Speed too Slow	2 (0.1%)	1 (0.1%)	2 (0.1%)	18 (1.0%)	3 (0.2)
Fail to Yield	39 (2.4%)	38 (2.6%)	36 (2.3%)	60 (3.5%)	36 (2.1%)
Traffic Control	8 (0.5%)	20 (1.4%)	12 (0.8%)	15 (0.9%)	19 (1.1%)
Wrong Way	4 (0.2%)	3 (0.2%)	3 (0.2%)	1 (0.1%)	0 (0.0%)
Left of Center	7 (0.4%)	11 (0.8%)	11 (0.7%)	33 (1.9%)	14 (0.8%)
Improper Passing	19 (1.2%)	22 (1.5%)	13 (0.8%)	22 (1.3%)	22 (1.3%)
Improper Lane Use	12 (0.7%)	17 (1.2%)	15 (1.0%)	27 (1.6%)	10 (0.6%)
Improper Turn	7 (0.4%)	4 (0.3%)	8 (0.5%)	7 (0.4%)	8 (0.5%)
Improper Signal	0 (0.0%)	2 (0.1%)	1 (0.1%)	0 (0.0%)	4 (0.2%)
Improper Backing	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	0 (0.0%)
Clear Distance	119 (7.4%)	120 (8.3%)	141 (8.9%)	143 (8.3%)	148 (8.8%)
Reckless Driving	43 (2.7%)	30 (2.1%)	26 (1.6%)	42 (2.4%)	50 (3.0%)
Careless/Negligent Driving	86 (5.4%)	80 (5.5%)	83 (5.3%)	94 (5.4%)	103 (6.1%)
Other	147 (9.2%)	128 (8.8%)	130 (8.2%)	130 (7.5%)	149 (8.8%)
Unknown	83 (5.2%)	70 (4.8%)	80 (5.1%)	63 (3.7%)	68 (4.0%)

The pattern of hazardous actions recorded for motorcyclists in multi-vehicle crashes is similar to that of motorcyclists in single-vehicle crashes. In about one-half (47-51%) of these crashes, no hazardous action was recorded for the motorcyclist involved in the crash. “Speed too fast” was the most frequently recorded hazardous action, accounting for 12-17% of the crashes, and “(failing to maintain) clear distance” accounted for 7-8% of the crashes. “Reckless driving” and “careless/negligent driving” together were recorded for 7-9% of motorcyclists in multi-vehicle crashes.

Hazardous actions of motorcyclists in multi-vehicle crashes were partitioned at age 45 (Tables 33 and 34).

Table 33. Hazardous Actions for Multi-Vehicle Crash-Involved Motorcyclists 44 Years and Under, 2001-2005

Hazardous Action	2001	2002	2003	2004	2005
None	507 (43.4%)	428 (45.1%)	431 (44.4%)	449 (44.2%)	425 (44.1%)
Speed too Fast	224 (19.2%)	136 (14.3%)	169 (17.4%)	156 (15.4%)	153 (15.9%)
Speed too Slow	1 (0.1%)	0 (0.0%)	1 (0.1%)	11 (1.1%)	2 (0.2%)
Fail to Yield	29 (2.5%)	28 (2.9%)	18 (1.9%)	45 (4.4%)	16 (1.7%)
Traffic Control	6 (0.5%)	17 (1.8%)	7 (0.7%)	10 (1.0%)	12 (1.2%)
Wrong Way	4 (0.3%)	3 (0.3%)	3 (0.3%)	1 (0.1%)	0 (0.0%)
Left of Center	4 (0.3%)	7 (0.7%)	7 (0.7%)	14 (1.4%)	9 (0.9%)
Improper Passing	9 (0.8%)	13 (1.4%)	8 (0.8%)	12 (1.2%)	13 (1.3%)
Improper Lane Use	8 (0.7%)	10 (1.1%)	9 (0.9%)	18 (1.8%)	6 (0.6%)
Improper Turn	6 (0.5%)	2 (0.2%)	6 (0.6%)	4 (0.4%)	2 (0.2%)
Improper Signal	0 (0.0%)	0 (0.0%)	1 (0.1%)	0 (0.0%)	3 (0.3%)
Improper Backing	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	0 (0.0%)
Clear Distance	86 (7.4%)	76 (8.0%)	84 (8.7%)	80 (7.9%)	76 (7.9%)
Reckless Driving	41 (3.5%)	25 (2.6%)	22 (2.3%)	35 (3.4%)	36 (3.7%)
Careless/Negligent Driving	70 (6.0%)	65 (6.8%)	65 (6.7%)	71 (7.0%)	74 (7.7%)
Other	110 (9.4%)	85 (8.9%)	89 (9.2%)	77 (7.6%)	85 (8.8%)
Unknown	63 (5.4%)	55 (5.8%)	51 (5.3%)	32 (3.1%)	50 (5.3%)

Table 34. Hazardous Actions for Multi-Vehicle Crash-Involved Motorcyclists 45 Years and Older, 2001-2005

Hazardous Action	2001	2002	2003	2004	2005
None	241 (55.6%)	300 (60.5%)	340 (57.5%)	354 (58.6%)	378 (58.4%)
Speed too Fast	53 (12.2%)	44 (8.9%)	73 (12.4%)	56 (9.3%)	63 (9.7%)
Speed too Slow	1 (0.2%)	1 (0.2%)	1 (0.2%)	6 (1.0%)	1 (0.2%)
Fail to Yield	10 (2.3%)	10 (2.0%)	17 (2.9%)	14 (2.3%)	16 (2.5%)
Traffic Control	2 (0.5%)	2 (0.4%)	3 (0.5%)	5 (0.8%)	4 (0.6%)
Wrong Way	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Left of Center	3 (0.7%)	4 (0.8%)	3 (0.5%)	18 (3.0%)	5 (0.8%)
Improper Passing	10 (2.3%)	9 (1.8%)	4 (0.7%)	6 (1.0%)	6 (0.9%)
Improper Lane Use	4 (0.9%)	7 (1.4%)	6 (1.0%)	5 (0.8%)	4 (0.6%)
Improper Turn	1 (0.2%)	2 (0.4%)	2 (0.3%)	3 (0.5%)	5 (0.8%)
Improper Signal	0 (0.0%)	2 (0.4%)	0 (0.0%)	0 (0.0%)	1 (0.2%)
Improper Backing	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Clear Distance	33 (7.6%)	44 (8.9%)	57 (9.6%)	50 (8.3%)	63 (9.7%)
Reckless Driving	2 (0.5%)	3 (0.6%)	3 (0.5%)	1 (0.2%)	3 (0.5%)
Careless/Negligent Driving	16 (3.7%)	12 (2.4%)	18 (3.0%)	17 (2.8%)	20 (3.1%)
Other	37 (8.5%)	42 (8.5%)	41 (6.9%)	44 (7.3%)	61 (9.4%)
Unknown	20 (4.6%)	14 (2.8%)	23 (3.9%)	25 (4.1%)	17 (2.6%)

As in single-vehicle crashes, motorcyclists age and older involved in multi-vehicle crashes were less likely to be flagged with a hazardous action than younger motorcyclists. In the 5-year period from 2001 through 2005, no hazardous actions were recorded for 55-61% of multi- vehicle crashes involving motorcyclists age 45 years and older, and for 41-45% of single vehicle crashes involving motorcyclists under 45 years of age. Speeding and reckless, careless, or negligent driving were recorded for 15-5-% and 8-11% of younger motorcyclists. For older motorcyclists involved in multi-vehicle crashes, speeding was recorded in 9-12% of the crashes, and reckless, careless, or negligent driving was recorded in 2-4% of the crashes over the 5 years from 2001 through 2005. As in single-vehicle crashes, failure to maintain (clear distance) was recorded for about 8% of multi-vehicle crashes for both age groups.

Other Driver

Table 35 shows the distribution of hazardous actions recorded for other drivers involved in multi-vehicle motorcycle crashes for each year from 2001 through 2005.

Table 35. Hazardous Actions by Other Drivers in Multi-Vehicle Motorcycle Crashes, 2001-2005

Hazardous Action	2001	2002	2003	2004	2005
None	630 (39.3%)	586 (37.4%)	615 (38.5%)	655 (40.4%)	569 (35.3%)
Speed too Fast	8 (0.5%)	6 (0.4%)	13 (0.8%)	9 (0.6%)	8 (0.5%)
Speed too Slow	1 (0.1%)	2 (0.1%)	3 (0.2%)	7 (0.4%)	2 (0.1%)
Fail to Yield	450 (28.0%)	459 (29.3%)	470 (29.4%)	445 (27.4%)	538 (33.4%)
Traffic Control	45 (2.8%)	32 (2.0%)	32 (2.0%)	28 (1.7%)	25 (1.6%)
Wrong Way	1 (0.1%)	3 (0.2%)	1 (0.1%)	3 (0.2%)	2 (0.1%)
Left of Center	18 (1.1%)	10 (0.6%)	15 (0.9%)	8 (0.5%)	13 (0.8%)
Improper Passing	12 (0.8%)	12 (0.8%)	9 (0.6%)	6 (0.4%)	13 (0.8%)
Improper Lane Use	46 (2.9%)	43 (2.7%)	38 (2.4%)	56 (3.5%)	39 (2.4%)
Improper Turn	45 (2.8%)	47 (3.0%)	42 (2.6%)	44 (2.7%)	50 (3.1%)
Improper Signal	14 (0.9%)	6 (0.4%)	9 (0.6%)	12 (0.7%)	7 (0.4%)
Improper Backing	27 (1.7%)	34 (2.2%)	11 (0.7%)	32 (2.0%)	34 (2.1%)
Clear Distance	173 (10.8%)	164 (10.5%)	174 (10.9%)	173 (10.7%)	181 (11.2%)
Reckless Driving	7 (0.4%)	7 (0.5%)	13 (0.8%)	9 (0.6%)	10 (0.6%)
Careless/Negligent Driving	28 (1.7%)	32 (2.0%)	40 (2.5%)	40 (2.5%)	36 (2.2%)
Other	63 (3.9%)	69 (4.4%)	66 (4.1%)	58 (3.6%)	62 (3.8%)
Unknown	37 (2.3%)	55 (3.5%)	45 (2.8%)	37 (2.3%)	23 (1.4%)

The pattern of hazardous actions recorded for other drivers in multi-vehicle motorcycle crashes was relatively stable over the 5 years from 2001 through 2005, but quite different from the hazardous actions recorded for motorcyclists in multi-vehicle crashes. Hazardous actions were recorded for a larger proportion of other drivers involved in crashes with motorcycles than for crash-involved motorcyclists. The proportion of other drivers with no hazardous action recorded was 37-39% in the 5-years from 2001 through 2005, whereas, no hazardous action was recorded for 47-51% of the motorcyclists involved in the same crashes. "Failing to yield" (the right of way) was the

most frequently recorded hazardous action, which accounted for 27-33% of the crashes. As with motorcyclists, the second most frequent action was "(failing to maintain) clear distance", which was recorded for 11% of the other drivers in multi-vehicle motorcycle crashes each year from 2001 through 2005.

Table 36 shows the number and proportion of motorcyclists and other drivers who received a citation for the hazardous action in the 5 years from 2001 through 2005.

Table 36. Number and Proportion of Drivers with a Hazardous Citation by Crash-Type, 2001-2005

	Single-Vehicle Crashes	Multi-Vehicle Crashes	
	Motorcyclist	Motorcyclist	Other Driver
2001	209 12.8%	304 18.4%	485 28.5%
2002	174 11.8%	211 12.9%	508 30.4%
2003	206 12.3%	237 14.1%	515 30.4%
2004	225 13.9%	273 15.3%	522 29.7%
2005	241 13.4%	257 14.2%	554 31.7%

Two patterns are revealed by this table. First, for each year from 2001 through 2005, the proportion of motorcyclists receiving citations for hazardous actions in multi-vehicle crashes was slightly higher than for single-vehicle crashes. The proportion of motorcyclists receiving citations in multi-vehicle crashes varied from 13-18%, while the proportion receiving citations in single vehicle crashes was 12-14% in the 5 years from 2001 through 2005. Second, the proportion of other drivers involved in multi-vehicle motorcycle crashes who received citations for a hazardous action was consistently higher than that of motorcyclists involved in the same crashes, at 29-32%.

Table 37 shows the number and proportion of motorcyclists who received citations for hazardous actions in single and multi-vehicle crashes partitioned at age 45.

Table 37. Number and Proportion of Motorcyclists with a Hazardous Citation by Age and Crash-Type, 2001-2005

	Age <45 years		Age ≥45 years	
	Single-Vehicle Crashes	Multi-Vehicle Crashes	Single-Vehicle Crashes	Multi-Vehicle Crashes
2001	170 (15.1%)	233 (21.1%)	37 (9.0%)	58 (12.8%)
2002	134 (14.3%)	154 (15.5%)	38 (8.5%)	51 (9.8%)
2003	168 (15.8%)	165 (16.5%)	38 (7.1%)	60 (9.9%)
2004	168 (16.8%)	185 (17.8%)	57 (9.6%)	73 (11.6%)
2005	176 (16.4%)	191 (18.8%)	65 (9.4%)	51 (7.3%)

Motorcyclists age 45 and older received proportionately fewer citations for hazardous actions than did motorcyclists under age 45 for each year from 2001 through 2005. In single vehicle crashes, 14-16% of motorcyclists under age 45 received citations, while among motorcyclists age 45 and older, 7-10% received citations. In multi-vehicle crashes, 15-21 % of younger motorcyclists received citations for a hazardous action, while 7-13% of motorcyclists age 45 years and older received citations for hazardous actions.

Time, Location, and Environmental Conditions

The distributions of single- and multi-vehicle motorcycle crashes from 2001 through 2005 were examined by month, day of week, time of day, road type, roadway condition, weather, and light condition. With the exception of the distributions of crashes by time of day and light condition, the distributions were very similar to that of all motorcycle crashes, and therefore are not discussed in this section, but can be found in Appendix B.

Tables 38 and 39 and Figures 4 and 5 show the distributions of single- and multi-vehicle motorcycle crashes by time of day.

Table 38. Single Motorcycle Crashes by Time of Day, 2001-2005								
	12:01 am to 3:00 am	**3:01 am to 6:00 am**	**6:01 am to 9:00 am**	**9:01 am to 12 pm**	**12:01 pm to 3:00 pm**	**3:01 pm to 6:00 pm**	**6:01 pm to 9:00 pm**	**9:01 pm to 12:00 am**
2001	127 (8.3%)	66 (4.3%)	83 (5.4%)	116 (7.6%)	236 (15.4%)	320 (20.9%)	336 (21.9%)	249 (16.2%)
2002	113 (8.1%)	52 (3.7%)	58 (4.2%)	108 (7.7%)	217 (15.5%)	326 (23.3%)	324 (23.2%)	201 (14.4%)
2003	124 (7.7%)	42 (2.6%)	81 (5.1%)	102 (6.4%)	265 (16.5%)	324 (20.2%)	389 (24.3%)	275 (17.2%)
2004	103 (6.4%)	56 (3.5%)	73 (4.6%)	146 (9.1%)	258 (16.1%)	350 (21.9%)	385 (24.1%)	229 (14.3%)
2005	136 (7.7%)	67 (3.8%)	103 (5.8%)	139 (7.8%)	269 (15.2%)	384 (21.7%)	417 (23.5%)	256 (14.5%)

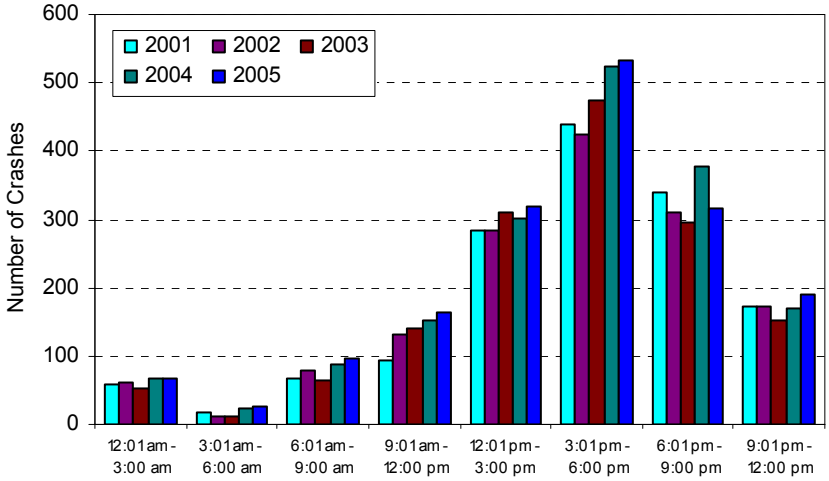

Figure 4. Single Motorcycle Crashes by Time of Day, 2001-2005

Table 39. Multi-Vehicle Motorcycle Crashes by Time of Day, 2001-2005								
	12:01 am to 3:00 am	**3:01 am to 6:00 am**	**6:01 am to 9:00 am**	**9:01 am to 12 pm**	**12:01 pm to 3:00 pm**	**3:01 pm to 6:00 pm**	**6:01 pm to 9:00 pm**	**9:01 pm to 12:00 am**
2001	58 (3.9%)	19 (1.3%)	68 (4.6%)	95 (6.4%)	285 (19.3%)	439 (29.7%)	340 (23.05)	172 (11.7%)
2002	62 (4.2%)	13 (0.9%)	78 (5.3%)	132 (9.0%)	284 (19.3%)	424 (28.8%)	309 (21.0%)	173 (11.7%)
2003	54 (3.6%)	13 (0.9%)	63 (4.2%)	141 (9.4%)	309 (20.6%)	474 (31.6%)	297 (19.8%)	151 (10.1%)
2004	66 (3.9%)	22 (1.3%)	88 (5.2%)	153 (9.0%)	302 (17.7%)	523 (30.7%)	377 (22.2%)	171 (10.0%)
2005	68 (4.0%)	27 (1.6%)	97 (5.7%)	164 (9.6%)	319 (18.6%)	532 (31.0%)	317 (18.5%)	191 (11.1%)

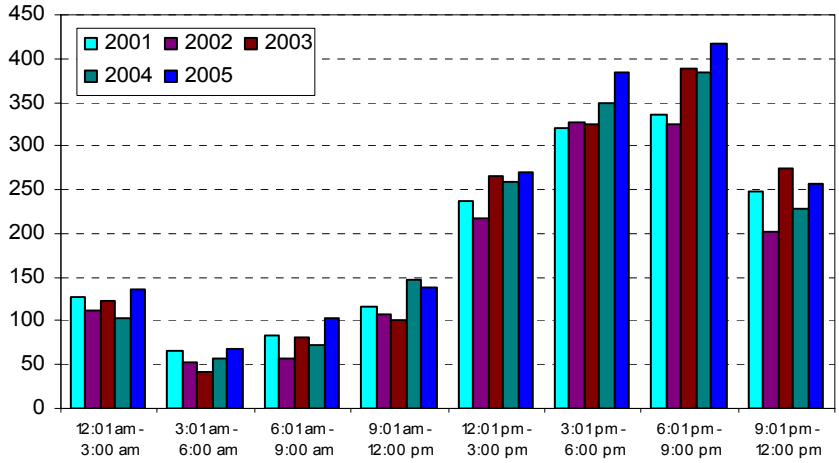

Figure 5. Multi-Vehicle Motorcycle Crashes by Time of Day, 2001-2005

Examination of these tables shows that a greater proportion of single-vehicle than multi-vehicle motorcycle crashes occurred at night. Approximately 21-25% of all single-vehicle motorcycle crashes occurred between 9:00 P.M. and 3:00 A.M., while 14-16% of the multi-vehicle crashes occurred during those hours.

Examining the crashes by light condition (Tables 40 and 41) shows again that a greater proportion of single-vehicle than multi-vehicle motorcycle crashes occurred at night, under dark lighted or unlighted conditions. Generally, 25-29% of all single-vehicle motorcycle crashes and 17-20% of multi-vehicle motorcycle crashes occurred at night. This pattern was somewhat different in 2002 when 28% of multi-vehicle crashes were at night. However, this departure from the pattern is most likely chance variation.

Table 40. Single Motorcycle Crashes by Light Condition, 2001-2005

	Daylight	Dawn	Dusk	Dark lighted	Dark unlighted	Other
2001	1,029 (63.8%)	28 (1.7%)	80 (5.0%)	195 (12.1%)	277 (17.2%)	4 (0.2%)
2002	1,176 (76.2%)	16 (1.0%)	72 (4.7%)	198 (12.8%)	81 (16.8%)	0 (0.0%)
2003	1,078 (64.9%)	29 (1.7%)	75 (4.5%)	186 (11.2%)	291 (17.5%)	3 (0.2%)
2004	1,061 (66.3%)	32 (2.0%)	98 (6.1%)	137 (8.6%)	268 (16.7%)	5 (0.3%)
2005	1,154 (65.1%)	40 (2.3%)	89 (5.0%)	157 (8.9%)	329 (18.6%)	3 (0.2%)

Table 41. Multi-Vehicle Motorcycle Crashes by Light Condition, 2001-2005						
	Daylight	**Dawn**	**Dusk**	**Dark lighted**	**Dark unlighted**	**Other**
2001	1,172 (75.7%)	8 (0.5%)	56 (3.6%)	223 (14.4%)	88 (5.7%)	2 (0.1%)
2002	952 (65.1%)	25 (1.7%)	73 (5.0%)	160 (10.9%)	245 (16.8%)	7 (0.5%)
2003	1,232 (78.1%)	17 (1.1%)	56 (3.5%)	187 (11.9%)	85 (5.4%)	1 (0.1%)
2004	1,320 (77.2%)	19 (1.1%)	75 (4.4%)	216 (12.6%)	78 (4.6%)	2 (0.1%)
2005	1,334 (77.7%)	26 (1.5%)	53 (3.1%)	210 (12.2%)	91 (5.3%)	2 (0.1%)

5. HAD BEEN DRINKING (HBD) CRASHES

Number and Severity

Table 42 shows the number and proportion of motorcycle crashes in which a motorcyclist or driver of the other vehicle had been drinking. The number of HBD crashes involving motorcycles decreased by almost 5% from 2001, despite a 9% increase in motorcycle crashes. The proportion of HBD crashes among motorcycle crashes decreased from almost 10% in 2001 to 8% in 2005. In approximately 85% of HBD motorcycle crashes each year, the motorcyclist was the driver who had been drinking.

Table 42. Number and Proportion of HBD Crashes Involving Motorcycles, 2001-2005

Year	All Motorcycle Crashes	HBD Crashes Involving Motorcycles		HBD Crashes Involving Motorcyclist who had been Drinking	
		Number	Percent of All	Number	Percent of All
2001	3,216	308	9.6%	275	8.6%
2002	3,051	284	9.3%	237	7.8%
2003	3,261	284	8.7%	241	7.4%
2004	3,321	294	8.9%	247	7.4%
2005	3,504	292	8.3%	250	7.1%
% Change 2001-2005	9.0%	-5.2%	-1.3%	-9.1%	-1.5%

The number and proportion of motorcyclists who had been drinking in single-vehicle motorcycle HBD crashes and the number and proportion of motorcyclists and other drivers who had been drinking in multi-vehicle motorcycle HBD crashes is shown in Table 43 for each year from 2001 through 2005.

Table 43. Number and Proportion of Single- and Multi-Vehicle Motorcycle Crashes Involving Had Been Drinking Drivers, 2001-2005

	Single -Vehicle Crash	Multi-Vehicle Crash	
	Motorcyclist HBD	Motorcyclist HBD	Other Driver HBD
2001	128 (7.8%)	147 (8.9%)	51 (3.0%)
2002	127 (8.6%)	110 (6.7%)	60 (3.6%)
2003	116 (6.9%)	125 (7.4%)	53 (3.1%)
2004	122 (7.6%)	125 (7.0%)	50 (2.8%)
2005	119 (6.7%)	131 (7.2%)	58 (3.3%)
% Change 2001-2005	-7.0% (-1.1%)	-10.9% (-1.7%)	13.7% (0.3%)

From 2001 through 2005, 7-9% of single-vehicle motorcycle crashes involved a motorcyclist who had been drinking. During those 5 years, the proportion of motorcyclists involved in multi-vehicle crashes who had been drinking also ranged from 7% to 9%. Thus, it appears that the proportion of motorcyclists who had been drinking is about the same among single-vehicle as multi-vehicle motorcycle crashes. In about 3-4% of HBD crashes involving other vehicles, the drivers of the other vehicle had been drinking. (Note that the total of had-been-drinking drivers exceeds the number of HBD crashes in Table 43 because in a small number of the HBD multi-vehicle crashes, both the motorcyclist and other driver had been drinking).

Table 44 shows the number and proportion of people killed and injured in HBD motorcycle crashes.

Table 44. Number and Proportion of People Killed and Injured in HBD Motorcycle Crashes, 2001-2005

		2001	2002	2003	2004	2005	% change 2001-2005
Persons Killed	All Motorcycle Crashes	94	82	80	79	122	29.8%
	HBD Motorcycle Crashes (% of all)	31 (33.0%)	22 (26.8%)	27 (33.8%)	25 (31.6%)	35 (28.7%)	12.9% (-4.3%)
Persons Injured	All Motorcycle Crashes	2,767	2,607	2,811	2,803	3,175	14.7%
	HBD Motorcycle Crashes (% of all)	281 (10.2%)	234 (9.0%)	225 (8.0%)	220 (7.8%)	230 (7.2%)	-18.1% (-3.0%)

Although HBD crashes accounted for 8-10% of motorcycle crashes from 2001 through 2005, they accounted for a much larger proportion of fatalities. In 2001, 33% of fatalities in motorcycle crashes were in HBD crashes, decreasing to 29% in 2005. Between 2001 and 2005, the number non-fatal injuries sustained in HBD motorcycle crashes decreased by 18%, and their proportion among all motorcycle injuries decreased from 10% to about 7%.

Distributions of HBD Motorcycle Crashes by Age and Sex

Table 45 shows the distribution by age of crash-involved motorcyclists who had been drinking. Approximately one-half of all crash-involved motorcyclists who had been

drinking are in the 30-44 age group. However, the largest change in the proportion of HBD crash-involved motorcyclists is a 6% increase among motorcyclists age 45- 64.

Table 45. Number* and Proportion of Crash-Involved Motorcyclists Who Had Been Drinking by Age, 2001-2005

	≤18	19-29	30-44	45-64	65+
2001	8 (3.4%)	52 (22.2%)	120 (51.3%)	53 (22.6%)	1 (0.4%)
2002	11 (4.9%)	52 (23.3%)	89 (39.9%)	70 (31.4%)	1 (0.4%)
2003	2 0.9%	35 15.0%	115 49.1%	81 34.6%	1 0.4%
2004	1 0.4%	44 18.0%	118 48.2%	80 32.7%	2 0.8%
2005	0 0.0%	56 22.4%	120 48.0%	72 28.8%	2 0.8%
% change 2001-2005	-3.4%	0.2%	-3.3%	6.2%	0.4%

*The total for each year might not add up to the totals in Table 44 because of missing age data in some cases.

Table 46 shows that the proportion by sex of crash-involved, had-been drinking motorcyclists did not change significantly from 2001 through 2005. About 96-99% of all crash-involved had-been-drinking motorcyclists were men.

Table 46. Number and Proportion of HBD Motorcyclists by Sex, 2001-2005

	Male	Female
2001	226 (96.2%)	9 (3.8%)
2002	233 (97.1%)	7 (2.9%)
2003	233 (97.9%)	5 (2.1%)
2004	244 (98.8%)	3 (1.2%)
2005	248 (99.2%)	2 (0.8%)

BAC Levels in Fatal Crashes

Blood alcohol concentration (BAC) information for motorcyclists involved in fatal crashes was obtained from FARS data. In general, about 50% of fatal-crash-involved motorists in Michigan are tested for BAC (Kostyniuk and Miller, 2003b). However, the proportion of motorcyclists tested was higher. From 2001 through 2004, 69-76% of fatal-crash-involved motorcyclists were tested for BAC (Table 47). As noted earlier, FARS data for 2005 were not available at the time this report was prepared.

Table 47. Fatal-Crash-Involved Motorcyclists Tested for BAC, 2001-2004			
	Tested	Not Tested	Total
2001	63 (73.3)	23 (35.6%)	86 (100%)
2002	58 (69.0%)	26 (31.0%)	84 (100%)
2003	63 (75.9%)	20 (24.1%)	83 (100%)
2004	63 (75.9%)	20 (24.1%)	83 (100%)

Table 48 shows the BAC level of fatal-crash-involved motorcyclists who had been tested. Of the tested motorcyclists each year, 57-60% had BAC levels of 0 g/dl, 2-6% had BAC levels between 0 and 0.08 g/dl, and 25-32% had BAC at or over 0.08 g/dl. BAC test results were not reported for 5-8% of the motorcyclists.

Table 48. BAC Levels (g/dl) of Fatal-Crash-Involved Motorcyclists, 2001-2004					
	BAC=0.00	0.0<BAC<0.08	BAC>=0.08	Results Unknown	Total
2001	38 (60.3%)	3 (4.8%)	19 (25.4%)	3 (4.8%)	63 (100%)
2002	35 (60.3%)	1 (1.7%)	15 (25.9%)	3 (5.2%)	58 (100%)
2003	36 (57.1%)	4 (6.3%)	20 (31.7%)	3 (4.8%)	63 (100%)
2004	37 (58.7%)	3 (4.8%)	18 (28.6%)	5 (7.9%)	63 (100%)

Time of Occurrence

Table 49 shows the distribution of HBD motorcycle crashes by month for each year from 1997 through 2002. The peak months for motorcycle HBD crashes in 2001 through 2005 were June, July, and August. In some years, September can be included among the peak months. This pattern in peak months for HBD motorcycle crashes resembles the pattern of peak months for all motorcycle crashes.

Table 49. HBD Motorcycle Crashes by Month, 2001-2005												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
2001	2 (0.8)	3 (1.2)	8 (3.3)	24 (9.9)	29 (11.9)	41 (16.9)	38 (15.6)	41 (16.9)	18 (7.4)	31 (12.8)	5 (2.1)	3 (1.2)
2002	1 (0.8)	1 (0.4)	3 (1.3)	6 (2.5)	21 (8.9)	56 (23.6)	52 (21.9)	42 (17.7)	35 (14.8)	10 (4.2)	9 (3.8)	0 (0.0)
2003	1 (0.4)	1 (0.4)	8 (3.3)	21 (8.7)	32 (13.3)	39 (16.2)	49 (20.3)	35 (14.5)	35 (14.5)	14 (5.8)	4 (1.7)	2 (0.8)
2004	2 (0.8)	3 (1.2)	7 (2.8)	23 (9.3)	28 (11.3)	39 (15.8)	32 (13.0)	45 (18.2)	41 (16.6)	19 (7.7)	7 (2.8)	1 (0.4)
2005	0 (0.0)	0 (0.0)	3 (1.2)	12 (4.8)	25 (10.0)	44 (17.7)	39 (15.7)	60 (24.1)	39 (15.7)	17 (6.8)	10 (4.0)	0 (0.0)

Table 50 shows the pattern of HBD motorcycle crashes by day of week. The majority (60-67%) of HBD crashes occurred on Fridays, Saturdays, and Sundays. Saturdays were the peak days for HBD motorcycle crashes from 2001 through 2005.

Table 50. HBD Motorcycle Crashes by Day of Week, 2001-2005							
	Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
2001	54 (22.2%)	19 (7.8%)	17 (7.0%)	17 (7.0%)	27 (11.1%)	45 (18.5%)	64 (26.3%)
2002	29 (12.2%)	18 (7.6%)	26 (11.0%)	16 (6.8%)	35 (14.8%)	35 (14.8%)	78 (32.9%)
2003	59 (24.5%)	23 (9.5%)	20 (8.3%)	20 (8.3%)	32 (13.3%)	28 (11.6%)	59 (24.5%)
2004	55 (22.3%)	24 (9.7%)	20 (8.1%)	30 (12.1%)	26 (10.5%)	27 (10.9%)	65 (26.3%)
2005	57 (22.8%)	19 (7.6%)	23 (9.2%)	21 (8.4%)	29 (11.6%)	40 (16.0%)	61 (24.4%)

The occurrence of motorcycle HBD crashes is examined by time of day in Table 51, and shown graphically in Figure 6.

Table 51. HBD Motorcycle Crashes by Time of Day, 2001-2005								
	12:01 am to 3:00 am	**3:01 am to 6:00 am**	**6:01 am to 9:00 am**	**9:01 am to 12 pm**	**12:01 pm to 3:00 pm**	**3:01 pm to 6:00 pm**	**6:01 pm to 9:00 pm**	**9:01 pm to 12:00 am**
2001	67 (29.0%)	11 (4.8%)	3 (1.3%)	1 (0.4%)	5 (2.2%)	27 (11.7%)	59 (25.5%)	58 (25.1%)
2002	68 (30.4%)	10 (4.5%)	1 (0.5%)	1 (0.5%)	4 (1.8%)	31 (13.8%)	46 (20.5%)	63 (28.1%)
2003	58 (24.8%)	11 (4.7%)	7 (3.0%)	1 (0.4%)	5 (2.1%)	28 (12.0%)	60 (25.6%)	64 (27.4%)
2004	51 (20.9%)	13 (5.3%)	5 (2.0%)	1 (0.4%)	8 (3.3%)	37 (15.2%)	56 (23.0%)	73 (29.9%)
2005	73 (29.3%)	13 (5.2%)	3 (1.2%)	1 (0.4%)	7 (2.8%)	39 (15.7%)	47 (18.9%)	66 (26.5%)

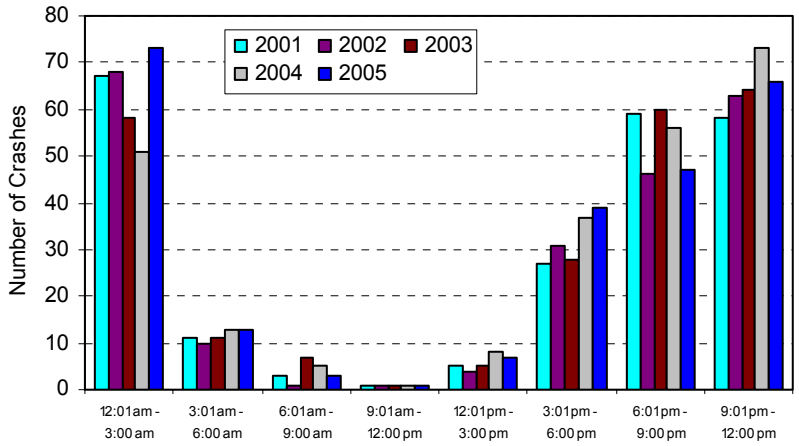

Figure 6. HBD Motorcycle Crashes by Time of Day, 2001-2005

The pattern of motorcycle HBD crashes by time of day did not change significantly over the 5 years from 2001 through 2005. Approximately three-quarters (74-79%) of all motorcycle HBD crashes occurred from 6:00 P.M. to 3:00 AM.

6. HELMET USE

Michigan law requires that motorcyclists and motorcycle passengers wear DOT-approved helmets when riding motorcycles (Michigan Vehicle Code Section 257.658). As can be seen from Table 52, helmet use of crash-involved motorcyclists for 2001 through 2005 was at 96-97% for the 5 years from 2001 through 2005.

Table 52. Helmet Use of Crash-Involved Motorcyclists, 2001-2005

	Helmet Worn	No Helmet
2001	2,010 (96.6%)	71 (3.4%)
2002	1,956 (96.5%)	70 (3.5%)
2003	2,145 (96.0%)	90 (4.0%)
2004	2,238 (96.1%)	92 (3.9%)
2005	2,546 (97.8%)	58 (2.2%)
% Change 2001 - 2005	1.2%	-1.2%

Table 53 shows the proportion of crash-involved motorcycle drivers who were killed, sustained an incapacitating injury (A level injury as defined in State of Michigan, 1999), sustained other injuries (B or C level as defined in State of Michigan, 1999), or were uninjured while wearing a helmet.

Table 53. Injury Severity of Crash-Involved Motorcycle Drivers by Helmet Use, 2001-2005

		Killed	Incapacitating Injury	Other Injury	No Injury	Total
2001	Helmet Worn	61 (3.0%)	383 (19.1%)	1,110 (55.2%)	456 (22.7%)	2,010 (100%)
	No Helmet	3 (4.2%)	20 (28.2%)	37 (52.1%)	11 (15.5%)	71 (100%)
2002	Helmet Worn	59 (3.0%)	389 (19.9%)	1,060 (54.2%)	448 (22.9%)	1,956 (100%)
	No Helmet	0 (0.0%)	19 (27.1%)	43 (61.4%)	8 (11.4%)	70 (100%)
2003	Helmet Worn	58 (2.7%)	433 (20.3%)	1,148 (53.9%)	490 (23.0%)	2,129 (100%)
	No Helmet	5 (5.6%)	24 (27.0%)	49 (55.1%)	11 (12.4%)	89 (100%)
2004	Helmet Worn	64 (2.9%)	440 (19.8%)	1,196 (53.8%)	524 (23.6%)	2,224 (100%)
	No Helmet	3 (3.3%)	28 (30.8%)	48 (52.7%)	12 (13.2%)	91 (100%)
2005	Helmet Worn	78 (3.1%)	530 (20.9%)	1,394 (55.0%)	533 (21.0%)	2,535 (100%)
	No Helmet	6 (10.3%)	24 (41.4%)	24 (41.4%)	4 (6.9%)	58 (100%)

The severity of injuries among motorcyclists not wearing helmets was greater than among motorcyclists wearing helmets. From 2001 through 2005, 3% of crash-involved motorcyclists wearing helmets were killed in the crash. The proportion of those not wearing helmets who were killed ranged from 0% to 10% in the 5 years. Of crash-involved motorcyclists wearing helmets, 19-21% sustained incapacitating injuries, as compared to 27-41% of those not wearing helmets. Furthermore, 21-23% of crash-involved motorcyclists wearing helmets were not injured at all, while only 7-16% of those not wearing helmets were not injured in the crash.

7. SUMMARY AND DISCUSSION

Trends and patterns of motorcycle crashes in Michigan from 2001 through 2005 were explored with the objective of identifying changes that might help explain the increase in motorcycle fatalities in Michigan from 2004 and 2005. Analysis of motorcycle registrations and license endorsements records shows that motorcycling activity in Michigan continued to increase in the 5 years from 2001 through 2005. During that time, the number of registered motorcycles increased by 32%, and the proportion of motorcycles increased from 2% to 3% of all vehicles in the state. From 2001 through 2005, the number of motorcycle endorsements on drivers' licenses increased by 9%.

Analysis of crash records shows that during the 5 years from 2001 through 2005, the number of motorcycle crashes increased by 9%, fatal motorcycle crashes increased by 32%, and non-fatal injury motorcycle crashes increased by 11%. During the same time period, the overall number of vehicle crashes in Michigan decreased by 12%, fatal crashes decreased by 15%, and non-fatal injury crashes decreased by 18%. Thus, motorcycle crashes are becoming an increasing portion of vehicle crashes in Michigan. This is especially noticeable in fatal crashes. In 2001, fatalities from motorcycle crashes accounted for 8% of all vehicle-crash fatalities in the state, while in 2005, this proportion was 12%.

Examination of crash rates per registered motorcycle and per licensed motorcyclist indicates that the increase in crashes is most likely the result of the growing number of motorcycles and motorcyclists. During the 5 years from 2001 through 2005, the crash rate per registered motorcycle decreased from 17 crashes per 1,000 registered motorcycles to 14 crashes per registered motorcycle. The crash rate per licensed motorcyclists in 2005 was the same as in 2001 at 7 crashes per 1,000 licensed motorcyclists. It should be noted that a substantial proportion of motorcyclists do not have motorcycle endorsements on their driving licenses. Only 55-62% of motorcyclists involved in crashes from 2001 through 2005 had motorcycle endorsements. Thus, a rate based on licensed motorcyclists should be used with that caveat in mind.

There were no changes in the distributions of single and multi-vehicle motorcycle crashes, and in their pattern of occurrence that could possibly explain the increase in fatalities. Examining the crashes by whether they involved only the motorcycle or a collision between the motorcycle and another vehicle shows a stable pattern over the 5 years from 2001 through 2005. About one-half of the motorcycle crashes involved only

the motorcycle. About 47% of all injuries and 35% of fatalities in motorcycle crashes occurred in single-vehicle motorcycle crashes, and approximately one-half of all injuries and 61-66% of fatalities occurred in multi-vehicle motorcycle crashes. The patterns of motorcycle crashes by month, day of week, and time of day did not change in the 5 years from 2001 through 2005. The peak months of motorcycle crashes were June, July, and August. The peak days were Saturdays followed by Sundays, the peak hours were between 3:00 P.M. and 6:00 P.M. Most motorcycle crashes occurred on dry roads, in good weather, and in daylight.

Because changes in motorcyclists' behavior could possibly explain the increase in fatalities, the incidence hazardous actions, drinking, and helmet use were examined. Patterns of hazardous actions recorded for motorcyclists in single- and multi-vehicle crashes were similar to each other, and did not change from 2001 through 2005. Hazardous actions were recorded for approximately one-half of crash-involved motorcyclists, and for 60-65% of other drivers in multi-vehicle motorcycle crashes. The most frequently recorded hazardous actions for motorcyclists regardless of crash type, were speeding (about 11-17 % of crashes), (failure to maintain) clear distance (7-9%), and reckless, careless, or negligent driving (6-10%). Failure to yield right of way was the most frequently recorded hazardous action for other drivers in multi-vehicle motorcycle crashes (26-29% of all multi-vehicle crashes). About 15% of crash-involved motorcyclists, and 27-33% of crash-involved other drivers received citations for hazardous actions. The overall pattern of hazardous actions did not change over the 5 years examined and does not provide an explanation for the increase in fatalities.

There has been a 5% decrease in the number of motorcycle crashes in which a motorcyclist or other driver had been drinking, and a 13% decrease in the number of fatalities from these crashes. The proportion of all motorcycle fatalities that resulted from HBD crashes also decreased. In 2001, 33% of motorcycle crash fatalities were from HBD crashes, and in 2005, the proportion of motorcycle crash fatalities from HBD crashes was 30%. Each year from 2001 through 2005, 7-9% of both single-vehicle and multi-vehicle motorcycle crashes involved motorcyclists who had been drinking. Of motorcyclists involved in fatal crashes who were tested for blood alcohol concentration, 29-36% had BAC levels at or exceeding 0.08 g/dl. The trends and patterns in HBD motorcycle crashes are similar to those going back to 1997 Kostyniuk and Miller, 2003a), and do not provide an explanation of the increase in fatalities.

From 2001 through 2005, 22-24% of crash-involved motorcyclists with helmets were killed or sustained incapacitating injuries, while 27-52% of crash-involved motorcyclists without helmets were killed or sustained incapacitating injuries. However, helmet use among crash-involved motorcycle drivers was at 97-98% in the 5 years from 2001 through 2005, eliminating nonuse of helmets as the explanation for the increase in fatalities.

Analysis of licensing and crash records by age showed an aging of the motorcycling population in Michigan. Motorcyclists age 45 years and older have increased in number, and their proportion among all motorcyclists has grown. Between 2001 and 2005, the number of licensed motorcyclists 45 years and older increased by 23%, and their proportion among licensed motorcyclists increased from 56% to 64%. Although the overall crash rate per licensed motorcyclists remained unchanged from 2001 through 2005, the crash rate for motorcyclists age 45-64 increased by 30%, from 3.5 crashes per 1,000 licensed motorcyclists in 2001 to 4.5 crashes per 1,000 licensed motorcyclists in 2005. During the same 5 years, the crash rate for motorcyclists under age 45 increased from 11.1 crashes per 1,000 licensed motorcyclists in 2001 to 11.8 crashes per 1,000 licensed motorcyclists in 2005, an increase of 6%. However, in those 5 years, the number of motorcyclists under 45 years of age decreased by 12%, and the number of their crashes decreased by 6%.

It is also worth noting that there has also been an increase of motorcyclists age 65 and older. The number of licensed motorcyclists in that age group increased by 48% in the 5 years from 2001 through 2005. Although, these oldest motorcyclists have the lowest crash rate among all motorcyclists, their crash rate increased by 33% in the last 5 years.

The number and proportion of older motorcyclists killed and injured in motorcycle crashes increased in the 5-years from 2001 through 2005. However, the change was greatest among fatalities. In 2001, 13 of motorcyclists age 45 years and older (14% of all motorcycle fatalities) were killed in crashes. In 2005, 47 motorcyclists age 45 years or older were killed in crashes. Their deaths comprised 41% of all motorcycle fatalities that year.

Examination of the hazardous actions in motorcycle crashes by age showed that the older crash-involved motorcyclists (age 45 years and older) were less likely than younger motorcyclists to have committed a hazardous action or to have been cited for a

hazardous action. Over the 5 years from 2001 through 2005, reckless, careless and negligent driving was recorded for 2-5% of the older motorcyclists' crashes and for 7-11% of the younger motorcyclists' crashes. Older motorcyclists received citations for 7-9% of single-vehicle crashes and 7-12% of multi-vehicle crashes, while younger motorcyclists received citations in 14-17% of single-vehicle crashes and 16-21% of multi-vehicle crashes. The lower incidence of hazardous actions and citations among the older motorcyclists suggests that they are less likely to engage in risky driving behaviors than younger motorcyclists.

The aging of the motorcycling population in Michigan may be contributing to the increase in motorcycle fatalities. As people age, their bodies become more fragile, and their chances of dying as a result of a crash increase (Evans, 2004). The increase in older motorcyclists, the increase in the number of their crash involvements, and the higher probability of death in the event of a crash, may well explain the increase in motorcycle fatalities that occurred in 2005 in Michigan.

An additional supporting explanation for the large increment in motorcycle fatalities in 2005 may be a "regression to the mean." This is based on the assumption that there is an underlying trend in the motorcycle fatality rate with chance variations from year to year. These variations may bring the rate away from the underlying trend for a while, and every so often, there is a large change which brings the fatality rate back to the trend line. Motorcycle fatalities increased steadily from 64 deaths in 1997 to 94 deaths in 2001 (Kostyniuk and Miller, 2003a). However, in 2002, the number of motorcycle crash fatalities dropped to 82 deaths. From 2002 through 2004, the number of motorcycle-crash deaths remained relatively unchanged at 79-82. In 2005, there were 120 fatal crashes and 122 deaths. Given that motorcycling had been growing steadily over that time period, and that the number and proportion of older motorcyclists had been increasing, it is very plausible that the number of motorcycle fatalities in 2002, 2003, and 2004 were a departure from the trend line, and the number in 2005 simply continued the long term trend.

The aging of the motorcycling population in Michigan parallels the demographics of baby boomers. As such, it can be expected to continue. However, the large proportion of older motorcyclists is a new phenomenon and little is known about their motorcycling activities. Are they new to motorcycling? Are they coming back to it, or have they been riding all their lives? What are their skill levels, and how are they affected by age? How vulnerable are older motorcyclists to injury and death, given a crash? What type of

occupant protection might help them? Answers to these questions will help understand the new trend of aging motorcyclists, and help to develop programs, methods, and technologies that will enable motorcyclists to continue their activities as safely as possible.

REFERENCES

Eby, D.W., Kostyniuk, L.P., Molnar, L.J., Joksch, H.C. and Vivoda, J.M. (2002). *The Effects of Standard Safety Belt Enforcement on Police Harassment: Year 2 Annual Report*, Report No. UMTRI-2002-13. Ann Arbor, MI: University of Michigan Transportation Research Institute.

Evans, L. (2004). *Traffic Safety,* Bloomfiled Hills, MI: Science Serving Society.

Kostyniuk, L.P. and Miller, L.L. (2003a). *Trends in Motorcycle Crashes in Michigan: 1997-2002*. Report No. UMTRI-2003-10. Ann Arbor, MI: University of Michigan Transportation Research Institute.

Kostyniuk, L.P. and Miller, L.L. (2003b). *Fatal and Serious-Injury Traffic Crash Trends in Michigan: 1997-2002*. Report No. UMTRI-2003-30. Ann Arbor, MI: University of Michigan Transportation Research Institute.

Michigan Department of State (2002). *Registration, Driver License, and Title Transaction History*. Lansing, MI.

Michigan Vehicle Code, Act 300 of 1949, 257.312a. Motorcycle Endorsement.

Michigan Vehicle Code, Act 300 of 1949 Section 257.658. Crash Helmets.

National Highway Traffic Safety Administration (2005). *Traffic Safety Facts 2004, Motorcycles.* Washington, DC: US Department of Transportation.

National Highway Traffic Safety Administration (2004). *FARS Analytic Reference Guide 1975-2002.* Washington, DC: US Department of Transportation.

State of Michigan (1999). UD-10 Traffic Crash Report Instruction Manual, Lansing MI, Michigan Department of State Police.

UMTRI Transportation Data Center (2002). *State of Michigan 2001 Motor Vehicle Accident Codebook.* Ann Arbor, MI: University of Michigan Transportation Research Institute.

UMTRI Transportation Data Center (2003). *State of Michigan 1992 Motor Vehicle Accident Codebook.* Ann Arbor, MI: University of Michigan Transportation Research Institute.

UMTRI Transportation Data Center (2004). *State of Michigan 2003 Motor Vehicle Accident Codebook.* Ann Arbor, MI: University of Michigan Transportation Research Institute.

UMTRI Transportation Data Center (2005). *State of Michigan 2004 Motor Vehicle Accident Codebook.* Ann Arbor, MI: University

UMTRI Transportation Data Center (2006). *State of Michigan 2005 Motor Vehicle Accident Codebook.* Ann Arbor, MI: University of Michigan Transportation Research Institute.

APPENDIX A

Motorcycle Licenses
by Age and Sex, 2001-2005

Table A1. Number and Rate of Licensed Motorcycle Drivers by Sex, 2001-2005			
	Male	**Female**	**Total**
2001	418,334 (91.5%)	38,667 (8.5%)	457,001 (100%)
2002	424,924 (91.2%)	40,862 (8.8%)	465,786 (100%)
2003	433,468 (90.9%)	43,429 (9.1%)	476,897 (100%)
2004	441,661 (90.6%)	45,858 (9.4%)	487,519 (100%)
2005	448,925 (90.3%)	48,240 (9.7%)	497,165 (100%)

Table A2. Number of Licensed Motorcycle Drivers by Age Group, 2001-2005						
Male and Female						
	#18	19-29	30-44	45-64	65+	All Ages
2001	761 (0.2%)	31,513 (6.9%)	168,826 (36.9%)	230,362 (50.4%)	25,539 (5.6%)	457,001 (100%)
2002	764 (0.2%)	31,179 (6.7%)	160,813 (34.5%)	244,835 (52.6%)	28,195 (6.1%)	465,786 (100%)
2003	914 (0.2%)	31,957 (6.7%)	155,760 (32.7%)	257,448 (54.0%)	30,818 (6.5%)	476,897 (100%)
2004	985 (0.2%)	32,362 (6.6%)	149,926 (30.8%)	270,304 (55.4%)	33,942 (7.0%)	487,519 (100%)
2005	922 (0.2%)	32,879 (6.6%)	143,144 (28.8%)	282,525 (56.8%)	37,695 (7.6%)	497,165 (100%)

Table A3. Number of Licensed Motorcycle Drivers by Sex and Age Group, 2001-2005						
Male						
	#18	19-29	30-44	45-64	65+	All Males
2001	725 (0.2%)	29,481 (7.0%)	154,382 (36.9%)	209,681 (50.1%)	24,065 (5.8%)	418,334 (100%)
2002	705 (0.2%)	28,898 (6.8%)	146,447 (34.5%)	222,398 (52.3%)	26,476 (6.2%)	424,924 (100%)
2003	829 (0.2%)	29,355 (6.8%)	141,124 (32.6%)	233,278 (53.8%)	28,882 (6.7%)	433,468 (100%)
2004	902 (0.2%)	29,588 (6.7%)	135,061 (30.6%)	244,335 (55.3%)	31,775 (7.2%)	441,661 (100%)
2005	834 (0.2%)	29,877 (6.7%)	128,330 (28.6%)	254,705 (56.7%)	35,179 (7.8%)	448,925 (100%)
Female						
	#18	19-29	30-44	45-64	65+	All Females
2001	36 (0.1%)	2,032 (5.3%)	14,444 (37.4%)	20,681 (50.1%)	1,474 (3.8%)	38,667 (100%)
2002	59 (0.1%)	2,281 (5.6%)	14,366 (35.2%)	22,437 (52.3%)	1,719 (4.2%)	40,862 (100%)
2003	85 (0.2%)	2,602 (6.0%)	14,636 (33.7%)	24,170 (55.7%)	1,936 (4.5%)	43,429 (100%)
2004	83 (0.2%)	2,774 (6.0%)	14,865 (32.4%)	25,969 (56.6%)	2,167 (4.7%)	45,858 (100%)
2005	88 (0.2%)	3,002 (6.2%)	14,814 (30.7%)	27,820 (57.7%)	2,516 (5.2%)	48,240 (100%)

APPENDIX B

Conditions of Single- and Multi-Vehicle Motorcycle Crashes

Table B1. Single Motorcycle Crashes by Month, 2001-2005												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2001	1 (0.1)	3 (0.2)	48 (2.9)	150 (9.2)	202 (12.3)	267 (16.3)	305 (18.6)	288 (17.6)	191 (11.7)	96 (5.9)	67 (4.1)	20 (1.2)
2002	18 (1.2)	8 (0.5)	30 (2.0)	109 (7.4)	179 (12.1)	268 (18.1)	272 (18.4)	243 (16.4)	227 (15.3)	91 (6.2)	31 (2.1)	4 (0.3)
2003	3 (0.2)	2 (0.1)	41 (2.5)	152 (9.1)	187 (11.2)	285 (17.1)	318 (19.0)	302 (18.1)	218 (13.1)	132 (7.9)	26 (1.6)	4 (0.2)
2004	3 (0.2)	11 (0.7)	30 (1.9)	151 (9.4)	170 (10.6)	270 (16.8)	290 (18.0)	237 (14.7)	283 (17.6)	128 (8.0)	27 (1.7)	8 (0.5)
2005	1 (0.1)	2 (0.1)	34 (1.9)	168 (9.4)	223 (12.5)	309 (17.3)	299 (16.8)	275 (15.4)	264 (14.8)	153 (8.6)	54 (3.0)	0 (0.0)

Table B2. Single Motorcycle Crashes by Day of Week, 2001-2005							
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2001	312 (19.1%)	162 (9.9%)	186 (11.4%)	199 (12.2%)	194 (11.8%)	257 (15.7%)	328 (20.0%)
2002	261 (17.6%)	137 (9.3%)	173 (11.7%)	173 (11.7%)	181 (12.2%)	210 (14.2%)	345 (23.3%)
2003	352 (21.1%)	178 (10.7%)	181 (10.8%)	186 (11.1%)	187 (11.2%)	249 (14.9%)	337 (20.2%)
2004	314 (19.5%)	188 (11.7%)	150 (9.3%)	165 (10.3%)	213 (13.2%)	230 (14.3%)	348 (21.6%)
2005	377 (21.2%)	172 (9.7%)	231 (13.0%)	199 (11.2%)	189 (10.6%)	242 (13.6%)	372 (20.9%)

Table B3. Single Motorcycle Crashes by Roadway Condition, 2001-2005							
	Dry	Wet	Icy	Snowy	Muddy	Debris	Other Unknown
2001	1,429 (89.3%)	91 (5.7%)	3 (0.2%)	2 (0.1%)	6 (0.4%)	29 (1.8%)	40 (2.5%)
2002	1,290 (89.1%)	71 (4.9%)	1 (0.1%)	1 (0.1%)	2 (0.1%)	35 (2.4%)	48 (3.3%)
2003	1,482 (88.7%)	96 (5.7%)	2 (0.1%)	5 (0.3%)	30 (1.8%)	41 (2.5%)	14 (0.8%)
2004	1,388 (87.8%)	106 (6.7%)	1 (0.1%)	1 (0.1%)	4 (0.3%)	45 (2.8%)	35 (2.2%)
2005	1,606 (91.4%)	83 (4.7%)	1 (0.1%)	0 (0.0%)	2 (0.1%)	34 (1.9%)	32 (1.8%)

TableB4. Single Motorcycle Crashes by Weather, 2001-2005							
	Clear	Cloudy	Fog, Smoke	Rain	Snow, Blowing Snow	Severe Wind	Other
2001	1,193 (74.0%)	350 (21.7%)	8 (0.5%)	50 (3.1%)	3 (0.2%)	1 (0.1%)	8 (0.5%)
2002	1,145 (78.3%)	248 (17.0%)	8 (0.6%)	46 (3.2%)	0 (0.0%)	2 (0.1%)	13 (0.9%)
2003	1,211 (73.1%)	363 (21.9%)	6 (0.4%)	65 (3.9%)	1 (0.1%)	2 (0.1%)	9 (0.5%)
2004	1,176 (73.4%)	335 (20.9%)	8 (0.5%)	70 (4.4%)	1 (0.1%)	4 (0.3%)	8 (0.5%)
2005	1,386 (77.9%)	321 (18.0%)	5 (0.3%)	57 (3.2%)	0 (0.0%)	4 (0.2%)	6 (0.3%)

Table B5. Multi-Vehicle Motorcycle Crashes by Month, 2001-2005												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2001	2 (0.1)	5 (0.3)	42 (2.7)	139 (8.8)	186 (11.8)	284 (18.0)	265 (16.8)	272 (17.2)	195 (12.4)	97 (6.2)	68 (4.3)	23 (1.5)
2002	18 (1.2)	11 (0.7)	27 (1.7)	128 (8.2)	195 (12.4)	246 (15.7)	299 (19.0)	299 (19.0)	216 (13.8)	92 (5.9)	35 (2.2)	5 (0.3)
2003	1 (0.1)	3 (0.2)	39 (2.5)	118 (7.4)	156 (9.8)	277 (17.4)	298 (18.7)	268 (16.8)	232 (14.6)	156 (9.8)	33 (2.1)	10 (0.6)
2004	6 (0.4)	17 (1.0)	45 (2.6)	138 (8.1)	195 (11.4)	278 (16.2)	293 (17.1)	284 (16.6)	289 (16.9)	122 (7.1)	34 (2.0)	12 (0.7)
2005	4 (0.2)	4 (0.2)	22 (1.3)	158 (9.2)	189 (11.0)	273 (15.9)	300 (17.4)	295 (17.1)	278 (16.1)	153 (8.9)	42 (2.4)	4 (0.2)

Table B6. Multi-Vehicle Motorcycle Crashes by Day of Week, 2001-2005							
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2001	234 (14.8%)	186 (11.8%)	200 (12.7%)	236 (15.0%)	209 (13.2%)	232 (14.7%)	281 (17.8%)
2002	226 (14.4%)	186 (11.8%)	220 (14.0%)	215 (13.7%)	200 (12.7%)	256 (16.3%)	268 (17.1%)
2003	233 (14.6%)	199 (12.5%)	199 (12.5%)	220 (13.8%)	211 (13.3%)	244 (15.3%)	285 (17.9%)
2004	240 (14.0%)	204 (11.9%)	177 (10.3%)	226 (13.2%)	254 (14.8%)	285 (16.6%)	327 (19.1%)
2005	239 (13.9%)	214 (12.4%)	236 (13.7%)	246 (14.3%)	179 (10.4%)	286 (16.6%)	322 (18.7%)

Table B7. Multi-Vehicle Motorcycle Crashes by Roadway Condition, 2001-2005							
	Dry	Wet	Icy	Snowy	Muddy	Debris	Other Unknown
2001	1,463 (95.6%)	54 (3.5%)	1 (0.1%)	0 (0.0%)	2 (0.1%)	5 (0.3%)	5 (0.3%)
2002	1,492 (96.6%)	45 (2.9%)	2 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (0.3%)
2003	1,500 (95.2%)	65 (4.1%)	0 (0.0%)	1 (0.1%)	1 (0.1%)	3 (0.2%)	6 (0.4%)
2004	1,576 (93.5%)	87 (5.2%)	1 (0.1%)	4 (0.2%)	1 (0.1%)	8 (0.5%)	9 (0.5%)
2005	1,640 (96.3%)	49 (2.9%)	2 (0.1%)	0 (0.0%)	1 (0.1%)	4 (0.2%)	7 (0.4%)

Table B8. Multi-Vehicle Motorcycle Crashes by Weather, 2001-2005							
	Clear	Cloudy	Fog, Smoke	Rain	Snow, Blowing Snow	Severe Wind	Other
2001	1,215 (78.8%)	278 (18.0%)	4 (0.3%)	36 (2.3%)	1 (0.1%)	1 (0.1%)	6 (0.4%)
2002	1,298 (83.8%)	210 (13.6%)	2 (0.1%)	36 (2.3%)	1 (0.1%)	0 (0.0%)	2 (0.1%)
2003	1,236 (78.1%)	287 (18.1%)	3 (0.2%)	48 (3.0%)	0 (0.0%)	1 (0.1%)	7 (0.4%)
2004	1,290 (75.5%)	351 (20.6%)	3 (0.2%)	55 (3.2%)	4 (0.2%)	0 (0.0%)	5 (0.3%)
2005	1,366 (79.8%)	315 (18.4%)	2 (0.1%)	26 (1.5%)	0 (0.0%)	0 (0.0%)	3 (0.2%)