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An Analysis of Motorcycle Helmet Use In Fatal Crashes

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16. Abstract

This report examined the helmet use of motorcycle riders 21 and older involved in fatal crashes. The analysis is based on data from the National Highway Traffic Safety Administration's Fatality Analysis Reporting System (FARS) over the years 1997-2006. Crashes were separated into two categories: (a) single-vehicle motorcycle crashes and (b) two-vehicle crashes involving one passenger vehicle and one motorcycle. A logistic regression model was constructed to perform a multivariate analysis that examined the relationship between a motorcycle rider's helmet use and many other factors.

For the purposes of this report, a universal helmet law is defined as a law that requires all motorcyclists age 21 and older to wear a helmet, without respect to their insurance coverage. Currently 20 States and the District of Columbia have universal motorcycle helmet laws.

Factors that were found to be the most highly correlated with a motorcycle rider's helmet use include the following: the existence of a universal helmet law in the State where the crash occurred, the motorcycle rider's age and blood alcohol concentration at the time of the crash, the engine size of the motorcycle, and whether the crash occurred at night or during the day.

The odds that a motorcycle rider in a single-vehicle crash wore a helmet were 72 percent less in States without a universal helmet law, compared to States with a universal helmet law. Similarly, the absence of a universal helmet law led to a 69-percent reduction in the odds of a rider wearing a motorcycle helmet among two-vehicle crashes. In this study's model, the existence of a universal helmet law was the strongest predictor of a motorcycle rider's helmet use in a fatal crash.

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Table of Contents

I. **Executive Summary** 1

II. **Introduction** 2

III. **Methodology** 3

IV. **Results** 4
- Motorcycle Rider and Passenger Vehicle Driver Fatalities, by Year 4
- Motorcycle Rider Fatalities, by Helmet Use and Year 5
- Passenger Vehicle Driver Fatalities, by Restraint Use and Year 5
- Helmet Use 6
- Single- and Two-Vehicle Motorcycle Crashes 6
- Single- and Two-Vehicle Motorcycle Crashes, by Year 7
- State Motorcycle Helmet Laws 7
- Motorcycle Engine Size 9
- Time of Day 10
- Weekday/Weekend 11
- Sex 13
- Injury Severity 14
- Age Group 17
- Number of Motorcyclists per Motorcycle 18
- Blood Alcohol Concentration 19

V. **Logistic Regression Analysis** 21

VI. **Conclusion** 25

VII. **Appendix** 26

VIII. **References** 39

I. Executive Summary

This report examines the helmet use patterns of motorcycle riders age 21 and older involved in fatal crashes. More specifically, we estimate the likelihood of motorcycle rider helmet use in fatal motorcycle crashes by examining the correlation between helmet use and the following factors: State motorcycle helmet law at the time of the crash, motorcycle engine size, crash time of day, motorcycle rider age, and motorcycle rider blood alcohol concentration (BAC). Our analysis reveals that the strongest predictor of motorcycle rider helmet use in fatal crashes is the status of the State motorcycle helmet law. In States where all motorcyclists 21 and older were required to wear helmets (referred to in the report as universal helmet law States), motorcycle riders involved in fatal crashes were helmeted at significantly higher rates than those in States where less stringent laws were in effect.

This analysis is based on data from National Highway Traffic Safety Administration's Fatality Analysis Reporting System (FARS) over the years 1997-2006. We separated crashes into two categories: (1) single-vehicle motorcycle crashes and (2) two-vehicle crashes involving one passenger vehicle and one motorcycle. Our analysis defines a universal helmet law as one requiring all motorcyclists age 21 and older to wear a helmet, regardless of insurance coverage. The report examines only motorcycle riders 21 and older, since these individuals are either uniformly covered by a State helmet law or they are not. Currently 20 States and the District of Columbia require all motorcyclists to wear helmets.

Motorcycle rider fatalities have risen from 1,742 in 1997 to 4,155 in 2006, an increase of 138 percent, while passenger vehicle driver fatalities have dropped 1.2 percent from 21,782 in 1997 to 21,527 in 2006.

The logistic regression model estimates the odds (and thus the probability) that a motorcycle rider was helmeted. The odds that a rider in a single-vehicle crash wore a helmet was 72 percent less in States without a universal helmet law, compared to States with a universal helmet law. Similarly, the absence of a universal helmet law led to a 69-percent reduction in the odds of a rider wearing a motorcycle helmet among two-vehicle crashes.

During the period 1997-2006, 13,883 motorcycle riders were involved in single-vehicle fatal motorcycle crashes, with 51 percent of those riders helmeted, 46 percent unhelmeted, and 3 percent with unknown helmet use. A total of 11,573 motorcycle riders were involved in two-vehicle fatal crashes between a motorcycle and a passenger vehicle, with 59 percent helmeted, 38 percent unhelmeted, and 3 percent with unknown helmet use. Of the 11,573 motorcycle riders involved in two-vehicle fatal crashes, 10,998 (95%) were killed; by comparison, 108 passenger vehicle drivers were killed (1%), out of the total of 11,573 passenger vehicle drivers involved.

A note on the terminology used in the report:

motorcycle rider *- the person operating or in control of the motorcycle*
motorcycle passenger *- the person seated behind the rider and not in control of the motorcycle*
motorcyclist *– a collective term used for any combined reference to the rider and passenger of the motorcycle*

II. Introduction

The number of motorcyclist fatalities has climbed 122 percent since 1997, with 4,810 motorcyclists being killed in 2006. Motorcyclists represented more than 11 percent of traffic fatalities in 2006, compared to only 5 percent in 1997. From 1997 through 2006, there were 33,385 motorcyclist fatalities. This report focuses on motorcycle riders because the vast majority of fatal motorcycle crashes involve motorcycles without passengers, only riders. These fatalities include over 25,000 motorcycle riders who have been fatally injured in either single-vehicle motorcycle crashes or two-vehicle crashes between a motorcycle and a passenger vehicle. Given that motorcycle fatalities make up an increasing proportion of total traffic fatalities, our attention turns to methods that might reduce motorcycle fatalities. One method of reducing motorcycle fatalities is through motorcycle helmet use. Thus our report tries to answer the following research question: What factors are most strongly associated with motorcycle helmet use in fatal crashes?

Single-vehicle motorcycle crashes and two-vehicle crashes between a motorcycle and a passenger vehicle were examined separately in this report. This stratification was chosen due to the differing patterns seen between the motorcycle riders in the single-vehicle crashes compared to the riders in the two-vehicle crashes.

This report defines a universal helmet law as one that requires motorcyclists 21 and older, regardless of insurance coverage, to wear a motorcycle helmet. Since 1968, State motorcycle helmet laws have been characterized by change. By 1980, many States had changed their motorcycle helmet laws, so that their motorcycle helmet laws covered only riders under 18. During the period 1997-2006, 5 States eased motorcycle helmet laws, while only 2 States made laws more comprehensive. As of June 2007, 20 States and the District of Columbia require all motorcyclists to wear helmets. Additionally, 27 States have laws requiring only some riders to wear helmets, varying by age and insurance restrictions (IIHS, 1). Three States have no motorcycle helmet laws at all.

During the 10-year time-period from 1997 through 2006, 13,883 motorcycle riders were fatally injured in single-vehicle fatal motorcycle crashes, with 51 percent of these riders being helmeted, 46 percent unhelmeted, and 3 percent with unknown helmet use. In single-vehicle fatal motorcycle crashes in States with a universal helmet law, 81 percent of motorcycle riders were helmeted, 16 percent were unhelmeted, and 4 percent with unknown helmet use. By comparison, in States without a universal helmet law, only 24 percent of riders were helmeted, 73 percent were unhelmeted, and 3 percent unknown. Some of the percentages discussed in this report may not total to 100 percent due to rounding. Please note that for additional precision the percent of each category of helmet use (helmeted/unhelmeted/unknown) is listed to the nearest one-hundredth of one percent in the appendices of this report.

In two-vehicle crashes between a motorcycle and a passenger vehicle, 11,573 motorcycle riders were fatally injured, with 59 percent helmeted, 38 percent unhelmeted, and 3 percent with unknown helmet use. Among two-vehicle crashes between a motorcycle and a passenger vehicle, in helmet law States 84 percent were helmeted and 12 percent were unhelmeted. By comparison, in States without a universal motorcycle helmet law, only 33 percent of motorcycle riders were helmeted, and 64 percent were unhelmeted.

III. Methodology

Data used in this analysis is from the Fatality Analysis Reporting System from the years 1997-2006. Only fatal crashes were considered where at least one person involved in each crash was fatally injured. The motorcycle crashes we examined were separated into two categories: (1) single-motorcycle crashes (referred to in the report as single-vehicle crashes) and (2) two-vehicle crashes involving one motorcycle and one passenger vehicle (referred to in the report as two-vehicle crashes). The focus of the report is on motorcycle rider helmet use, so nonoperating motorcycle passenger helmet use is not considered. There is significant variation in motorcycle helmet law coverage from State to State. Some States require all motorcyclists to wear helmets, while others cover only younger riders (the definition of *younger* varies as well). Still other States do not require helmets if the rider carries a specified amount of insurance (which varies as well). Given the considerable variation, our analysis concentrates only on motorcycle riders 21 and older. At this age threshold, motorcycle riders are either uniformly covered by a universal helmet law or they are not. For the purpose of this analysis, a universal helmet law is a State law that requires all motorcyclists 21 and older to wear a helmet, regardless of insurance coverage.

The FARS restraint use variable defines helmet use for this analysis. Code 05 for this variable represents helmet use in our study. Codes 00 and 15 represent the absence of helmet use.

This report examines the following factors as they relate to motorcycle helmet use in fatal crashes. Each factor is listed with the appropriate categories within that factor.

1. State Motorcycle Helmet Law: Universal or Nonuniversal.
2. Motorcycle Engine Size: 0-500cc, 501-1000cc, 1001-1500cc, >1500cc.
3. Time of Day: Day (6 a.m.-5:59 p.m.) or Night (6 p.m.-5:59 a.m.).
4. Weekday/Weekend: Weekday (Monday at 6 a.m. to Friday at 5:59 p.m.) or Weekend (Friday at 6 p.m. to Monday at 5:59a.m.).
5. Year—1997 to 2006.
6. Sex: Male or Female.
7. Injury Severity: Fatal Injury (K), Incapacitating Injury (A), Non-incapacitating Evident Injury (B), Possible Injury (C), Unknown Injury (U), No Injury (0).
8. Age Groups: 21-29, 30-39, 40-49, 50-59, >59.
9. Blood Alcohol Concentration (BAC): .00 grams per deciliter, .01 to .07 g/dL, .08+. Note: Currently, it is illegal for a driver to operate a motor vehicle if the driver has a BAC of .08 or above. This law applies to all 50 States and the District of Columbia.

A note on the terminology used in the report:

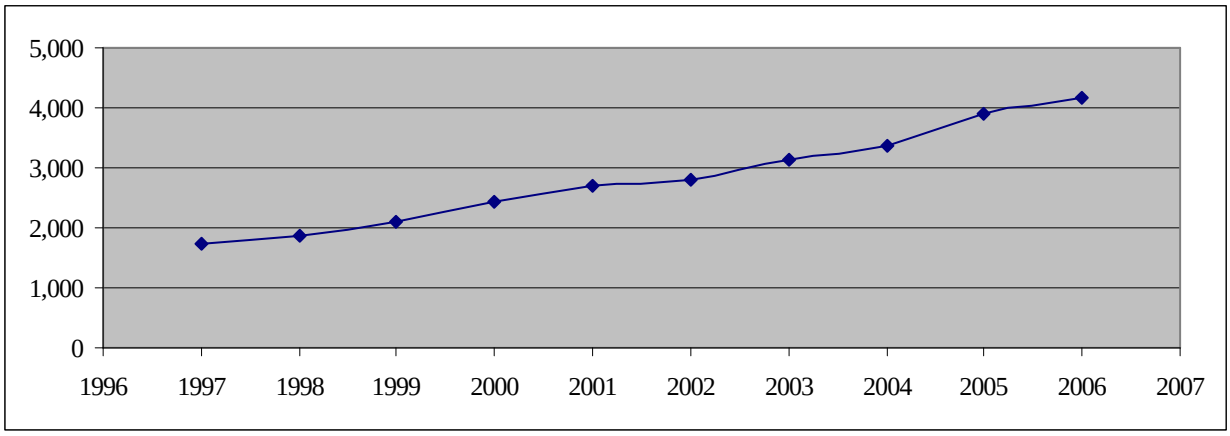
motorcycle rider *- the person operating or in control of the motorcycle*
motorcycle passenger *- the person seated behind the rider and not in control of the motorcycle*
motorcyclist *– a collective term used for any combined reference to the rider and passenger of the motorcycle*

IV. Results

Motorcycle Rider and Passenger Vehicle Driver Fatalities, 1997 to 2006

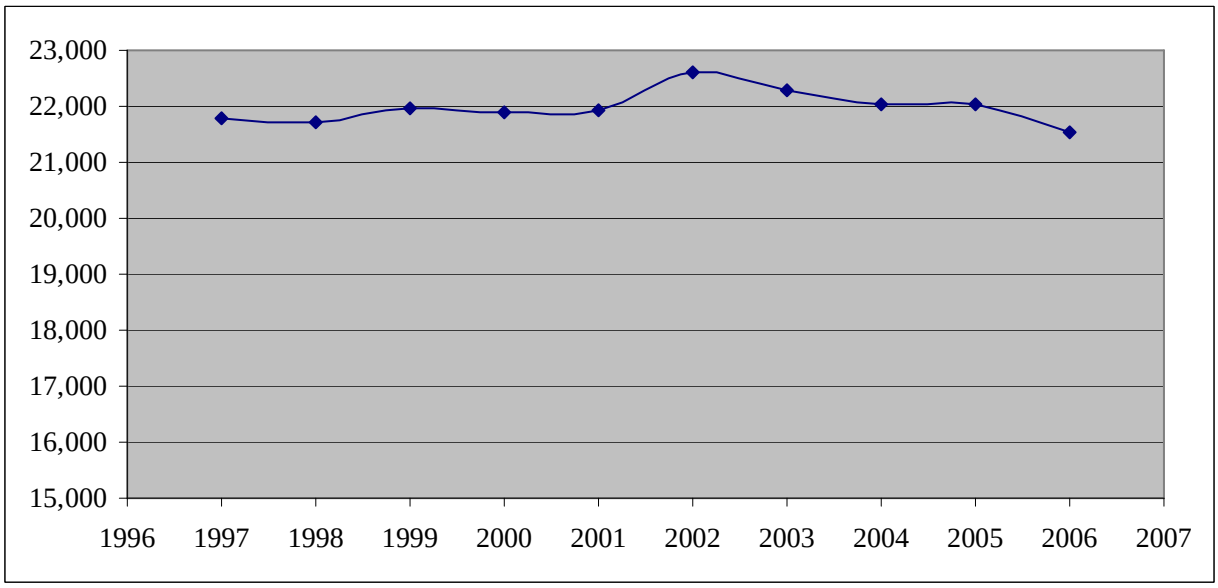
Motorcycle rider fatalities have risen from 1,742 in 1997 to 4,155 in 2006, an increase of 138 percent, while passenger vehicle driver fatalities have dropped 1.2 percent from 21,782 in 1997 to 21,527 in 2006. Figure 1 displays the annual count of motorcycle rider fatalities over this ten-year period, while Figure 2 shows the count of passenger vehicle driver fatalities for the same time-period.

Figure 1: Motorcycle Rider Fatalities, 1997-2006



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Figure 2: Passenger Vehicle Driver Fatalities, 1997-2006

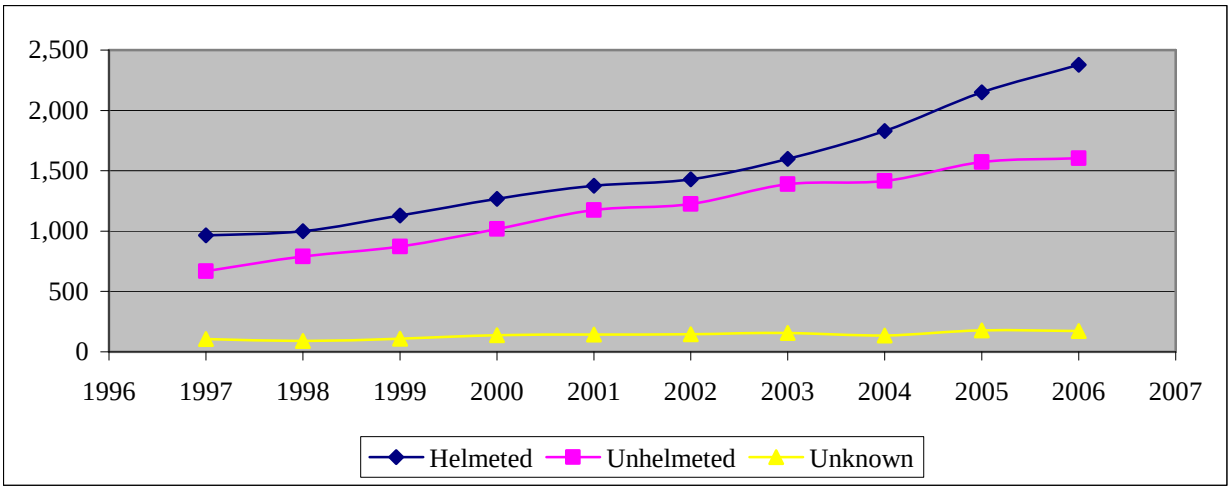


Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

The overall temporal trend of motorcycle rider fatalities in Figure 1 is stratified by the helmet use of the motorcycle rider and displayed in Figure 3. By comparison, the trend of passenger vehicle driver fatalities shown in Figure 2 is stratified according the restraint use of the driver, and displayed in Figure 4. For both motorcycle riders and passenger vehicle drivers, the proportion

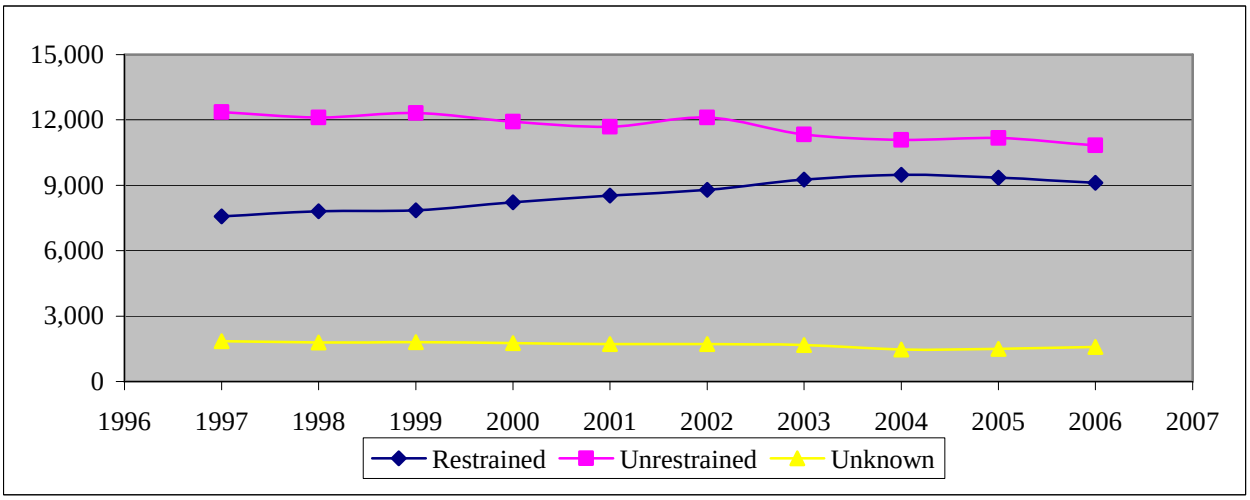
of fatally injured riders/drivers who were restrained has improved from 1997 to 2006. Motorcycle helmet use in fatal crashes increased from 55 percent in 1997 to 57 percent in 2006, while over the same years passenger vehicle driver restraint use in fatal crashes rose from 35 percent to 42 percent. It is important to note that the FARS database does not identify whether or not the individual motorcycle helmets involved in fatal crashes comply with U.S. Department of Transportation regulations. The National Occupant Protection Use Survey (NOPUS), a national probability-based sample survey of estimated that overall motorcycle helmet use at 51 percent in 2006. NOPUS estimated that overall seatbelt use for 2006 was 81 percent.

Figure 3: Motorcycle Rider Fatalities by Helmet Use, 1997-2006



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Figure 4: Passenger Vehicle Driver Fatalities by Restraint Use, 1997-2006



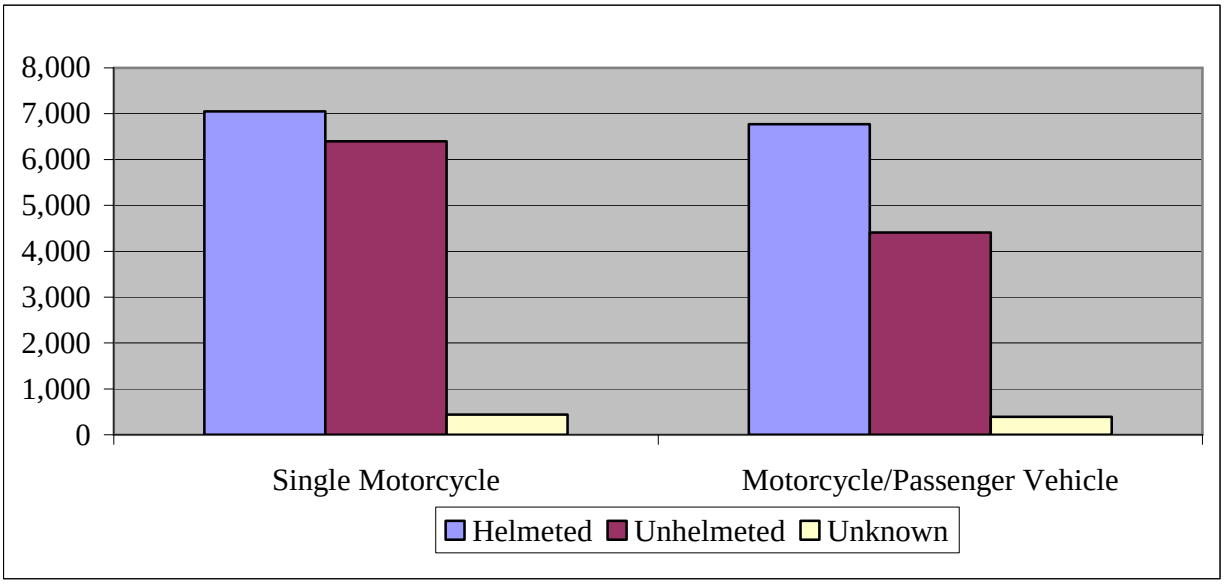
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Helmet Use

Single-Vehicle and Two-Vehicle Motorcycle Crashes

Over 25,000 motorcycle riders have been fatally injured in the last decade in either single-vehicle motorcycle crashes or two-vehicle crashes between a motorcycle and a passenger vehicle. As shown in Figure 5, 51 percent of the 13,883 motorcycle riders in single-vehicle fatal crashes were helmeted, 46 percent were unhelmeted, and 3 percent had unknown helmet use. In two-vehicle motorcycle-passenger vehicle fatal crashes, a total of 11,573 motorcycle riders were fatally injured, with 59 percent of these riders being helmeted, 38 percent unhelmeted, and 3 percent with unknown helmet use.

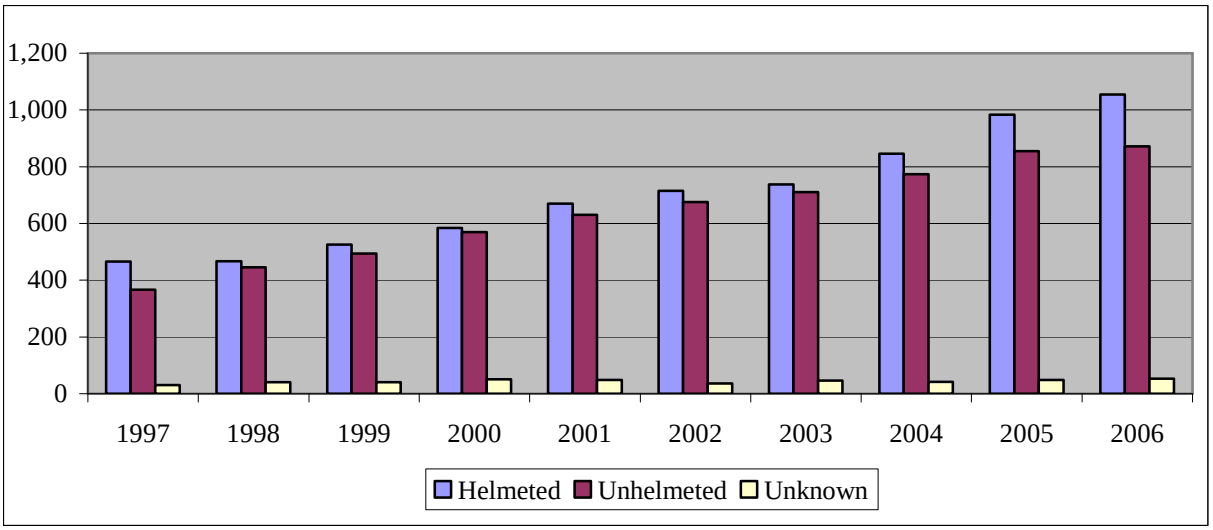
Figure 5: Motorcycle Rider Fatalities by Crash Type and Helmet Use



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

From 2003 to 2006, helmet use in fatal single-vehicle motorcycle crashes has risen from 49 percent to 53 percent, after remaining fairly constant since 1998 (see Figure 6). In 2006, 53 percent of motorcycle riders were helmeted, 44 percent were unhelmeted, and 3 percent had unknown helmet use.

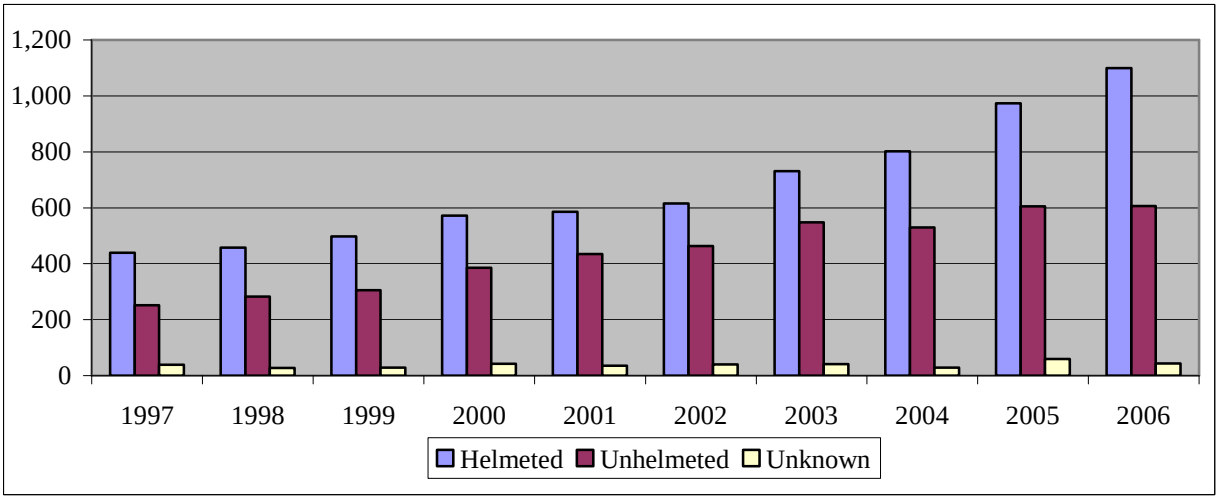
Figure 6: Motorcycle Rider Fatalities by Year and Helmet Use, Single-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

In multivehicle crashes, Figure 7 shows that rider helmet use dropped from 60 percent in 1997, down to 55 percent in 2001 through 2003, and then gradually rose to 63 percent in 2006. The year 2006 was the first year in the last decade that helmet use in multivehicle crashes climbed over 60 percent, as 63 percent of motorcycle riders were helmeted, 35 percent unhelmeted, and 3 percent unknown.

Figure 7: Motorcycle Rider Fatalities by Year and Helmet Use, Two-Vehicle Crashes



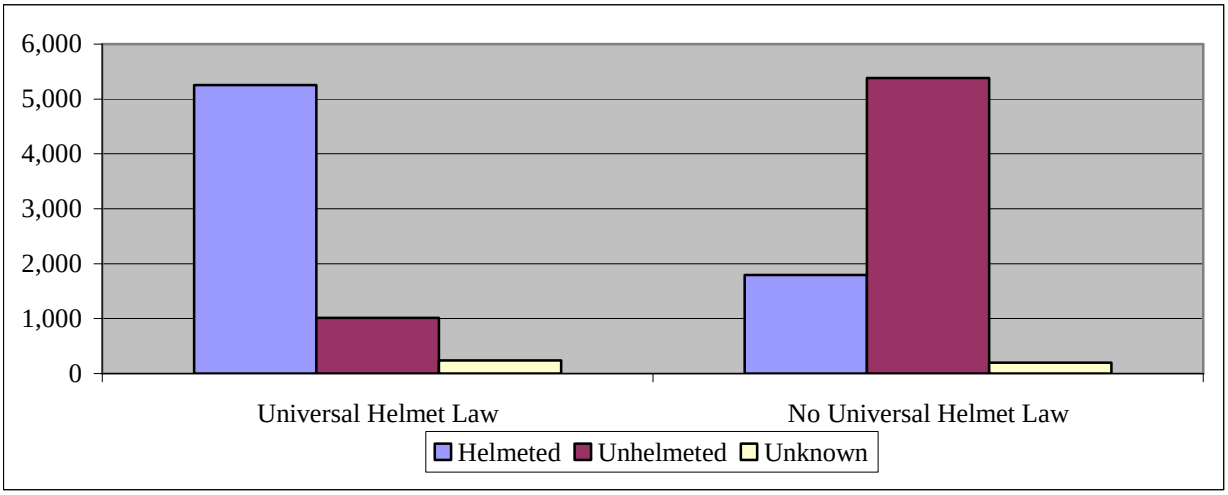
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

State Motorcycle Helmet Laws

Stratifying these riders according to the helmet law of the State in which the fatal crash occurred shows a strong association between helmet use and the existence of a universal helmet law. Figure 8 shows that in States with universal helmet laws for motorcycle riders 21 and older, 81 percent of these motorcycle riders were helmeted, and 16 percent were unhelmeted, with 4

percent unknown. By comparison, only 24 percent of motorcycle riders were helmeted in States without a universal helmet law, with 73 percent unhelmeted, and 3 percent unknown.

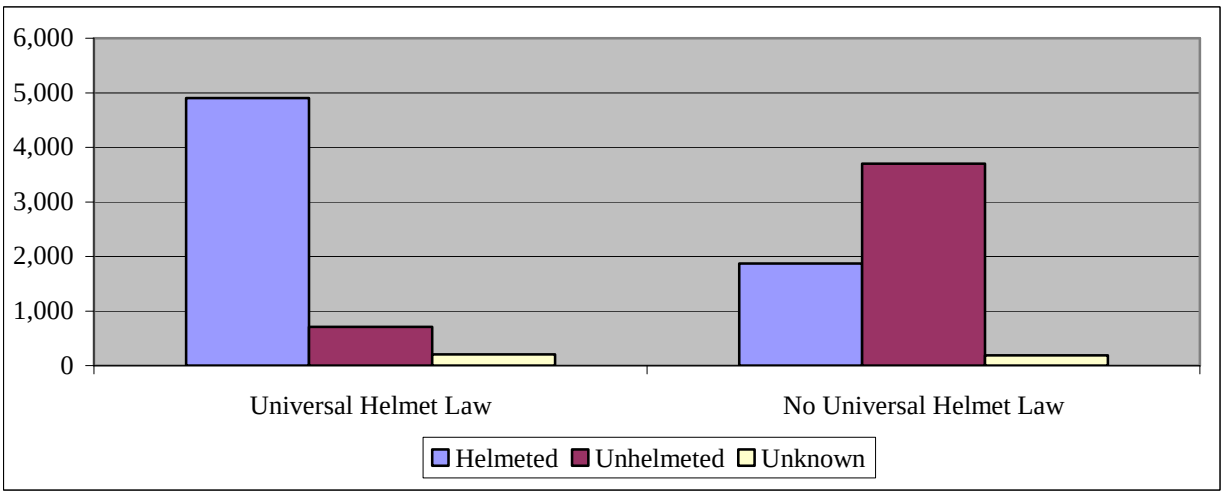
Figure 8: Motorcycle Rider Fatalities by State Helmet Law and Helmet Use, Single-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

In two-vehicle fatal crashes between a motorcycle and a passenger vehicle, Figure 9 shows that helmet use in States with a universal helmet law (84%) was 51 percentage points higher than in States without a universal helmet law (33%). Only 12 percent of motorcycle rider fatalities were unhelmeted in States with a universal helmet law, while 64 percent of motorcycle rider fatalities were unhelmeted in States without a universal helmet law.

Figure 9: Motorcycle Rider Fatalities by State Helmet Law and Helmet Use, Two-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Figures 8 and 9 display the differences in helmet use between motorcycle riders in universal helmet law States and in States without a universal helmet law. These differences, of above 50 percentage points in both single-vehicle motorcycle crashes as well as two-vehicle motorcycle-

passenger vehicle crashes, show that the existence of a universal helmet law is a strong predictor of motorcycle helmet use in fatal crashes.

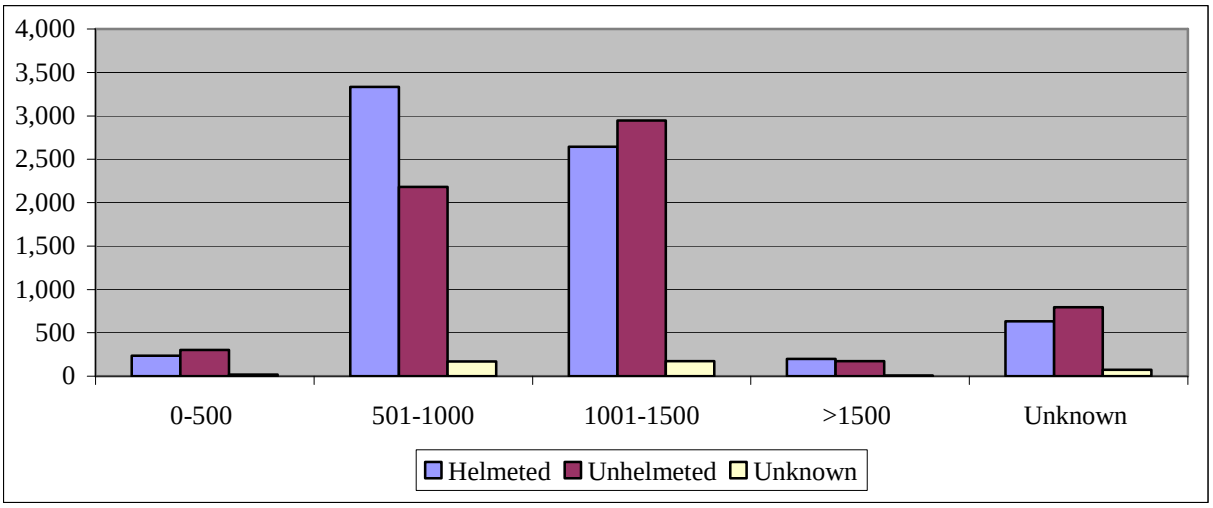
Motorcycle Engine Size

A large majority of the motorcycles involved in fatal crashes have an engine size that is either from 501 to 1000 or from 1001 to 1500 cubic centimeters (cc). The number of fatally injured motorcycle riders of each these engine sizes was more than 10 times as large as the number of motorcycle riders of smaller engines (0 to 500 cc) or larger engines (>1500 cc).

Among the 5,650 motorcycles with an engine size of 501 to 1000 cc, 59 percent of their riders were helmeted, with 38 percent unhelmeted, and 3 percent unknown (see Figure 8). The 5,747 riders of the motorcycles with a larger engine size (1001 to 1500 cc) were much less likely to be helmeted. Only 46 percent of these riders were helmeted, with 51 percent unhelmeted and 3 percent unknown. Among the 546 riders of motorcycles with the smallest engine size (0 to 500 cc), only 43 percent of these riders wore their helmets at the time of the crash, with 54 percent unhelmeted and 3 percent unknown.

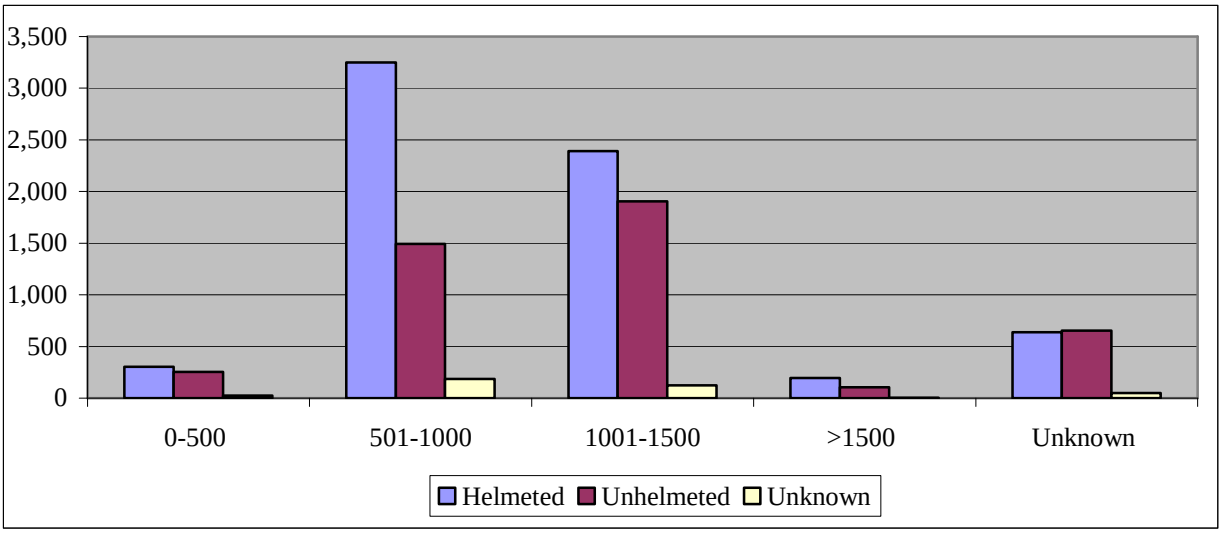
Figure 10 shows that, for two-vehicle fatal crashes between a motorcycle and a passenger vehicle, each category of motorcycle engine size had a larger proportion of helmeted riders than the corresponding category of motorcycle engine size among motorcycles in single-vehicle crashes, as shown in Figure 10. Sixty-six percent of riders of motorcycles of engine size 501 to 1000 cc were helmeted, with 30 percent unhelmeted and 4 percent unknown. The riders of the larger motorcycles of engine size 1001 to 1500 cc were 12 percent less likely to be helmeted, with only 54 percent wearing helmets, 43 percent unhelmeted, and 3 percent with unknown helmet use.

Figure 10: Motorcycle Rider Fatalities by Engine Size and Helmet Use, Single-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Figure 11: Motorcycle Rider Fatalities by Engine Size and Helmet Use, Two-Vehicle Crashes



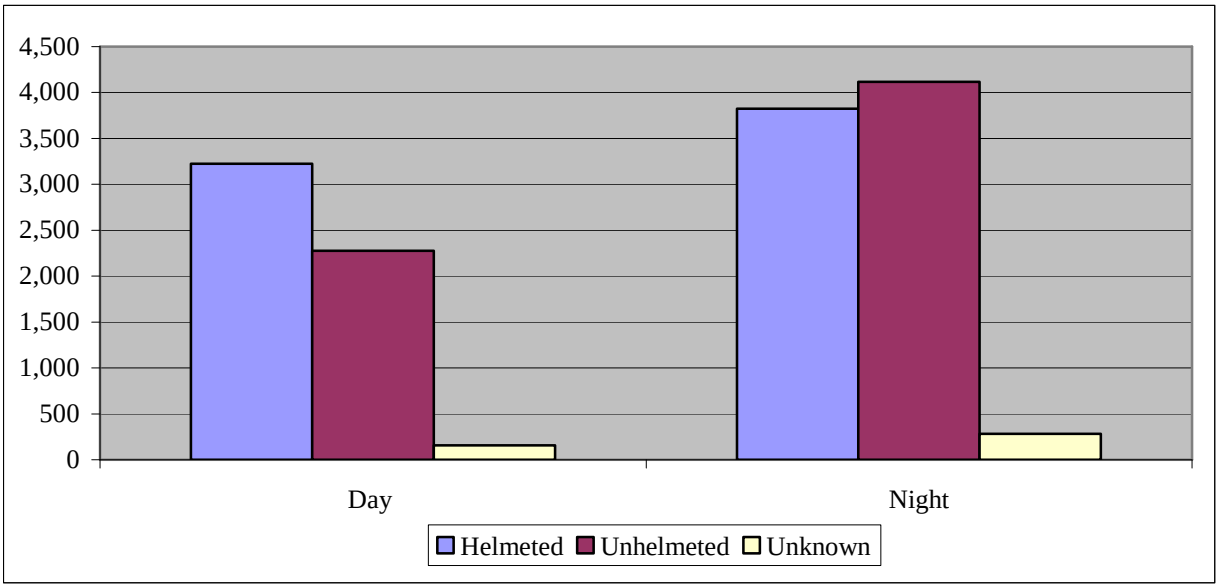
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Time of Day

For both single-vehicle and two-vehicle fatal motorcycle crashes, the helmet use was higher during the day than at night. The day is defined as 6 a.m. to 5:59 p.m. and the night is 6 p.m. to 5:59 a.m.. Figure 12 shows that during the day 57 percent of motorcycle riders in single-vehicle crashes were helmeted, compared to 47 percent of riders at night. In multivehicle crashes, 62 percent were helmeted during the day, versus 54 percent at night, as shown in Figure 13.

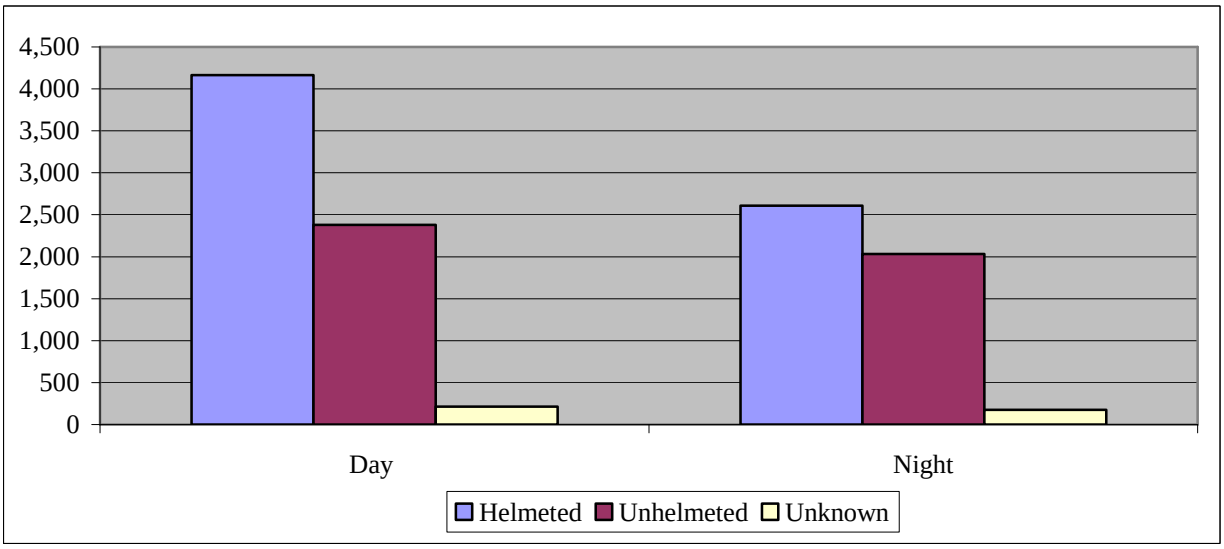
Fifty-nine percent (8,223) of fatally injured motorcycle riders in single-vehicle crashes were traveling at night, compared to 41 percent (5,660) who traveled during the day. This daytime versus nighttime distribution was nearly reversed among motorcycle riders in multivehicle fatal crashes, with 58 percent (6,757) of these fatally injured motorcycle riders traveling during the day, and 42 percent (4,816) traveling at night.

Figure 12: Motorcycle Rider Fatalities by Time of Day and Helmet Use, Single-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Figure 13: Motorcycle Rider Fatalities by Time of Day and Helmet Use, Two-Vehicle Crashes



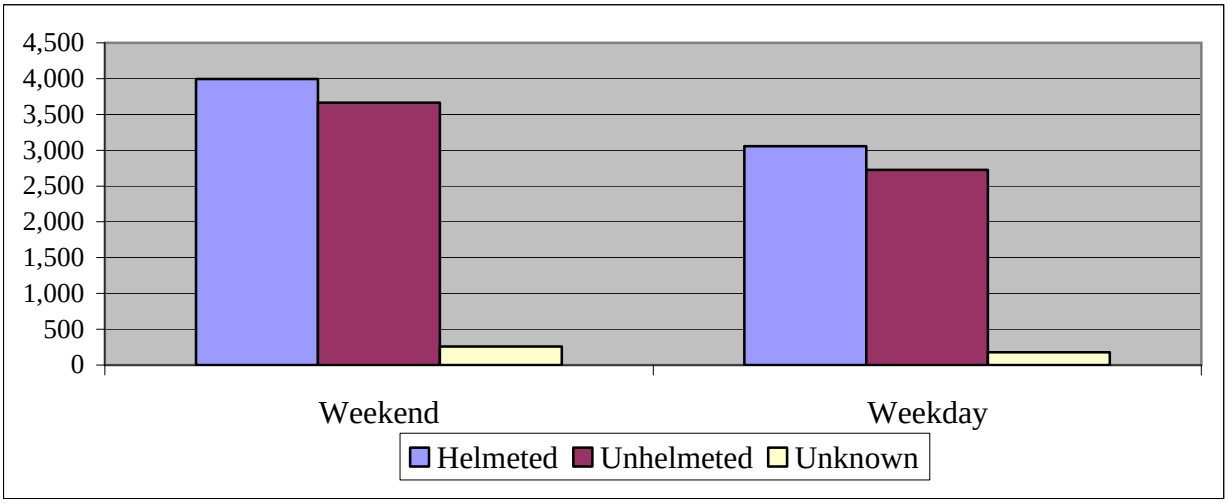
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Weekday/Weekend

In fatal crashes, the proportion of riders who were helmeted varied little between weekday and weekend. Weekday is defined as Monday morning at 6 a.m. to Friday at 5:59 p.m., and weekend is Friday 6 p.m. to Monday 5:59 a.m. For both single-vehicle and multivehicle crashes, the proportion of motorcycle riders who were helmeted differed by no more than one percentage point (see Figures 14 and 15) between crashes that occurred on the weekday and crashes that occurred on the weekend. For single-vehicle crashes, 57 percent of crashes occurred on

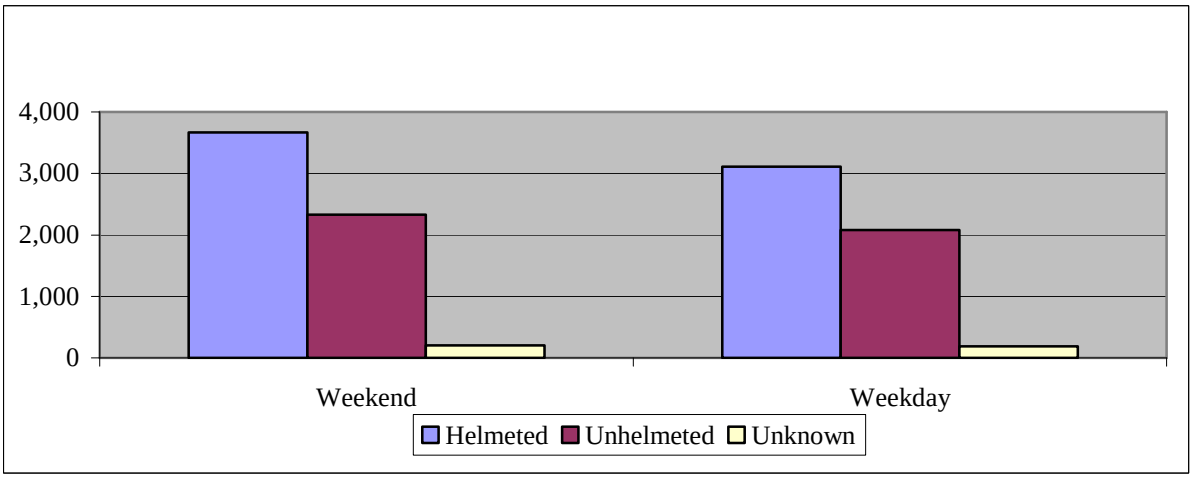
weekends, while 43 percent of crashes occurred on weekdays. For two-vehicle crashes, 54 percent of crashes occurred on weekends and 46 percent of crashes occurred on weekdays.

Figure 14: Motorcycle Rider Fatalities by Weekday/Weekend and Helmet Use, Single-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Figure 15: Motorcycle Rider Fatalities by Weekday/Weekend and Helmet Use, Two-Vehicle Crashes



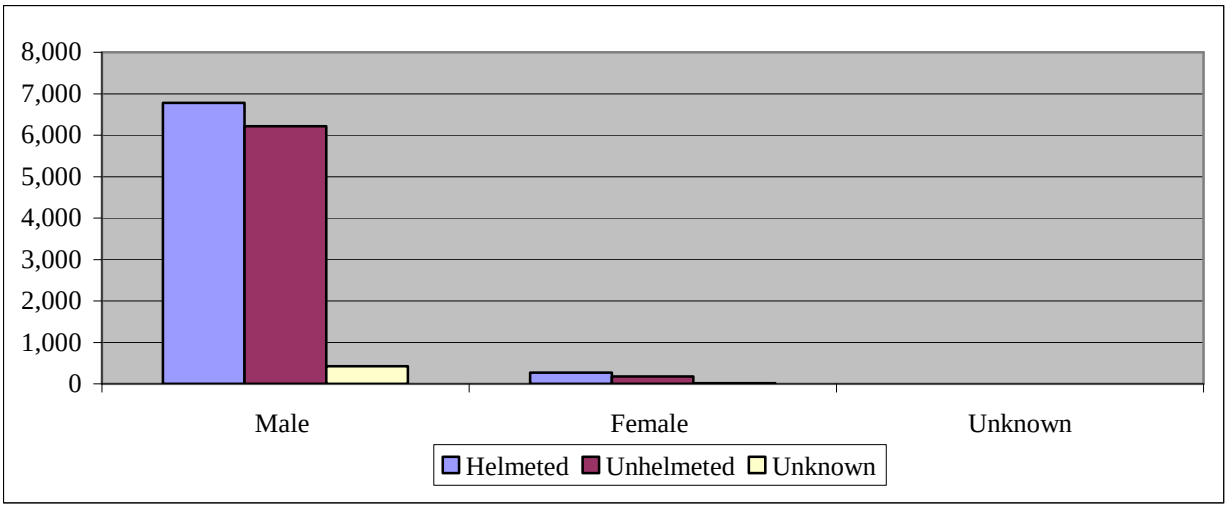
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Sex

Among the motorcycle riders examined in this study, in both single-vehicle motorcycle crashes and multivehicle crashes between motorcycles and passenger vehicles, the overwhelming majority of motorcycle riders were male (97%), while only 3 percent were female.

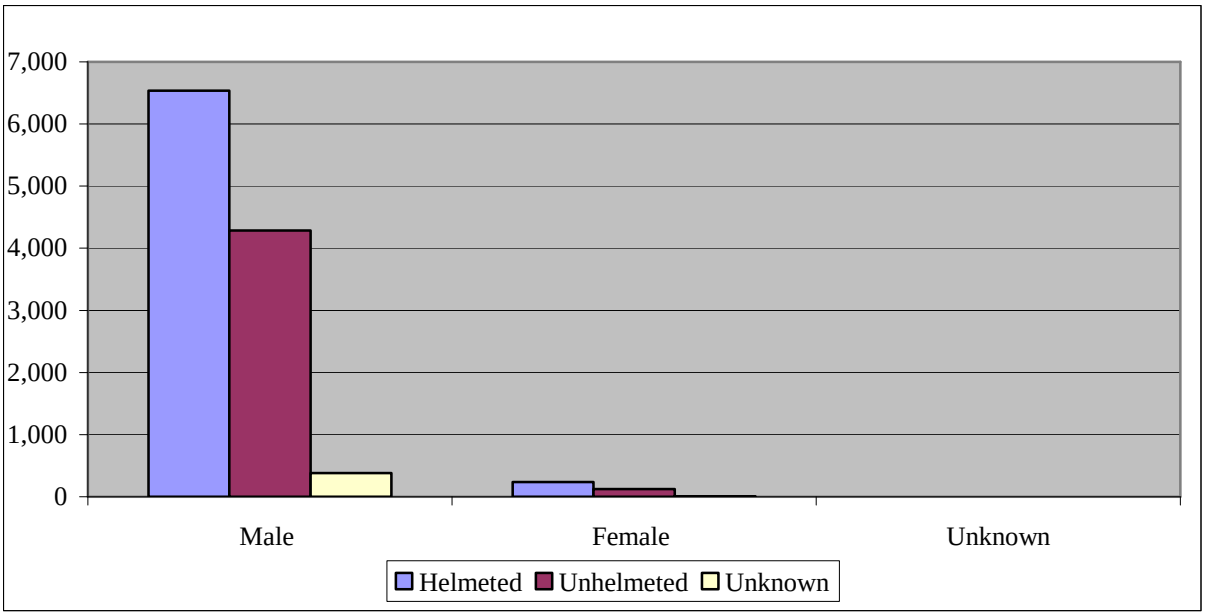
In single-vehicle motorcycle crashes, female riders (59%) were more frequently helmeted than male riders (51%), as shown in Figure 16. Figure 17 shows that female riders in motorcycle / passenger vehicle crashes were helmeted 64 percent, and unhelmeted 34 percent, with unknown helmet use of 1 percent. Male riders in these multivehicle crashes were less often helmeted than female riders, which mirrors the trend seen in single-vehicle crashes. Only 58 percent of male riders in multivehicle crashes were helmeted, with 38 percent unhelmeted, and 3 percent unknown.

Figure 16: Motorcycle Rider Fatalities by Sex and Helmet Use, Single-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Figure 17: Motorcycle Rider Fatalities by Sex and Helmet Use, Two-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Injury Severity

Table 1 shows that in two-vehicle crashes between a motorcycle and a passenger vehicle, the motorcycle rider was killed 95 percent of the time, while the passenger vehicle driver was killed only one percent of the time. Ninety-three percent (12,969 fatalities) of the 13,883 motorcycle riders in single-vehicle crashes were fatally injured, as shown in Table 2 **(**p. 15**).** Among the 11,573 two-vehicle fatal crashes between a motorcycle and a passenger vehicle, Table 3 (p. 15-16) shows that the motorcycle rider was killed 95 percent of the time (10,998 fatalities out of 11,573 motorcycle-rider fatalities), while Table 4 (p. 16) shows that the passenger vehicle driver was killed 1 percent of the time (which translates to 108 fatalities out of a total of 11,573 passenger vehicle driver fatalities). A pedestrian or bicyclist was killed in the remainder of each of these 11,573 fatal crashes involving one motorcycle rider and one passenger vehicle driver, with at least one person in the crash being fatally injured; 71 percent of the passenger vehicle drivers were not injured (8,211 out of 11,573) compared to 0.3% of motorcycle riders (32 out of 11,573).

Table 4 shows the distribution of injury severity for passenger vehicle drivers among two-vehicle crashes between motorcycles and passenger vehicles. Table 4 (passenger vehicle drivers) presents a stark contrast with Table 3 (motorcycle riders) for injury severity between the different vehicles involved in the two-vehicle crashes. Only 1 percent of the 11,573 passenger vehicle drivers were fatally injured, 4 percent received an “incapacitating” injury, 12 percent received a “non-incapacitating” injury, while 83 percent of the passenger vehicle drivers had either a possible injury or were not injured. By comparison, Table 3 shows that 95 percent of the motorcycle riders were fatally injured, 3 percent received an incapacitating injury, 1 percent received a “non-incapacitating” injury and 0.5 percent had either a possible injury or were not injured.

Table 1: Survival Status of Riders/Drivers in Motorcycle/Passenger Vehicle Crashes, 1997-2006							
		Killed		Survived		Total	
		#	%	#	%	#	%
Vehicle Type	Passenger Vehicle	108	0.93	11,465	99.07	11,573	100
	Motorcycle	10,998	95.03	575	4.97	11,573	100
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF							

Table 2: Motorcycle Rider Fatalities by Injury Severity and Helmet Use, Single-Vehicle Crashes, 1997-2006								
Motorcycle Rider Injury Severity	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Fatal Injury (K)	6,599	50.88	5,962	45.97	408	3.15	12,969	100
Incapacitating Injury (A)	228	48.93	226	48.5	12	2.58	466	100
Non-incapacitating Evident Injury (B)	139	47.77	146	50.17	6	2.06	291	100
Possible Injury (C)	44	57.89	30	39.47	2	2.63	76	100
No Injury (0)	38	50.67	29	38.67	8	10.67	75	100
Injury, Severity Unknown	2	50.00	1	25.00	1	25.00	4	100
Unknown	0	0.00	0	0.00	2	100.00	2	100
Total	7,050	50.78	6,394	46.06	439	3.16	13,883	100
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Table 3: Motorcycle Rider Fatalities by Injury Severity and Helmet Use, Two-Vehicle Crashes, 1997-2006								
Motorcycle Rider Injury Severity	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Fatal Injury (K)	6,503	59.13	4,124	37.50	371	3.37	10,998	100
Incapacitating Injury (A)	197	49.62	189	47.61	11	2.77	397	100
Non-incapacitating Evident Injury (B)	50	42.02	66	55.46	3	2.52	119	100
Possible Injury (C)	9	36.00	15	60.00	1	4.00	25	100
No Injury (0)	15	46.88	16	50.00	1	3.13	32	100
Injury, Severity Unknown	0	0.00	1	50.00	1	50.00	2	100
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Table 4: Passenger Vehicle Driver Fatalities by Injury Severity and Restraint Use, Two-Vehicle Crashes, 1997-2006								
Passenger Vehicle Driver Injury Severity	Restraint Use						Total	
	Restrained		Unrestrained		Unknown			
	#	%	#	%	#	%	#	%
Fatal Injury (K)	61	56.50	42	38.90	5	4.63	108	100
Incapacitating Injury (A)	318	75.70	79	18.80	23	5.48	420	100
Non-incapacitating Evident Injury (B)	1,046	78.00	186	13.90	109	8.13	1,341	100
Possible Injury (C)	1,189	83.30	122	8.54	117	8.19	1,428	100
No Injury (0)	6,725	81.90	685	8.34	801	9.76	8,211	100
Unknown	15	40.50	1	2.70	21	56.8	37	100
Injury, Severity Unknown	17	60.70	7	25.00	4	14.30	28	100
Total	9,371	81.00	1,122	9.69	1,080	9.33	11,573	100
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

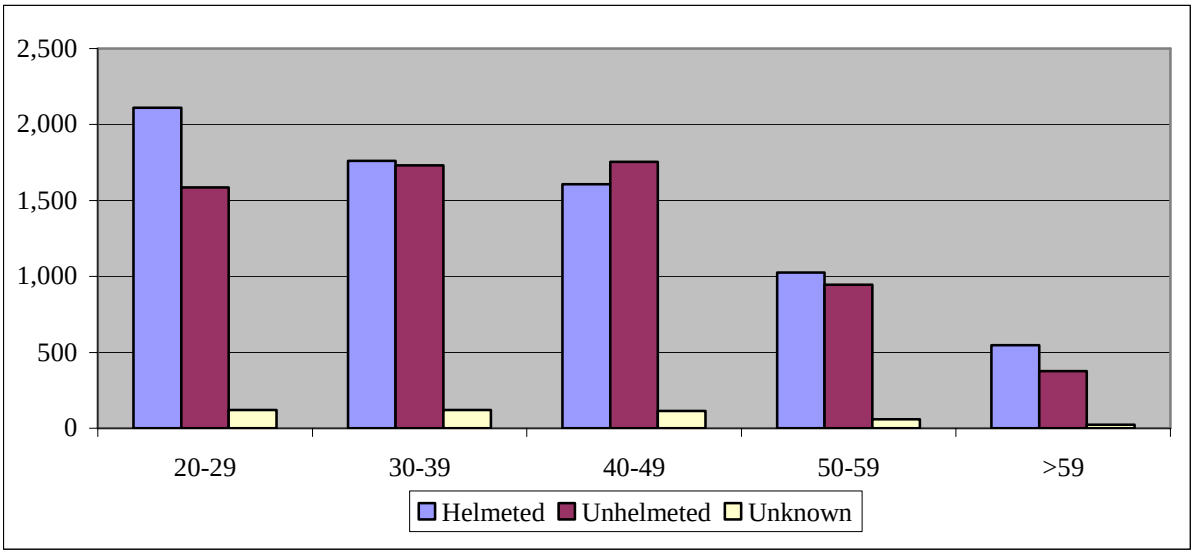
Age Group

In both single-vehicle and multivehicle motorcycle crashes, motorcycle riders in the 20 to 29 age range and the over 59 age range had the highest helmet use, and 40- to 49-year-olds had the lowest helmet use. Figures 18 and 19 display helmet use among different age groups for single-vehicle and multivehicle motorcycle crashes respectively.

In single-vehicle motorcycle crashes, 55 percent of 20- to 29-year-olds were helmeted, 42 percent were unhelmeted, and 3 percent unknown, while similarly 58 percent of motorcycle riders 60 or older were helmeted, 40 percent were unhelmeted, and 3 percent unknown. These two age categories had the highest percent of motorcycle riders helmeted. Less than 50 percent of riders age 30 to 39 (49%) and age 40 to 49 (46%) were helmeted.

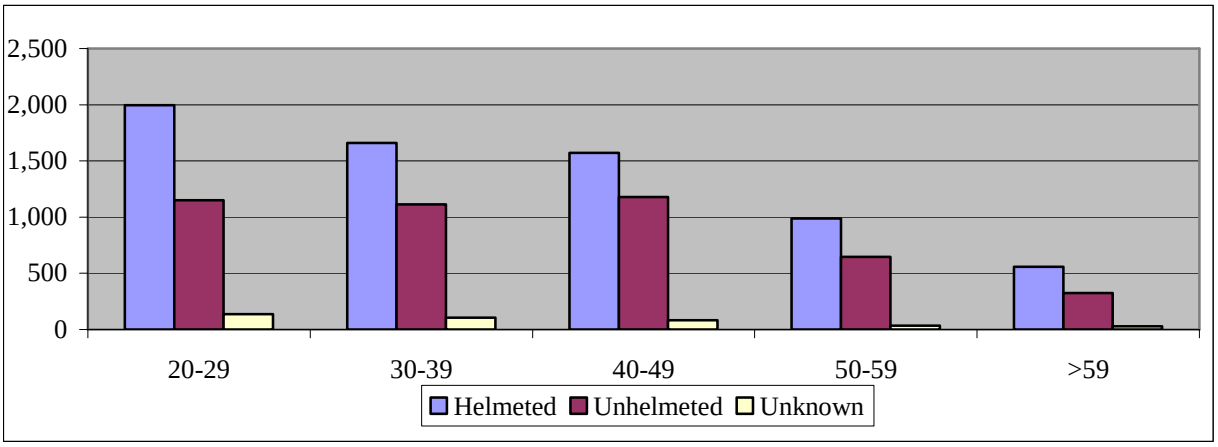
The helmet use among motorcycle riders in multivehicle crashes was also greatest among 20- to 29-year-olds (61%) and those 60 and older (61%), and lowest among 40- to 49-year-olds (55%) and 30- to 39-year-olds (58%). For each age range, the helmet use was higher among motorcycle riders in multivehicle crashes, than among motorcycle riders in single-vehicle crashes.

Figure 18: Motorcycle Rider Fatalities by Age Group and Helmet Use, Single-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Figure 19: Motorcycle Rider Fatalities by Age Group and Helmet Use, Two-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Number of Motorcyclists per Motorcycle

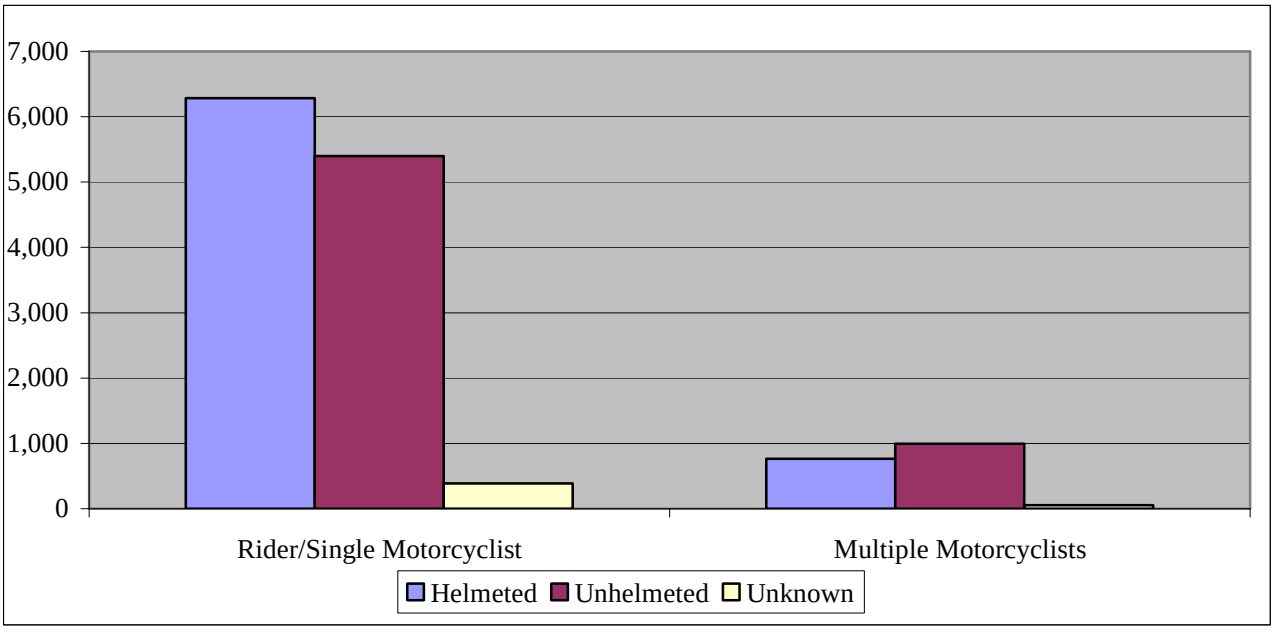
For the reader's convenience we restate the definitions for motorcycle rider, motorcycle passenger, and motorcyclist below:

motorcycle rider *- the person operating or in control of the motorcycle*
motorcycle passenger *- the person seated behind the rider and not in control of the motorcycle*
motorcyclist *– a collective term used for any combined reference to the rider and passenger of the motorcycle*

In fatal crashes where the only motorcyclist was the rider, the rider was helmeted in 52 percent of single-vehicle fatal crashes, unhelmeted in 45 percent of these crashes, and helmet use was unknown in the remaining 3 percent of these crashes (see Figure 20). In 12,069 (87%) of the 13,883 single-vehicle motorcycle crashes, the only motorcyclist was the motorcycle rider, while in 1,814 (13%) single-vehicle crashes, there were two or more motorcyclists on the motorcycle. The helmet use of the rider was only 42 percent when there were two or more motorcyclists on the motorcycle. This helmet usage was 10 percentage points less than when the only motorcyclist was the rider.

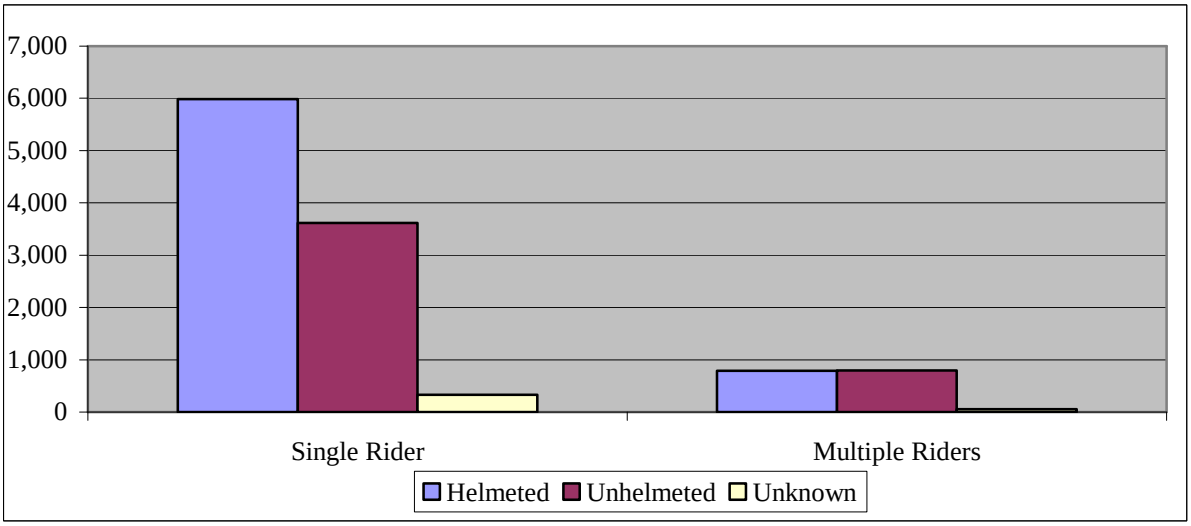
While helmet use was 10 percentage points higher in single-vehicle crashes when the only motorcyclist was the rider, a similar pattern was seen among motorcycle riders in multivehicle crashes. Figure 21 shows that 60 percent of motorcyclists were helmeted when the only motorcyclist was the rider, while only 48 percent of riders were helmeted when two or more motorcyclists were on the motorcycle.

Figure 20: Motorcycle Rider Fatalities by Number of Motorcyclists and Helmet Use, Single-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Figure 21: Motorcycle Rider Fatalities by Number of Riders and Helmet Use, Two-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

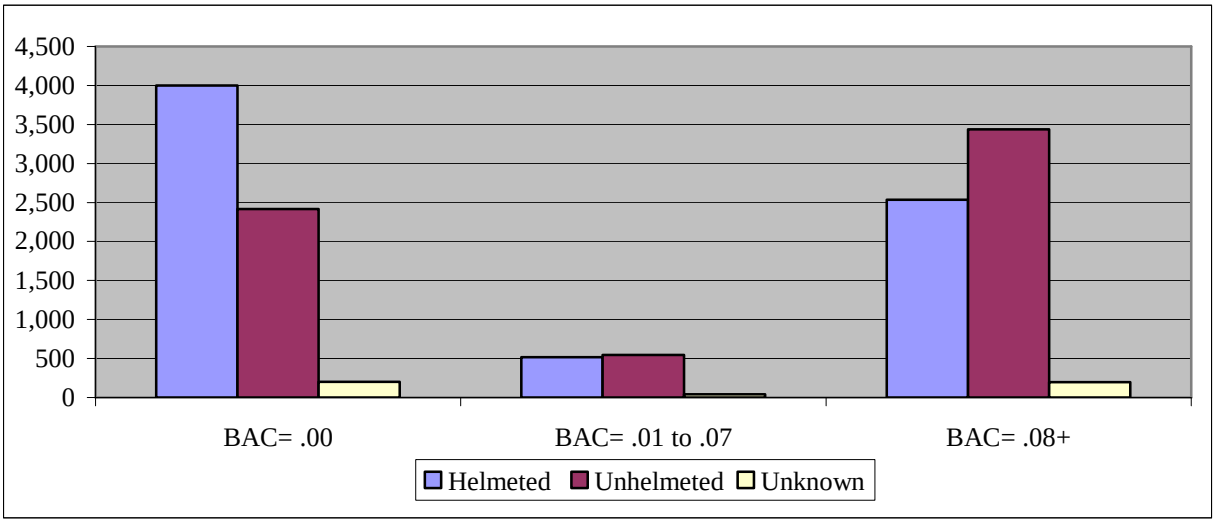
Blood Alcohol Concentration

Figure 22 shows that motorcycle riders with zero blood alcohol concentration (BAC=.00 grams per deciliter) values were helmeted 60 percent of the time in single-vehicle crashes. Conversely, riders with BAC values at the other end of the spectrum (BAC=.08+) were helmeted at a rate of only 41 percent (as seen in Figure 22).

Figure 23 demonstrates that motorcycle riders involved in single-vehicle crashes had more fatalities with high-level BAC values than did motorcycle riders involved in two-vehicle crashes. In two-vehicle crashes, riders with BAC=.00 g/dL had the highest helmet use (61%), while those with BAC=.01 to .07 g/dL had a lower helmet use (53%), and those with BAC=.08+ had the lowest helmet use (46%).

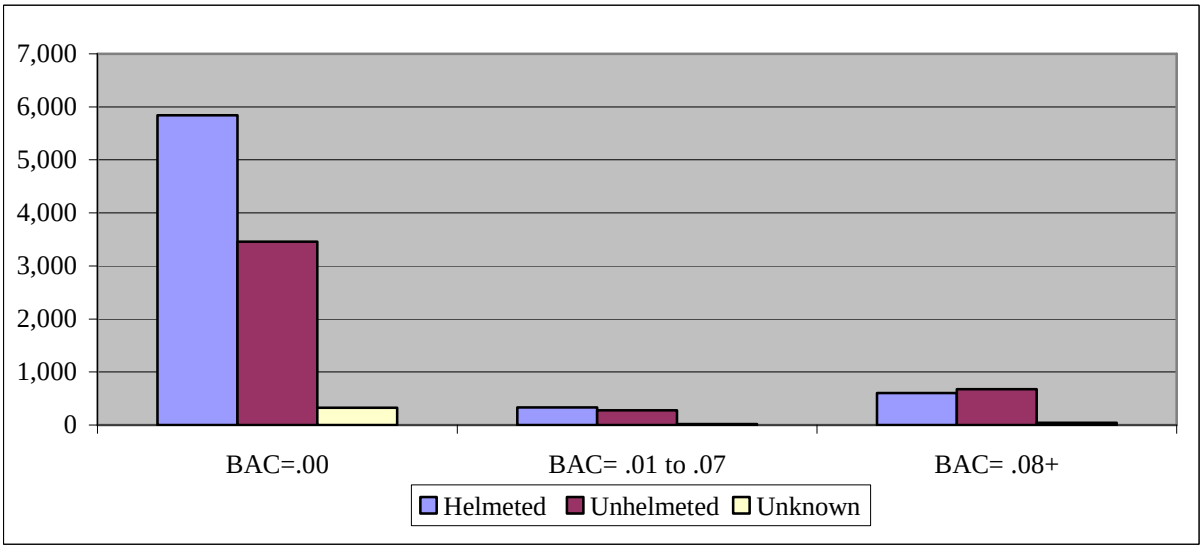
Overall, 44 percent of motorcycle riders in single-vehicle crashes had BACs of .08 or greater. By comparison, only 11 percent of motorcycle riders in two-vehicle crashes between a motorcycle and a passenger vehicle had BACs of .08 or greater.

Figure 22: Motorcycle Rider Fatalities by BAC Group and Helmet Use, Single-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Figure 23: Motorcycle Rider Fatalities by BAC Group and Helmet Use, Two-Vehicle Crashes



Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

V. Logistic Regression Analysis

This section examines fatal crashes involving motorcycles and models the probability that a motorcycle rider wears a helmet. Separate logistic regression analyses were conducted on single-vehicle crashes and two-vehicle crashes to determine if there are any fundamental differences in helmet use between the two types of crashes. Tables 5 and 6 present the odds ratios produced through the logistic regression analyses. The various levels of the categorical variables used in the analysis and their reference categories are listed next:

Dependent Variable

- Helmet Use: Helmet used, helmet not used

Independent Variables

- Age Group: 20-29, 30-39, 40-49, 50-59, and >59. (reference: 20-29)
- BAC Level: .00, 0.1-.07, and .08+. (reference: .00)
- Time of Day: Day=6 a.m. to 5:59 p.m., Night=6 p.m. to 5:59 a.m. (reference: day)
- Motorcycle Engine Size: 0-500cc, 501-1000cc, 1001-1500cc, >1500cc, and Unknown cc. (reference: 0-500cc)
- State Motorcycle Helmet Law: Universal Helmet Law versus No Universal Helmet Law. (reference: Universal Helmet Law)

The preceding variables represent those that were found significant at the alpha=0.05 level in the logistic regression analysis. Not all of the variables presented in the tabulations before were found significant in the logistic analysis. This difference exists because this logistic regression estimates the influence of a single variable on the probability of helmet use, holding the other variables constant.

The odds ratios in Tables 5 and 6 show the odds that a motorcycle rider involved in a fatal crash in a particular category wore a helmet divided by the odds that a motorcycle rider in the associated reference category wore a helmet. For example, a motorcycle rider older than 59 is 1.4 times more likely to wear a helmet than a motorcycle rider in the 20-29 reference age group, holding other factors constant. Another way to State this result is that, on average, the odds of a motorcycle rider older than 59 wearing a helmet are 40 percent greater (odds ratio=1.4 which is derived from 1.4 - 1.0=0.4, translated to a percentage: 0.4*100=40%) than the odds of a motorcycle rider in the 20-29 reference age group. Conversely, motorcycle riders in the 30-39 age group (for single-vehicle crashes) have an odds ratio of 0.84. This indicates that, relative to fatally-injured motorcycle riders in the 20-29 reference age group, fatally-injured motorcycle riders in the 30-39 age group are approximately 16 percent less likely to be helmeted (0.84 - 1.0 = -0.16). Translated to a percentage basis, this is equivalent to: -0.16*100 = -16%, or a reduction in odds of 16 percent.

The results of the logistic analysis are similar for single-vehicle crashes and two-vehicle crashes, so their summary is presented collectively:

Age Group

The odds ratios of the 30-39 and 40-49 age groups indicate that relative to the 20-29 age group, those motorcycle riders are less likely to wear a motorcycle helmet. However, since the odds ratios of the 50-59 and over-59 age groups are greater than 1, those groups are more likely to wear a motorcycle helmet.

In Table 5, which models helmet use in single-vehicle motorcycle crashes, an odds ratio of 1.40 is seen for motorcycle riders older than 59 compared to riders in the 20-29 reference age group. This example of the impact of age on helmet use estimates that in single-vehicle crashes, the odds that riders older than 59 are helmeted are 40 percent higher than riders age 20-29.

BAC Level

Motorcycle riders with positive BAC (.01 to .07) values are less likely to wear motorcycle helmets than those riders with a BAC value of .00. Motorcycle riders with higher BAC values (.08+) are the least likely to be helmeted.

The odds ratio of 0.73 is seen in the Odds Ratio column of the BAC section of Table 5, which examined single-vehicle crashes. This result estimates the impact that having a BAC of .08 or greater had on a rider's likelihood of helmet use, compared to riders in the reference category of BAC=.00. In single-vehicle crashes, the odds of an rider with a BAC of .08 or greater being helmeted is thus 27 percent less than an rider with a BAC of .00.

Time of Day

The odds ratios indicate that motorcycle riders involved in fatal crashes at night are less likely to wear helmets relative to those involved in daytime fatal crashes.

Table 6 models helmet use in two-vehicle crashes between a motorcycle and a passenger vehicle. This table shows an odds ratio of 0.89 for helmet use of motorcycle riders at night (6 p.m. to 5:59 a.m.) compared to the reference group of riders during the day (6 a.m. to 5:59 p.m.). The odds of motorcycle riders in these crashes being helmeted is therefore 11 percent less at night compared to during the day.

Engine Size

Relative to motorcycle riders riding motorcycles in the 0-500cc range, those riding motorcycles in the 501-1000cc and the over-1500cc range are more likely to be helmeted. However those riding motorcycles in the 1001-1500cc range are less likely to be helmeted relative to those riding motorcycles in the 0-500cc range.

The odds ratio of 1.72 is seen in the Odds Ratio column of the Engine Size section of Table 6, which examined two-vehicle crashes. This result estimates the impact that having an engine size greater than 1500 cc had on a rider's likelihood of helmet use, compared to riders in the reference category of engine size (0 to 500 cc). In two-vehicle crashes, the odds of an rider with an engine size of greater than 1500 cc being helmeted is thus 72 percent higher than an rider with an engine size of 0 to 500 cc.

Helmet Law

Motorcycle riders in States without universal helmet laws are much less likely to wear helmets relative to riders in States that require all motorcyclists to wear helmets.

Table 5 shows the calculated odds ratio of 0.28 for helmet use in single-vehicle crashes, comparing riders in a State with a universal helmet law to riders in a State that did not have a universal helmet law. This result states that the odds that an rider in a single-vehicle crash wore a helmet was 72 percent less in States without a universal helmet law, compared to States with a universal helmet law.

Table 6 shows the comparable odds ratio of 0.31 for two-vehicle crashes. The absence of a universal helmet law thus led to a 69-percent reduction in the odds of a rider wearing a motorcycle helmet among two-vehicle crashes.

In this study's model, the existence of a universal helmet law was the strongest predictor of a motorcycle rider's helmet use in a fatal crash.

For these variables and their categories, the estimated logistic regression coefficients, their associated standard errors, and p-values are listed in the appendix on pages 38 and 39.

Table 5: Logistic Regression Predicting Motorcycle Helmet Use in Fatal Single-Vehicle Crashes, 1997-2006

Parameter	Level	Odds Ratio	95% Confidence Interval of the Odds Ratio		Difference in Odds From Reference Category
Age Group	30-39 (vs. 20-29)	0.8443	0.7794	0.9147	-0.1557
	40-49 (vs. 20-29)	0.8647	0.7983	0.9366	-0.1353
	50-59 (vs. 20-29)	1.0461	0.9499	1.1521	0.0461
	>59 (vs. 20-29)	1.4023	1.2299	1.5989	0.4023
BAC Level	.01 to .07 (vs. 0.0)	0.8795	0.7958	0.9720	-0.1205
	.08+ (vs. 0.0)	0.7266	0.6784	0.7782	-0.2734
Time of Day	Night (vs. Day)	0.9312	0.8894	0.9750	-0.0688
Engine Size	501-1000 cc. (vs. 0-500 cc.)	1.6906	1.5425	1.8529	0.6906
	1001-1500 cc. (vs. 0-500 cc.)	0.9876	0.8057	1.2105	-0.0124
	>1500 cc. (vs. 0-500 cc.)	1.3785	1.2633	1.5043	-0.3785
	Unknown cc. (vs. 0-500 cc.)	0.6976	0.6191	0.7861	-0.3024
Helmet Law	No Universal Helmet Law (vs. Universal Helmet Law)	0.2846	0.2729	0.2968	-0.7154

Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Table 6: Logistic Regression Predicting Motorcycle Helmet Use in Fatal Two-Vehicle Crashes, 1997-2006					
Parameter	**Level**	**Odds Ratio**	**95% Confidence Interval of the Odds Ratio**		**Difference in Odds From Reference Category**
Age Group	**30-39 (vs. 20-29)**	0.8371	0.7692	0.9110	-0.1629
	40-49 (vs. 20-29)	0.9052	0.8360	0.9801	-0.0948
	50-59 (vs. 20-29)	1.1200	1.0168	1.2336	0.1200
	>59 (vs. 20-29)	1.3171	1.1660	1.4877	0.3171
BAC Level	**.01 to .07 (vs. 0.0)**	0.9935	0.8769	1.1256	-0.0065
	.08+ (vs. 0.0)	0.7899	0.7094	0.8797	-0.2101
Time of Day	**Night (vs. Day)**	0.8907	0.8506	0.9328	-0.1093
Engine Size	**501-1000 cc. (vs. 0-500 cc.)**	1.5443	1.4044	1.6982	0.5443
	1001-1500 cc. (vs. 0-500 cc.)	0.8589	0.6891	1.0705	-0.1411
	>1500 cc. (vs. 0-500 cc.)	1.7239	1.5718	1.8907	0.7239
	Unknown cc. (vs. 0-500 cc.)	0.5765	0.5099	0.6518	-0.4235
Helmet Law	**No Universal Helmet Law (vs. Universal Helmet Law)**	0.3147	0.3009	0.3292	-0.6853
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF					

An example of the potentially different results from a tabulation and a regression model is seen when examining motorcycle rider helmet use across different age groups. The regression model shows that after adjusting for the other factors examined in this report, the age category of 30- to 39-year-olds were seen to be the least likely to be helmeted. By comparison, without adjusting for other variables, the table of helmet use by age range shows that riders in the 40-49 age range had the least helmet use. These results apply to both the single-vehicle and the two-vehicle crashes discussed in this report. This example underscores the importance of comparing the tabular results against analytical models.

VI. Conclusion

This report examined the helmet use of motorcycle riders age 21 and older involved in fatal crashes, during 1997-2006. Crashes were stratified into single-vehicle motorcycle crashes and two-vehicle crashes involving one motorcycle and one passenger vehicle. A descriptive exploratory data analysis was followed by a more rigorous logistic regression analysis to examine the relationship between motorcycle rider helmet use and a variety of factors.

Factors most highly correlated with motorcycle rider helmet use include the following: the existence of universal helmet law in the State where the crash occurred, the rider's age and blood alcohol concentration at the time of the crash, motorcycle engine size, and whether the crash occurred at night or during the day. By far, the most important factor contributing to motorcycle helmet use was the universal helmet law status for a particular crash. The odds that a motorcycle rider in a single-vehicle crash wore a helmet were 72 percent less in States without universal helmet laws, compared to States with universal helmet laws. Similarly, the absence of a universal helmet law led to a 69-percent reduction in the odds of wearing motorcycle helmets in two-vehicle crashes.

In addition to determining that the most important factor contributing to helmet use in fatal crashes was the universal helmet law status, the exploratory data analysis and logistic regression analysis revealed the following important relationships:

- Motorcycle rider helmet use declined as the rider's BAC level increased.
- In single-vehicle motorcycle crashes, motorcycle riders with BAC=.00 had the highest helmet use (60%), while riders with BAC=.01 to .07 had a lower helmet use (47%) and those with BAC=.08+ had the lowest helmet use (41%).
- In two-vehicle crashes, riders with BAC=.00 had the highest helmet use (61%), while those with BAC=.01 to .07 had a lower helmet use (53%), and those with BAC=.08+ had the lowest helmet use (46%).
- Forty-four percent of motorcycle riders in single-vehicle crashes had a BAC of .08 or greater. By comparison, only 11 percent of motorcycle riders in two-vehicle crashes between a motorcycle and a passenger vehicle had BACs of .08 or greater.
- Riders 60 and older were the most likely to be helmeted, while riders in the 30-39 age range were the least likely to be helmeted, controlling for other factors.
- Motorcycle rider helmet use was less at night than during the day.
- Motorcycle riders with engine sizes in the 1001-1500 cc range were least likely to be helmeted.

VII. Appendix

Note: Tables in the Appendix are numbered independently from those in the main body of this report. The corresponding Figure number or Table number is listed below each table in the Appendix.

Table 1: Motorcycle Rider Fatalities, 1997-2006	
Year	**Fatalities**
1997	1,742
1998	1,877
1999	2,111
2000	2,421
2001	2,693
2002	2,799
2003	3,143
2004	3,382
2005	3,900
2006	4,155
Total	28,223
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF	

Note: This table corresponds to Figure 1

Table 2: Passenger Vehicle Driver Fatalities, 1997-2006	
Year	**Fatalities**
1997	21,782
1998	21,714
1999	21,971
2000	21,893
2001	21,933
2002	22,616
2003	22,270
2004	22,027
2005	22,018
2006	21,527
Total	219,751
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF	

Note: This table corresponds to Figure 2

Table 3: Motorcycle Rider Fatalities by Helmet Use, 1997-2006							
Year	Helmet Use						Total
	Helmeted		Unhelmeted		Unknown		
	#	%	#	%	#	%	
1997	966	55.45	669	38.40	107	6.14	1,742
1998	999	53.22	789	42.04	89	4.74	1,877
1999	1,130	53.53	871	41.26	110	5.21	2,111
2000	1,266	52.29	1,017	42.01	138	5.70	2,421
2001	1,377	51.13	1,174	43.59	142	5.27	2,693
2002	1,428	51.02	1,226	43.80	145	5.18	2,799
2003	1,598	50.84	1,389	44.19	156	4.96	3,143
2004	1,829	54.08	1,417	41.90	136	4.02	3,382
2005	2,150	55.13	1,573	40.33	177	4.54	3,900
2006	2,379	57.26	1,604	38.60	172	4.14	4,155
Total	15,122	53.58	11,729	41.56	1,372	4.86	28,223
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF							

Note: This table corresponds to Figure 3

Table 4: Passenger Vehicle Driver Fatalities by Restraint Use, 1997-2006							
Year	Restraint Use						Total
	Restrained		Unrestrained		Unknown		
	#	%	#	%	#	%	
1997	7,573	34.77	12,354	56.72	1,855	8.52	21,782
1998	7,811	35.97	12,106	55.75	1,797	8.28	21,714
1999	7,853	35.74	12,318	56.06	1,800	8.19	21,971
2000	8,212	37.51	11,915	54.42	1,766	8.07	21,893
2001	8,532	38.90	11,689	53.29	1,712	7.81	21,933
2002	8,795	38.89	12,107	53.53	1,714	7.58	22,616
2003	9,264	41.60	11,328	50.87	1,678	7.53	22,270
2004	9,487	43.07	11,077	50.29	1,463	6.64	22,027
2005	9,344	42.44	11,173	50.74	1,501	6.82	22,018
2006	9,120	42.37	10,828	50.30	1,579	7.33	21,527
Total	85,991	39.13	116,895	53.19	16,865	7.67	219,751
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF							

Note: This table corresponds to Figure 4

Table 5: Motorcycle Rider Fatalities by Crash Type and Helmet Use, 1997-2006							
Crash Type	Helmet Use						Total
	Helmeted		Unhelmeted		Unknown		
	#	%	#	%	#	%	
Single-vehicle	7,050	50.78	6,394	46.05	439	3.16	13,883
Two-vehicle	6,774	58.53	4,411	38.11	388	3.35	11,573
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF							

Note: This table corresponds to Figure 5

Table 6: Motorcycle Rider Fatalities by Year and Helmet Use, Single-Vehicle Crashes, 1997-2006								
Year	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
1997	466	54.00	366	42.41	31	3.59	863	100.00
1998	467	48.95	446	46.75	41	4.30	954	100.00
1999	526	49.58	494	46.56	41	3.86	1,061	100.00
2000	584	48.46	570	47.30	51	4.23	1,205	100.00
2001	670	49.63	631	46.74	49	3.63	1,350	100.00
2002	715	50.11	676	47.37	36	2.52	1,427	100.00
2003	738	49.40	710	47.52	46	3.08	1,494	100.00
2004	846	50.90	774	46.57	42	2.53	1,662	100.00
2005	984	52.12	855	45.29	49	2.60	1,888	100.00
2006	1,054	53.26	872	44.06	53	2.68	1,979	100.00
Total	7,050	50.78	6,394	46.06	439	3.16	13,883	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 6

Table 7: Motorcycle Rider Fatalities by Year and Helmet Use, Two-Vehicle Crashes, 1997-2006								
Year	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
1997	439	60.14	252	34.52	39	5.34	730	100.00
1998	458	59.64	282	36.72	28	3.65	768	100.00
1999	498	59.86	305	36.66	29	3.49	832	100.00
2000	572	57.26	385	38.54	42	4.20	999	100.00
2001	586	55.44	435	41.15	36	3.41	1,057	100.00
2002	615	55.01	463	41.41	40	3.58	1,118	100.00
2003	731	55.38	548	41.52	41	3.11	1,320	100.00
2004	802	58.93	530	38.94	29	2.13	1,361	100.00
2005	974	59.43	605	36.91	60	3.66	1,639	100.00
2006	1,099	62.84	606	34.65	44	2.52	1,749	100.00
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 7

Table 8: Motorcycle Rider Fatalities by Helmet Law Status and Helmet Use, Single-Vehicle Crashes, 1997-2006								
State Helmet Law Status	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Universal Helmet Law	5,255	80.76	1,011	15.54	241	3.70	6,507	100.00
No Universal Helmet Law	1,795	24.34	5,383	72.98	198	2.68	7,376	100.00
Total	7,050	50.78	6,394	46.06	439	3.16	13,883	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 8

Table 9: Motorcycle Rider Fatalities by State Helmet Law Status and Helmet Use, Two-Vehicle Crashes, 1997-2006								
State Helmet Law Status	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Universal Helmet Law	4,903	84.27	712	12.24	203	3.49	5,818	100.00
No Universal Helmet Law	1,871	32.51	3,699	64.27	185	3.21	5,755	100.00
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 9

Table 10: Motorcycle Rider Fatalities by Engine Size and Helmet Use, Single-Vehicle Crashes, 1997-2006								
Engine Size (cc)	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
0-500	237	42.63	301	54.14	18	3.24	556	100.00
501-1000	3,334	58.66	2,181	38.37	169	2.97	5,684	100.00
1001-1500	2,646	45.91	2,945	51.10	172	2.98	5,763	100.00
>1500	199	52.51	172	45.38	8	2.11	379	100.00
Unknown	634	42.24	795	52.96	72	4.80	1,501	100.00
Total	7,050	50.78	6,394	46.06	439	3.16	13,883	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 10

Table 11: Motorcycle Rider Fatalities by Engine Size and Helmet Use, Two-Vehicle Crashes, 1997-2006								
Engine Size (cc)	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
0-500	302	51.80	255	43.74	26	4.46	583	100.00
501-1000	3,248	65.92	1,494	30.32	185	3.75	4,927	100.00
1001-1500	2,391	54.10	1,906	43.12	123	2.78	4,420	100.00
>1500	196	64.69	104	34.32	3	0.99	303	100.00
Unknown	637	47.54	652	48.66	51	3.81	1,340	100.00
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 11

Table 12: Motorcycle Rider Fatalities by Time of Day and Helmet Use, Single-Vehicle Crashes, 1997-2006								
Time of Day	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Day	3,225	56.98	2,277	40.23	158	2.79	5,660	100.00
Night	3,825	46.52	4,117	50.07	281	3.42	8,223	100.00
Total	7,050	50.78	6,394	46.06	439	3.16	13,883	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 12

Table 13: Motorcycle Rider Fatalities by Time of Day and Helmet Use, Two-Vehicle Crashes, 1997-2006								
Time of Day	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Day	4,166	61.65	2,379	35.21	212	3.14	6,757	100.00
Night	2,608	54.15	2,032	42.19	176	3.65	4,816	100.00
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 13

Table 14: Motorcycle Rider Fatalities by Weekday/Weekend and Helmet Use, Single-Vehicle Crashes, 1997-2006								
Weekday/Weekend	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Weekend	3,995	50.44	3,666	46.28	260	3.28	7,921	100.00
Weekday	3,055	51.24	2,728	45.76	179	3.00	5,962	100.00
Total	7,050	50.78	6,394	46.06	439	3.16	13,883	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 14

Table 15: Motorcycle Rider Fatalities by Weekday/Weekend and Helmet Use, Two-Vehicle Crashes, 1997-2006								
Weekday/Weekend	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Weekday	3,665	59.13	2,332	37.63	201	3.24	6,198	100.00
Weekend	3,109	57.84	2,079	38.68	187	3.48	5,375	100.00
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 15

Table 16: Motorcycle Rider Fatalities by Sex and Helmet Use, Single-Vehicle Crashes, 1997-2006								
Sex	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Male	6,777	50.51	6,215	46.33	424	3.16	13,416	100.00
Female	273	58.58	178	38.20	15	3.22	466	100.00
Unknown	0	0.00	1	100.00	0	0.00	1	100.00
Total	7,050	50.78	6,394	46.06	439	3.16	13,883	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 16

Table 17: Motorcycle Rider Fatalities by Sex and Helmet Use, Two-Vehicle Crashes, 1997-2006								
Sex	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Male	6,535	58.33	4,285	38.25	383	3.42	11,203	100.00
Female	237	64.40	126	34.24	5	1.36	368	100.00
Unknown	2	100.00	0	0.00	0	0.00	2	100.00
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 17

Table 18: Survival Status of Motorcycle Riders and Passenger Vehicle Drivers in Motorcycle/Passenger Vehicle Crashes, 1997-2006							
		Killed		Survived		Total	
		#	%	#	%	#	%
Vehicle Type	Passenger Vehicle	108	0.93	11,465	99.07	11,573	100%
	Motorcycle	10,998	95.03	575	4.97	11,573	100%
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF							

Note: This table corresponds to Table 1, page 15

Table 19: Motorcycle Rider Fatalities by Injury Severity and Helmet Use, Single-Vehicle Crashes, 1997-2006								
Motorcycle Rider Injury Severity	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
Fatal Injury (K)	6,599	50.88	5,962	45.97	408	3.15	12,969	100.00
Incapacitating Injury (A)	228	48.93	226	48.50	12	2.58	466	100.00
Non-incapacitating Evident Injury (B)	139	47.77	146	50.17	6	2.06	291	100.00
Possible Injury (C)	44	57.89	30	39.47	2	2.63	76	100.00
No Injury (0)	38	50.67	29	38.67	8	10.67	75	100.00
Injury, Severity Unknown	2	50.00	1	25.00	1	25.00	4	100.00
Unknown	0	0.00	0	0.00	2	100.00	2	100.00
Total	7,050	50.78	6,394	46.06	439	3.16	13,883	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Table 2, page 15

Table 20: Motorcycle Rider Fatalities by Injury Severity and Helmet Use, Two-Vehicle Crashes, 1997-2006								
Motorcycle Rider Injury Severity	**Helmet Use**						**Total**	
	Helmeted		**Unhelmeted**		**Unknown**			
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Fatal Injury (K)	6,503	59.13	4,124	37.50	371	3.37	10,998	100.00
Incapacitating Injury (A)	197	49.62	189	47.61	11	2.77	397	100.00
Non-incapacitating Evident Injury (B)	50	42.02	66	55.46	3	2.52	119	100.00
Possible Injury (C)	9	36.00	15	60.00	1	4.00	25	100.00
No Injury (0)	15	46.88	16	50.00	1	3.13	32	100.00
Injury, Severity Unknown	0	0.00	1	50.00	1	50.00	2	100.00
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Table 3, page 15

Table 21: Passenger Vehicle Driver Fatalities by Injury Severity and Restraint Use, Two-Vehicle Crashes, 1997-2006								
Passenger Vehicle Driver Injury Severity	Restraint Use						Total	
	Restrained		Unrestrained		Unknown			
	#	%	#	%	#	%	#	%
Fatal Injury (K)	61	56.50	42	38.90	5	4.63	108	100.00
Incapacitating Injury (A)	318	75.70	79	18.80	23	5.48	420	100.00
Non-incapacitating Evident Injury (B)	1,046	78.00	186	13.90	109	8.13	1,341	100.00
Possible Injury (C)	1,189	83.30	122	8.54	117	8.19	1,428	100.00
No Injury (0)	6,725	81.90	685	8.34	801	9.76	8,211	100.00
Unknown	15	40.50	1	2.70	21	56.80	37	100.00
Injury, Severity Unknown	17	60.70	7	25.00	4	14.30	28	100.00
Total	9,371	81.00	1,122	9.69	1,080	9.33	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Table 4, page 16

Table 22: Motorcycle Rider Fatalities by Age Group and Helmet Use, Single-Vehicle Crashes, 1997-2006								
Age Group	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
20-29	2,111	55.31	1,585	41.52	121	3.17	3,817	100.00
30-39	1,760	48.74	1,731	47.94	120	3.32	3,611	100.00
40-49	1,606	46.22	1,755	50.50	114	3.28	3,475	100.00
50-59	1,026	50.52	945	46.53	60	2.95	2,031	100.00
>59	547	57.64	378	39.83	24	2.53	949	100.00
Total	7,050	50.78	6,394	46.06	439	3.16	13,883	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 18

Table 23: Motorcycle Rider Fatalities by Age Group and Helmet Use, Two-Vehicle Crashes, 1997-2006								
Age Group (Motorcycle Riders)	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
20-29	1,996	60.78	1,150	35.02	138	4.20	3,284	100.00
30-39	1,659	57.66	1,113	38.69	105	3.65	2,877	100.00
40-49	1,572	55.47	1,179	41.60	83	2.93	2,834	100.00
50-59	989	59.29	645	38.67	34	2.04	1,668	100.00
>59	558	61.32	324	35.60	28	3.08	910	100.00
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 19

Table 24: Motorcycle Rider Fatalities by Number of Motorcyclists and Helmet Use, Single-Vehicle Crashes, 1997-2006								
Number of Motorcyclists	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
1	6,284	52.07	5,399	44.73	386	3.20	12,069	100.00
2 or more	766	42.23	995	54.85	53	2.92	1,814	100.00
Total	7,050	50.78	6,394	46.06	439	3.16	13,883	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 20

Table 25: Motorcycle Rider Fatalities by Number of Motorcyclists and Helmet Use, Two-Vehicle Crashes, 1997-2006								
Number of Motorcyclists	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
1	5,985	60.25	3,616	36.40	333	3.35	9,934	100.00
2 or more	789	48.14	795	48.51	55	3.36	1,639	100.00
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 21

Table 26: Motorcycle Rider Fatalities by BAC Group and Helmet Use, Single-Vehicle Crashes, 1997-2006								
BAC Group	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
BAC= .00	4,000	60.44	2,415	36.49	203	3.07	6,618	100.00
BAC= .01 to .07	516	46.91	544	49.45	40	3.64	1,100	100.00
BAC= .08+	2,534	41.09	3,436	55.72	197	3.19	6,167	100.00
Total	7,050	50.77	6,395	46.06	440	3.17	13,885	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 22

Table 27: Motorcycle Rider Fatalities by BAC Group and Helmet Use, Two-Vehicle Crashes, 1997-2006								
BAC Group	Helmet Use						Total	
	Helmeted		Unhelmeted		Unknown			
	#	%	#	%	#	%	#	%
BAC= .00	5,843	60.69	3,458	35.92	328	3.41	9,628	100.00
BAC= .01 to .07	329	52.64	278	44.48	18	2.88	625	100.00
BAC= .08+	602	45.61	675	51.14	43	3.26	1,320	100.00
Total	6,774	58.53	4,411	38.11	388	3.35	11,573	100.00
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF								

Note: This table corresponds to Figure 23

Logistic Regression Models and Description

The estimated logistic regression coefficients and their associated standard errors are reported below for both single-vehicle crashes and two-vehicle crashes. These coefficients represent the average value of coefficients estimated in each of the 10 regressions performed using the imputed BAC values. These tables match the results presented in Section V (Tables 5 and 6).

Table 28: Logistic Regression Predicting Motorcycle Rider Helmet Use in Single-Vehicle Crashes, 1997-2006

Coefficient	Estimate	Standard Error	Wald Chi-Square	p-value	Exponentiated Coefficient
Intercept	-0.0907	0.0421	4.7186	0.0369	0.9132
Age Group 30-39 vs. 20-29	-0.1692	0.0408	17.1852	<.0001	0.8442
Age Group 40-49 vs. 20-29	-0.1454	0.0408	12.7285	0.0004	0.8647
Age Group 50-59 vs. 20-29	0.0451	0.0492	0.8438	0.3595	1.0462
Age Group >59 vs. 20-29	0.3381	0.0669	25.5139	<.0001	1.4023
BAC Group .01 to .07 vs. .00	-0.1284	0.0511	6.5686	0.0195	0.8797
BAC Group .08+ vs. .00	-0.3194	0.0350	83.3303	<.0001	0.7266
Day vs. Night	-0.0713	0.0235	9.2973	0.0029	0.9311
Engine Size 1001-1500 vs. 0-500	-0.0125	0.0446	0.0902	0.7792	0.9874
Engine Size 501-1000 vs. 0-500	0.5251	0.0468	126.0762	<.0001	1.6907
Engine Size >1500 vs. 0-500	0.3210	0.1039	9.5607	0.0021	1.3787
Engine Size Unknown vs. 0-500	-0.3601	0.0609	34.9208	<.0001	0.6977
No Helmet Law vs. Helmet Law	-1.2566	0.0215	3428.9545	<.0001	0.2847

Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF

Table 29: Logistic Regression Predicting Motorcycle Rider Helmet Use in Two-Vehicle Crashes, 1997-2006					
Coefficient	**Estimate**	**Standard Error**	**Wald Chi-Square**	**p-value**	**Exponentiated Coefficient**
Intercept	0.1946	0.0504	14.9954	0.0007	1.2150
Age Group 30-39 vs. 20-29	-0.1778	0.0432	16.9579	<.0001	0.8371
Age Group 40-49 vs. 20-29	-0.0996	0.0430	5.3579	0.0207	0.9053
Age Group 50-59 vs. 20-29	0.1133	0.0524	4.6784	0.0306	1.1201
Age Group >59 vs. 20-29	0.2754	0.0665	17.1436	<.0001	1.3171
BAC Group .01 to .07 vs. .00	-0.0065	0.0672	0.1065	0.8105	0.9937
BAC Group .08+ vs. .00	-0.2358	0.0549	18.5522	0.0002	0.7898
Day vs. Night	-0.1157	0.0235	24.2089	<.0001	0.8908
Engine Size 1001-1500 vs. 0-500	-0.1521	0.0471	10.4161	0.0013	0.8589
Engine Size 501-1000 vs. 0-500	0.4346	0.0485	80.4406	<.0001	1.5443
Engine Size >1500 vs. 0-500	0.5446	0.1124	23.4920	<.0001	1.7241
Engine Size Unknown vs. 0-500	-0.5508	0.0626	77.3149	<.0001	0.5766
No Helmet Law vs. Helmet Law	-1.1560	0.0229	2553.2114	<.0001	0.3149
Source: NCSA, NHTSA, FARS 1997-2005 Final, 2006 ARF					

Note: Tables 28 and 29 in the Appendix correspond to Tables 5 and 6 in Section V

VIII. References

1. Insurance Institute for Highway Safety: Helmet Use Laws, June 2007. http://www.iihs.org/laws/HelmetUseOverview.aspx

2. Deutermann, W. V. Motorcycle Helmet Effectiveness Revisited. NHTSA Technical Report. DOT HS 809 715. Washington, DC: National Highway Traffic Safety Administration

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