

Evaluation of the Reinstatement of the Universal Motorcycle Helmet Law In Louisiana

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16. Abstract <p>Louisiana has enacted and repealed motorcycle helmet laws many times. Louisiana first adopted an all-rider motorcycle helmet law in 1968, amended it in 1976 to require helmet use only by riders under the age of 18, and reenacted a universal helmet law in 1982. In 1999, the State amended that law to require helmet use only by motorcyclists under 18 and riders over 18 who did not have a minimum of \$10,000 in medical insurance coverage. In 2004, Louisiana reinstated its universal helmet law that required all motorcyclists, riders and passengers, to wear helmets all the time. This study examined rates of motorcycle helmet usage, fatalities, and injuries.</p> <p>Observed helmet use rose to 100 percent after reinstatement of the universal helmet law. Helmet use in motorcycle crashes during the period (1999 – 2003) without the helmet law was 42.3% (pre-reinstatement) and increased to 87% in 2004 – 2005 (post-reinstatement).</p> <p>Motorcycle crashes increased from 1999 to 2005 in Louisiana. Fatal crashes decreased in 2004 for the first time since the 1999 repeal, increasing slightly in 2005, but with fewer than before the law was reinstated in Louisiana. The national trend showed a steady increase in fatal motorcycle crashes during this time period. Kentucky, a comparison State, also showed steadily increasing fatal crashes. The drop in fatal motorcycle crashes in Louisiana was not replicated in a nearby State, and is therefore likely attributable to the law change</p> <p>Motorcycle fatalities had been accounting for a larger proportion of all motor vehicle fatalities in Louisiana doubling between 1999 and 2003 (4% to 9%), slightly decreasing for the first time in 2005 (8%). The proportion of fatal and serious injury motorcycle crashes to all motorcycle crashes (fatal crashes, serious injury, moderate injuries, complaint of injury, and property damage only) declined after the helmet law was reinstated in Louisiana.</p>					
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Hope Gilbert, Neil Chaudhary, Mark Solomon, David Preusser, Linda Cosgrove¹

¹National Highway Traffic Safety Administration, Office of Behavioral Safety Research

Mandatory helmet use laws first came into being following the issuance of highway safety program standards in 1967. The enactment of helmet laws has been a contentious issue in many States as public policy makers have debated the balance between personal freedoms and the societal costs of crashes. Those opposed to mandatory helmet laws generally argue that their individual rights are, or will be, infringed upon and that helmet use should be left to the choice of individual riders. Those who advocate for helmet laws note that helmets are effective in reducing injury severity and that society bears a significant portion of motorcycle crash costs, thereby establishing a public interest in requiring the use of reasonable safety equipment. Over the years, States have variously enacted, repealed, and reenacted universal, or all-rider, motorcycle helmet laws.

Louisiana first adopted a motorcycle helmet law applicable to all riders in 1968. That law was amended in 1976 to require helmet use only by riders under the age of 18. Then, in 1982, Louisiana reenacted a universal helmet law. It was this latter law that was amended, effective August 1999, to require helmet use only by motorcyclists under 18 and riders over 18 who did not have a minimum of \$10,000 in medical insurance coverage.

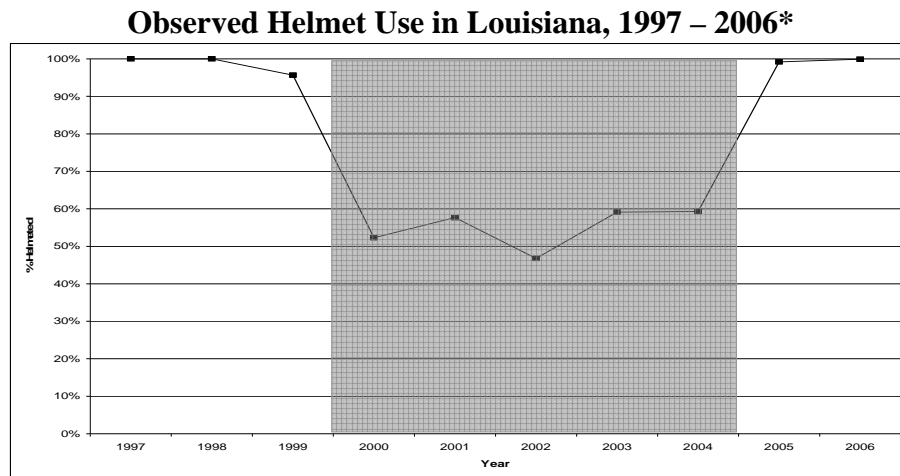
In August 2004, the helmet law that was repealed in 1999 was reinstated. This reinstatement resulted in all motorcyclists, drivers, and passengers being required to wear helmets. Twenty States and the District of Columbia have universal helmet laws for all motorcyclists now.

National Trends

There exists a relationship between motorcycle fatalities, motorcycle registrations, and the percentage of all registrations subject to a universal helmet law. Motorcycle registrations and fatalities have been steadily increasing in recent years. There is a strong positive relationship between fatalities and the percentage of registrations not covered by a universal helmet law even when removing the influence of registrations ($r = .71, p < .001$). However, the correlation may not take into account the systematic and interrelated variation of these three variables over time. The results show that even accounting for the effects of time (i.e., year) there is still a significant relationship of both registrations ($t = 7.451, p < .001$) and the percent of registrations not covered by a universal helmet law ($t = 4.193, p < .001$). Thus, there is a clear and strong positive relationship between the percentage of motorcycle registrations not covered by a universal helmet law and fatalities. This relationship is present even after accounting for the number of motorcycle registrations and any systematic interrelated fluctuations in the three variables over time.

Helmet Use and Observational Surveys

The figure indicates that when Louisiana was under the universal helmet law (years 1997, 1998, 1999, 2005, and 2006) virtually all riders were compliant with the law and wore helmets. However, during the years that the Louisiana helmet law was repealed, (years 2000 to 2004), observed helmet use declined to around 50 percent.



* Shaded area represents the lack of a universal helmet law

Source: Louisiana

Crash Data

There was a consistent increase in the number of motorcycle crashes in Louisiana from 1999 to 2005. Statewide, the number of motorcycles in crashes in 1999 ($n = 957$) approximately doubled in 2005 ($n = 1,877$).

There were 7,615 motorcycles in crashes during the pre-law period (January 1, 1999, to August 14, 2004) and 2,479 motorcycles in crashes during the post-law period (August 15, 2004 to December 31, 2005). Only data from prior to August 25 2005 was included in the analyses as a result of the devastation caused by Hurricane Katrina. During the almost 12-month post-law and pre-Katrina time period, there were 1,860 motorcycles in

crashes in the State. Helmet use by motorcyclists in crashes before the repeal was 42 percent (n = 3,218). After the reinstatement of the law, helmet use in crashes rose to 87 percent (n = 1,390).

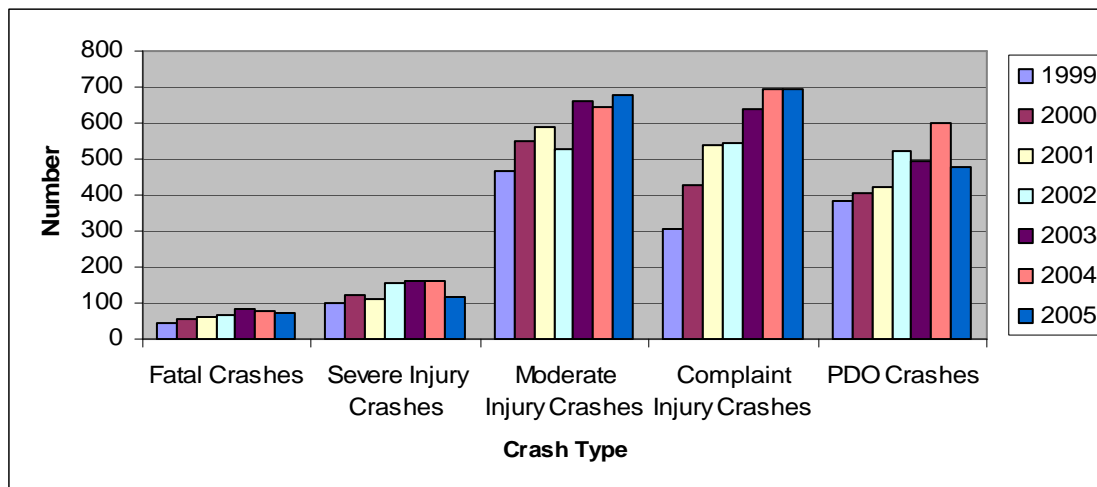
**Motorcycle Crashes Pre- and Post-Law
Reinstatement for Louisiana, January 1999 – August 25, 2005**

Pre- and Post–Law Reinstatement Percent* Helmet Use		
	Pre-Law % (n)	Post-Law % (n)
Helmet Use (Yes)	42.3% (3,218)	87.0% (1,390)
Injury Status		
Fatal	5.0% (377)	4.4% (81)
Severe	9.4% (713)	7.2% (133)
Moderate	38.0% (2,894)	34.7% (645)
Complaint	32.1% (2,445)	34.9% (649)
None	15.6% (1,185)	18.9% (352)

Source: Louisiana State University

The next figure shows the annual distribution of motorcycle crash types in Louisiana from 1999, when the universal helmet law was repealed through 2005, the year after the law was reinstated. The graph shows that all injury types were increasing from 1999. Fatal and severe injury crashes declined in 2005, as did property damage only crashes. Moderate injury crashes increased and complaint injury crashes remained approximately the same from 2004 to 2005.

Number of Louisiana Motorcycle Crashes by Type, 1999-2005



Source: Louisiana State University

Multiple logistic regression analyses were conducted to explore helmet use and injury levels after the law change to before the law change. Given the association between helmet use and injury status, two separate models were produced to show the effect of each on the outcome of pre- and post-law status. These analyses include the ability to account for, and mathematically remove, the effects of other potentially confounding variables. There were no significant effects of gender or race in either model. The logistic regression showed a strong positive effect of helmet use post-law reinstatement. The odds of wearing a helmet in a crash post-law reinstatement were 11.7 times greater in comparison to wearing a helmet during the pre-law time period ($p < 0.001$) (see Table IV.6).

Injuries were also significantly lower in the post-law period compared to the pre-law period after adjusting for age, gender, and race. Fatalities were 30 percent less likely to occur post-law as compared to pre-law ($p = 0.012$). There were similar findings for severe injuries (OR = 0.62, $p < 0.001$) and moderate injuries (OR = 0.74, $p < 0.001$). Injury complaints (OR = 0.87, $p = 0.085$) post-law reinstatement compared to pre-law reinstatement were not significantly different. These injury changes were in comparison to a “base” of non-injury crashes. Thus, these data support the contention that the reenactment of the universal helmet law in Louisiana led to an increase in helmet use and a reduction in the injury severity of crashes.

An ARIMA time series analysis also indicated that there were fewer fatal and severe injuries combined following the law. Specifically, controlling for the overall rate of motorcycling by using complaint of injury and non-injury crashes as a covariate, there was a significant drop in fatal and severe injuries coincident to the reinstatement of the universal law ($p = 0.04$). There were an estimated 9.4 fewer fatal/severe crashes per month.

EXPOSURE

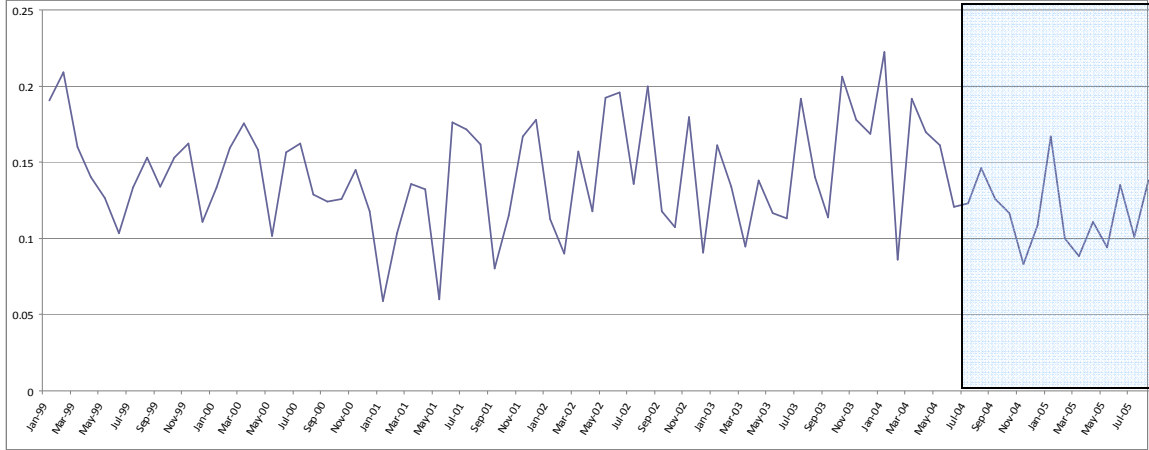
Previous studies of motorcycle helmet laws have used registrations as a proxy measure for exposure. Reliable registration data from Louisiana was unavailable to use in the analysis. However, there was a trend toward increasing registrations as reported by R.L. Polk and Company. In the year following reinstatement of the law, the number of fatal and serious injury motorcycle crashes declined. Thus there was a decline in severity despite rising exposure that followed reinstatement of the motorcycle helmet law in Louisiana.

FATAL AND SERIOUS INJURIES

Another way to consider the impact of helmet usage after the reinstatement of the universal helmet law is to calculate the number of fatal and serious injuries as a proportion of all motorcycle crashes (fatal crashes, serious injuries, moderate injuries, complaint of injury, and property damage only). This proportion is independent of changes in exposure. The following figure shows that the proportion of monthly fatal

and serious injury motorcycle crashes declined after the helmet law was reinstated, when all motorcycle crashes are considered.

Proportion of Fatal and Serious Injuries to all Motorcycle Crashes Before and After The Law Change, January 1999 - August 2005



FARS Data

There was a total of 523 fatal crashes in Louisiana from 1996 through 2005 in which at least one motorcycle occupant was killed for each crash. Kentucky was chosen as a comparison State for Louisiana given that its universal helmet law was repealed in 1998 and to explore the possibilities that any changes in Louisiana may have been due to regional effects. Kentucky had less than a hundred fewer fatal crashes between 1996 and 2005 than Louisiana (N = 436).

The number of fatal crashes in Louisiana increased from 1997 through 2003 prior to the helmet law reinstatement (Figure IV.3). In 2004 following the law change there was the first decrease in crashes since the 1999 repeal. There was a slight increase in crashes in 2005 but there were still fewer than before the law was reinstated. Kentucky, during the same time period, also showed a general increase in crashes. There was a major shift in Kentucky’s crashes in 1999 perhaps due to its repeal of its universal helmet law in 1998. Beginning in 2002, Kentucky’s crashes increased steadily. Thus, it appears that the drop in fatal crashes in Louisiana occurring after the helmet law reinstatement was not due to any regional effects, and is likely attributable to the law change.

Conclusion

Observed helmet use rose to 100 percent after reinstatement of the universal helmet law in Louisiana in 2004. Helmet use in motorcycle crashes during the period (1999 – 2003) without the helmet law was 42.3 percent (pre-reinstatement) but increased to 87 percent in 2004 – 2005 (post-reinstatement). Motorcycle crashes increased from 1999 to 2005. Fatal crashes decreased in 2004 for the first time since the 1999 repeal, increasing slightly in 2005, but with fewer than before the law was reinstated in Louisiana. The proportion of motorcycle fatal crashes to all motorcycle crashes began falling in 2004 (41%), continuing into 2005 (38%) compared to 45 percent at the end of the period when the helmet law was repealed. Motorcycle fatalities had been accounting for a larger

proportion of all motor vehicle fatalities in Louisiana doubling between 1999 and 2003 (4% to 9%), slightly decreasing for the first time in 2005 (8%).

Crash data showed that the odds of wearing a helmet in a crash post the Louisiana motorcycle helmet law compared to pre-law were extremely high. This increase in the compliance of helmet use after the reinstatement of the universal helmet law also led to significantly fewer fatalities and severe injuries, during the post-law period compared to the pre-law reinstatement.

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I. INTRODUCTION

Louisiana reinstated its laws requiring motorcycle helmet use in August 2004. These actions follow the State's helmet law repeal in 1999.

This report uses data from Louisiana and FARS (Fatality Analysis Reporting System; NHTSA) to study the effects of the reinstatement of the helmet law. Specifically, the study examines changes in incidence of motorcyclist fatalities, injuries, healthcare costs, and length of stay in a hospital. Following this introduction, the report is organized as follows:

- Chapter II, Background, describes the legislative history of motorcycle helmet laws in the United States and reviews the literature on the effects of helmet use and helmet use laws.
- Chapter III, National Trend, provides national data on trends in motorcycle registrations, casualties, and helmet laws.
- Chapter IV, Effects of the Law Change in Louisiana, describes the effect of Louisiana's law change on helmet use, fatalities, injuries, healthcare costs, and casualty rates.
- Chapter V, Discussion, briefly discusses the findings of the study.
- Appendix A, Crash Descriptions, presents qualitative descriptions of the fatal motorcycle crashes that took place in Louisiana immediately following the helmet law changes from August 2004 through December 2004.

II. BACKGROUND

Mandatory helmet use laws were first adopted following the issuance of highway safety program standards in 1967. The enactment of helmet laws has been a contentious issue in many States as public policy makers have debated the balance between personal freedoms and the societal costs of crashes. Those opposed to mandatory helmet laws generally argue that their individual rights are, or will be, infringed upon and that helmet use should be left to the choice of individual riders. Those who advocate for helmet laws note that helmets are effective in reducing injury severity and that society bears a significant portion of motorcycle crash costs, thereby establishing a public interest in requiring the use of reasonable safety equipment. Over the years, States have variously enacted, repealed, and reenacted universal, or all-rider, motorcycle helmet laws. There are now 20 States and the District of Columbia that have universal helmet laws.

Louisiana first adopted a motorcycle helmet law applicable to all riders in 1968. That law was amended in 1976 to require helmet use only by riders under the age of 18. Then, in 1982 the State re-enacted a universal helmet law. It was this latter law that was amended effective August 15, 1999, to require helmet use only by:

- Motorcycle operators and passengers under the age of 18; and
- Riders 18 and older who do not have medical insurance coverage of at least \$10,000.

This action resulted in a dramatic increase in motorcyclist fatalities. Louisiana legislators approved the reinstatement of the Louisiana all-rider (i.e., universal) helmet law in June 2004. It was this 1999 repeal and the 2004 reinstatement that is the focus of this report.

The primary objective for the Evaluation of the Reinstatement of the Helmet Law in Louisiana is to identify changes in motorcycle crashes and injuries following the reinstatement of the motorcycle helmet law in August 2004. In particular, this study will examine the effect of the change in helmet law on rates of motorcycle helmet utilization. It will also explore some impacts of the law change on motorcycle fatalities and injuries. Additionally, admittance of motorcyclists to a level one trauma center and subsequent health care costs will be explored.

This research follows a recently completed examination of the law changes in Arkansas, Texas, and Florida (Preusser et al., 2000; Ulmer et al., 2005) and an examination of the law repeal in Louisiana (Ulmer et al., 2003). In Louisiana, Ulmer et al. found that motorcycle helmet use dramatically decreased after the universal helmet law was repealed. Prior to the repeal, helmet use was considered to be full compliance statewide; however, in 2000 and 2001, helmet use fell to approximately 52 percent.

LEGISLATIVE HISTORY

1966-1975: Most States Enact Universal Helmet Use Laws in Response to a Federal Requirement

Prior to 1966, no State had enacted a motorcycle helmet use law. The Highway Safety Act of 1966 (P.L. 89-564) changed this situation abruptly. The Act required the Secretary of Transportation to set uniform standards for State Highway Safety Programs. One of these standards, issued in 1967, dealt with motorcycle safety. It included the requirement that States adopt universal helmet use laws -- laws that mandate helmet use by all motorcycle riders. States that failed to comply would lose a portion of their Federal aid highway construction funds.

States immediately began to enact and implement universal helmet laws. Twenty-two States had universal helmet use laws in effect by the end of 1967 and 14 more States added laws in 1968. By 1975, 47 States and the District of Columbia had adopted universal helmet use laws.

From the first, helmet use laws generated controversy. The Illinois law, effective in 1967, was repealed in 1969 after being declared unconstitutional by the Illinois Supreme Court. Michigan enacted a universal helmet law in 1967, repealed it in 1968, and enacted it again in 1969. Kansas enacted a universal helmet law in 1967, amended it to cover only riders under 21 in 1970, and reinstated universal coverage in 1972. Oklahoma did likewise, enacting a universal helmet law in 1967, amending it to cover only riders under 21 in 1969, and reinstating universal coverage in 1975 (finally amending it again in 1976 to cover only riders under 18).

1976-1980: Half the States Repealed or Amended Their Universal Helmet Use Laws After Congress Eliminates Sanctions

In 1975, under the authority of the Highway Safety Act of 1966, the Secretary of Transportation was prepared to penalize the three States (California, Illinois, and Utah) still lacking universal helmet laws by withholding the specified portion of their Federal aid highway construction funds. This action prompted Congress to revisit the Highway Safety Act. Congress eliminated the motorcycle helmet law requirement and withdrew the potential withholding of funds from States without such laws. As a result, many States reconsidered their laws. By 1978, 25 States had repealed their universal helmet laws or amended them to cover only riders below a specified age (typically 18). Two more States did the same in 1979 and 1980, reducing the total number of States with universal helmet laws to 19 and the District of Columbia.

1981-1988: Period of Stability

In contrast to the preceding 15 years, the 1980s saw little legislative activity on the issue. In 1983, Wyoming became the 28th State to repeal its universal law and require use only

by riders under 18. In 1982, Louisiana re-enacted the universal use law it had repealed in 1976.

1989-1994: Gradual Re-enactment and Congressional Encouragement

Oregon and Texas re-enacted universal helmet use laws in 1989. Nebraska and Washington followed suit in 1990, as did Maryland in 1992. California, a State with more than 10 percent of the nation's registered motorcycles and one of only two States that had never had a helmet use law applicable to adults, implemented a universal law in 1992, following extensive debate and publicity. From 1992 to 1996, 25 States and the District of Columbia had universal helmet use laws in effect. Another 22 States had laws applicable only to young riders (usually those under the age of 18), while three States (Colorado, Illinois, and Iowa) had no helmet use law at all.

During this time, Congress once again took an interest in motorcycle helmets. In April 1990, Senators Moynihan and Chafee requested the United States General Accounting Office (GAO) to review and evaluate the available information on helmet effectiveness in preventing deaths and serious injuries, the effect of helmet laws on helmet use and motorcycle rider fatalities, and the costs to society of injuries to unhelmeted motorcyclists. GAO conducted the requested review and reported to Congress in July 1991. The report concluded that "helmet use reduces fatality rates and reduces injury severity among survivors of motorcycle accidents" and that "universal helmet laws have been very effective in increasing helmet use, virtually doubling use compared with experience without a law or with a limited law applying only to young riders. Under universal helmet laws, most States experienced 20 to 40 percent lower fatality rates than during periods without laws or under limited laws." The report recommended that "because there is convincing evidence that helmets save lives and reduce society's burden of caring for injured riders, the Congress may wish to consider encouraging States to enact and retain universal helmet laws. The Congress could return to the use of penalties [as in the 1966 Act], use incentives (e.g., making additional funds available to States that have universal laws), or use a combination of penalties and incentives" (GAO, 1991, p. 31).

With the GAO report findings as support, Congress used an incentive and stipulation to promote universal helmet laws as part of the Intermodal Surface Transportation Efficiency Act of 1991, commonly known as ISTEA. An incentive was additional Federal funding for States. ISTEA provided special "incentive" grants to States with both universal motorcycle helmet laws and passenger vehicle seat belt use laws. A State qualified for a first-year grant by having these two laws in effect. In subsequent years, the State also was required to exceed minimum motorcycle helmet and seat belt use levels (helmet use of 75 percent in the second year and 85 percent in the third year). Twenty-three States and the District of Columbia received grants for one or more of the fiscal years 1992, 1993, and 1994 for which the grants were authorized.

As a stipulation, ISTEA provided that States without both a universal motorcycle helmet law and a seat belt use law by October 1, 1993, would have a portion of their fiscal year

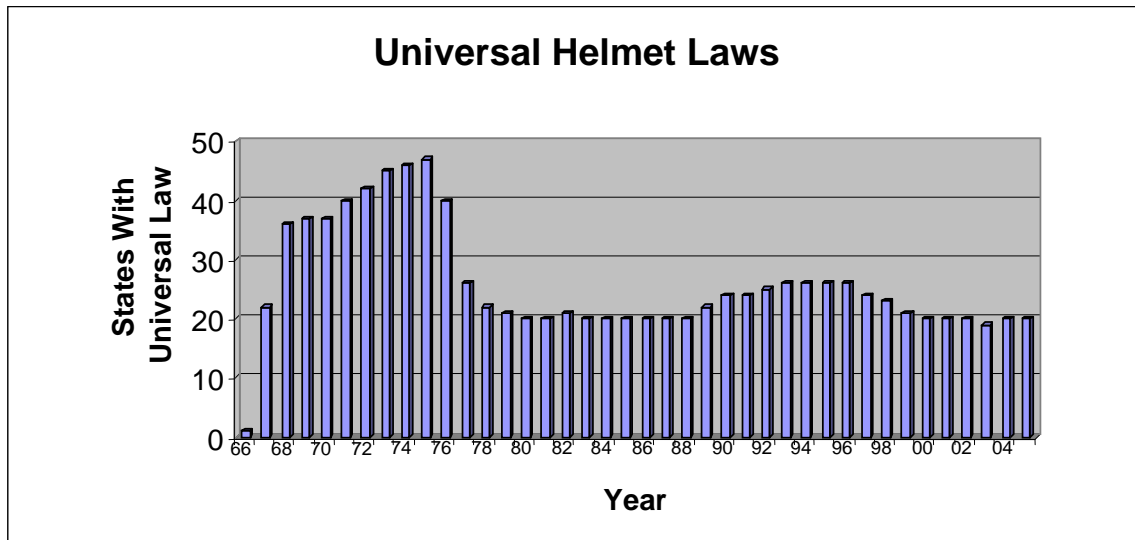
1995 Federal aid highway funds transferred to their highway safety programs. As most States had seat belt use laws in place, the provision's main goal was to encourage States to enact universal helmet laws.

The incentive and stipulation plan had little effect on State motorcycle helmet laws. Maryland was the only State to enact a universal helmet law since 1992 except for Louisiana's reinstatement in 2004.

1995-2001: Congress Acts Again; Five States Drop Universal Helmet Laws

In November 1995, as part of the National Highway System Designation Act, Congress repealed the ISTEA transfer provision for States lacking universal helmet laws, effective with the 1996 fiscal year. Efforts to amend or repeal universal helmet laws grew in many States and, as noted, Arkansas, Florida, Kentucky, Louisiana and Texas repealed their laws. At the end of 2001, 20 States and the District of Columbia had universal helmet laws in effect. Another 27 States had laws applicable only to some riders (typically riders under a specified age), while three States had no helmet law at all. Figure II.1 shows the number of States with a universal helmet law in effect at the end of each year, beginning in 1966.

Figure II.1. Universal Helmet Law States



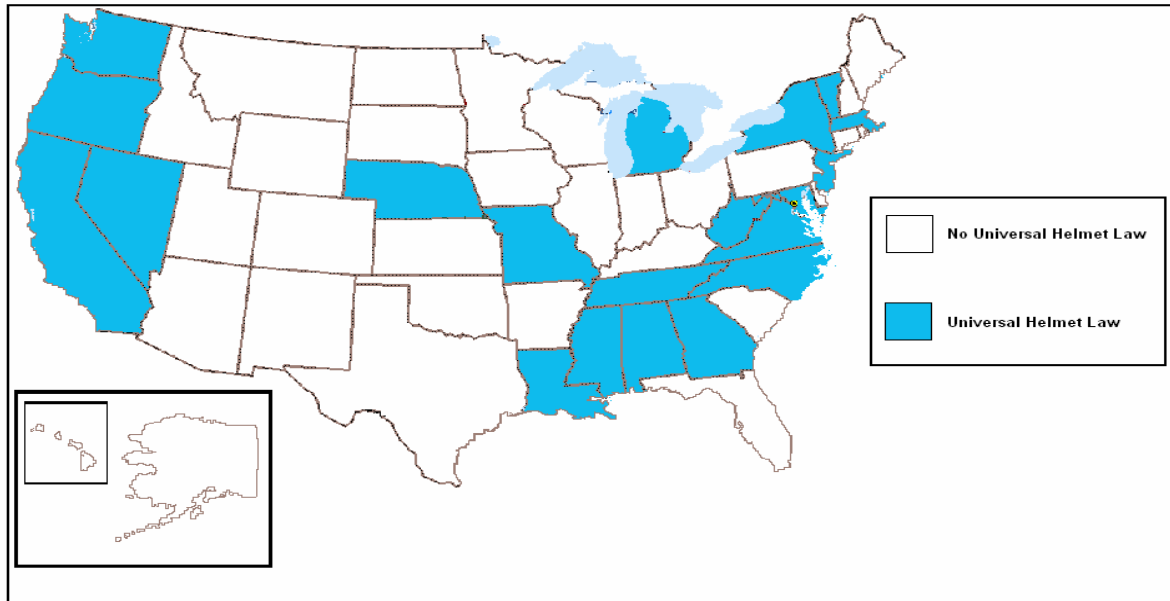
Source: Insurance Institute for Highway Safety

2002- July 2007

Currently, 20 States and the District of Columbia have universal helmet laws (see Figure II.2). In addition, there are 27 States with some/partial helmet laws, which usually are targeted at riders under a certain age (usually 18). There are 3 States that continue to have no helmet use law: Illinois, Iowa, and New Hampshire. Illinois' universal helmet

law was repealed in 1970, Iowa's law was repealed in 1976, and New Hampshire's helmet law was repealed in 1995 with the withdrawal of Federal incentives for States' helmet laws (IIHS, 2007). Louisiana was the only State during this time period to reinstate its universal helmet law, which occurred on August 15, 2004. While NHTSA (2007) reported that overall vehicle crashes decreased between 2005 and 2006, the incidence of motorcyclist fatalities increased by approximately 5 percent during the same time period and by 47 percent since 2002.

Figure II.2. Helmet Law Status in 2007



Source: Insurance Institute for Highway Safety

STUDIES OF HELMET USE LAW EFFECTS

The effects of State helmet law enactment and repeal have been studied in great detail. GAO's 1991 review summarizes all studies available in 1990. The GAO study and studies that have appeared since the GAO review are discussed below.

1991 GAO Review of Helmet Use Law Studies

GAO conducted a broad search for studies as of 1990 and discovered 46 that were published between 1975 and 1990, used data from the United States, and "contained original data or original analyses and met minimum criteria for methodological soundness" (GAO, 1991, p. 2).

GAO found 9 studies that included data on helmet use in States with and without universal laws. These studies:

"reported that helmet use under universal laws ranged from 92 to 100 percent, while without a law or under a limited law [requiring only some riders to wear helmets], helmet use generally ranged from 42 to 59 percent. These data also indicated low helmet use among young riders in States with limited helmet laws" (GAO, 1991, p. 4).

GAO found 20 studies that compared motorcycle rider fatality rates under universal helmet laws with rates during periods before enactment or after repeal of these laws.

"These studies consistently showed that fatality rates were lower when universal helmet laws were in effect; most rates ranged from 20 to 40 percent lower. Several of these studies compared periods before a helmet law was enacted, while it was in effect, and after it was repealed. They showed that the decreases in fatality rates when laws were enacted were matched by comparable increases when the laws were repealed" (GAO, 1991, p. 4).

GAO found 13 studies with data on some aspect of the societal costs of motorcycle accidents.

"These studies indicated that non-helmeted riders were more likely to (1) need ambulance service, (2) be admitted to a hospital as an inpatient, (3) have higher hospital charges, (4) need neurosurgery and intensive care, (5) need rehabilitation, and (6) be permanently impaired and need long-term care" (GAO, 1991, p. 4).

Studies Since 1990

The following review includes research on motorcycle helmet laws in several States. There have been many studies that have appeared since GAO's review. Some investigate the effects of enacted helmet laws in multiple States. Others provide new data on the effectiveness of helmets in preventing injury.

Arkansas was among the first group of States that adopted a universal helmet law in 1967. That law was repealed as of August 1, 1997. Preusser et al. (2000) found that following the law repeal, helmet use declined from 97 percent to 52 percent while fatalities and injuries increased. The percentage of cases involving head injury also increased.

Arkansas has relatively few motorcyclists' fatalities per year. In the three years before the repeal (1994-1996) the State experienced an average of 21 motorcyclists killed per year. This increased to 25 killed per year in the three years after the law change (1998-2000).

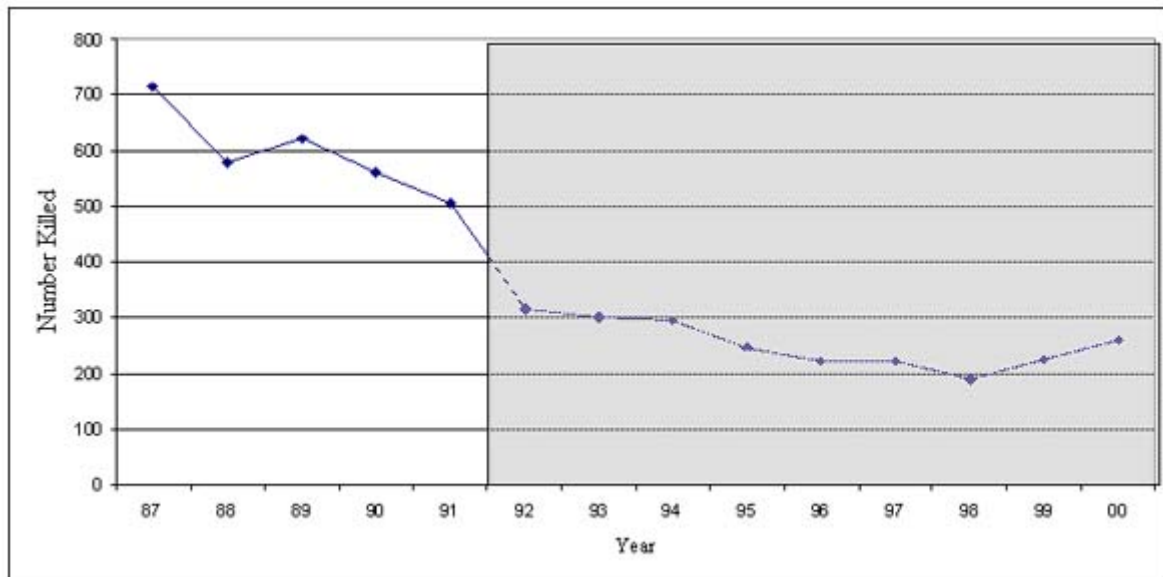
California's universal helmet law became effective in January 1992. Kraus et al. (1995) observed helmet use at 60 locations in seven California counties, twice before and four times after California's law became effective. They concluded that helmet use increased from about 50 percent in 1991 to more than 99 percent in 1992.

Kraus et al. (1994) compared California's motorcycle crash experience in 1991, before the law, with 1992, after the universal law. Motorcycle fatalities statewide decreased 37 percent in 1992 compared with a year earlier. The fatality rate per registered motorcycle decreased 26 percent.

There is now considerably more data regarding motorcycle fatalities in California since its adoption of a universal helmet law. In the five years immediately before the universal law (1987-1991), the annual average of motorcyclists killed was 596. In the five years following adoption (1992-1996), the average was 274, a 54-percent decrease. Figure II.3 shows the trend in the State's motorcyclist fatalities over the 1987-2000 period. Prior to the adoption of the universal helmet law, fatalities had declined from 716 in 1987 to 505 in 1991. A sharp decline was then experienced following enactment of the law. This was followed by gradual declines through 1998, then increases in 1999 and 2000, mirroring national trends.

Kraus and Peek (1995) studied injured motorcyclists treated at 18 hospitals in 10 California counties between January 1, 1991 and December 31, 1993 (2,037 patients in 1991, before the law, and 2,753 in 1992 and 1993, after the law). Helmet use among these injured motorcyclists rose from 30 percent in 1991 to 86 percent in 1992 and 88 percent in 1993. Both the severity and number of head injuries per rider decreased after the law.

Figure II.3. California Motorcyclists Killed, 1987-2000



Source: FARS

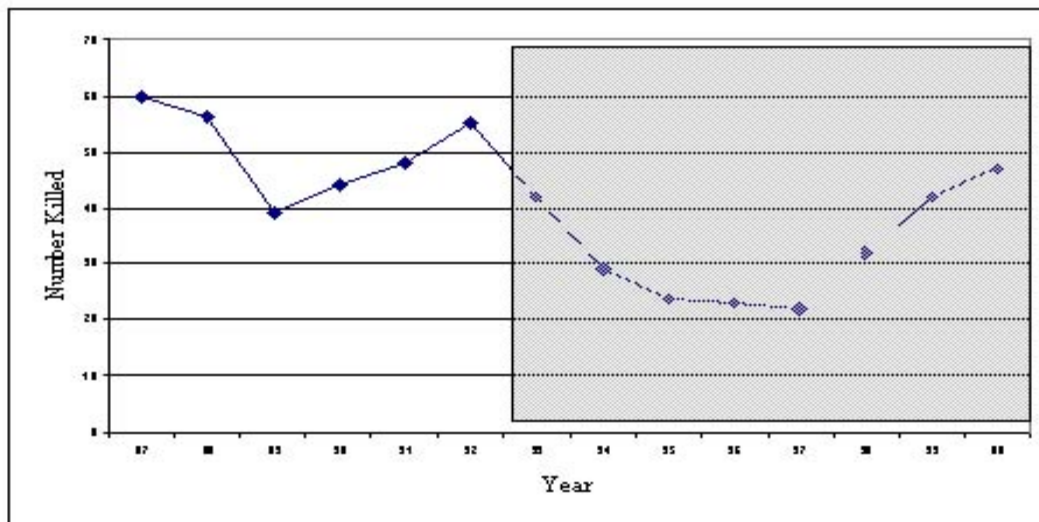
Florida's universal helmet law was originally effective in September 1967. In July 2000, the law was changed. The new law did not require motorcyclists over the age of 20 and medically insured (minimum \$10,000 insurance required) to wear a helmet. Since that

repeal in the law, Florida has seen an estimated increase in motorcyclist fatalities by approximately 25 percent. It was also estimated, that had the universal helmet law not been repealed, over 100 lives would have been saved during 2001 and 2002 alone (IIHS, 2005; Ulmer et al., 2005).

Louisiana's universal helmet law was repealed in 1999. Ulmer et al. (2003) examined the effect of the Louisiana universal helmet law repeal. They found that helmet use decreased by approximately 50 percent in the two years following the repeal, injury crashes and injuries increased by more than 40 percent in 2000, and the fatality rate increased by 75 percent. This study proved that the repeal of helmet laws directly affects the decrease in helmet utilization, and this leads to an increase in motorcyclist fatalities and catastrophic injuries.

Maryland's universal helmet law was adopted in 1992. Mitchell et al. (2001) used autopsy records to study the effects of the law. They reported that there was a 36-percent decline in the number of motorcyclist fatalities in the 33-month period immediately following the law compared to the 33 months just prior to the law. Helmeted motorcyclists were significantly less likely to have died from traumatic brain injury as compared to non-helmeted motorcyclists. In the five years prior to the law's adoption (1987-1991) the State averaged 49 motorcyclist fatalities per year. In the five years after the law's passage (1993-1997) the State averaged 28 motorcyclist fatalities. However, as shown in Figure II.4, fatalities have been on the increase in recent years.

Figure II.4. Maryland Motorcyclists Killed, 1987-2000



Source: FARS

Nebraska's universal helmet law became effective in January 1989; a previous universal law had been declared unconstitutional by the Nebraska Supreme Court and was repealed in 1977. Mulleman, Mlinek, and Collicott (1991) observed a 26-percent reduction in crashes per registered motorcycle in 1990, compared to the five previous years and to five adjoining States without universal helmet laws. They also studied all motorcyclists

with reported crash injuries in two urban counties during 1988 and 1989 (421 in 1988 and 250 in 1989). They found that the universal law produced sharp declines in the numbers and rates of injuries, hospital transports, hospital admissions, severe injuries to the head, and deaths.

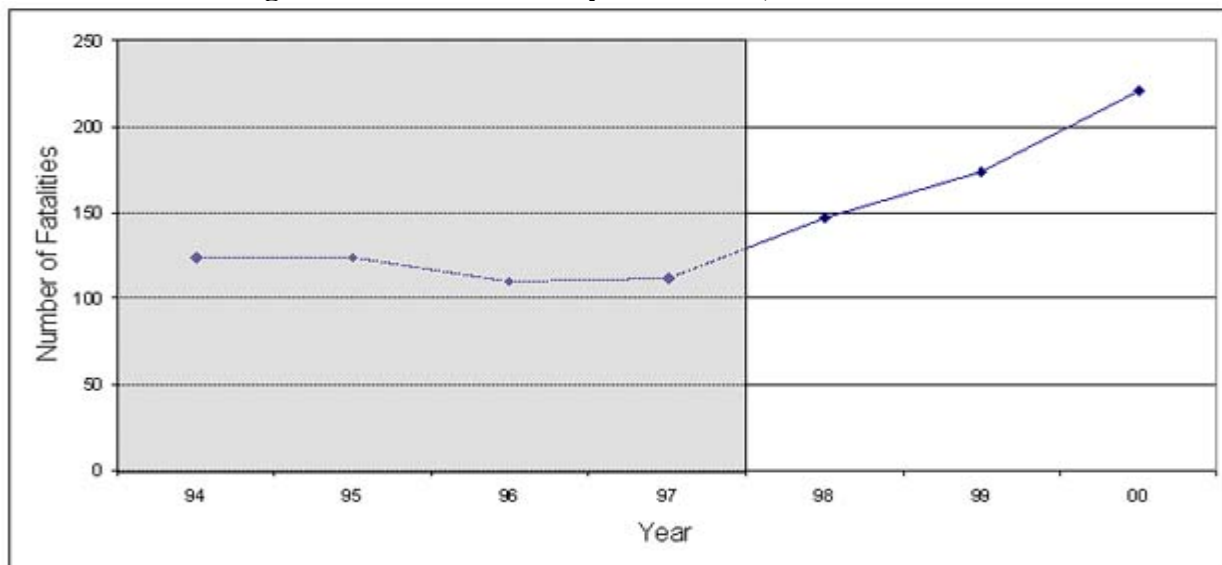
Nebraska is another State with relatively few motorcyclist fatalities. Nevertheless, in the five years just prior to adopting a universal helmet law, the State averaged 24 fatalities per year. In the five years just after the universal law, fatalities declined to an average of 10 per year. In 2000 the State experienced just three motorcyclist fatalities.

Texas enacted a universal helmet use law in 1968, repealed it in 1977 and required helmet use only for riders under 18, and re-enacted a universal helmet law in 1989. Lund, Williams, and Womack (1991) present data showing that helmet use increased from less than 50 percent just before the 1989 universal law to 90 percent immediately after the law became effective and to 95 percent two months later.

Mounce et al. (1992) found an 11-percent reduction in serious injury crashes per registered motorcycle after the law, using police-reported data. Hospital data from the first 9 months after the law showed that motorcyclists injured after the law suffered less serious injuries and were less likely to have head or face injuries than motorcyclists injured before the law. Fleming and Becker (1992) found a 13-percent reduction in fatalities and in severe injuries in the first 12 months after the universal law was reinstated, after using time series methods to control for long-term declines in motorcycle fatalities. They found a 57-percent decrease in head-related fatalities and a 55-percent reduction in severe head-related injuries among hospital-admitted motorcyclists.

Effective September 1, 1997, Texas again repealed its universal helmet law and thereafter required helmet use only by riders under 21 or who had not completed a rider education course or who did not have at least \$10,000 medical insurance coverage. Preusser et al. (2000) found that the 1997 repeal was accompanied by a decline in helmet use, an increase in fatalities, while non-fatal injuries did not change appreciably. However, there was a marked increase in traumatic brain injury cases and in the costs of treating these cases. Also, in the three years immediately following the law change (1998-2000), an average of 180 motorcyclists were killed each year compared to an average of 119 in the three years (1994-1996) before the law change; a 51-percent increase (see Figure II.5).

Figure II.5. Texas Motorcyclists Killed, 1994-2000



Source: FARS

Washington's universal helmet law became effective in June 1990. Mock et al. (1995) analyzed 992 motorcycle crash victims admitted to the Seattle region's only level 1 trauma center from 1986 through 1993. They found that severe head injuries decreased from 20 percent of all admitted patients before the law to 9 percent after the law. Mortality among admitted patients decreased following the law. In the five full years (1984-1988) before the universal law was adopted, Washington averaged 77 motorcyclist fatalities per year. In the five full years after the law (1991-1995), the average declined to 39 fatalities per year.

Studies of Helmet Effects

As part of the 1991 ISTEA legislation, Congress required NHTSA to study the effects of seat belt and motorcycle helmet use in crashes. NHTSA conducted the analysis using its Crash Outcome Data Evaluation System (CODES) data system, in which 7 States linked data from their police crash reports, emergency medical services, hospital emergency departments, hospital discharge files, claims, and other sources. NHTSA's 1996 Report to Congress found that "motorcycle helmet effectiveness ranged from 9 percent in preventing any kind of injury to 35 percent in preventing a fatality." "The average inpatient charge for motorcycle crash victims receiving inpatient care was \$14,377 for those who used helmets, and \$15,578 for those who did not" (NHTSA, 1996).

Additional analyses of the CODES data showed that helmet use for motorcycle riders involved in crashes ranged from 80 to 98 percent in three CODES States with universal helmet laws, and from 30 to 49 percent in three CODES States without universal laws. Helmets were found to be 65 percent effective in preventing brain injuries in a crash (NHTSA, 1998a).

Sosin, Sacks, and Holmgren (1990) used National Center for Health Statistics Multiple Cause of Death data to study motorcycle fatalities from 1979 through 1986. They found that 53 percent of the 28,749 motorcycle fatalities were associated with head injuries. Rates per population for motorcycle fatalities associated with head injury (adjusted by age, sex, and race) were almost twice as high in States without universal helmet laws as in States with universal helmet laws. Fatalities per registered motorcycle also were greater in States without universal helmet laws. In the two States that dropped universal coverage during the study period, motorcyclist fatalities per population rose substantially: by 184 percent in South Carolina and by 73 percent in Wyoming.

Kelley et al. (1991) studied 398 motorcycle crash victims in eight Illinois medical centers from April through October 1988. Illinois had no helmet law at that time. They concluded that unhelmeted patients had higher overall injuries (measured by the Injury Severity Score) and more frequent head and neck injuries than helmeted motorcyclists.

Kraus et al. (1995) studied 174 fatally injured and 379 non-fatally injured crash-involved motorcyclists in Los Angeles County, California, in 1988 and 1989, before California's universal helmet law. They concluded that "those not using helmets where helmet use is voluntary are a higher-risk population than helmet users. They are more likely to be involved in crashes but, because they are unhelmeted, less likely to be protected against serious head injury."

Sarkar, Peek, and Kraus (1995) studied 173 fatally injured motorcyclists in Los Angeles County, California, between July 1, 1988, and October 31, 1989. They concluded that head and cervical spine injuries were more frequent in unhelmeted than in helmeted fatally injured motorcyclists.

Rowland et al. (1996) studied 86 fatally injured and 386 hospitalized motorcyclists in Washington in 1989 (when Washington's helmet law covered only riders under age 18). They concluded that "motorcycle helmet use is strongly and independently associated with reduced likelihood and severity of head injury, reduced overall injury severity, and reduced probability of motorcycle-related hospitalization and death attributable to head injury."

Bigelow (2001) examined CODES data from 18,394 motorcyclists involved in crashes in Wisconsin. Helmeted riders were less likely to have sustained traumatic brain injury across a variety of crash related factors including crash type, speed limit, highway type, and alcohol involvement. The average hospital charges for the brain injury cases was almost \$28,806 and the average length of stay was 10.6 days.

Finison (2001) examined CODES data from 806 motorcyclists involved in crashes in Maine during 1995 and 1996. Riders not wearing helmets were found to be three times more likely to have head injuries requiring EMS transport, hospitalization, or resulting in death than motorcyclists who were helmeted.

Kostyniuk et al. (2006) studied a noticeable spike in motorcycle fatalities from 2004 through 2005 in Michigan. Their research on helmet usage in the State showed that injury severity was higher among non-helmeted motorcyclists compared to helmeted motorcyclists. They reported that helmeted motorcyclists had lower incapacitating injuries (19 to 21%) in comparison to the incapacitating injuries among non-helmeted motorcyclists (27 to 41%).

NHTSA (2006) reported that approximately half of all motorcyclists wore helmets deemed appropriate by DOT guidelines, which was a slight increase from 2005 (48%). It was reported that the hours that constitute the rush hour commute for motorcyclists had only 42-percent compliance (a 22-percent decrease) for motorcyclists to be wearing DOT-compliant helmets. As expected, those States that do not have universal helmet laws retained significantly lower use rates as compared to States with universal helmet laws (37% versus 68%).

SUMMARY

The studies since the 1991 GAO report repeatedly support the GAO's conclusions with more recent data. All studies concluded that universal motorcycle helmet laws raise helmet use and promote fewer injuries among motorcyclists. Universal laws are continually associated with the reduction of motorcycle fatalities and severe head trauma.

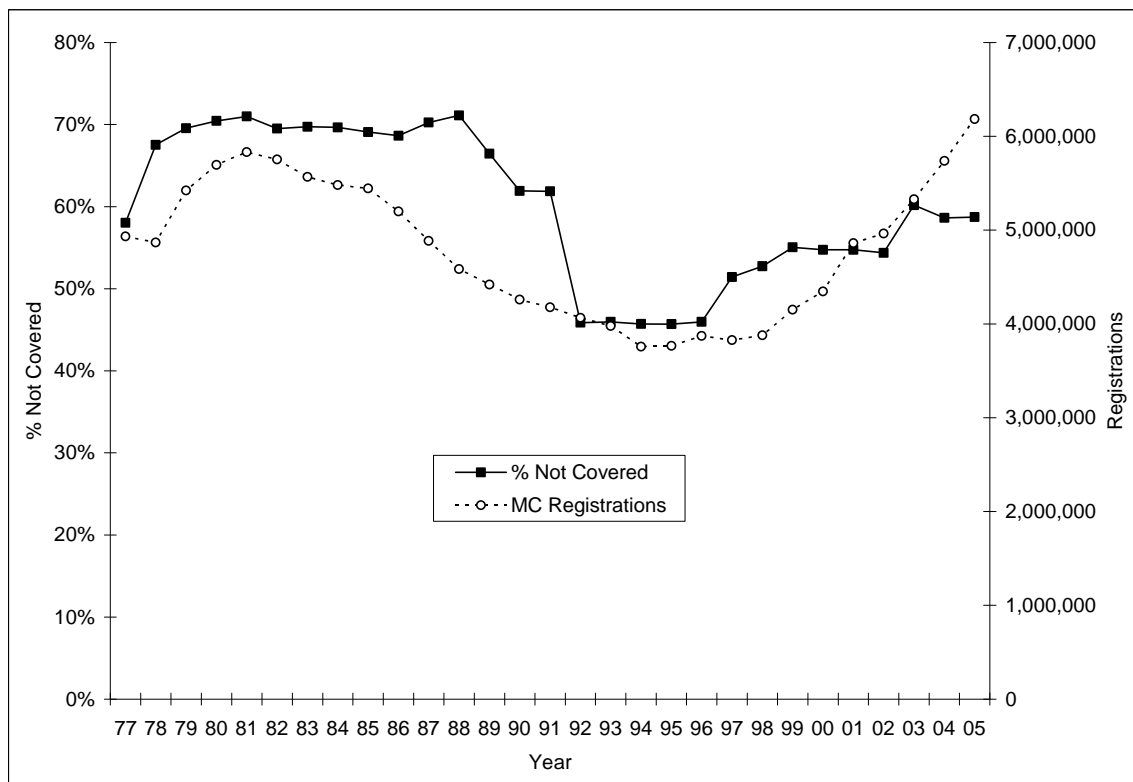
III. NATIONAL TRENDS

Motorcycle registration and fatality trends in the United States differ considerably from passenger vehicle trends. This chapter examines these trends briefly to provide context for the United States as well as Louisiana.

REGISTRATIONS, FATALITIES, AND UNIVERSAL HELMET LAWS

Figure III.1 shows the number of registered motorcyclists reported nationally for the United States from 1977 through 2005 according to the Federal Highway Administration (FHWA). Motorcycle registrations decreased starting in the 1980s and reached a low in 1994 of approximately 3.8 million. From 1994 on, there was a general increase in motorcycle registrations that peaked in 2005 with approximately 6.2 million registered vehicles. Nationally, there has been a steady increase in registrations resulting in over 2.3 million additional motorcycle registrations in the last 10 years.

Figure III.1. U.S. Motorcycle Registrations and Percent Registration Not Covered By a Universal Helmet Law, 1977 — 2005



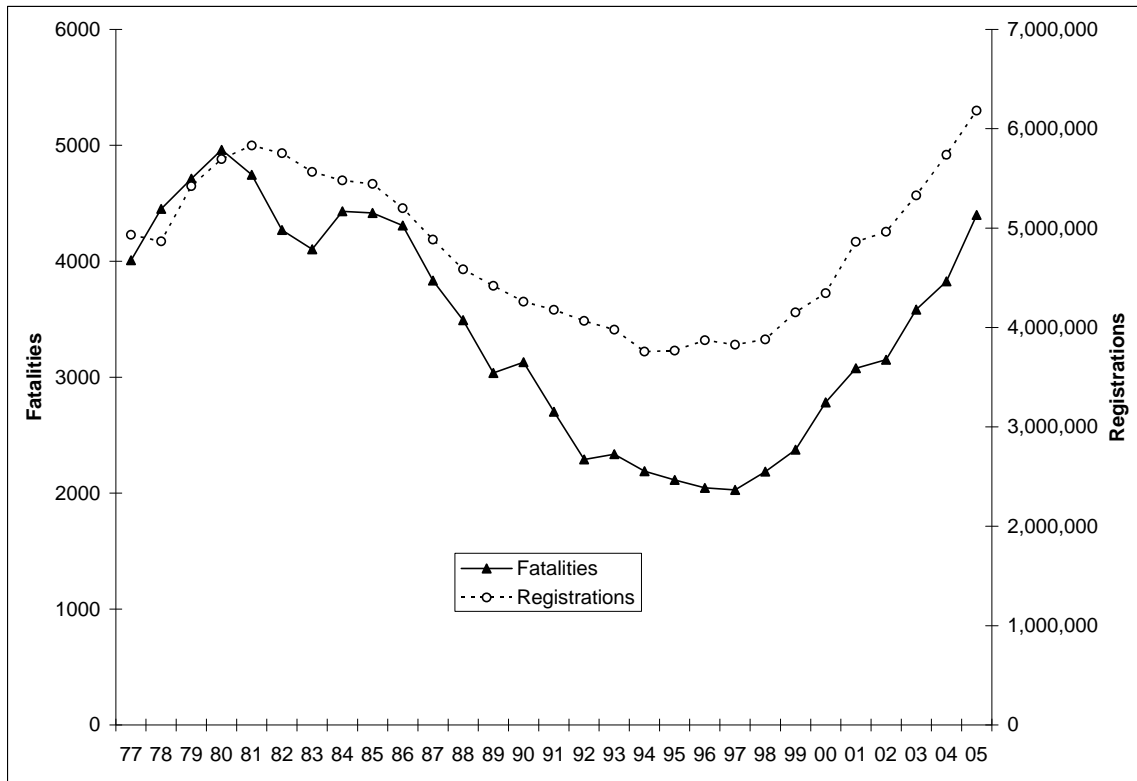
Source: FHWA (Registrations)

Figure III.1 also shows the percent of registrations not covered by a universal helmet law. This was calculated by dividing the registrations in States without universal helmet laws

in a given year by the total number of registrations in the Nation. This data shows a clear relationship between the percentage of motorcyclists not covered under universal helmet laws and the number of registrations ($r = .71, p < .001$). This suggests the possibility that more motorcycles become registered as a result of weaker helmet laws.

It could be argued that this strong positive correlation between percent not covered by helmet laws and registrations accounts for any increases in fatalities following repeals of universal helmet laws. Figure III.2 shows that registrations and fatalities in the United States follow a similar pattern (with a brief deviation in the early 1980s). The fatality data is the number of motorcyclists (drivers and passengers) killed in the United States annually from 1977 to 2005, using data from FARS. The definition of motorcycles used here excludes mopeds and similar vehicles from the tabulations. This data shows that motorcycle fatalities were at an all-time high of nearly 5,000 in 1980. There was a decline in fatalities until 1998, when there were just over 2,000 motorcyclists killed. Starting from this low, there was a consistent increase until the most recent year's data (2005) when there were nearly 4,400 fatalities—the highest level in 19 years.

Figure III.2. U.S. Motorcycle Registrations and Motorcycle Fatalities, 1977 - 2005



Two analyses were conducted to tease apart the role of number of registrations and helmet laws on motorcycle fatalities. The first analysis was a partial correlation of motorcycle fatalities in the United States with the percent of registrations not covered under universal helmet laws while controlling for the influence of registrations. This relationship is represented graphically in Figure III.3 which shows the percent not

covered by a universal helmet law and fatalities per 10k registrations. This analysis describes a strong positive relationship between fatalities and the percentage of registrations not covered by universal helmet laws even when removing the influence of registrations ($r = .71, p < .001$). However, the correlation may not take into account the systematic and interrelated variation of these three variables over time. Therefore, a time series (ARIMA) analysis was conducted to control for any such fluctuation. A stable series for annual fatalities was obtained by including a 1 for the moving average in the model. Both percentage of registrations not covered by a universal helmet law and registrations were included as covariates to the fatalities series. Table III.1 shows that even accounting for the effects of time (i.e., year) there is still a significant relationship of fatalities to both registrations ($t = 7.451, p < .001$) and the percentage of registrations not covered by a universal helmet law ($t = 4.193, p < .001$). Thus, there is a clear and strong positive relationship between the percentage of motorcycle registrations not covered by universal helmet laws and fatalities. This relationship is present even after accounting for the number of motorcycle registrations and any systematic interrelated annual fluctuations in the three variables over time.

Figure III.3. Percent Motorcycle Registrations Not Covered by Law and Motorcycle Fatalities/10k Registrations

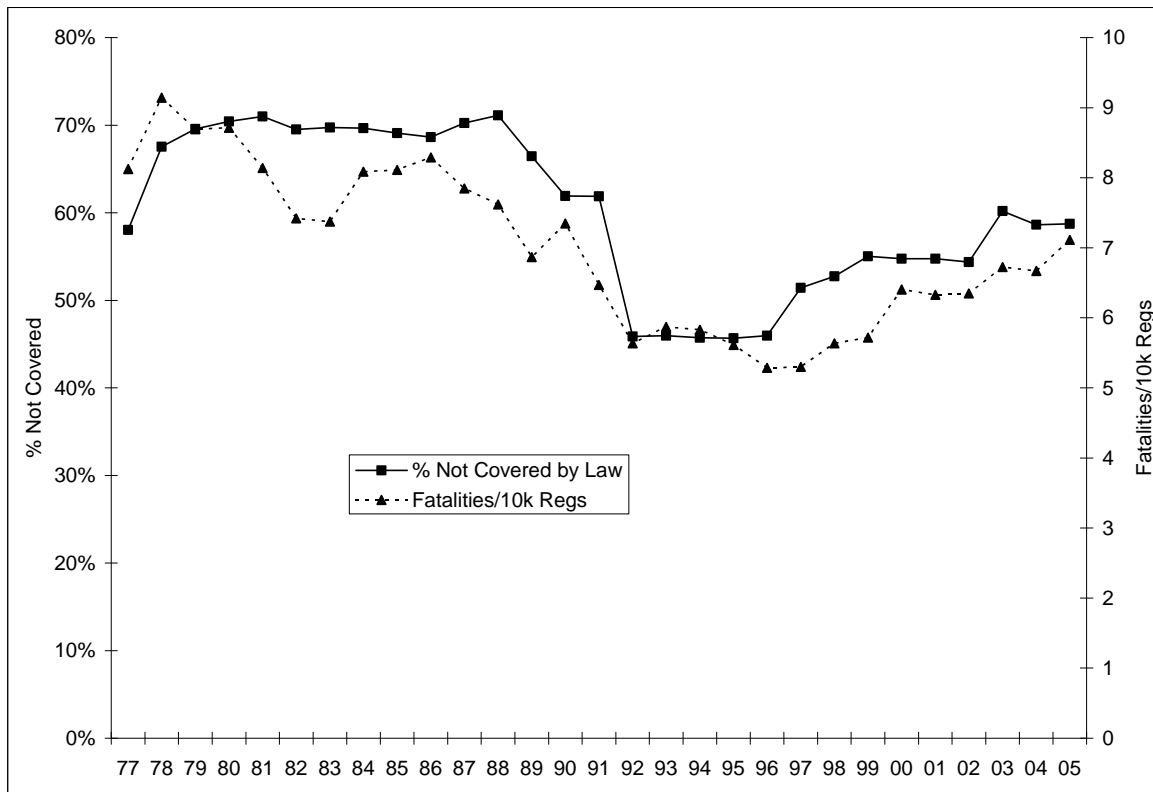


Table III.1. Time Series Analysis

	Estimates	Std Error	t	Approx Sig
Non-Seasonal Lags	-.474	.192	-2.460	.021
Regression Coefficients				
Registrations	.001	.000	7.451	.000
% Not Covered	3795.309	905.071	4.193	.000
Constant	-2910.084	463.405	-6.280	.000

IV. EFFECTS OF THE LAW CHANGE IN LOUISIANA

THE LAW

Louisiana first adopted a motorcycle helmet law applicable to all riders in 1968. That law was amended in 1976 to require helmet use only by riders under the age of 18. Then, in 1982, Louisiana reenacted a universal helmet law. It was this latter law that was amended effective August 1999 to require helmet use only by motorcyclists under the age of 18 and riders over 18 who did not have a minimum of \$10,000 in medical insurance coverage – effectively rescinding the universal helmet law.

Table IV.1. History of Louisiana's Universal Helmet Law

Year	Universal Hemet Law
1968	Enacted
1976	Repealed
1982	Reenacted
1999	Repealed
2004	Reenacted

In August 2004 the helmet law that was repealed in 1999 was reinstated. This reinstatement resulted in all motorcyclists, drivers and passengers, being required to wear helmets. Twenty States and the District of Columbia, including Louisiana, now have universal helmet laws for all motorcyclists.

There are three sources of data used in the analyses of the effects of the reinstatement of the universal helmet law in Louisiana. These data are observational surveys for helmet use rates, hospital data from the Level 1 trauma facility records in Shreveport, statewide crash data from Louisiana State University, and the Fatality Analysis Reporting System (FARS).

OBSERVATIONAL SURVEYS

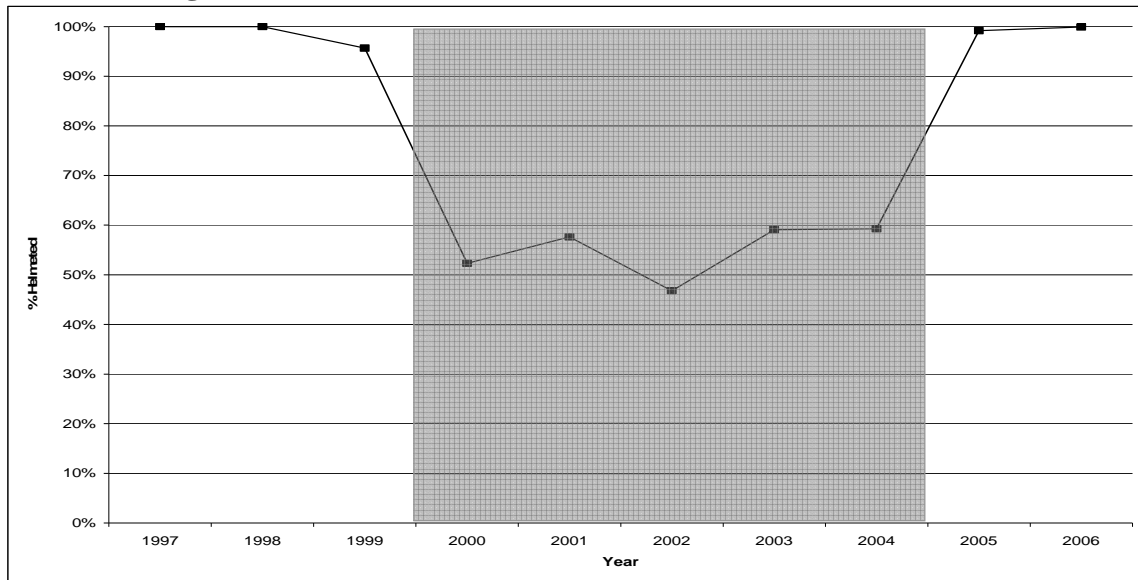
The statewide rate of motorcycle helmet use is determined once a year in Louisiana. The observational survey of helmet use is conducted at the same time as the statewide survey of seat belt use (see Table IV.2).

Table IV.2. Number of Motorcyclists Observed in Louisiana, 1997-2006

Year Observed	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Number Observed	127	188	210	247	321	192	237	333	272	1,128

Results from recent Louisiana helmet use surveys are shown in Figure IV.1. The figures indicate that when Louisiana was under the universal helmet law (years including 1997, 1998, 1999, 2005, and 2006) virtually all riders were compliant with the law and wore helmets. During the years that the Louisiana helmet law was repealed (2000 to 2004), helmet use declined to around 50 percent. It is unclear why there were so many more observations in 2006, but the rate of helmet use in that year was not dissimilar to 2005.

Figure IV.1. Observed Helmet Use in Louisiana, 1997 – 2006*



* Shaded area represents the lack of a universal helmet law

Source: Louisiana

CRASH DATA

State Data

Crash data was obtained from Louisiana State University for the years 1999 through 2005 for all reported motorcycle crashes in the State. There were 10,094 motorcycles involved in crashes in Louisiana from 1999 through 2005 (see Table IV.3), and there was a consistent increase in the number of motorcycle crashes in the State during that time. Statewide, the number of motorcycles in crashes in 1999 (n = 957) was approximately doubled in 2005 (n = 1,877). Injuries were classified by investigating police officers using the “KABCO” injury scale where injuries were: K (Killed/Fatal), A (Severe), B (Moderate), C (there was a Complaint of injury but no injury was visible) or O (no injury).

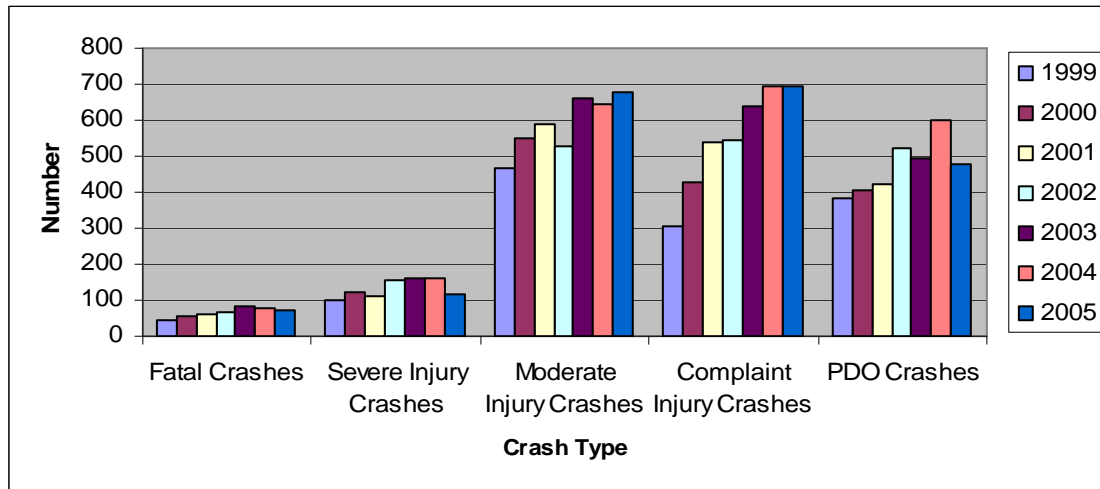
Table IV.3. Louisiana Motorcycle Crashes per Year

Year	Number
1999	957
2000	1,210
2001	1,266
2002	1,464
2003	1,645
2004	1,672
2005	1,877
Total	10,091

Source: Louisiana State University

The next figure shows the distribution by year of motorcycle crash types in Louisiana from 1999, when the universal helmet law was repealed, through 2005, the year after the law was reinstated. The graph shows that all injury types were increasing from 1999. Fatal and severe injury crashes declined in 2005, as did property damage only crashes. Moderate injury crashes increased and complaint injury crashes remained the same.

Figure IV.2. Number of Louisiana Motorcycle Crashes by Type, 1999-2005



Source: Louisiana State University

Most motorcycle drivers in crashes were male ($n = 9,449$; 96%), and white ($n = 7,307$; 75%), with a mean age of 36 years. Slightly more than half ($n = 5,075$; 52%) were helmeted at the time of the crash. Most injuries were classified as moderate ($n = 3,754$; 37%), with approximately 14 percent being fatal ($n = 478$; 5%) or severe ($n = 880$, 9%) (see Table IV.4).

Table IV.4. Motorcycle Crash Characteristics

	January 1999 – August 24, 2005	
	Frequency	Percent
Driver Sex		
Male	8,872	96.0
Female	373	4.0
Race		
White	6,823	74.8
Black	2,293	25.1
Other	11	0.1
Age		
Mean Years	36.2	-
Helmet Use		
Yes	4,608	50.0
No	4,604	50.0
Injury Status		
Fatal	458	4.8
Severe	846	8.9
Moderate	3,539	37.4
Complaint	3,094	32.7
None	1,537	16.2

Source: Louisiana State University

There were 7,615 motorcycles in crashes during the pre-law period (January 1, 1999 - August 14, 2004) and 2,479 motorcycles in crashes during the post-law period (August 15, 2004 – December 31, 2005). Only data from prior to August 25, 2005, was included in the analyses as a result of the devastation caused by Hurricane Katrina. During the almost 12 months post-law and pre-Katrina time period, there were 1,860 motorcycles in crashes in the State.

The approximately 68 months of crash data before the reinstatement of Louisiana’s universal helmet law were compared to the 12 months of crash data after the reinstatement and before Katrina. Helmet use by motorcyclists before the repeal was 42 percent (n = 3,218). After the reenactment of the law, helmet use rose to 87 percent (n = 1,390) (see Table IV.5).

Table IV.5. Motorcycle Crashes Pre-and Post-Law Reinstatement for Louisiana, January 1999 – August 25, 2005

Pre-and Post- Law Reinstatement Percent* Helmet Use		
	Pre-Law (68 months) % (n)	Post-Law (12 months) % (n)
Helmet Use (Yes)	42.3% (3,218)	87.0% (1,390)
Injury Status		
Fatal	5.0% (377)	4.4% (81)
Severe	9.4% (713)	7.2% (133)
Moderate	38.0% (2,894)	34.7% (645)
Complaint	32.1% (2,445)	34.9% (649)
None	15.6% (1,185)	18.9% (352)

Source: LSU

Multiple logistic regression analyses were conducted to explore helmet use and injury levels after the law change to before the law change. Given the association between helmet use and injury status, two separate models were produced to show the effect of each on the outcome of pre-post-law status. These analyses include the ability to account for, and mathematically remove, the effects of other potentially confounding variables. Specifically, age, sex, and race were included as factors in both regressions. As a result of the relatively large number of tests conducted, alpha was set at 0.01. That is, in order to avoid erroneous reports of significance, we used a stricter criterion than the standard alpha of 0.05.

There were no significant effects of gender or race in either model (see Tables IV.6 and IV.7). The logistic regression showed a strong positive effect of helmet use post-law reinstatement. The odds of wearing a helmet in a crash post-law reinstatement was 11.7 times greater in comparison to wearing a helmet during the pre-law time period ($p < 0.001$) (see Table IV.6). Odds ratios (OR) are a method to show the size of an effect. An odds ratio of 1:1 means that there would be no difference between the two groups, in this case the likelihood of wearing a helmet in a crash before and after the law change.

Injuries were also significantly lower in the post-law period compared to the pre-law period (see Table IV.7) after adjusting for age, gender, and race. Fatalities were 30 percent less likely to occur post-law as compared to pre-law ($p = 0.012$). There were similar findings for severe injuries (OR = 0.62, $p < 0.001$) and moderate injuries (OR = 0.74, $p < 0.001$). Injury complaints (OR = 0.87, $p = 0.085$) post-law reinstatement compared to pre-law reinstatement were not significantly different, however the outcome was still protective (see Table IV.7). These injury changes were in comparison to a “base” of non-injury crashes. Thus, the data supports the contention that the reenactment of the universal helmet law in Louisiana led to an increase in helmet use and a reduction in the proportion of more-severe injury crashes.

Table IV.6. Multiple Logistic Regression Model for Helmet Use Pre-Post-Law Reinstatement for Louisiana

Pre-Post-Law Reinstatement	Odds Ratio	P-value (95% CI)
Helmet (Yes)	11.7	<0.001
Age	1.0	0.002
Sex (Male)	1.3	0.106
Race (White)	1.2	0.036

Source: LSU

Table IV.7. Multiple Logistic Regression Model for Injury Status Pre-Post-Law Reinstatement for Louisiana

Pre-Post-Law Reinstatement	Odds Ratio	P-value (95% CI)
Injury Status		
Fatal	0.70	0.012
Severe	0.62	<0.001
Moderate	0.74	<0.001
Complaint	0.87	0.085
Age	1.00	0.025
Sex (Male)	1.10	0.476
Race (White)	1.06	0.328

Source: LSU

A time series (ARIMA) analysis was conducted to see if the actual number of fatal and severe crashes declined following reinstatement of the helmet law. Complaint of injury crashes combined with property damage only (non-injury) crashes were used as a covariate to the combined fatal and severe injury crash series in order to control for the overall rate of motorcycling. Monthly motorcycle crashes from January 2000 until July 2004 were used as the pre-law series. The 12 months post-law change until the last full pre-Katrina month were the post-series (August 2004 to July 2005). A stable series was obtained by the addition of the covariate. The results indicated that there was a significant decrease in the number of fatal and severe injury crashes coincident to the law change ($p = 0.04$). There was an estimated 9.4 fewer fatal/severe crashes per month with an estimated reduction of 46 percent over the year following law change.

Table IV.8. Time Series Results

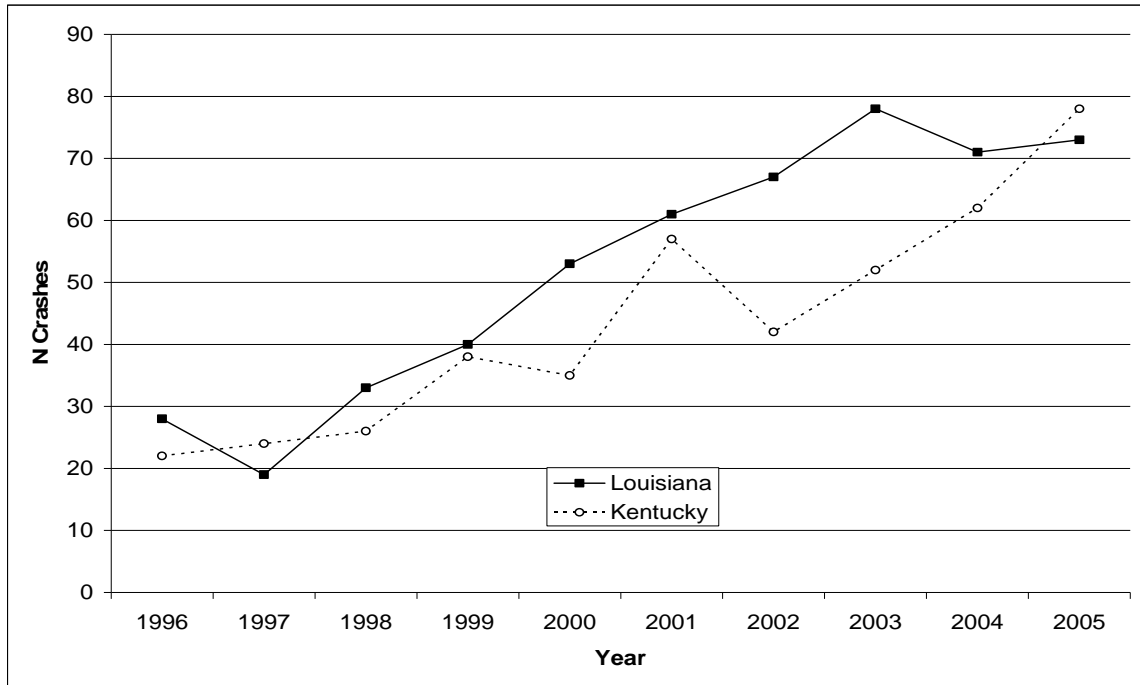
	Estimates	Std Error	t	Approx Sig
Regression Coefficients				
Law Change	-9.423	4.502	-2.093	.040
Complaint/PDO	.791	.077	10.217	.000
Constant	15.149	4.825	3.140	.003

FARS Data for Louisiana and Kentucky

Fatality data was also obtained from FARS for both Louisiana and Kentucky. Kentucky was chosen as a comparison State for Louisiana given its universal helmet law was repealed in 1998 and to explore the possibilities that any changes in Louisiana may have been due to regional effects. Data included fatally injured motorcycle (excluding mopeds, etc.) occupants (drivers and passengers).

There were a total of 523 fatal crashes in Louisiana from 1996 through 2005 in which at least one motorcycle occupant was killed. Kentucky had less than 100 fewer fatal crashes between 1996 and 2005 than Louisiana (N = 436). The number of fatal crashes in Louisiana increased from 1997 through 2003 prior to the helmet law reinstatement (Figure IV.2). In 2004 following the law change there was the first decrease in crashes since the 1999 repeal. There was a slight increase in crashes in 2005, but there were still less than before the law was reinstated. Kentucky, during the same time period, also showed a general increase in crashes. There was a major shift in Kentucky crashes in 1999, perhaps due to the repeal of its universal helmet law in 1998. However, beginning in 2002, Kentucky's crashes increased steadily. Thus, it appears that the drop in fatal crashes in Louisiana occurring after the helmet law reinstatement was not due to any regional effects, and is likely attributable to the law change.

Figure IV.3. Fatal Motorcycle Crashes in Louisiana and Kentucky, 1996-2005



Source (FARS 1996 – 2005)

A qualitative crash type (as per CITE) analysis is included in Appendix A for all Louisiana motorcycle crashes occurring after the law change until the end of 2005 with at least one fatality. These data provide a description of the types of crashes motorcyclists

are involved in that includes descriptions of the crash scene, motorcyclists' behaviors, and other victims involved in the fatal crash (see Appendix A).

REGISTRATIONS

Prior research on motorcycle helmet laws has considered the role of registrations on crashes as a way to take into account variations in the number of motorcycles on the road. Motorcycle registrations have been steadily increasing in Louisiana since 1990 when there were slightly more than 30,000 registered motorcycles, reaching the mid 50,000s by 2002. Crashes per registered motorcycle could not be calculated in Louisiana because of limitations in the data available at the time of this report. Specifically, registration data reflects an annual number and crash data were available only up until August 2005. However, registrations were fairly constant for the full year prior to the reinstatement (2003) through the first full year after reinstatement (2005). There are not enough data points to make a meaningful calculation before and after the law change using registrations as a denominator. The next table shows annual motorcycle registration data provided by the Federal Highway Administration (FHWA) and R.L. Polk & Company (POLK). FHWA's data reflect the number of motorcycles registered in a given year, and the Polk data represent the number of registered motorcycles in the state. In Louisiana, a motorcycle registration is for a four-year period.

Table IV.9. Louisiana Motorcycle Registrations 2002-2006. A Comparison of Federal Highway Administration (FHWA) Data and RL Polk & Company (POLK) Data

Year	FHWA ¹	POLK ²	Difference
2000	48,244	133,320	+85,076
2001	50,507	140,993	+90,486
2002	53,935	147,572	+93,637
2003	57,275	150,764	+93,489
2004	55,846	166,432	+110,586
2005	55,071	172,172	+117,101
2006	61,117	189,097	+127,980

Source: National Center for Statistics and Analysis

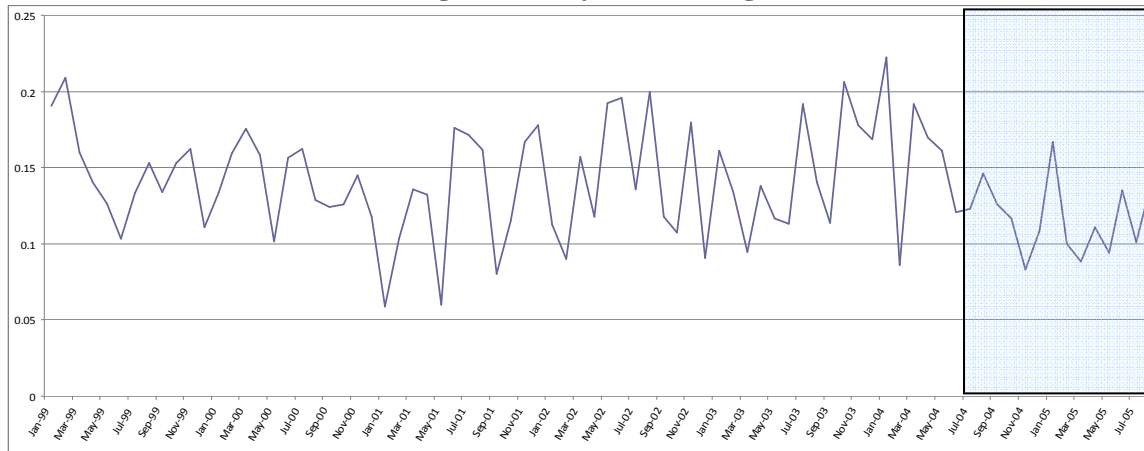
¹FHWA excludes all off-highway motorcycles such as ATVs, dirt, and trail.

²RL POLK compiles data from 26 makes on the following categories: ATV, MOPED, OFF-HIGHWAY, ON HIGHWAY, ON/OFF, SCOOTER AND UNKNOWN.

FATAL AND SERIOUS INJURIES

Another way to consider the impact of helmet usage after the reinstatement of the universal helmet law is to calculate the number of fatal and serious injuries as a proportion of all motorcycle crashes (fatal crashes, serious injuries, moderate injuries, complaint of injury, and property damage only). This proportion is independent of changes in exposure. The following figure shows that the proportion of monthly fatal and serious injury motorcycle crashes declined after the helmet law was reinstated, when all motorcycle crashes are considered.

Figure IV.3. Proportion of Fatal and Serious Injuries to all Motorcycle Crashes Before and After the Law Change, January 1999 – August, 2005



Source: Louisiana State University

HOSPITAL DATA

Statewide hospital discharge data was unavailable from Louisiana at the time of this study. Data from the Level I trauma unit in Shreveport, Louisiana, was obtained to attempt a cost analysis exploring changes in hospital charges, type of injury, and length of stay as a result of the helmet law change. However, there were only a total of 428 motorcyclists treated at this facility from June 2002 through June 2006 (see Table IV.9).

Table IV.10. Shreveport, Louisiana Trauma Registry Data, 2002 – 2006

Number of Trauma Patients by Year	
Year	Number
2002*	38
2003	97
2004	116
2005	111
2006**	66
Total	428
* June -- December data	
** January -- June data	

There were 216 motorcyclists treated before the law reinstatement and 212 motorcyclists treated after the universal law was reinstated. It is unclear what effect Hurricane Katrina had on the data from post-Katrina. Specifically, it is unknown if the coverage area changed for this Level I Trauma Unit. That is, this hospital could have been needed to treat additional patients in need of trauma services due to the destruction of infrastructure along the coast. This left only 91 motorcycle crash-related admissions from law change

until to July 2005 (pre-Katrina). Meaningful statistical analyses given the small sample size were unlikely to detect any actual changes in charges by this single hospital. Therefore, estimates were created using the 216 cases prior to the law change.

Table IV.10 shows means and media values for the length of stay and total charges. Patients before the law change were on average 33.6 years old and were treated on average for 4.6 (median = 1.0) days prior to release. The hospital charges for the patients averaged \$14,287.82 (median = \$7,605.88). The discharge status (e.g., deceased, discharged to home, discharged to other hospital) was unavailable for the patients.

Table IV.11. Shreveport, Louisiana, Patient Age, Length of Stay and Total Charges, 2002 – August 14, 2004

Mean and Median Patient Characteristics		
	Pre- (n = 216)	
	Mean	Median
Age (years)	33.6	33.3
Length of Stay (days)	4.6	1
Total Charges (dollars)	\$14,287.82	\$7,605.88

Data indicating primary and secondary diagnoses were collapsed into categories based on the injury diagnosis matrix from the Centers for Disease Control and Prevention (the Barell Matrix). ICD-9 codes were used to collapse the data into usable classifications.

Primary Diagnoses

Primary diagnostic classifications for Shreveport trauma patients admitted as a result of a motorcycle crash are presented in Tables IV.11.a and IV.11.b during the pre-law period (2002 – August 14, 2004). Injuries to the extremities were most prevalent (n = 123, 56.9%), followed by head and neck injuries (n = 48, 22.2%).

Table IV.12.a Trauma Registry Data by Primary Diagnosis Classification, 2002 – August 14, 2004

Primary Diagnosis Using the Broad Barell Diagnosis Matrix Classification		
	Frequency	Percent
Extremities	123	56.9
Head and Neck	48	22.2
Torso	22	10.2
Spinal Cord/Back	14	6.5
Unclassified	9	4.2
Total	216	100.0

Table IV.12. b

Primary Diagnosis Using Barell Diagnosis Matrix Classification		
	Frequency	Percent
Lower Extremities	70	32.4
Upper Extremities	53	24.5
Brain	30	13.9
Torso	22	10.2
Other Head, Face, Neck	18	8.3
Vertebral Column	10	4.6
Other & Unspecified	9	4.2
Spinal Cord	4	1.9
Total	216	100.0

Secondary Diagnoses

Of the 216 motorcyclists that entered the Shreveport trauma facility before the law change, 136 also had a secondary diagnosis (see Tables IV.12.a and b) during the pre-law period of 2002 through August 14, 2004. Head and neck injuries were more prevalent as primary diagnoses (n = 48, 22.2%) than as secondary diagnoses (n = 24, 17.6%).

Table IV.13.a Trauma Registry Data by Secondary Diagnosis Classification, 2002 – August 14, 2004

Secondary Diagnosis Using the Broad Barell Diagnosis Matrix Classification		
	Frequency	Percent
Extremities	44	32.4
Torso	31	22.8
Unclassified	30	22.1
Head and Neck	24	17.6
Spinal Cord/Back	7	5.1
Total	136	100.0

Table IV.13.b

Secondary Classification Diagnosis Using Barell Diagnosis Matrix		
	Frequency	Percent
Torso	31	22.8
Other & Unspecified	29	21.3
Upper Extremities	26	19.1
Lower Extremities	18	13.2
Brain	13	9.6
Other Head, Face, Neck	11	8.1
Vertebral Column	7	5.1
System Wide	1	0.7
Total	136	100.0

Estimates on cost savings by the reinstatement can be drawn using prior research. Based on Ulmer and Shabanova (2005) admissions by motorcyclists for brain injuries can be expected to drop by 55.6 percent following a helmet law reinstatement. Prior to the law change there were 43 drivers with brain injuries with an average cost of \$23,669 per injury. Post-law change, this number could be expected to drop to about 24 (19 fewer emergency room admissions). At \$23,669 per admission, the direct charges could be expected to drop by nearly \$450,000 over the same time frame. It is likely that this number would be even higher as Ulmer and Shabanova reported that the more severe (and costly) injuries were affected more by law change than the less severe injuries.

This estimate represents only a small portion of the likely medical cost savings. Brain injuries are likely to lead to additional care at other facilities and depending on the severity, this care may be required for years to come. Additionally, there are other costs not directly related to medical costs that are also likely to be reduced (loss of employment due to serious brain injury, legal costs associated with permanent injury, etc.).

VI. DISCUSSION

The 1999 helmet law repeal in Louisiana dramatically decreased helmet usage from almost complete usage by all motorcyclists to approximately 50 percent. The years following repeal showed a sharp increase in the number of motorcyclist fatalities in Louisiana. Observed helmet use doubled upon reinstatement of the law in August 2004.

Crash data showed that the odds of wearing a helmet in a crash after the Louisiana motorcycle helmet law compared to pre-law was extremely high. This increase in the compliance of helmet use after the reinstatement of the universal helmet law also led to significantly lower proportion of fatalities, severe injuries, and moderate injuries during the post-law period compared to the pre-law reinstatement. A time series analysis indicated that there were also fewer severe and fatal crashes following the law change.

Data related to hospital stay by people in motorcycle crashes were limited, and conclusive results could not be determined. Prior to the law change, there were 43 drivers with brain injuries with an average cost of \$23,669 per injury at this Shreveport trauma facility. Based on the observational data, it is likely that only about 50 percent of those riders would have been unhelmeted. NHTSA has estimated that the helmet is 67 percent effective at reducing brain injury (NHTSA, 2004). Given that nearly 100 percent of riders were helmeted after the law, we can estimate that nearly all of those riders would have been helmeted had there been a helmet law. Thus, at Shreveport alone an additional 21.5 riders would have been helmeted with 14.4 of them avoiding brain injury.

The first decrease in the occurrence of motorcyclist fatalities since the original repeal occurred when the universal helmet law was reinstated in Louisiana. These results support the supposition that the decrease in fatal motorcycle crashes in Louisiana after the helmet law was reinstated was directly impacted by the law change.

Nationally, there is a relationship between the passage and repeals of helmet laws and the number of registrations. As a greater proportion of the population was not required to wear a helmet, so did a greater number of motorcycles become registered. The relationship has been used as an argument for why fatalities increase following repeal of helmet laws. However, further analysis suggests that regardless of this relationship the lack of a helmet requirement is still related to fatalities well beyond what might be expected from an increase in registrations.

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APPENDIX A

FATAL CRASH TYPING

Crash Typing Descriptions

The following qualitative analyses include descriptive crash typing of fatal motorcycle crashes in Louisiana. The goal is to describe qualitatively motorcycle crashes in which a motorcycle occupant (driver or passenger) was fatally injured during the years 1996 through 2005. This data was obtained through translating FARS data into narrative descriptions.

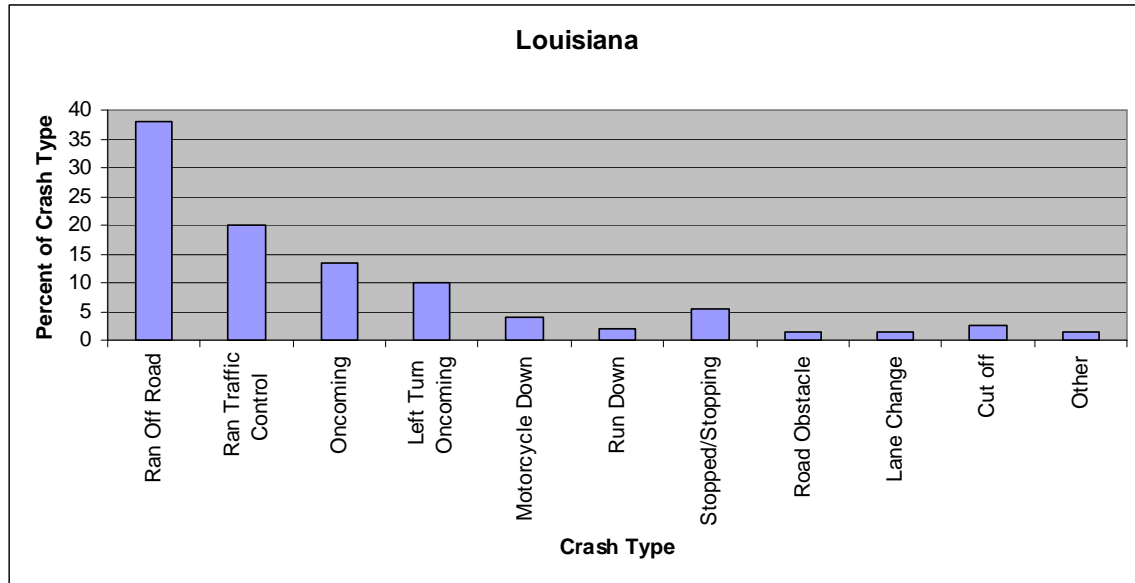
Preusser, Williams, and Ulmer (1995) originally developed this qualitative technique as a means of crash-typing motorcycle crashes. Crashes were categorized as Ran Off Road, Ran Traffic Control, Oncoming, Left Turn Oncoming, Motorcyclist Down, Run Down, Stop/Stopping, Road Obstacle, Lane Change, Cut Off, and Other.

Crash Typing Definitions of Motorcycle Crashes

Crash Type	Definition
Ran Off Road	A motorcyclist leaves or strays off the travel lane and overturns or strikes an off-road object (guardrails, rocks, trees, etc.)
Ran Traffic Control	A vehicle that has a requirement to stop, remain stopped, or yield disregards the requirement and collides with some other vehicle(s)
Oncoming	Vehicles traveling in opposite directions collide (includes head-on and sideswipe opposite direction crashes)
Left Turn Oncoming	In the process of making a left turn in front of oncoming traffic; struck or strikes a vehicle that is coming from the opposite direction and that has a superior right of way
Motorcyclist Down	A motorcyclist loses control of the vehicle in the roadway and goes down
Run Down	One vehicle "runs down" another vehicle traveling in the same direction, striking it in the rear. Unlike Stop/Stopping the vehicle struck in the rear was traveling at an unimpeded speed prior to the crash
Stop/Stopping	A vehicle stopped, stopping, or just starting up in a travel lane is hit from the rear
Road Obstacle	A motorcyclist strikes an object in or on the roadway
Lane Change	A vehicle in a travel lane swerves or moves into another same direction travel lane that is already occupied
Cut Off	A vehicle making a turn, turns in front of a vehicle, or into a vehicle traveling in the same direction
Other	Crash types that occur infrequently and crashes for which no type assignment could be made

The five most prevalent types of fatal motorcycle crashes from 1996 to 2005 in Louisiana included the following: ran off road crashes (38.0%), ran traffic control crashes (20.1%), oncoming or head-on crashes (13.4%), left-turn oncoming crashes (10.1%), and stopped/stopping crashes (5.4%). Other, less prevalent crash types included the following: motorcyclist down crashes (4.0%), cut-off crashes (2.5%), run-down crashes (1.9%), road obstacle crashes (1.5%), and lane-change crashes (1.5%).

Percent of Fatal Motorcycle Crash Types in Louisiana, 1996 – 2005



Crash Typing Narratives

After Louisiana's repeal of its universal helmet law effective August 15, 2004, there was a decrease in motorcyclist fatalities compared to the first half of the same year. From August 15, 2004, to the end of the year, there were 19 motorcyclists killed in 18 separate crashes. The following narratives describe the 18 crashes that took place after the Louisiana helmet law was reinstated.

The first crash took place on a Sunday early in the evening. An 18-year-old male was killed when he *ran off the road* and struck a motor vehicle in a parking lane. He was driving in an erratic manner and probably in excess of the posted speed limit of 25 mph, although actual travel speed was unknown. The crash site was an urban local street with undivided two-way traffic and two travel lanes. It was daylight, the weather was clear, and the road surface was dry. The victim was alone at the time of the crash. His helmet use was unknown.

The second crash following the helmet law reinstatement took place almost two weeks later on a Friday late in the evening. In this single-vehicle crash, a 26-year-old motorcycle operator was killed when he *ran off the road* to the left and struck a highway sign. The crash site was at the roadside of an urban minor arterial that had two travel lanes and a 45 mph speed limit. The vehicle's estimated speed was 80 mph. It was dark, the weather was clear, and the road surface was dry. The victim was alone at the time of the crash. The operator had a valid license and had one previous moving violation and one DWI violation. It was unknown if this crash alcohol-related. The victim was wearing a helmet.

The third crash occurred a week later on a Wednesday evening. This was also a single-vehicle crash. A 51-year-old motorcycle operator was killed when he crossed the centerline and *ran off the road* into ditch and then a culvert. He was changing lanes prior to the crash. The crash site was a rural major collector with two travel lanes and a 45 mph speed limit. His speed was estimated to be 70 mph. It was dark, the weather was clear, and the road surface was dry. The operator had a valid license and had no previous violations. It was unknown whether an alcohol test was given. The victim was wearing a helmet.

The fourth crash took place on a Saturday evening at about 7 p.m. Both the 53-year-old male motorcycle driver and his 48-year-old female passenger were killed in this two vehicle *oncoming* crash. The passenger vehicle was at fault, crossing the centerline and striking the motorcycle head-on. The passenger vehicle driver was operating in a reckless manner, driving in excess of the posted speed limit, and tested positive for alcohol use. The crash site was a rural major collector with two travel lanes and a 45 mph speed limit. It was daylight with smog, smoke, blowing sand or dust with a wet road surface. The motorcycle operator had a valid license with no prior violations. Both victims were wearing helmets.

Another multiple vehicle crash occurred later the same evening. In this crash, the 24-year-old male motorcycle driver was killed when a passenger vehicle *ran the traffic control* at a stop-sign intersection. The motorcyclist was braking to avoid the crash but could not stop and struck the left side of the passenger vehicle. The crash site was a one-way road with one travel lane. The roadway was lighted, the weather was clear, and the road surface was dry. The motorcycle operator had a license that was suspended, and it was reported that the driver was operating without required equipment. The victim was not wearing a helmet. No alcohol involvement was reported.

Ten days later, on a Tuesday one hour before midnight, a two-vehicle crash occurred in which the motorcyclist struck the rear of a driverless pickup stopped in a travel lane. There is no information about the pickup, which was classified as a *roadway obstacle*. The 21-year-old motorcycle operator was killed. He was described as reckless, traveling 60 mph in a 15 mph zone. The crash occurred on a rural local road with two travel lanes and two-way traffic. It was dark, with smog, smoke, blowing sand or dust, and a dry roadway surface. The motorcycle operator's license was cancelled or denied, and he had had one previous accident and was cited for speeding. He was wearing a helmet.

The seventh crash occurred on a Saturday just after midnight. This two-vehicle crash involved a utility vehicle that *ran the traffic control* at a stop sign intersection. The utility vehicle was turning left and was struck on the left by a motorcycle. The 31-year-old motorcyclist was killed. His passenger was injured. Both were wearing helmets. The crash occurred on an urban principal arterial that was a divided roadway with two travel lanes. It was a dark night, but there was light with clear weather and a dry roadway surface. The motorcycle operator had a valid license at the time of the crash with one previous suspension.

The next crash occurred two days later at an unknown time. The motorcyclist *ran off the road* and was killed when he went into a ditch and then struck an earth embankment. The victim was a 40-year-old male. He crossed the centerline of a curved rural arterial with two traffic lanes. Daylight and roadway conditions were unknown, but the weather was clear. The motorcycle operator was the owner of the vehicle and had a valid license with no prior citations. Helmet use of the victim was unknown.

The ninth crash occurred on the following Thursday in the early hours of the morning. The 26-year-old motorcycle operator was killed in a two-vehicle crash when a passenger car *ran the traffic control* at a stop sign intersection. The passenger vehicle was turning left and was struck on its left side by the motorcyclist, who was using illicit drugs, driving too fast, and tested positive for alcohol. He was not wearing a helmet. A 22-year-old female passenger, who was wearing a helmet, was injured. The roadway was an urban collector with two travel lanes and a posted speed limit of 25 mph. It was a dark night, but there was light with smog, smoke, blowing sand or dust, and the roadway surface was dry. It was reported the driver of the passenger vehicle was also using illicit drugs and sustained incapacitating injuries. The motorcycle operator had a valid license with a previous suspension.

The tenth crash took place in early October on a Saturday early in the morning. The motorcyclist, a 64-year-old man, was killed in this single-vehicle crash. He *ran off the road* and struck an impact attenuator. The crash was on an urban interstate, a divided roadway with two travel lanes. The road was curved at point of impact. The motorcyclist was using illicit drugs, was reckless, and tested positive for alcohol use. He was wearing a helmet. It was dawn with clear weather and a dry roadway surface. The victim had a suspended license with two recorded previous suspensions.

The eleventh crash occurred two weeks later on a Tuesday after midnight. This was a single-vehicle crash with one fatality. A 39-year-old motorcyclist was killed when he *ran off the road* and went into a ditch. Neither he nor his 40-year-old female passenger were wearing helmets. He was operating in a reckless manner. His vision was reportedly obscured by head restraints. The victim was not licensed, and he was not the owner of the motorcycle. The crash site was on a curve on an undivided two-way roadway with two travel lanes. It was dark but lighted, weather was clear, and the road surface was dry.

The twelfth crash occurred four days later on a Saturday early in the afternoon. A 51-year-old motorcyclist was killed in a three-vehicle *Stop/Stopping* crash that involved a piece of farm equipment and a second motorcycle. The motorcycle victim was charged with driving in a reckless manner and traveling 20 miles over the speed limit. He rear-ended the farm equipment that was traveling on the roadway 25 miles under the speed limit. The second motorcyclist, who was injured, also struck the farm equipment from the rear. Both motorcyclists wore helmets. Both were reported to have alcohol involvement. The crash occurred on a rural minor collector with two travel lanes. It was daylight with clear weather and dry surface conditions.

The next crash after the law reinstatement occurred on a Sunday after midnight. The 21-year-old motorcycle operator *ran off the road* and was killed after striking a guardrail with the right side of his vehicle. His passenger was injured. It is unknown if the motorcyclist was wearing a helmet. He was traveling at the speed limit on a rural local road with two travel lanes. It was dark with clear weather and a dry roadway surface. The motorcycle operator had a valid license with no prior citations.

The last crash in October took place late in the morning on a Sunday. The motorcyclist, a 71-year-old male, was killed when he *ran off the road* and overturned on the shoulder. The crash site was a rural minor collector with two travel lanes. It was estimated that the motorcyclist was traveling 10 miles under the speed limit on a curved section of the roadway. He was wearing a helmet. His license was valid with no noted driving citations.

The fifteenth crash occurred three weeks later on a Friday afternoon. A 29-year-old motorcyclist was killed in a *Stop/Stopping* crash when he struck a pickup from the rear as the pickup was slowing in the travel lane. The motorcycle operator was traveling at the speed limit and trying to brake to avoid a collision. He was wearing a helmet. The crash site was a rural arterial divided roadway with two travel lanes. It was daylight with clear weather and a dry roadway surface. The victim had a valid license with no previous citations.

The next crash after the Louisiana helmet law was reinstated occurred a week later on a Friday afternoon. A passenger vehicle failed to yield the right of way and turned left in front of an oncoming motorcyclist. The driver in this *Left Turn Oncoming* crash was charged with driving in a reckless manner and hit-and-run. The motorcycle struck the passenger vehicle on its right side, and the motorcyclist, a 50-year-old male, was killed. The victim was wearing a helmet and traveling at the speed limit. The crash site was a rural minor collector with two travel lanes and no intersection. It was daylight with clear weather and a dry roadway surface.

The seventeenth crash took place two weeks later in December on a Saturday just after noon. A passenger vehicle failed to yield the right-of-way at a stop-sign intersection and was struck on the left by a motorcyclist. The driver of the passenger vehicle was charged with driving in a reckless manner and hit-and-run. The motorcyclist, a 53-year-old male, was killed in this *Ran Traffic Control* crash. He was slowing and using the brake to avoid the collision. He was wearing a helmet and had a valid license with no prior citations. It was daylight with clear weather and dry roadway conditions. The crash site was a rural local road with two travel lanes.

The final motorcyclist fatality in Louisiana in 2004 occurred on the same day in early afternoon. A motorcyclist *ran off the road* and struck a guardrail. He bounced back onto the roadway and was then struck by a following motorcyclist in a secondary incident. The first operator, a 22-year-old male, was killed. He was driving in a negligent manner. Both motorcyclists were wearing helmets. Alcohol was not a factor. The crash site was a divided roadway with two travel lanes. It was daylight with clear weather and dry

surface conditions. The victim had a valid license with no previous citations. The driver of the other motorcycle sustained an evident injury.

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