

## IV. EFFECTS OF THE LAW CHANGE IN FLORIDA

### **The Law**

Florida originally adopted an all-rider motorcycle helmet law in 1967. It was this law that was amended effective July 1, 2000, to require helmet use only by riders under the age of 21. Riders 21 and older who do not wear helmets must have at least \$10,000 in medical insurance coverage.

### **Helmet Use**

#### ***Observational Surveys***

A Florida helmet use observation survey carried out before the helmet law change (Center for Urban Transportation Research, 1998) showed that virtually all observed riders were wearing helmets. However, only 59 percent of the observed sample wore compliant helmets (headgear that meets FMVSS No. 218), while 40 percent were wearing noncompliant helmets (headgear that does not meet FMVSS No.218). These figures compare to 84 percent compliant and 15 percent noncompliant observed in a 1993 survey, suggesting that noncompliant helmet use was increasing over time. Following weighting, the 1998 survey results yielded estimated statewide helmet use of 65 percent compliant helmets and 35 percent noncompliant helmets.

A post law change survey, done in 2002, (Turner and Hagelin, 2004) found 47 percent compliant helmet use, 6 percent noncompliant helmet use and 47 percent no helmet use. These results indicate that use of compliant helmets has declined following the law change while wearing noncompliant helmets has largely been abandoned.

#### ***Crash Involvement***

Helmet use among motorcyclists involved in crashes before and after the law change is shown in Table 3. Among the 515 motorcyclists killed in traffic crashes in the three years prior to the helmet law change (1997-1999), 9.4 percent were recorded in FARS as not wearing a helmet. In the three years following the law change (2001-2003), 60.8 percent of the 933 fatally injured motorcyclists were reported being unhelmeted. In 1997-1999, there were 35 motorcyclists under the age of 21 killed in Florida. Of these, 25.7 percent were not helmeted. In 2001-2003, 101 motorcyclists under 21 were killed with 45.0 percent of them being unhelmeted.

Excluding cases where helmet use was not recorded (less than 7 percent of the cases), 26.8 percent of all motorcyclists involved in crashes in 1999, of all degrees of severity, were recorded in the Florida crash database as being unhelmeted. In 2001, the figure was 51.4 percent. Among motorcyclists who sustained incapacitating injury, 20.8 percent of those involved in 1999 crashes were unhelmeted while 50.3 percent of those involved in year 2001 crashes were not wearing helmets.

Among riders under the age of 21, 39.8 percent of those involved in crashes in 1999 were unhelmeted. In 2001, the figure was 49.3 percent. For those sustaining incapacitating injury, 35.4 percent of those in 1999 crashes were not helmeted while in 2001, 49.5 percent were not helmeted.

Table 3. Helmet Use Among Florida Crash Involved Motorcyclists

	<b>1997-1999</b>	<b>2001-2003</b>
<b>All Motorcyclists Killed (N)</b>	515	933
<b>Percent Not Helmeted</b>	9.4%	60.8%
<b>Motorcyclists &lt; 21 Killed (N)</b>	35	101
<b>Percent Not Helmeted</b>	25.7%	45.0%
	1999	2001
<b>All Crash-Involved</b>	5,251	7,710
<b>Motorcyclists (N)</b>		
<b>Percent Not Helmeted</b>	26.8%	51.4%
<b>Incapacitating Injuries (N)</b>	1,428	1,890
<b>Percent Not Helmeted</b>	20.8%	50.3%
<b>&lt;21 Age Involved (N)</b>	610	781
<b>Percent Not Helmeted</b>	39.8%	49.3%
<b>&lt;Age 21 Incapacitating</b>	145	199
<b>Injuries (N)</b>		
<b>Percent Not Helmeted</b>	35.4%	49.5%

Source: Fatality data FARS; Injury data Florida crash database.

Both the observational survey results and the fatal and other crash data show that helmet use has declined substantially in Florida since the repeal of the all-rider use law. The crash data also indicate that the declining use has extended to riders under the age of 21, the group that was to continue helmet use under the revised law.

### **Motorcycle Registrations**

Table 4 and Figure 7 contain annual motorcycle registration data for the years 1994-2002. These data indicate that Florida registrations had been increasing gradually during the 1990s, then increased markedly coincidental with the repeal of the State's all-rider helmet law. This outcome is similar to what occurred in Arkansas, Louisiana, and Texas following helmet law repeals in those States.

Table 4. Florida Motorcycle Registrations, 1994-2002

<b>Year</b>	<b>Motorcycles Registered</b>
<b>1994</b>	177,374
<b>1995</b>	184,526
<b>1996</b>	189,574
<b>1997</b>	194,903
<b>1998</b>	207,371
<b>1999</b>	220,923
<b>2000</b>	240,844
<b>2001</b>	289,760
<b>2002</b>	323,301

Source Florida Department of Highway Safety and Motor Vehicles (DHSMV)

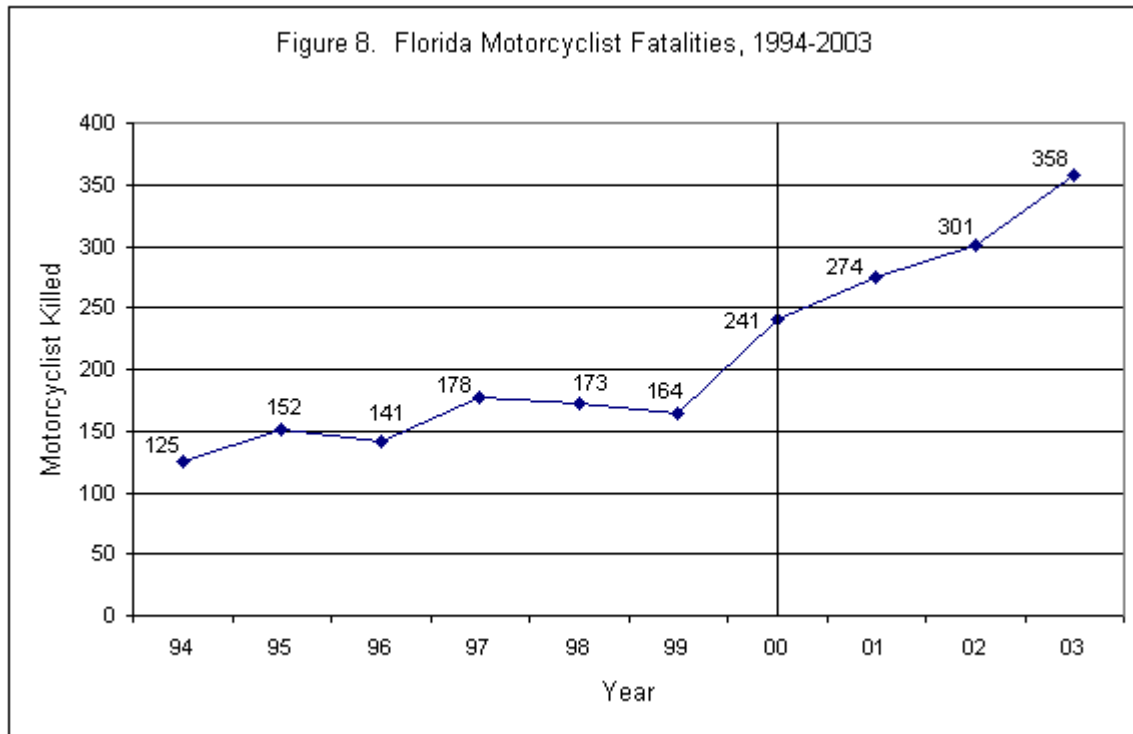
Figure 7. Annual Florida Motorcycle Registrations

## Fatalities

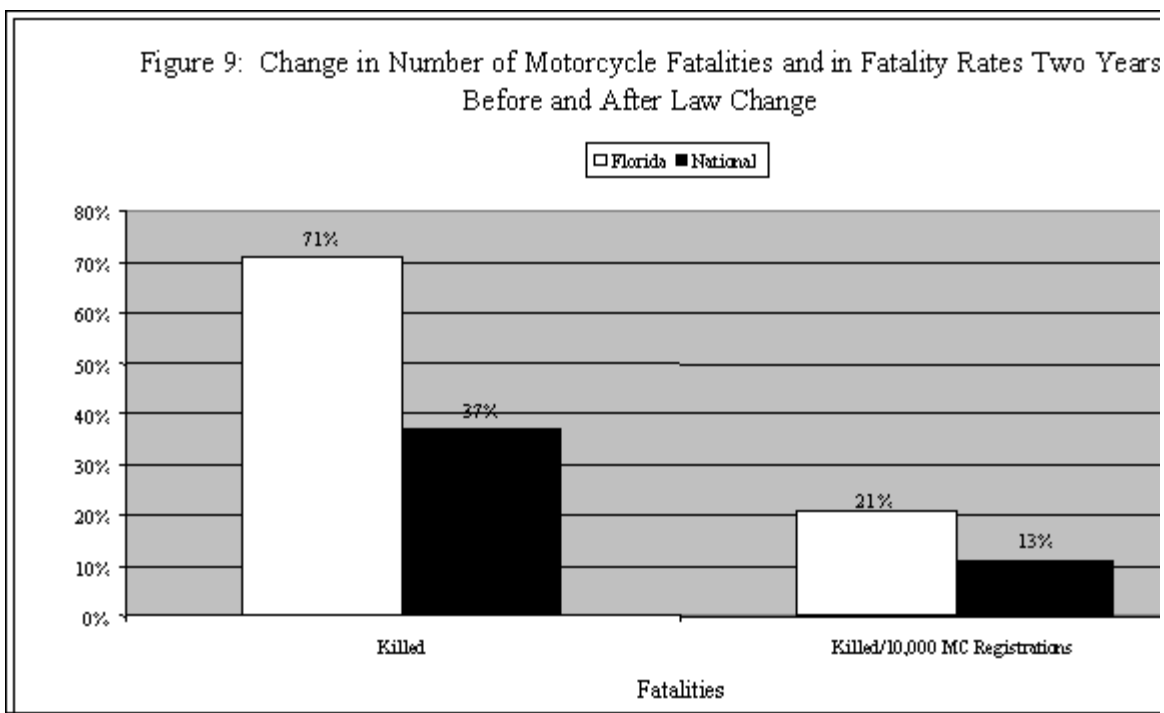
Table 5 and Figure 8 contain the numbers of motorcyclists killed in Florida during the years 1994-2002.

Year	Motorcyclists Killed	Fatalities per 10,000 Registered Motorcycles	Two Year Average		Percent Change	
Fatalities	Fatality Rate	Fatalities	Fatality Rate			
1994	125	7.0	139	7.6		
1995	152	8.2				
1996	141	7.4	160	8.2	+15.1%	+7.9%
1997	178	9.1				
1998	173	8.3	169	7.8	+5.6%	-4.8%
1999	164	7.4				
2000	241	10.0				
2001	274	9.5	288	9.4	+71.0%	+20.5%
2002	301	9.3				
2003	358	n/a				

Source: Fatalities FARS; Registrations DHSMV



These data indicate that there has been a substantial increase in motorcyclists killed in Florida following repeal of the State's all-rider helmet law in 2000 (though the increase started in the first six months of 2000 before the law was effective in July). The 575 fatalities in the two years following the law change (2001-2002) were 71 percent greater than the 337 fatalities that occurred in 1998-1999, compared to an increase of 37 percent for the nation as a whole (4,560 to 6,227). Fatalities in Florida per 10,000 registered motorcycles increased 21 percent compared to 13 percent nationally for the two years before and after the law change (See Figure 9). Another way to look at this is to compare the average of the 30 months before and after the law change. There was an annual average of 181 motorcyclists killed in Florida in 1998, 1999, and the first six months of 2000, compared to an average of 280 in the last six months of 2000, 2001, and 2002, a 59 percent increase. Registrations increased an average 33.7 percent (219,486 to 293,393) in this time period. The expected number of motorcycle fatalities as a result of the increase in registrations was 242 ( $181 \times 1.337=242$ ). The actual number who died in 2002 was 301, 59 more motorcycle fatalities than expected as a result of increased registrations alone (a 24 percent increase).



Motorcyclist fatalities in Florida have continued to increase. In the *three years* after the law change (2001-2003), 933 motorcyclists were killed, 81 percent more than the 515 motorcyclists who were killed in 1997-1999. The actual number who died in 2003 was 358.

### Time Series Analysis

Autoregressive Integrated Moving Average (ARIMA) models were used to examine the relationship between the change in Florida's motorcycle helmet law and motorcyclist fatalities. The date of the law change was used as an intervention point in the time series. Data on motorcyclist fatalities in Georgia were employed as a comparison. Georgia was selected based on proximity to Florida and the fact that it had an all-rider helmet law in effect for the entire time period. Monthly fatalities in Florida and Georgia, before and after the intervention point (July 2000), were modeled in the presence of the annual number of motorcycle registrations in each

State. This was done to control for the extent to which changes in fatalities were associated with changes in motorcycle registrations

The numbers of monthly motorcyclist fatalities for Florida and Georgia from 1994 to 2002 were included in the analysis. The number of annual motorcycle registrations in Florida came from DHSMV while Georgia registration figures came from FHWA. The ARIMA models explored 78 months prior to the law change and 30 months after the law change (Figure 10). Partial Autocorrelation (PACF) and Autocorrelation (ACF) plots were used in determining the order of components in ARIMA models. At the time of this report, 2002 was the latest year for which registration data were available. December 2002, therefore, was the last point of the time series.

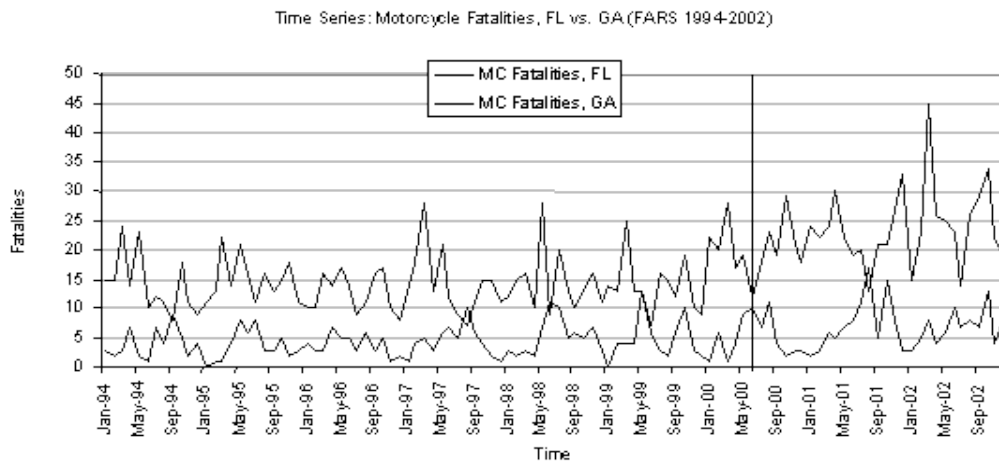
Florida monthly motorcycle fatalities were modeled using (0, 0, 0) (1, 0, 1) ARIMA; all final PACFs and ACFs were non-significant. The intervention was statistically significant such that there was an average 9.1 increase in the number of monthly motorcyclist fatalities following the law change ( $p < .001$ ; see Table 6). The specified final ARIMA parameters were also significant. There was no statistically significant change in the fatality rate following the same intervention date for Georgia. Change in annual motorcycle registrations was not a statistically significant parameter in the final time series model.

Table 6. Florida and Georgia Interrupted Time Series Results

State	ARIMA Model	Months Pre/Post	Significant Component	B	T-Ratio	Approx. p
Florida	(0,0,0) (1,0,1)	78/30	Intervention	9.11	8.91	<.001
Georgia	(0,0,0) (0,1,1)	78/30	-	-	-	-

Thus, according to time series analysis, controlling for the annual number of motorcycle registrations, there was a statistically significant increase in fatalities in Florida following the repeal of the all-rider motorcycle helmet law. There was no comparable increase in Georgia suggesting that the Florida result was not due to some coincidental change in the region.

Figure 10. Time Series Motorcycle Fatalities, Florida versus Georgia (FARS 1994 ? 2002)

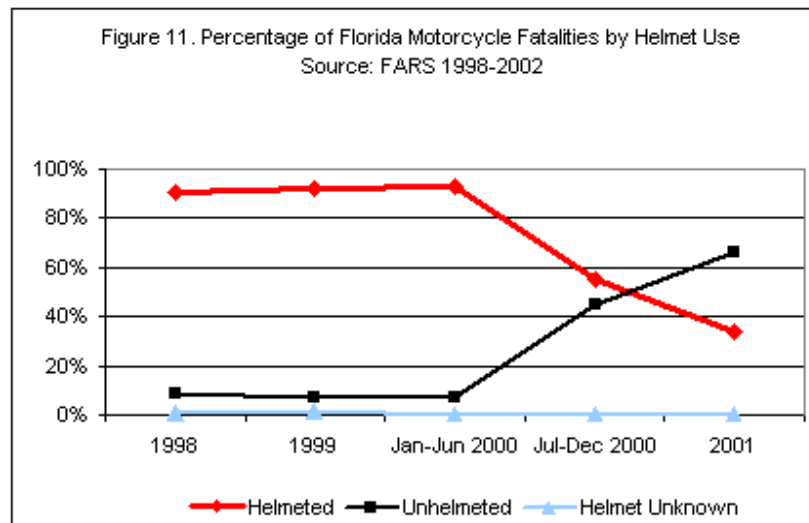


Muller (2004) also used time series methods to study the effects of Florida's helmet law change and reports a significant intervention effect on motorcycle fatalities using data for the 72 months before the law change and the 12 months immediately following the change. Stolzenberg and D'Alessio (2003) also examined Florida motorcycle crash data using a multiple time series design. Their findings differ from those reported here and by Muller (2004). They conclude that the repeal of Florida's motorcycle helmet law had little observable effect on serious injuries or fatalities and, therefore, that the helmet law change was "inconsequential." Unfortunately, the analytic design employed by Stolzenberg and D'Alessio (2003) is methodologically flawed. That is, they employ fatal and injury crash rates of motorcyclists under the age of 21 as a control series saying, "because the repeal of the motorcycle helmet use law applied only to motorcycle operators and passengers older than 21 years of age, the repeal of the law should have little if any effect on the serious injury and fatality rate series for motorcycle riders younger than 21 years of age" (p134). As indicated earlier, helmet use among young motorcyclists killed and injured has decreased markedly since the helmet law change, thereby making their crash experience unsuitable as an unaffected control series.

### Helmeted and Non-helmeted Motorcycle Fatalities .

Non-helmeted motorcyclists who were killed in Florida increased from 15 (9 percent) in 1998 when observed helmet use was close to 100 percent, to 198 (66 percent) of the total motorcycle fatalities in 2002, an increase of over thirteen times. When the increase in motorcycle registrations after the law was changed is taken into account, the non-helmeted fatality rate per 10,000 registered motorcycles increased from 0.7 fatalities in 1998 to 6.1 fatalities in 2002. Helmeted motorcyclist fatalities, on the other hand, fell from a rate per 10,000 registered motorcycles of 7.6 in 1998 to 3.2 in 2002.

Figures 11 and 12 below show the numbers and rates for helmeted and non-helmeted Florida motorcyclists who died by year for the 30 months before and after the law change. Figure 13 shows the changes in the numbers of motorcyclists killed in the 30 months before and after the law change.



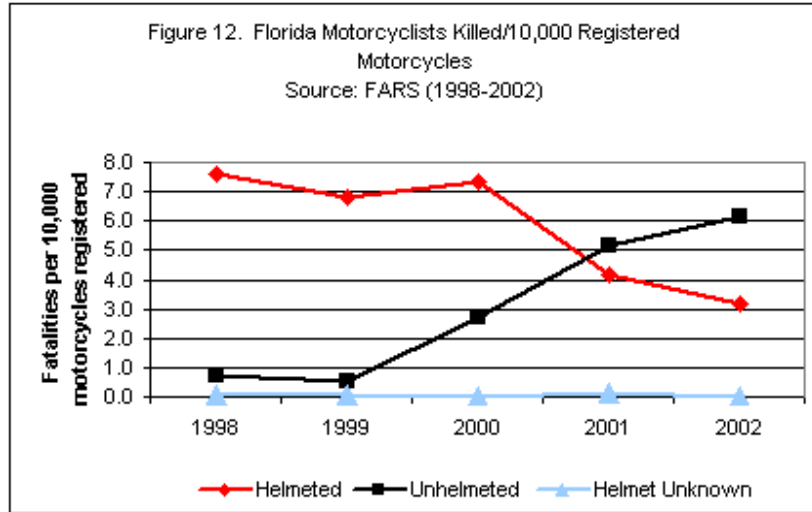


Table 7 shows these data for motorcyclists who died at the scene of the crash and those who were transported to a hospital, but died later, from 1998 through 2002. Of the 301 motorcyclists who died in 2002, two-thirds (198) were not wearing helmets; 100 of these riders died at the scene of the crash while 98 died after being transported to a hospital. Of the 173 motorcyclists who died in 1998, 15 (9 percent) were not wearing helmets; 6 died at the scene of the crash and 9 died after being transported to a hospital.

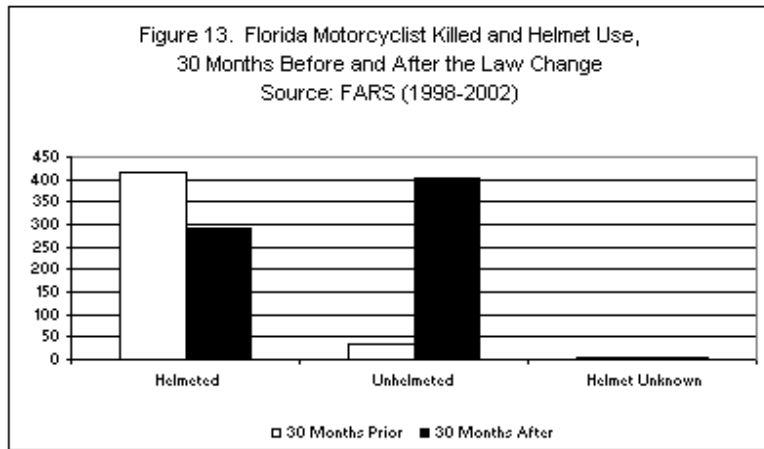


Table 7. Florida Motorcycle Fatalities, Place of Death, and Helmet Use (Number and Percentage) FARS 1998-2002

		All-Rider Helmet Law								After Law Change			
		1998		1999		Jan-Jun 2000		Jul-Dec 2000		2001		2002	
Died at Scene	Helmeted	77	44.5%	80	48.8%	55	47.8%	38	30.2%	65	23.7%	59	19.6%
	Unhelmeted	6	3.5%	5	3.0%	5	4.3%	25	19.8%	76	27.7%	100	33.2%
	Helmet	1	0.6%	2	1.2%	0	0.0%	0	0.0%	1	0.4%	0	0.0%

	Unknown												
<b>Transported to Hospital</b>	Helmeted	80	46.2%	71	43.3%	52	45.2%	31	24.6%	56	20.4%	44	14.6%
	Un-helmeted	9	5.2%	6	3.7%	3	2.6%	32	25.4%	74	27.0%	98	32.6%
	Helmet Unknown	0	0.0%	0	0.0%	0	0.0%	0	0.0%	2	0.7%	0	0.0%
<b>Total</b>		173	100%	164	100%	115	100%	126	100%	274	100%	301	100%

## Injuries

### Police Crash Reports

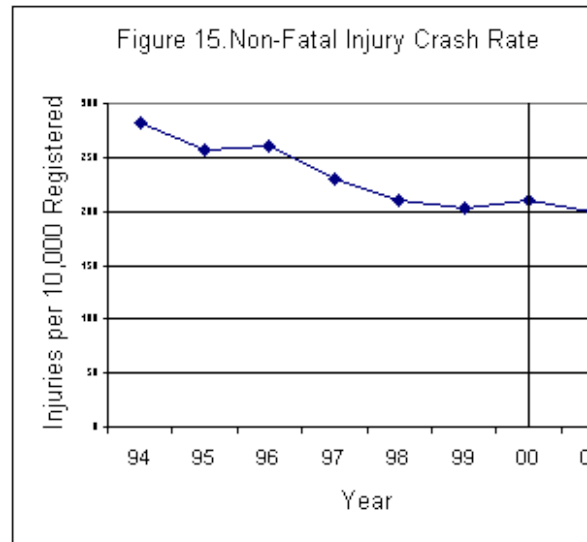
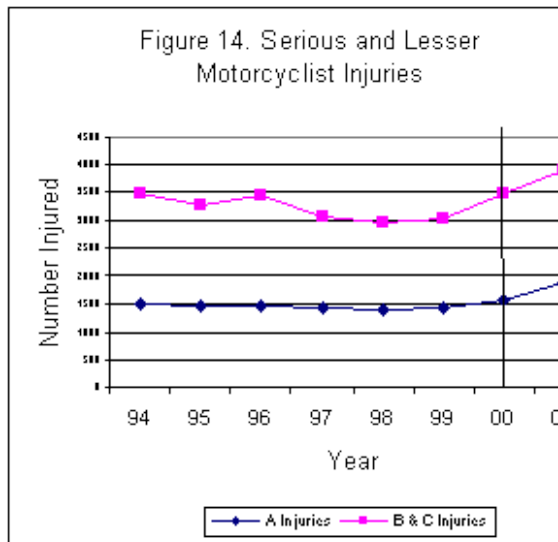
The Florida Department of Highway Safety and Motor Vehicles produces an annual database of information taken from police motor vehicle crash reports. Table 8, compiled from the annual databases, shows the number of statewide crashes involving motorcyclists, the number of seriously injured motorcyclists (A-injury), the number of motorcyclists sustaining lesser injuries (B & C injuries) and the injury rate per 10,000 registered motorcycles.

Table 8. All Motorcycle Crashes and Non-Fatal Injuries, 1994-2001

Year	Crashes Involving Motorcycles	Motorcyclists A Injuries	Motorcyclist B&C Injuries	Injuries per 10,000 Registered Motorcycles
1994	5,055	1,507	3,488	281.6
1995	4,887	1,487	3,257	257.1
1996	4,829	1,479	3,442	259.6
1997	4,712	1,432	3,050	230.0
1998	4,536	1,406	2,951	210.1
1999	4,662	1,428	3,037	202.1
2000	5,334	1,576	3,487	210.2
2001	6,069	1,890	3,886	199.3

A-Incapacitating Injury, B-Evident Injury, C-Possible Injury

Figure 14 shows these data graphically. These data exclude mopeds and all terrain vehicles. In the first full year following the law change (2001), there were 1,890 motorcyclists who sustained incapacitating injury and 3,886 who sustained lesser injury. These figures are 32.4 percent higher and 28.0 percent higher, respectively, than the comparable figures in 1999, but less than in 1999 when the increase in registrations is taken into account. Injuries per 10,000 registered motorcycles increased in 2000, but decreased in 2001. Some of the motorcyclists coded ?C?Possible Injury? may not have sought medical treatment. Table 8 and Figure 15 show that although the injury rate per registered motorcycle in 2001 is less than the rate in 1999, the previous downward trend of non-fatal injuries per registered motorcycle appears to have slowed following the law change period.



**Hospital Discharge Data**

The Florida Agency for Health Care Administration gathers and maintains a hospital discharge database containing information from the approximately 240 acute care hospitals in the State on cases involving people admitted for treatment. The annual hospital discharge databases for 1998-2002 were obtained for analysis. The following are the numbers of motorcyclists admitted for treatment during this period:

<b>1998</b>	<b>1,263</b>
1999	1,460
2000(Pre law change)	844
2000(Post law change)	799
2001	2,055
2002	2,132

In the 30 months immediately following the helmet law change, there were 4,986 motorcyclists admitted to hospitals for treatment, a figure 40 percent greater than the 3,567 admissions during the 30 months just before the law change.

Table 9 shows the distribution by age and gender of the hospital admitted motorcyclists in the 30 month periods pre and post the law change. In the pre law change period, 86.4 percent of admissions were males compared to 87.6 percent in the post law change period, figures that were not significantly different statistically (chi-square=2.64, df=1, p=0.104).

There is a tendency for the post law change motorcyclists to be slightly older than those in the pre change period. That is, 54.1 percent of the post law injured were age 35 and older compared to 51.6 of those in the pre change period. The overall age distributions were not statistically different (chi-square=11.74, df=6, p=0,068), however. Motorcyclists under the age of 21 made up 12.9 percent and 11.9 percent, respectively, of pre and post law change injured.

Table 10 shows the distributions of principal diagnosis injury among those admitted in the pre and post law change periods. The injury distributions before and after the law change differ significantly (chi-square=39.14, df=5, p<0.001). Injuries to the extremities represented 51.2

percent of the principal injuries in the pre law change period. These declined to 47.0 percent in the post law change period. Head/brain/skull injuries represented 16.9 percent of the principal injuries before the law change and 22.0 percent of the post law change injuries.

<b>Gender</b>	<b>Stat</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>Total</b>	<b>Pre</b>	<b>Post</b>
Male	%	85.9	86.6	86.4	88.1	87.8	87.1	86.4	87.6
	N	1085	1264	1420	1811	1872	7452	3083	4369
Female	%	14.1	13.4	13.6	11.9	12.2	12.9	13.6	12.4
	N	178	196	223	244	260	1101	484	617
Total	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	N	1263	1460	1643	2055	2132	8553	3567	4986
<b>Age</b>									
< 21	%	14.3	13.3	11.5	12.1	11.4	12.3	12.9	11.9
	N	181	194	189	248	244	1056	461	595
21-24	%	10.4	8.5	9.6	11.5	9.3	9.9	9.3	10.3
	N	131	124	158	236	199	848	332	516
25-34	%	25.2	26.8	26.2	23.4	22.8	24.7	26.1	23.6
	N	319	391	431	481	487	2109	931	1178
35-44	%	23.4	23.3	24.3	24.4	25	24.2	23.4	24.7
	N	296	340	399	501	533	2069	836	1233
45-54	%	16.8	17.4	18	18.2	18.5	17.9	17.5	18.2
	N	212	254	296	373	395	1530	623	907
55-64	%	6.5	7.3	7.5	7.3	8.9	7.6	7.3	7.8
	N	82	106	123	150	190	651	262	389
65+	%	3.4	3.5	2.9	3.2	3.9	3.4	3.4	3.4
	N	43	51	47	66	84	291	123	168
Total	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	N	1264	1460	1643	2055	2132	8554	3568	4986

As noted, hospital admissions of injured motorcyclists increased by 40 percent in the post law change period. Head related injury admissions increased by 82.2 percent followed by internal organ injuries (48.6 percent).

Table 10. Motorcyclists' Principal Diagnosis Injuries

Principal diagnosis is based on the ICD-9-CM coding system and represents the condition established after study, to be chiefly responsible for occasioning the admission of the patient to the hospital.

<b>Stat</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>Total</b>	<b>Pre</b>
%	50.4	51.5	48.4	46.8	48.2	48.8	51.2
N	637	752	795	961	1,027	4,172	1,827
%	14.9	18.0	20.0	21.7	22.2	19.9	16.9
N	188	263	329	445	474	1,699	602
%	2.8	2.0	2.1	2.0	1.9	2.1	2.4

N	36	29	35	42	40	182	85
%	10.9	9.6	9.9	10.6	10.2	10.2	9.9
N	138	140	162	218	217	875	352
%	15.6	14.5	14.4	14.4	13.4	14.3	14.8
N	197	211	237	295	286	1,226	527
%	5.4	4.5	5.2	4.6	4.1	4.7	4.9
N	68	65	85	94	88	400	175
%	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N	1,264	1,460	1,643	2,055	2,132	8,554	3,568

Comparing the 30-month periods just before and after the helmet law change, total gross costs charged to acute care hospital admitted motorcyclists with a principal diagnosis of head/brain/skull injury more than doubled from \$21 million to \$50 million; the average case cost rose by almost \$10,000 (28% increase); the median patient cost increased by almost \$4,000 (21% increase); and the range of costs also increased (see Table 11).

Table 11. Head-Brain-Skull Injury Treatment Costs

	30 Months Pre Law 1/1/98-6/30/2000	30 Months Post Law 7/1/2000-12/31/2002
<b>Total Reported Cost</b>	\$21,487,186	\$50,025,394
<b>Average per Case</b>	\$35,693	\$45,602
<b>Median Charge</b>	\$18,291	\$22,096
<b>Cost Range</b>	\$3,773-\$145,090	\$4,976-\$178,202

Range is 5 th -95 th percentiles

In the post law change period, 75 percent of the head, brain, skull injured admitted motorcyclists were charged approximately \$12,000 or more (the 75 th percentile) while the remaining 25 percent of patients were charged less than this amount. That is, less than one-quarter of the injured would be fully covered by the \$10,000 medical insurance requirement for those who chose not to use helmets.

The hospital discharge data indicate that in the post law change period, approximately 63 percent of admitted motorcyclists were covered by commercial insurance (\$31 million), 16 percent were classified as "self pay" because they were under insured or uninsured (\$8 million), while the remaining 21 percent had costs (\$10.5 million) billed to charitable and public sources (e.g., Medicaid).

During the years following 1998, the Department of Labor's Consumer Price Index for medical care rose by 3.5 percent in 1999; by 4.1 percent in 2000; by 4.6 percent in 2001; and by 4.7 percent in 2002. Adjusted for inflation (recalculated in 1998 dollars) the total acute care costs in the 30 months before the law change for those with a principal diagnosis of head-brain-skull injury were \$20,779,939; an average of \$34,518 per case. In 1998 dollars, total acute care costs in the 30 months after the law change were \$43,744,629; an average of \$39,877 per case. These figures are shown in Table 12 along with figures for the other principal diagnosis injuries.

Principal Diagnosis	Number of Cases		Cost Per Case	
	30 Months	30 Months	30 Months	30 Months
	Pre Law	Post Law	Pre Law	Post Law
Head/Brain/Skull	602	1,097	\$34,518	\$39,877

Extremities	1,827	2,345	\$29,110	\$32,652
Neck/Spine	85	97	\$49,219	\$53,194
Internal Organs	352	523	\$31,294	\$29,933
Torso	527	699	\$25,637	\$26,159
Other	175	225	\$14,794	\$15,607

In the 30 months before the helmet law change, 52 motorcyclists with head-brain-skull principal injury died *after* admission to an acute care hospital. The average treatment cost for these cases was \$48,126. In the 30 months after the law change, 115 motorcyclists died following admission. Inflation adjusted costs for these cases averaged \$52,450.

In 1998 and 1999, the hospital charges for head-brain-skull principal injury cases per 10,000 registered motorcycles were \$311,549 and \$428,347 respectively. The comparable figures for 2001 and 2002 were \$605,854 and \$610,386, adjusted for inflation.

### **Other Studies**

Hotz, et al., (2002), report the results of a prospective study of injured motorcyclists seen at two Miami-Dade County (Florida) emergency treatment facilities in the 6 months following repeal of the State's all-rider helmet law. Comparisons were made with injured motorcyclists seen in the same period the year before the helmet law change. The basic findings were that there was an increase in the number of cases seen, a decline in helmet use among the injured, and an increase in patients who had sustained brain injury. Treatment costs averaged \$41,311 for helmeted motorcyclists and \$55,055 for unhelmeted riders. Hospital length of stay and disability score did not differ between helmeted and unhelmeted motorcyclists.

Hotz et al., (2004) report the results of follow up interviews with the motorcyclists in the post law change period analyzed earlier (Hotz et al., 2002). They successfully contacted 48 percent of the injured motorcyclists at one year post injury and found that 51 percent reported continuing physical deficits. Only 27 percent continued to ride motorcycles and, of these, 92 percent were wearing helmets.

### **Summary**

After the repeal of Florida's universal motorcycle helmet law, observed helmet use dropped from nearly 100 percent compliance to the 50 percent range. A post law change survey, done in 2002, found 47 percent compliant helmet use, 6 percent noncompliant helmet use and 47 percent no helmet use. The use of compliant helmets has declined following the law change and wearing noncompliant helmets has largely been abandoned.

Non-helmet use among those killed in the three years before the law change was 9 percent and this increased to 61 percent in the three years after the law change. Non-helmet use among motorcyclists under the age of 21 who died was 26 percent in the three years before compared to 45 percent in the three years after the law change, an increase of 188 percent. Among riders under the age of 21 who sustained incapacitating injuries, non-helmet use rose from 35 percent in 1999 to 49 percent in 2001. Even though the law still applied to riders under the age of 21, helmet use dropped for this age group as well.

Motorcycle registrations increased 33.7 percent in the 30 months after repeal of the law compared to the 30 months before the law change. There was a 55 percent increase in the average number of motorcyclists killed in Florida in the same time period. The expected number of motorcycle fatalities as a result of the increase in registrations was 242. The actual number

who died was 301 in 2002, 59 more motorcycle fatalities than expected as a result of increased registrations alone (a 24 percent increase).

Fatalities in the two years following the law change were 71 percent greater than those that occurred in the two years before, compared to an increase of 37 percent for the nation as a whole. Fatalities in Florida per 10,000 registered motorcycles increased 21 percent compared to 13 percent nationally for the two years before and after the law change. Thus, the increase in registered motorcyclists alone did not account for the increase in motorcycle fatalities.

Time series analysis showed there was a statistically significant average 9.1 increase in the number of monthly motorcyclist fatalities following the law change ( $p < .001$ ) in Florida. There was no statistically significant change in the fatality rate following the same intervention date for nearby Georgia, which was selected as a comparison State whose universal helmet law remained unchanged. Change in annual motorcycle registrations was not a statistically significant parameter in the time series model.

Injuries rose among motorcycle riders. In the first full year following the law change, the number of motorcyclists who sustained incapacitating injury rose 32 percent and the number who sustained lesser injury rose 28 percent than the year before the law change, but less when the increase in registrations is taken into account. Injuries per 10,000 registered motorcycles increased in 2000, but decreased in 2001. Although the injury rate per registered motorcycle in 2001 is less than the rate in 1999, the previous downward trend of non-fatal injuries per registered motorcycle appears to have slowed following the law change period.

Motorcyclists admitted to hospitals for treatment rose 40 percent, comparing the 30 months before and after the law change. Head injury admissions increased by more than 80 percent.

Total gross costs charged to hospital admitted motorcyclists with head, brain or skull injury more than doubled from \$21 million to \$50 million; the average case cost rose by almost \$10,000; the median patient cost increased by almost \$4,000; and the range of costs also increased. Adjusted for inflation, total acute care hospital costs rose from \$21 million to \$44 million and the average cost per case rose from \$34,518 to \$39,877 in the 30 months after the law change.

Less than one-quarter of the head-brain-skull injured would be covered by the \$10,000 medical insurance requirement for those who chose not to use helmets. About 63 percent of admitted motorcyclists for head-brain-skull injuries were covered by commercial insurance (\$31 million), 16 percent were classified as "self pay" because they were under insured or uninsured (\$8 million), and the remaining 21 percent had their costs (\$10.5 million) billed to charitable and public sources (e.g., Medicaid).

The number of motorcyclists with head-brain-skull principal injury who died *after* admission to an acute care hospital doubled from 52 to 115, comparing the 30 months before and after the helmet law change. The average treatment cost for these cases rose from \$48,126 to \$52,450 (adjusted for inflation) in the same time period.

Comparing the years before and after the law change, the hospital charges for head-brain-skull principal injury cases per 10,000 registered motorcycles were \$311,549 (1998) and \$428,347 (1999). These costs rose to \$605,854 (2001) and \$610,386 (2002).

Based on the available evidence it appears likely the increase in motorcycle fatalities that occurred after the Florida motorcycle helmet law was repealed was due in part to the reduced use of helmets. Our analysis shows this is the case despite the pre-existing trend of increasing fatalities, the increase in fatalities associated with increased exposure (measured by registrations), the increase in fatalities that occurred in the first six months of 2000 (before the

helmet law repeal became effective), and the likely contribution of a demographic shift in motorcycle ridership.

The effect of the motorcycle helmet law repeal on injuries is somewhat less clear than the situation for fatalities. Two sources of data were available: police motor vehicle crash reports, which show an increase in injuries, but a small decline in injury rates per 10,000 registrations; and hospital discharge data that show large increases in hospital admissions and dramatic increases in admissions for head injuries. The weight of the evidence indicates that the repeal of the helmet law was associated with a slowing of the existing downward trend in injury rates, with an increase in head injuries. The cost data show that the total acute care cost more than doubled. As with fatalities, increased exposure (registrations) cannot account for these changes.