



Effects of Helmet Use on Hospitalization of Motorcyclists Involved in Crashes, Oklahoma, 1995-2000

Oklahoma Crash Outcome Data Evaluation System (CODES)

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Executive Summary

In Oklahoma, 4,242 motorcycle riders were injured and 177 motorcycle riders were killed as a result of crashes between 1995 and 2000. Motorcycles account for only 1% of crashes, but motorcycle rider fatalities account for 4% of crash-related fatalities. Across all crashes, an average of 1 person is killed for every 100 crashes; however, for motorcycle crashes, an average of 4 riders are killed for every 100 motorcycle crashes. The fatality rate is 4.2 times higher for motorcycle crashes compared to all crashes. The likelihood of injuries is 40% higher for motorcycle riders. Eighty percent of motorcycle riders who died from crashes died within the first 24 hours after the crash.

NHTSA estimates that helmets reduce fatalities from motorcycle crashes by 37% and reduce the likelihood of brain injuries by 67%; however, in Oklahoma, only persons under the age of 18 are required to wear a helmet when riding a motorcycle. Between 1995 and 2000, only 60.6% of riders under age 18 who were involved in reportable crashes were wearing a helmet. For riders ages 18 and older, only 31.4% were wearing helmets at the time of the crash. This study looks at the effects of helmet use on injuries sustained in motorcycle crashes.


For all crashes: Compared to helmeted riders, riders who were not wearing helmets:

 Were 2.1 times more likely to die from the crash.

 Were 1.8 times more likely to sustain a head injury from the crash.


If all of the motorcycle riders had been wearing helmets, approximately 93 fewer lives could have been lost during this time period.

Crash data were linked to inpatient hospitalization data to look at health outcomes for persons hospitalized as a result of a motorcycle crash. Compared to helmeted riders, riders who were not wearing helmets:

 Stayed in the hospital 42% longer, accrued 42% higher average charge per hospitalization, and were 23% more likely to die while in the hospital.

 Were 10% more likely to have injuries to multiple body areas.

 Were 79% more likely to suffer severe, critical or un-survivable injuries.

 Were 60% more likely to suffer a brain injury. Their brain injuries tended to be more severe. They were 21% more likely to lose consciousness as a result of their head injuries and riders who lost consciousness were 28% less likely to return to their previous state of consciousness by the time they were discharged from the hospital.



Effects of Helmet Use on Hospitalization of Motorcyclists Involved in Crashes, Oklahoma, 1995-2000

Crash Outcome Data Evaluation System (CODES)

According to The Oklahoma Highway Safety Office, 4,242 motorcycle riders were injured and 177 motorcycle riders were killed as a result of crashes in Oklahoma for calendar years 1995 through 2000 (see Table 1). Only 1% of all crashes involved motorcycles; however, 4% of crash-related fatalities were motorcyclists. Across all crashes, an average of 1 person was killed for every 100 crashes; however, for motorcycle crashes, an average of 4 riders were killed for every 100 motorcycle crashes. The fatality rate was 4.2 times higher for motorcycle crashes compared to all crashes. The likelihood of injuries was 40% higher for motorcycle riders.

Table 1. Oklahoma Crash Injuries and Fatalities by Year, 1995-2000

Outcome	Year						Total
	1995	1996	1997	1998	1999	2000	
All Crashes							
Persons Injured	51,461	53,264	58,083	50,249	48,478	47,115	308,650
Persons Killed	674	775	846	769	747	662	4,473
Total Crashes	77,712	80,392	79,636	80,376	79,120	78,645	475,881
Motorcycle crashes							
Persons Injured	780	748	697	662	687	668	4,242
Persons Killed	40	25	30	25	31	26	177
Total Motorcycle Crashes	837	788	739	710	721	734	4,529
Percent of Crashes	1.1%	1.0%	0.9%	0.9%	0.9%	0.9%	1.0%
Percent of Persons Injured	1.5%	1.4%	1.2%	1.3%	1.4%	1.4%	1.4%
Percent of Persons Killed	5.9%	3.2%	3.5%	3.3%	4.1%	3.9%	4.0%
Persons Injured per 100 Crashes							
All Crashes	66.2	66.3	72.9	62.5	61.3	59.9	64.9
Motorcycle Crashes	93.2	94.9	94.3	93.2	95.3	91.0	93.7
Persons Killed per 100 Crashes							
All Crashes	0.9	1.0	1.1	1.0	0.9	0.8	0.9
Motorcycle Crashes	4.8	3.2	4.1	3.5	4.3	3.5	3.9

The National Highway Traffic Safety Administration (NHTSA), National Center for Transportation Statistics estimates that helmets result in a 37% reduction in fatalities from motorcycle crashes. Other NHTSA estimates indicate that helmets reduce the likelihood of sustaining a brain injury by 67%. In Oklahoma, only persons under the age of 18 are required to wear a helmet when riding a motorcycle. However, during calendar years 1995 through 2000, only 60.6% of riders under age 18 who were involved in reportable crashes were wearing a helmet. For riders ages 18 and older, only 31.4% were wearing helmets at the time of the crash.

Motorcycle Crashes in Oklahoma, 1995-2000

Between 1995 and 2000, there were 5,218 motorcyclists involved in crashes in Oklahoma. For motorcyclists involved in reportable crashes: Helmets were used by 30.3% of riders, helmets were not used by 57.7% of motorcyclists and for 12% of motorcyclists involved in reportable crashes, helmet use was unknown.

Table 2. Characteristics of Motorcycle Crashes, Oklahoma, 1995-2000

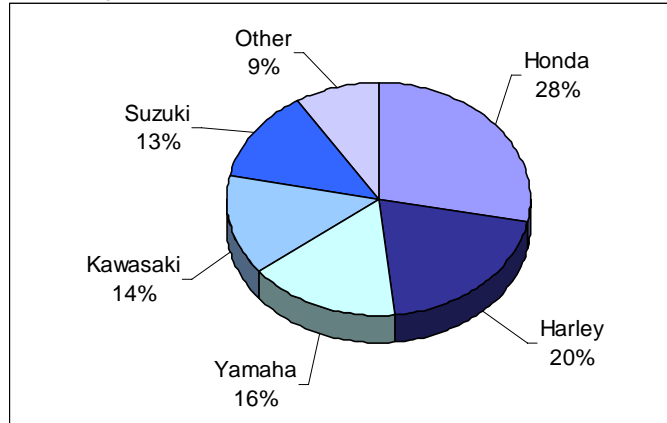
	Wearing Helmet		
	No	Yes	Unknown
Characteristics of Persons			
# Persons	3,010	1,581	627
% Persons*	57.7%	30.3%	12.0%
Average Age	33.1	31.1	33.4
% Male	87.3%	89.7%	90.6%
Ejected	25.0%	28.8%	27.1%
Pinned	0.6%	0.6%	0.7%
Alcohol or Drugs*	10.9%	4.4%	6.7%
Officer Reports of Injuries			
Fatal	5.9%	2.8%	0.8%
Injury Severity	3.0	2.8	2.5
Head Injury	47.0%	25.7%	23.9%
Trunk Injury	43.5%	42.6%	26.3%
Arm or Leg Injury	68.4%	72.0%	47.5%
Characteristics of Crash			
Legal Speed	42.0	44.1	38.1
Speed Before Impact	38.8	39.3	31.8
Speed At Impact	29.6	29.0	24.1
Two Lane	54.8%	49.1%	39.7%
Four Lane Divided	16.4%	20.7%	20.7%
Four Lane	20.1%	21.1%	29.9%
City Street	65.6%	63.2%	85.3%
County Road	29.5%	22.2%	22.8%
Highway	33.5%	35.5%	23.8%
Front Impact	44.3%	41.0%	43.3%
Side Impact	48.6%	51.2%	43.8%
# Vehicles Involved	1.6	1.6	1.8
Characteristics of Vehicles			
Harley Davidson	27.5%	6.5%	23.1%
Honda	25.6%	35.2%	23.1%
Kawasaki	12.6%	16.3%	14.3%
Suzuki	11.8%	15.9%	11.2%
Yamaha	15.6%	17.7%	16.4%
# Riders	1.3	1.2	1.2

Note: Officer ratings of injury severity range from 1=not injured to 5=killed; * Includes only drivers

- Most motorcycle riders were male.
- The average age of motorcyclists is early 30s.
- For riders not wearing helmets, 27.5% were riding Harley Davidsons, 25.6% were riding Hondas, 15.6% were riding Yamahas, 12.6% were riding Kawasakis, and 11.8% were riding Suzukis.
- About half of motorcycle crashes occurred on 2-lane roads. Two thirds happened on city streets.
- Riders not wearing helmets were slightly more likely to crash on 2-lane highways, county roads or city streets than were helmeted riders.
- Helmeted riders were slightly more likely to crash on 4-lane highways as compared to riders not wearing helmets.
- Riders not wearing helmets were more likely to be involved in front-impact collisions compared to helmeted riders, whereas, helmeted riders were more likely to be involved in side-impact collisions compared to riders not wearing helmets.
- Even though estimated speed at impact was similar, fatality rates for riders not wearing helmets were 2.1 times higher than fatality rates for riders wearing helmets.
- Riders not wearing helmets were 1.8 times more likely to have head injuries than were riders wearing helmets.
- The rate of trunk or extremity (arm or leg) injuries was similar for riders wearing or not wearing helmets.

Based on number of riders, Hondas were the most frequent make of motorcycle involved in reportable crashes, followed by Harley Davidson, Yamaha, Kawasaki and Suzuki (see Figure 1). Almost half of persons in reportable motorcycle crashes were riding Honda or Harley Davidson motorcycles.

Figure 1. Percent of Riders Involved in Crashes by Motorcycle Brand



The rate of helmet use varied by type of motorcycle ridden and by rider age (see Table 3). Overall, Harley Davidson riders had the lowest rate of helmet use (10.9%, average age 39.7), followed by Yamaha riders (37.3%, average age 29.1), Kawasaki riders (40.6%, average age 29.2), Suzuki riders (41.4%, average age 26.8), and Honda riders (42.0%, average age 33.5). This trend is also evident when taking age into account. Both older and younger Harley Davidson riders were less likely to wear helmets than were riders of other types of motorcycles. It should also be noted that even though the law requires riders younger than 18 years of age to wear helmets, only around 60% of these young riders were wearing helmets (see Table 3). Ninety percent of riders involved in crashes were 18 years of age or older.

Table 3. Helmet Use by Age and Type of Motorcycle.

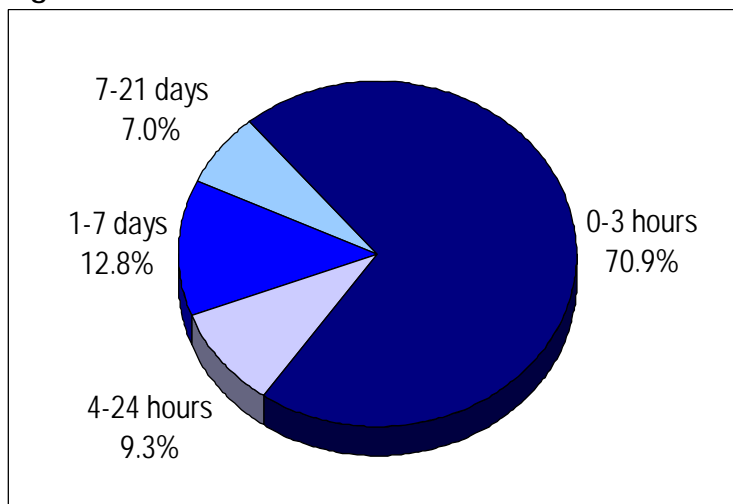
Make	Age < 18		Age 18+		Percent Wearing Helmet		
	No Helmet	Helmet	No Helmet	Helmet	Age < 18	Age 18+	All Ages
Honda	59	96	705	457	61.9%	39.3%	42.0%
Harley Davidson	9	8	814	93	47.1%	10.3%	10.9%
Yamaha	39	60	427	217	60.6%	33.7%	37.3%
Kawasaki	26	42	349	214	61.8%	38.0%	40.6%
Suzuki	34	61	319	188	64.2%	37.1%	41.4%

Of the riders who died from the crash, most died within 24 hours of the crash (see Figure 2):

- 80.2% died within 24 hours after the crash
- 12.8% died between one and seven days after the crash
- 7.0% died between seven and 21 days after the crash

Source: Fatal Analysis Reporting System data, NHTSA, 1995-2000.

Figure 2. Fatalities: Time from Crash to Death



Study Methodology

To explore the effects of helmet use on health outcomes for motorcycle riders involved in crashes, Department of Public Safety (DPS) motor vehicle crash data were linked to inpatient hospitalization data from the Oklahoma State Department of Health (OSDH). Police officers investigate the crash at the scene and complete reports that include information about the crash, vehicles, and persons involved. The crash data includes all drivers and injured passengers involved in crashes resulting in injury or death to a person or total property damage of \$300 or more for calendar year 1995 through October 31, 1999. Beginning November 1, 1999, the amount increased to \$500 or more in property damage. Persons who died within one year of the crash due to crash-related injuries are coded as fatalities in the crash data.

Inpatient hospitalizations are based on billing data submitted annually to OSDH by general acute care hospitals licensed by the State of Oklahoma. Occupants who were admitted to other types of hospitals (e.g., rehabilitation, Veterans, military, or Indian Health Service) or those who were transported to out-of-state hospitals are not included in the inpatient data. Occupants had to survive long enough to be admitted to the hospital. Occupants who died at the scene, died en-route to a hospital, or died in the emergency room prior to being admitted to a hospital are not included in the linked data. Data completeness varies for the inpatient hospitalization data. Nineteen ninety-five was the first year inpatient hospitalization data were collected in Oklahoma. Most licensed hospitals submitted data in 1995, 1998, and 1999; however, for 1996, 1997, and 2000 fewer hospitals submitted data.

Data linkage was performed using CODES 2000 record linkage software to implement Fellegi and Sunter's statistical theory of record linkage. Common information is identified between the crash and inpatient hospitalization data files (e.g., gender, age, event date). The more information that agrees between any two crashes and hospital records, the more likely the two records are to be considered a match. This report is based on linked crash and inpatient records matched at 90% probability or higher. Information from back-to-back admissions was compiled into a single hospitalization record. The following summary information is based on 721 matched high-probability crash and inpatient records for motorcycle riders identified from the 1995-2000 CODES linked dataset. The data summarized below under represents the actual number of hospitalizations from motorcycle crashes.

ICDMap90 software was used to calculate two scores used in this report. The Abbreviated Injury Scale (AIS) assigns injury severity scores by body region (head, face, chest, abdomen, extremities) based on injury diagnoses. The Maximum AIS score is the highest Injury Severity Score (ISS) across body regions. The Injury Severity Score provides an overall score for patients with multiple injuries. ISS scores can range from 1 to 75. If an injury is assigned an AIS score of 6 (un-survivable injury), the ISS score is automatically coded 75.

Linked Motorcycle Crashes in Oklahoma, 1995-2000

This data includes those motorcyclists who crashed and whose crash data linked to inpatient hospitalization data. Of the 721 motorcycle riders in the linked data, helmet use was unknown for 8.0% of riders. For the high probability linked crash-inpatient hospitalization data for motorcycle riders:

Table 4. Characteristics of Linked Motorcycle Crashes, by Helmet Use

	Wearing Helmet		
	No	Yes	Unknown
Characteristics of Persons			
# Riders	466	197	58
% Riders	64.6%	27.3%	8.0%
Average Age	34.9	34.6	36.9
% Male	87.1%	92.4%	89.7%
Ejected	35.0%	38.1%	37.9%
Pinned	1.1%	2.0%	0.0%
Officer Reports of Injuries			
Fatal	4.3%	3.0%	0.0%
Injury Severity	3.7	3.7	3.4
Head Injury	72.5%	48.2%	63.8%
Trunk Injury	61.4%	66.0%	53.4%
Arm or Leg Injury	80.3%	84.3%	77.6%
Characteristics of Crash			
Legal Speed	43.7	45.9	40.6
Speed before Impact	37.7	39.2	26.1
Speed at Impact	29.4	28.5	17.4
Two Lane	55.4%	54.3%	36.2%
Four Lane Divided	15.9%	18.8%	17.2%
Four Lane	17.8%	16.2%	32.8%
City Street	50.4%	44.7%	81.0%
County Road	20.6%	13.2%	1.7%
Highway	23.0%	34.5%	8.6%
Front Impact	44.4%	39.6%	44.8%
Side Impact	45.9%	48.7%	37.9%
# Vehicles Involved	1.6	1.6	1.6
Characteristics of Vehicles			
Harley Davidson	27.0%	6.6%	22.5%
Honda	25.3%	33.0%	26.6%
Kawasaki	13.7%	21.8%	15.8%
Suzuki	10.7%	15.2%	12.1%
Yamaha	18.0%	15.7%	17.5%
# Occupants	1.2	1.1	1.1

Note: Officer ratings of injury severity range from 1=not injured to 5=killed

- Almost two thirds of hospitalized motorcyclists were not wearing helmets.
- Riders not wearing helmets were 1.4 times more likely to die while in the hospital as result of their injuries than were riders who wore helmets.
- Hospitalized riders not wearing helmets were 1.5 times more likely to have head injuries than were helmeted riders.
- The likelihood of having trunk injuries or extremity (arm or leg) injuries was similar for helmeted and non-helmeted riders.
- Motorcycle crashes for hospitalized riders were most likely to occur on city streets, followed by highways and county roads.
- Motorcycle crashes for hospitalized riders were most likely to occur on 2-lane roads.
- Crashes involving hospitalized riders not wearing helmets were more likely to occur on city streets compared to riders wearing helmets.
- Crashes involving hospitalized riders wearing helmets were more likely to occur on highways compared to riders wearing helmets.
- Crashes involving hospitalized riders not wearing helmets were at slightly higher speeds compared to riders wearing helmets.
- Riders not wearing helmets were more likely to be involved in front-impact crashes than riders wearing helmets.

Linked Hospitalizations of Motorcycle Riders Involved in Crashes in Oklahoma, 1995-2000

The motorcycle riders most likely to be hospitalized are those rated by officers as having incapacitating or fatal injuries. The 1995-2000 high probability linked dataset contains records for 13.8% of all riders involved in motorcycle crashes and reflects approximately 51.9% of motorcycle riders involved in crashes who were rated by officers as having incapacitating or fatal injuries. Across the 721 linked motorcycle records, the average length of hospitalization was 9.2 days, resulting in 6,627 patient days spent in the hospital. The average charge per hospitalization was \$26,469 resulting in total charges of \$19,084,440. Twenty-four persons (4.1%) died while in the hospital and another 11.2% of persons were discharged to other types of facilities (not to home).

Table 5. Characteristics of Motorcycle Riders Hospitalized for Crashes by Helmet Use

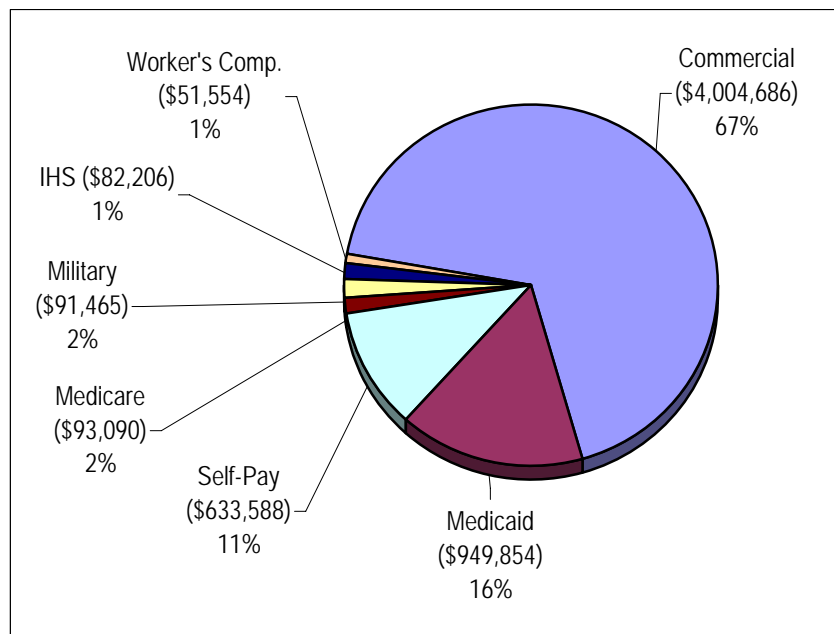
Characteristics of Hospitalizations	Wearing Helmet		
	No	Yes	Unknown
Number of Hospitalizations	466	197	58
Percent of Motorcycle Hospitalizations	64.6%	27.3%	8.0%
Average Length of Hospitalization (days)	10.2	7.2	7.8
Patient Days	4,754	1,419	454
Average Charge per Hospitalization	\$29,679	\$20,927	\$19,488
Total Charges	\$13,830,476	\$4,122,599	\$1,130,328
Charges per Patient Day	\$2,909	\$2,905	\$2,490
In-hospital Deaths	18	6	0
Percent Who Died In-hospital*	4.7%	3.8%	0.0%
Discharged Alive, but Not to Home	47	13	6
Percent Discharged Alive, to Other Facilities (Not to Home)	12.3%	8.3%	12.0%
Average Injury Severity Score	11.6	10.0	9.0

*Calculated based on hospitalizations where discharge status is known.

Table 5 displays summary information on hospitalizations of motorcycle riders:

- Of motorcycle riders who were hospitalized, 65% were not wearing helmets and 27% were wearing helmets. Helmet use was unknown for 8% of hospitalized motorcycle riders.
- Riders not wearing helmets stayed in the hospital an average of three more days (42% longer) than did riders wearing helmets.
- The average charge per hospitalization for riders not wearing helmets was 42% higher than for riders wearing helmets.
- Riders not wearing helmets were 24% more likely to die while in the hospital and were 48% less likely to be discharged to home than were riders wearing helmets.
- The average injury severity score for hospitalized riders not wearing helmets was 16% higher as compared to riders who were wearing helmets.

Figure 3. Total Inpatient Charges by Primary Payer, 1998-1999



Primary payer data were available only for calendar year 1998 and 1999 hospitalizations (see Figure 3). Payer was not coded for 28% of total charges for 1998 and 1999. For hospitalizations with known payers, commercial insurance accounted for 67% of total inpatient hospitalization charges, followed by Medicaid (16%), Self-Pay (11%), and Medicare (2%).

To examine the effects of restraint use on patterns of injuries, diagnosis codes were used to identify body areas injured--head, trunk, or extremity (arm or leg) (see Table 6).

Table 6. Body Area(s) Injured, by Helmet Use

Injuries			# Hospitalizations		% Hospitalizations		Average LOS	
Head	Trunk	Arm/Leg	No Helmet	Helmet	No Helmet	Helmet	No Helmet	Helmet
X	X	X	69	21	14.8%	10.7%	13.8	11.2
X	X		63	11	13.5%	5.6%	11.0	5.5
X		X	93	30	20.0%	15.2%	9.0	6.5
	X	X	52	44	11.2%	22.3%	14.1	8.3
X			44	9	9.4%	4.6%	10.2	3.2
	X		32	20	6.9%	10.2%	7.4	4.4
		X	108	62	23.2%	31.5%	7.9	7.1

Injuries			Average Charge per Patient Day		Average Charge per Hospitalization		Average Injury Severity Score	
Head	Trunk	Arm/Leg	No Helmet	Helmet	No Helmet	Helmet	No Helmet	Helmet
X	X	X	\$3,017	\$4,440	\$41,621	\$49,899	16.2	16.5
X	X		\$3,622	\$2,677	\$39,668	\$14,600	19.5	19.4
X		X	\$2,584	\$3,090	\$23,142	\$20,189	10.8	10.5
	X	X	\$3,006	\$3,123	\$42,322	\$26,045	12.2	12.2
X			\$2,625	\$1,781	\$26,732	\$5,740	12.5	10.4
	X		\$3,428	\$2,128	\$25,281	\$9,363	9.5	8.9
		X	\$2,597	\$2,031	\$20,437	\$14,514	16.2	16.5

Note: Hospitalizations are counted within an injury grouping if principal diagnosis or diagnosis 1 through 15 falls within that injury grouping. Percent of Hospitalizations is calculated within each restraint use/ejected group: wearing helmet (N=197), not wearing helmet (N=466). Average Injury Severity Score ranges from 1 to 75, with higher scores indicating more severe injuries.

- Hospitalized riders who were not wearing helmets had a 60% higher rate of head injuries—57.7% of riders not wearing helmets had head injuries compared to 36.1% of riders who were wearing helmets.
- Hospitalized riders who were not wearing helmets had a 10% higher rate of injuries to multiple body areas—59.4% of hospitalized riders not wearing helmets had injuries to more than one body area, as compared to 53.8% of riders wearing helmets.
- Hospitalized riders who were not wearing helmets had a 53% higher rate of injuries to the head and at least one other body area—48.3% of hospitalized riders not wearing helmets had injuries to the head and at least one other body area, as compared to 31.5% of riders wearing helmets.

The Abbreviated Injury Scale (AIS) is a scoring system that assigns injury severity scores by body region based on injury diagnoses. The Maximum AIS score is the highest injury severity score across body regions (see Table 7).

Table 7. Number and Percent of Persons Hospitalized by Abbreviated Injury Score Overall Maximum Score and Helmet Use

Abbreviated Injury Scale Overall Maximum Score	No Helmet		Helmet		Unknown	
	#	%	#	%	#	%
Minor	36	7.7%	17	8.7%	3	5.2%
Moderate	195	41.9%	82	41.8%	30	51.7%
Serious	128	27.5%	72	36.7%	16	27.6%
Severe	72	15.5%	17	8.7%	9	15.5%
Critical	33	7.1%	8	4.1%	0	0.0%
Un-survivable	1	0.2%	0	0.0%	0	0.0%
Total AIS Coded	465	100.0%	196	100.0%	58	100.0%
Note: Records not AIS coded: 1 No Helmet; 1 Helmet; 0 Unknown						

- The rate of minor or moderate injuries was similar for helmeted and un-helmeted riders (50.5% vs. 49.7%).
- The rate of serious injuries was 33% higher for helmeted riders (36.7% vs. 27.5%).
- Riders not wearing helmets were 79% more likely to suffer severe, critical or un-survivable injuries than were riders who wore helmets. Twelve point eight percent of riders wearing helmets suffered severe, critical or un-survivable injuries as compared to 22.8% of riders who did not wear helmets.

It appears that within the Overall Maximum AIS Scores, severity of head and face injuries is lower for helmeted riders (see Table 8):

- For riders with severe, critical or un-survivable overall AIS scores, the head injury AIS score for riders not wearing helmets was 23% higher than for helmeted riders (3.5 vs. 2.8). AIS scores for other body regions were similar for helmeted and un-helmeted riders.
- For riders with serious overall AIS scores, the head injury AIS score for riders not wearing helmets was 30% higher than for helmeted riders (0.6 vs. 0.5). The face

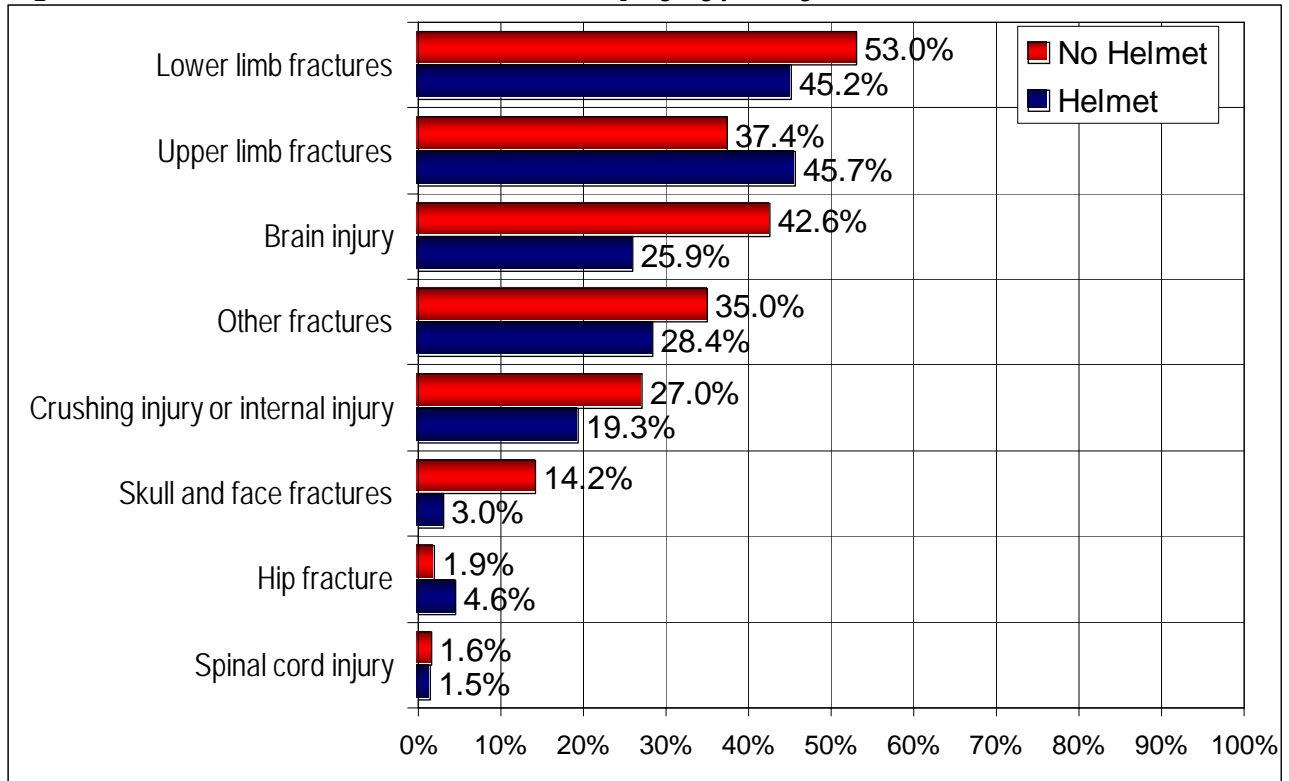
injury AIS score for riders not wearing helmets was 225% higher than for helmeted riders (0.4 vs. 0.2).

Table 8. Average AIS Scores by Body Area Injured, Helmet Use and Overall AIS Maximum Score

AIS Body Area	Abbreviated Injury Score Overall Maximum Score								
	Minor/Moderate			Serious			Severe, Critical or Un-survivable		
	No Helmet	Helmet	Difference	No Helmet	Helmet	Difference	No Helmet	Helmet	Difference
Head	0.5	0.4	-0.1	0.6	0.5	-0.1	3.5	2.8	-0.7
Face	0.4	0.1	-0.3	0.4	0.2	-0.2	0.5	0.5	0.0
Neck	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chest	0.1	0.1	0.0	0.9	0.9	0.0	1.4	1.5	0.0
Abdomen and Pelvic Contents	0.2	0.2	-0.1	0.2	0.2	0.0	0.7	0.8	0.1
Spine	0.2	0.2	0.0	0.2	0.2	0.0	0.4	0.5	0.1
Upper Extremity	0.7	0.9	0.2	0.9	1.5	0.6	0.8	0.9	0.1
Lower Extremity	1.2	1.1	-0.1	2.0	1.9	0.0	0.6	0.7	0.2
External Burns and Other Trauma	0.3	0.2	-0.1	0.2	0.2	0.0	0.1	0.1	0.0
Number of Riders	231	99		128	72		106	25	

The Single Level Clinical Classification System from the Agency for Healthcare Research and Quality Healthcare Cost and Utilization project was used to group diagnoses to examine the types of injuries that result from motorcycle crash hospitalizations (See Figure 4 and Table 9).

Figure 4. Percent of Persons with Each Injury Type, by Helmet Use



- Lower limb fractures were the most frequently occurring injury to hospitalized motorcyclists followed by upper limb fractures, brain injuries, and other fractures.
- Hospitalized riders not wearing helmets were 1.6 times more likely to suffer brain injuries and 4.7 times more likely to suffer skull and face fractures than were riders wearing helmets.
- For persons with a diagnosis of brain injury, riders not wearing helmets stayed in the hospital 59% longer and accrued an average of 42% higher average charges per hospitalization than did riders who were wearing helmets (see Table 8). In-hospital death rates were similar; however, riders who were not wearing helmets were twice as likely not to be discharged to home compared to riders wearing helmets.
- The rate of spinal cord injuries was similar for helmeted and non-helmeted hospitalized riders.

Table 9. Characteristics of Selected Injuries for Hospitalized Motorcycle Riders, by Helmet Use

	Hospitalizations		Utilization		Hospital Charges			Died In-Hospital		Discharged Alive, Not to Home		Injury Severity Score
	#	%	LOS	Patient Days	Per Hospitalization	Total Charges	Per Patient Day	#	%	#	%	
Brain injury												
No Helmet	156	42.6%	13.2	2,056	\$41,363	\$6,452,681	\$3,138	17	13.0%	23	17.6%	18.3
Helmet	51	25.9%	8.3	422	\$29,103	\$1,484,236	\$3,517	5	14.3%	3	8.6%	15.9
Crushing/internal injury												
No Helmet	99	27.0%	14.6	1,446	\$50,183	\$4,968,159	\$3,436	11	12.2%	12	13.3%	21.7
Helmet	38	19.3%	10.1	382	\$41,153	\$1,563,795	\$4,094	4	11.8%	3	8.8%	17.9
Hip fracture												
No Helmet	7	1.9%	8.7	61	\$30,011	\$210,074	\$3,444	0	0.0%	2	40.0%	11.7
Helmet	9	4.6%	14.3	129	\$39,993	\$359,938	\$2,790	0	0.0%	2	28.6%	16.0
Lower limb fractures												
No Helmet	194	53.0%	11.7	2,268	\$32,178	\$6,242,530	\$2,752	0	0.0%	18	11.5%	9.6
Helmet	89	45.2%	9.9	878	\$29,116	\$2,591,357	\$2,951	1	1.5%	10	15.2%	9.2
Other fractures—vertebra, ribs or pelvis												
No Helmet	128	35.0%	11.9	1,520	\$38,169	\$4,885,618	\$3,214	6	5.7%	20	19.0%	16.3
Helmet	56	28.4%	7.1	398	\$24,569	\$1,375,846	\$3,457	3	6.0%	8	16.0%	14.4
Skull and face fractures												
No Helmet	52	14.2%	14.1	731	\$43,275	\$2,250,283	\$3,078	5	11.1%	7	15.6%	16.5
Helmet	6	3.0%	11.2	67	\$84,841	\$509,046	\$7,598	0	0.0%	0	0.0%	23.2
Spinal cord injury												
No Helmet	6	1.6%	32.3	194	\$63,628	\$381,765	\$1,968	0	0.0%	2	40.0%	22.0
Helmet	3	1.5%	10.7	32	\$97,387	\$292,160	\$9,130	1	33.3%	2	66.7%	23.0
Upper limb fractures												
No Helmet	137	37.4%	10.7	1,464	\$32,287	\$4,423,300	\$3,021	6	5.3%	12	10.5%	14.4
Helmet	90	45.7%	9.4	846	\$26,094	\$2,348,428	\$2,776	2	2.8%	5	6.9%	11.3

Notes: * Percent of Hospitalizations is calculated within each Helmet use group: No Helmet (N=356), and Helmet (N=168). Hospitalizations are counted within an injury grouping if principal diagnosis or diagnosis 1 through 15 falls within that injury grouping. Average Injury Severity Score ranges from 1 to 75, with higher scores indicating more severe injuries. ISS were calculated using ICDMap90 software.

Motor vehicle crashes are the leading cause of traumatic brain injuries in Oklahoma (Injury Prevention Service, OSDH). According to *Traumatic Brain Injuries In Oklahoma, 1992-1997*:

“Survivors of severe brain injuries have persistent physical and behavioral problems which may require months or years of rehabilitation. The lifetime costs for persons suffering the most severe brain injuries have been estimated at \$4 million.”

For persons with a diagnosis of head injury for whom level of consciousness was specified:

- riders not wearing helmets were 21% more likely to lose consciousness as a result of their head injuries
- riders not wearing helmets and who lost consciousness were 28% less likely to return to their former state of consciousness by the time of discharge as compared to riders wearing helmets (See Table 10).

Table 10. Outcomes of Head Injuries, by Helmet Use

Persons Who Sustained Head Injuries:	No Helmet	Helmet
with no loss of consciousness (n=39)	29.9%	41.9%
with loss of consciousness, with return to previous state of consciousness (n=56)	49.4%	41.9%
with loss of consciousness, no return to previous state of consciousness (n=23)	20.7%	16.1%
Number of riders with brain injuries and level of consciousness specified	87	31

It appears from these data, that helmet use does reduce mortality and injuries from motorcycle crashes. This protective effect appears to primarily be from helmets reducing the prevalence and severity of brain injuries from motorcycle crashes.