

Characteristics of Motorcycle Crashes in the U.S.

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Abstract

While total traffic deaths in the United States increased by only 2 percent (2%) over a recent 10-year period (from 1996 to 2006), motorcycle deaths in the same period more than doubled compared to 1995. Per vehicle miles travelled, motorcyclists are about 35 times more likely than passenger car occupants to die in a traffic crash. This study examined data from the U.S. Fatality Analysis Reporting System (FARS) to identify characteristics of motorcycle crashes resulting in fatality and reviewed the consumer complaint database maintained by the Office for Defects Investigation to identify the complaints related to motorcycles. Fatal crashes were identified by motorcycle type, crash type, accident location, roadway profile, and other vehicle and driver factors. Exposure data on registered motorcycles was used to put the fatality risk in perspective. Factors including helmet use, alcohol involvement, driver age, and speed were examined to determine key contributing factors influencing motorcycle rider fatalities in the U.S. for the study period. The results show that speeding, alcohol use, age, and lack of helmet use are primary factors influencing motorcycle rider fatality. Results also show that more fatalities now occur on rural roads, reversing a trend that existed in the early 1990s. Finally, motorcycles with larger engines (e.g., Touring bikes over 1000 cc) are shown to have much lower fatality rates per registered motorcycle compared to Sport motorcycles with smaller engines.

Introduction

In the United States (U.S.), motorcycles have been steadily gaining in popularity in recent years, with large gains seen in motorcycle ownership and ridership. In 2006, over six-and-a-half million motorcycles were registered for street use in the U.S., accounting for about 3% of all registered vehicles in the U.S.. The Motorcycle Industry Council, a nonprofit trade organization, likewise estimates there were 6,390,000 “on-highway” motorcycles in use in 2003, compared to 3,650,000 in 1990.

The increase in the numbers of motorcycles on U.S. roads is not the only change in motorcycle use; there have also been significant changes in the types of motorcycles (particularly by engine size) in use and in the demographics of their owner/riders. [The following terms are used in this paper to define motorcycle occupants: “riders” are motorcycle operators (drivers) only; “motorcyclists” include both motorcycle riders and passengers.] Over 76% of the motorcycles in 2003 had an engine displacement of over 749 cc, compared to 40% in 1990. And survey data from the Motorcycle Industry Council for the period 1985-2003 reveals a shift towards older owners. The median age of owners increased from 27.1 years old in 1985 to 41 years old in 2003.

The mean age of a motorcycle owner in 2003 was 40.2 years, compared to 38.1 in 1998. In 2003, 25.1% of motorcycle owners were age 50 and over, compared to 19.1% in 1998 and 10.1% in 1990. Similar increases were seen for the 40-to-49 age group. Correspondingly, ownership in the under-18, 25-to-29, and 30-to-34 age groups showed significant decreases.

Along with the increase in motorcycle use, motorcycle fatalities in the U.S. have also been rapidly increasing in recent years. In 2007, 5,154 motorcyclists died in vehicle crashes (and 103,000 were injured), an increase of 7% over the 4,837 motorcycle fatalities in 2006 and an increase of 144% over the 2,116 motorcycle fatalities just 10 years earlier, in 1997 [NHTSA, 2008]. In 2006, the fatality rate for motorcyclists was 39 fatalities per 100 million vehicle miles travelled; the corresponding rate for passenger car occupants was 1.11 fatalities. Hence, per vehicle miles travelled, motorcyclists are about 35 times more likely than passenger car occupants to die in a traffic crash. In 2007, motorcycle fatalities accounted for 13% of total traffic fatalities and 14% of all occupant fatalities [NHTSA, 2008]. In addition, one out of four motorcycle riders (a full 25%) in fatal crashes in 2007 were operating their vehicle with an invalid license.

Given the significant increase in use, changes in driver demographics/engine sizes, and increase in fatal injury rates for motorcycle riders in the 10-year period from 1997-2007, it is important to identify the accident, vehicle, rider, and environmental factors associated with motorcycle occupant safety. Hence this study.

Data Used

To understand the factors associated with motorcycle crash injuries, field data collected by U.S. federal and state agencies were examined. The fatality risk was examined using the Fatality Analysis Reporting System (FARS) for the years 2000-2007. FARS is a census of all motor vehicle crashes occurring on public roadways and resulting in fatality within 30 days of the crash. The FARS database is maintained by NHTSA (the U.S. National Highway Traffic Safety Administration) and is widely used to assess vehicle safety standards and rulemaking activities in the U.S.. The motorcycle registration data was obtained from R.L. Polk & Company, which collects motor vehicle registration data from state Department of Motor Vehicle files for the entire nation. The annual miles travelled were obtained from estimates derived by the Federal Highway Administration (FHWA) using state survey data and the *Census of Transportation, Vehicle Inventory and Use Survey*. NHTSA's National Automotive Sampling System/General Estimates System (NASS/GES, 1990-2007), a nationally representative sample of over 30,000 police-reported crashes, was used to derive national estimates of injuries, types of crashes, and other factors. In addition, the consumer complaint database maintained by NHTSA's Office for Defects Investigation (ODI) was reviewed to identify the complaints related to motorcycles.

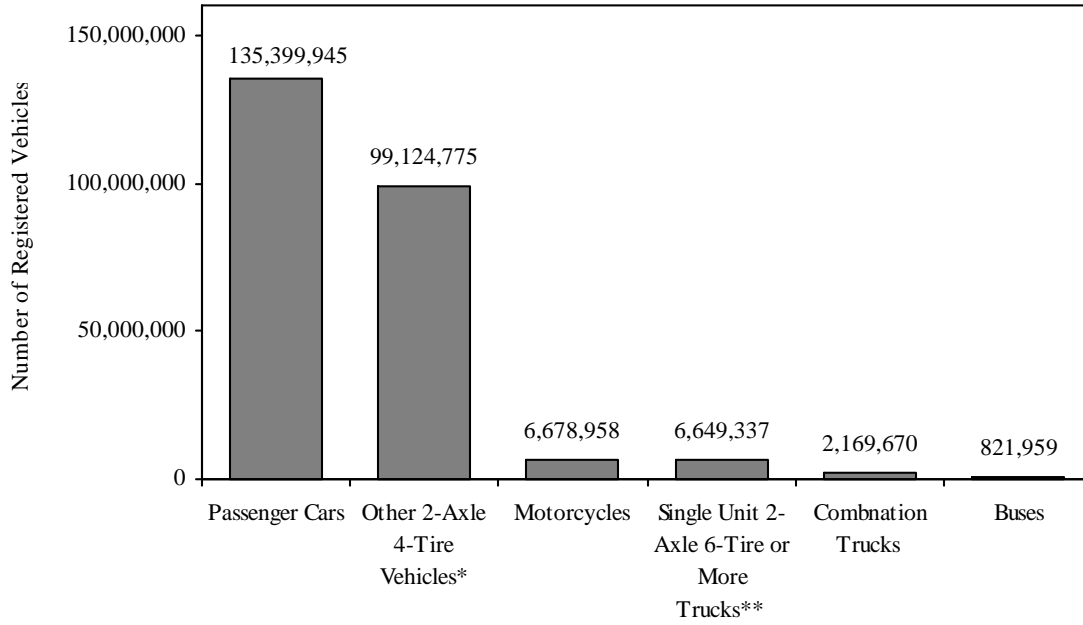
Results

U.S. Motorcycle Population

Figure 1 presents the number of vehicles, grouped by vehicle type, registered in the U.S in 2006. Figure 1A presents the number of registered motorcycles, by year, for the period 1997-2006. As seen in Figure 1A, there has been a significant increase in the number of motorcycles registered in the last decade (a 75% increase from 1997 to 2006). Sales of new street-legal¹ motorcycles grew even more sharply over the same period, from 260,000 in 1997 to 892,000 in 2006 (a 243% increase) [Morris, 2009].

¹ According to NHTSA, street-legal motorcycles include sport, sport-touring, super sport, touring, dual-purpose, and traditional bikes; cruisers; mopeds, scooters, and motorized bicycles; trikes and reverse trikes.

Figure 1. Vehicle Population by Type of Registered Vehicle in the U.S. (Calendar Year 2006)

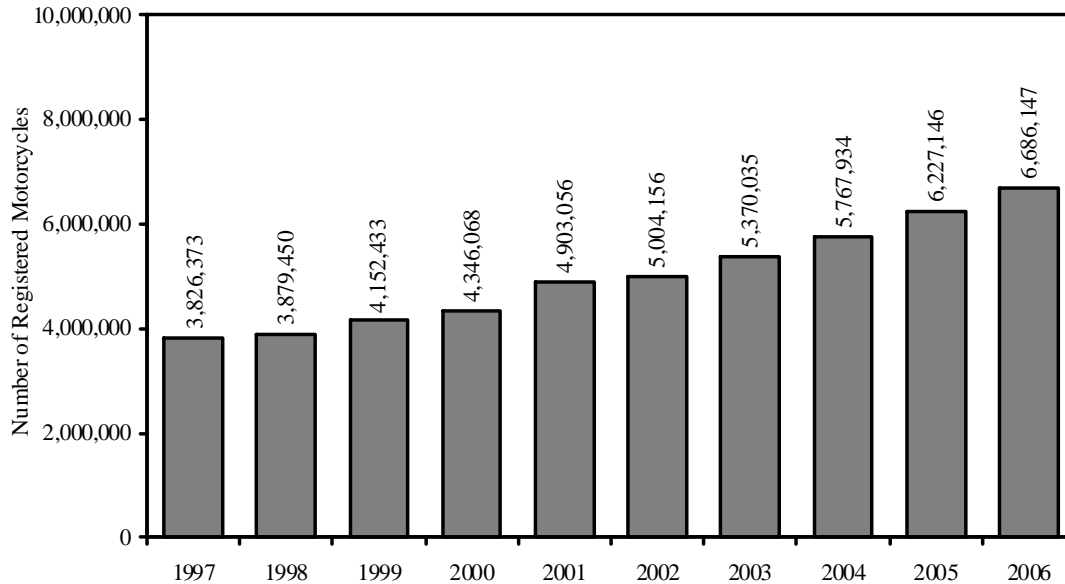


Source: U.S. Department of Transportation, Federal Highway Administration (FHWA).

*Other 2-axle, 4-tire vehicles include vans, pickup trucks, and SUVs that are not passenger cars.

**Single-unit, 2-axle, 6(or more)-tire trucks on a single frame with at least two axles and six tires.

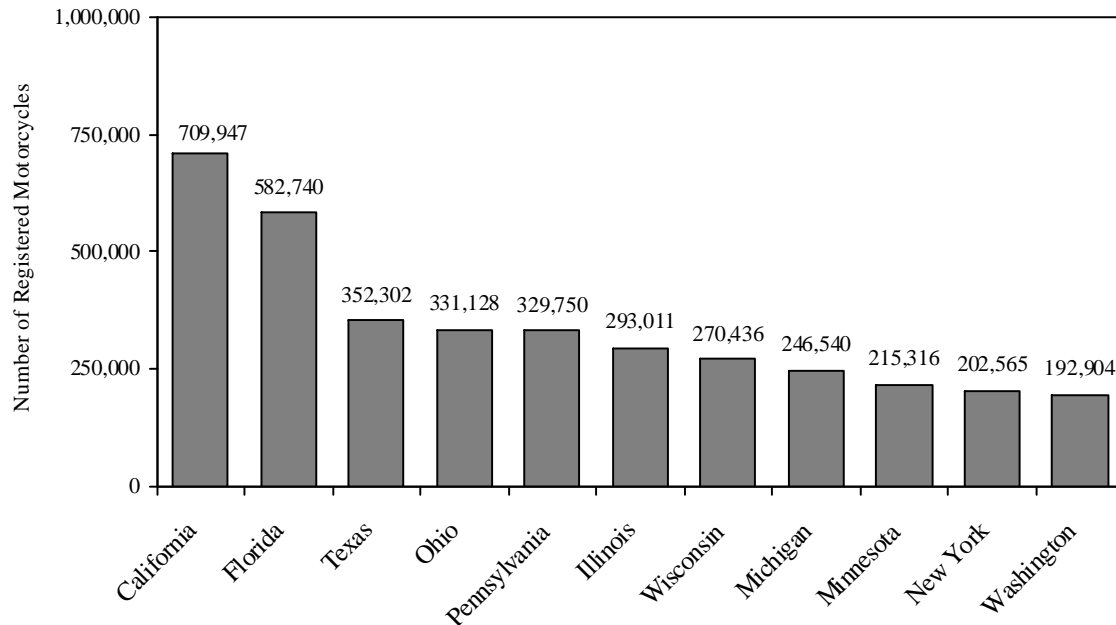
Figure 1A. Registered Number of Motorcycles by Year in the U.S. (Calendar Years 1997-2006)



Source: National Highway Traffic Safety Administration; Traffic Safety Facts - Motorcycles, 2007.

Figure 2 presents the 11 states with the highest volumes of motorcycle registrations in 2006. These 11 states account for 56% of total motorcycle registrations in 2006 for the entire nation.

Figure 2. Motorcycle Registration by State in 2006



Source: U.S. Department of Transportation, Federal Highway Administration (FHWA).

Motorcycle Crashes by Crash Type and Location

NASS/GES data was examined for the years 1990-2007 to identify the crash type and location for motorcycle crashes occurring in the U.S.. Of the approximately 42,000 motorcycle crashes that occurred each year in the U.S. (on average) during this period, about 59% were frontal crashes, about 29% were side impact crashes, about 10% were rear impact crashes, and about 2% were rollovers. About 28% of all motorcycle crashes occurred on grade/hill roadways and 71% occurred on level roadways. These percentages are consistent between 1990-2000 and 2001-2007 calendar years.

Fatal motorcycle crashes were examined using FARS data for the years 1990-2007. There were about 1,700-2,000 fatal motorcycle crashes each year between 1990 and 2000, and about 4,000 fatal crashes each year between 2000 and 2007. On average, about 79% of these fatal crashes were frontals, 17% were side impacts, 3% were rear impacts, and about 1% were rollovers. Of all fatal motorcycle crashes, about 30% occurred on grade/hill roadways. In addition, the data shows that more fatalities (about 50.3%) occurred on rural roads in 2001-2007, reversing a trend that existed in the early 1990s (about 44.7% fatalities occurred on rural roads in 1990-1995).

Risk of Fatality

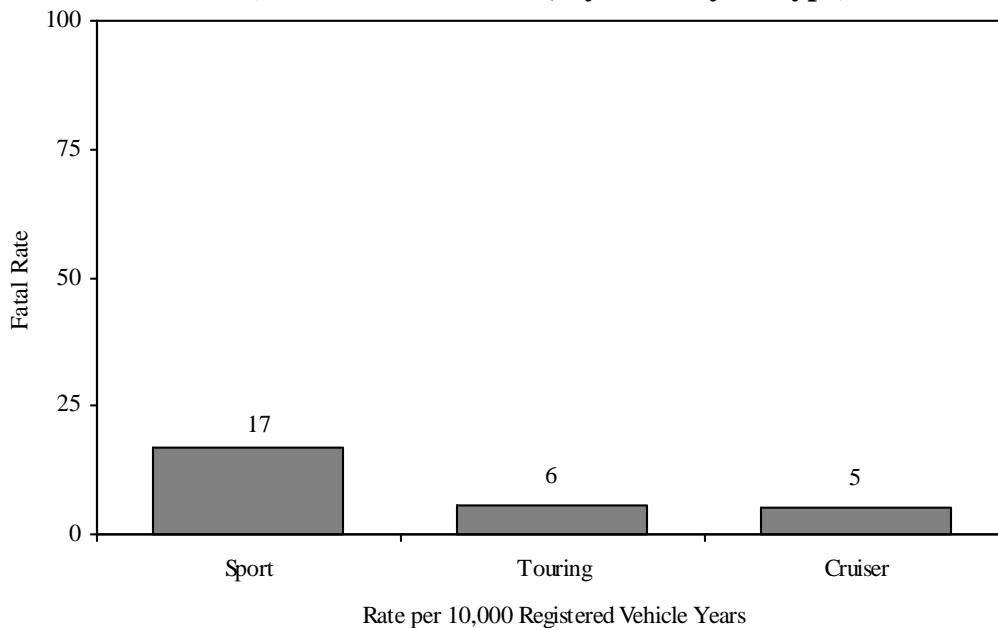
The growth in motorcycle sales and registrations has been accompanied by an increase in accidents, injuries, and fatalities involving motorcycles in the U.S.. One of the primary reasons for injuries and fatalities is the lack of helmet use. Currently in the U.S., only 22 states require

helmet use for all riders. NHTSA studies show that an unhelmeted motorcyclist is 40% more likely to incur a fatal head injury than a helmeted motorcyclist when involved in a crash. Another emerging trend is the growing popularity of racing-style motorcycles known as Super Sports, which have high power-to-weight ratios and are capable of extreme acceleration and speed (160+ mph). Super Sports have become extremely popular among young riders. The risk of fatality is significantly different among different types of motorcycles due to the differences in rider demographics and helmet use.

Figure 3 presents the fatal rider rate per 10,000 registered motorcycles by the basic motorcycle types: Touring, Cruiser and Sport. Touring bikes are a type of motorcycle designed for long-distance touring and heavy commuting. Sport/Super Sport bikes are capable of high acceleration and speeds, are lighter, and allow for agile cornering. Cruiser-style bikes reflect the classic design style of American motorcycles from the 1930s to the early 1960s.

As Figure 3 shows, the fatal rate for Sport motorcycles is 3 times greater than the fatal rates for other types. Figure 4 shows significant differences in driver and environmental factors among these motorcycle types. Sport motorcycles have a higher percentage of young male riders (ages 16-25), a higher percentage of risky driver behaviour², and a higher percentage of high speed (travel speed = 65+ mph) crashes.

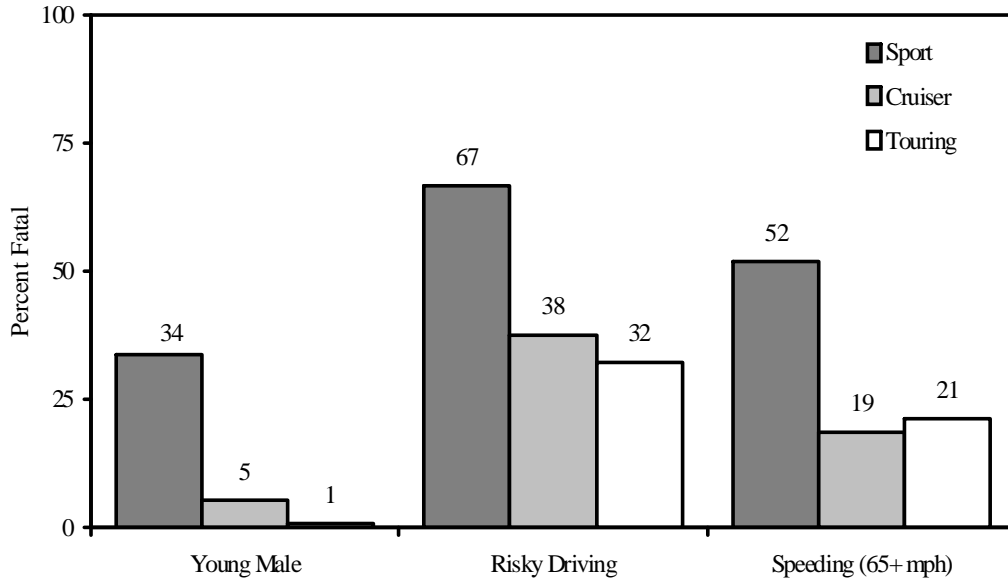
**Figure 3. Fatal Rate Per 10,000 Registered Motorcycles
(Riders in All Crashes, by Motorcycle Type)**



Source: Fatality Analysis Reporting System (FARS), 2000-2007. Model Years 1981-2007.
Sport Motorcycles include Dual Sport and Street Sport.

² Risky driving includes: reckless driving, speeding, unsafe/careless driving, and driving too fast for conditions.

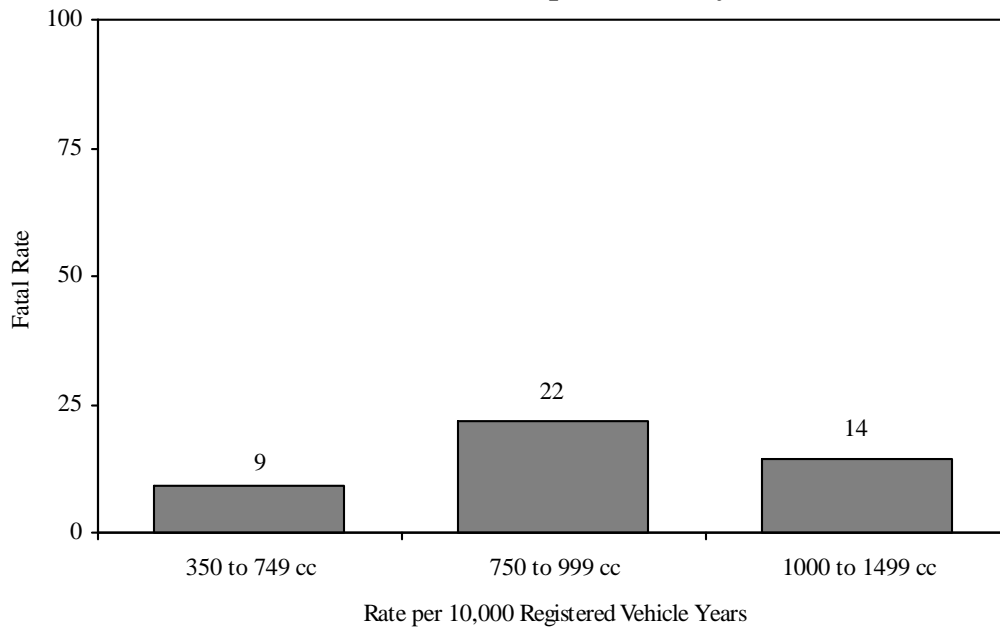
Figure 4. Factors Associated with Fatal Crashes, by Motorcycle Type



Source: Fatality Analysis Reporting System (FARS), 2000-2007. Model Years 1981-2007. Sport Motorcycles include Dual Sport and Street Sport.

There were also significant differences in fatal rates among different engine sizes for the Sport motorcycles (Figure 5). Sport motorcycles with engine sizes 750 cc or greater had significantly higher rates compared to Sport motorcycles with engine sizes less than 750 cc.

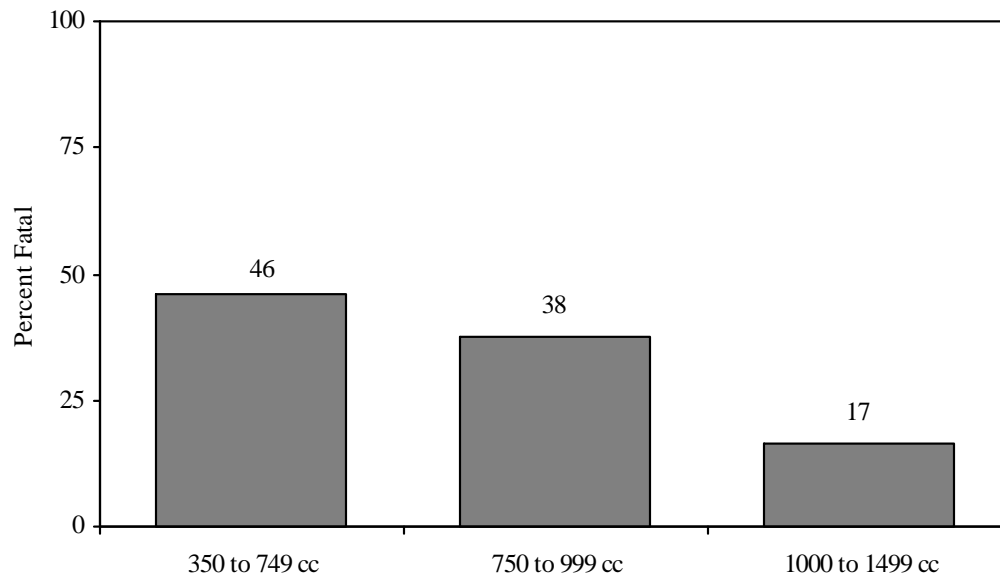
Figure 5. Fatal Rates per 10,000 Registered Motorcycles, by Engine Size (Riders in All Crashes, Sport Motorcycles)



Source: Fatality Analysis Reporting System (FARS), 2000-2007. Model Years 1981-2007. Sport Motorcycles include Dual Sport and Street Sport.

Figure 6 shows the percentage of young male riders by engine size for Sport motorcycles in fatal crashes. As seen in Figure 6, about 46% of fatally injured riders of Sport motorcycles with small engines (engine sizes less than 750 cc) were young males. The lower fatal rate for young males (Figure 5) could be due to the survivability of young riders in a severe crash despite their aggressive driving behaviour.

Figure 6. Percent of Young Male Riders in Fatal Crashes, by Engine Size (Sport Motorcycles)



Source: Fatality Analysis Reporting System (FARS), 2000-2007. Model Years 1981-2007.
Sport Motorcycles include Dual Sport and Street Sport.

Helmet Use and Alcohol

FARS data for the years 2000-2007 shows that about 30% of fatally injured riders were alcohol impaired, and about 44% of fatally injured riders were not wearing helmets. From 1984 through 1997, NHTSA estimates that helmets saved the lives of 8,474 motorcyclists [NHTSA, 2009]. The Crash Outcome Data Evaluation System (CODES) study found that motorcycle helmets are 67% effective in preventing brain injuries. A study conducted by the University of Southern California analyzed 3,600 motorcycle crashes and concluded that helmet use was the single most important factor governing survival in motorcycle crashes [NHTSA, 2009]. Currently, 22 states, the District of Columbia, and Puerto Rico require helmet use for all operators and passengers. In another 25 states, only persons under a specific age, usually 18, are required to wear helmets. Three states have no laws requiring helmet use. NHTSA's studies also showed a 20% increase in fatalities in states that repealed helmet use laws.

The U.S. Department of Transportation (DOT) is engaged in a comprehensive effort that is expected to mandate improvements to braking systems and use of anti-lock braking technology, increase helmet use, and provide tougher penalties for driving while alcohol impaired. In addition, the DOT is addressing rider training programs, appropriate licensing procedures, and means of increasing awareness of the growing numbers of motorcyclists who share the roads.

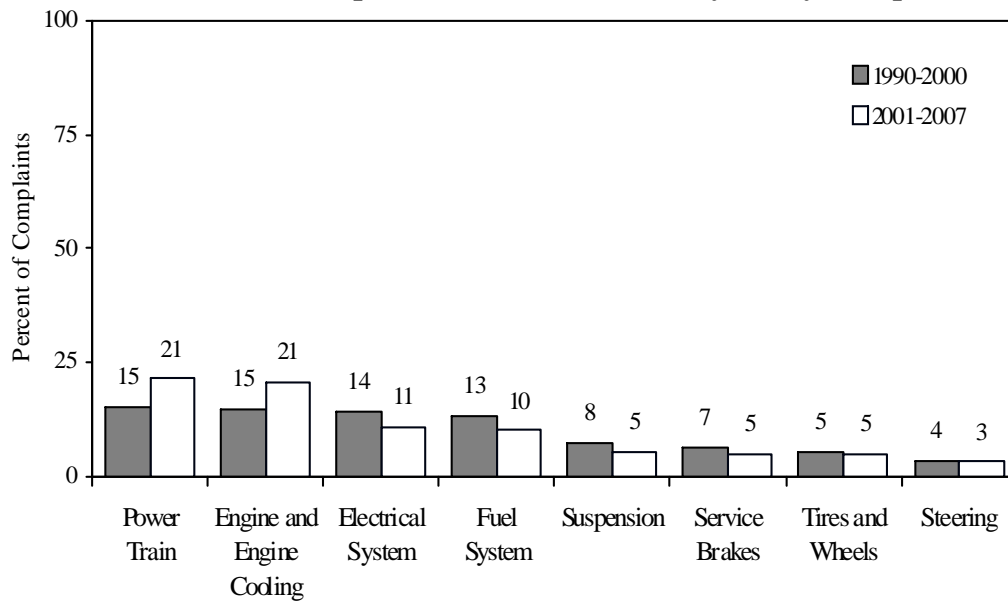
Run Off Road Crashes

Another important factor associated with fatal motorcycle crashes is the “run off the road”³ crash mode. FARS data for the years 2004-2007 was examined to identify all and single-vehicle fatal crashes that were run off road type crashes. Of all fatal crashes, about 40% were run off road crashes; of all single-vehicle fatal crashes, about 80% were run off road crashes. This type of crash is associated with young male riders, night/dark hours (8 P.M.-8 A.M.), and higher speeds (55 mph or greater).

Office of Defects Investigation Analysis

The consumer complaint database maintained by NHTSA’s Office of Defects Investigation (ODI) (1990-2007) was reviewed to identify the consumer complaints related to motorcycles. About 80% of the complaints include problems with the power train, engine, electrical system, fuel system, suspension, brakes, tires, wheels, and steering. The comparison of the complaint frequencies in 1990-2000 and 2001-2007 by motorcycle components is shown in Figure 7. There was an increase in power train and engine-related complaints in 2001-2007 compared to 1990-2000, while complaints related to electrical system, fuel system, suspension, brakes, and steering were more frequent in 1990-2000 than in 2001-2007.

Figure 7. Percent of ODI Complaint Records for Motorcycles by Component Type



Source: Office of Defects Investigation (ODI), 1990-2007. Model Years 1981-2007.

Conclusions

A study was conducted to examine the motorcycle crashes and injuries occurring in the U.S. for the last 20 years. Field data collected by federal and state patrol agencies were examined to address the nature of motorcycle crashes by motorcycle type, accident location and rider factors. The main conclusions of this study are that:

1. While the fatal rate per million miles travelled is higher for motorcycles compared to other motor vehicles, there are significant differences among different types of motorcycles. Sport

³ Run off road crashes include “first harmful event = ran off the road to the left or right”.

motorcycles have a fatal rate that is 3 times higher than the corresponding rates for Cruisers or Touring bikes.

2. The primary factors influencing motorcycle rider fatality are lack of helmet use, speeding, alcohol use, and rider age.
3. Fatal crashes for sport motorcycles are associated with young riders and risky driving behaviour, including speeding.
4. In a reversal from the early 1990s, motorcycle fatalities are more likely to occur on rural (vs. urban) roads.
5. In recent years (2000-2007), there has been an increase in consumer complaints relating to engine and power train systems.

The U.S., based on results of a comprehensive DOT study now underway, is expected to mandate regulatory changes to increase helmet use and safety and provide tougher penalties for driving while alcohol impaired. In addition, nationwide and statewide rider training programs are underway to educate motorcycle riders on ways to safely share the road with other modes of transportation. Efforts are being made to collect accurate and complete data on vehicle miles travelled for motorcycle riders to put the risk in perspective.

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