

Motorcycle Safety

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The number of people killed in motorcycle crashes in the United States increased dramatically in the decades prior to 1980, reaching a peak of 5,097 fatalities in that year. In the last two decades of the century, the nationwide incidence of motorcycle fatalities has declined, dropping to 2,106 fatalities per year in 1997 (1), 62 percent below the 1980 peak.

Some, but not all, of the drop can be attributed to a decline in riding. Between 1980 and 1997, the number of motorcycles registered in the United States fell by 35 percent, from a high of 5.7 million to 3.7 million. The fact that the decline in fatalities has far outstripped the decline in registrations, however, suggests that the widespread introduction of helmet laws, training programs, and public education campaigns during the last two decades has had a measurable impact on the number and severity of crashes. Even so, the National Highway Traffic Safety Administration (NHTSA) has estimated that at the turn of the century, the mileage-based death rate for motorcycle riders will be roughly 16 times greater than the overall motor-vehicle death rate. The more than 2,000 deaths per year represented by this rate provide a significant impetus for motorcycle safety research and the introduction of ongoing countermeasures at the federal, state, and local levels.

RIDER TRAINING

Background

The legislatures of 46 states have established motorcycle rider education programs. These programs are typically funded through motorcycle license or registration fees and are generally based on the curriculum of the Motorcycle Safety Foundation's (MSF) beginning rider education program—the Motorcycle Rider Course: Riding and Street Skills (MRC:RSS). This curriculum covers roughly 16 hours of training, 8 of which are spent on motorcycles on a controlled range. Eighteen states have made successful completion of the MRC:RSS course mandatory for young riders (under the age of 16, 18, or 21) seeking a motorcycle license, and Rhode Island requires training for all license applicants, regardless of age. MSF has also developed an 8-hour Experienced Rider Course for nonbeginners. In 1997 approximately 140,000 novice and experienced riders were formally trained in state and military programs.

Effectiveness

The ultimate measure of the effectiveness of any motorcycle training program is its impact on crash rates. During the 1980s several states and Canadian provinces attempted to assess

the impact of motorcycle training on crashes, only to obtain decidedly mixed results. In the 1990s an extensive evaluation of the California Motorcyclist Safety Program (2) used trend analysis and matched-pair comparisons to isolate the impacts of a statewide training program initiated in 1987. During the first 10 years of the program, motorcycle crashes in California dropped 72 percent, a decline far greater than that in the rest of the United States (55 percent) during the same period. A matched-pair analysis showed that the crash rates among untrained novice riders were more than double those among their trained counterparts for at least 6 months after the training, when riding experience begins to have a leveling effect on the differences between the two groups. In addition to lowering the crash rates among novice riders, research shows that formal training classes advance the use of protective equipment and discourage unpromising riders from becoming motorcyclists.

Look to the Future

Motorcycle rider education and training are the centerpieces of a comprehensive motorcycle safety program. There is a nationwide need to keep quality rider education and training programs available and accessible to all novices applying for first license and current motorcyclists seeking to improve their knowledge and skills. Meeting this need implies a requirement for the associated curriculum standards, sites, instructors, training motorcycles, protective gear, educational material, funding, and administrative support.

IMPAIRED RIDER

Recent Findings

Motorcycle operators involved in fatal crashes have higher intoxication rates than operators of all other motor vehicles. In 1997 almost 30 percent of all fatally injured motorcycle operators were intoxicated, with a blood alcohol concentration of $\geq .10$. An additional 11 percent had lower alcohol levels. Almost half of the motorcycle operators who died in single-vehicle crashes were intoxicated (1). These data have changed very little during the past 10 years.

In focus groups, motorcyclists who have admitted to riding after drinking have expressed greater concern about preventing damage to their motorcycles than about harming themselves or others in a crash. Traffic safety research shows that the most effective traffic safety programs are implemented at the local level. These programs usually include a media component, dedicated law enforcement, active local prosecution and judicial participation, and partnerships with a variety of community organizations.

Countermeasures

Intervention must focus on the unique characteristics of motorcyclists and motorcycling. Interventions designed for automobile drivers (e.g., the designated driver program) do not necessarily apply to motorcyclists. Impaired motorcyclists are much less likely than car drivers to accept a ride home, especially if it means leaving their motorcycle unsecured for the night.

Several interventions are currently in place. A required module in the MRC:RSS course focuses on impairment. Other examples include peer-to-peer programs promoting awareness and responsible use of alcohol, and "dial-a-ride" programs for motorcyclists, designed to get the impaired rider and motorcycle home safely. However, few data are available on the effectiveness of these programs or the degree to which they are being used by the target population. Specialized training that will enable law enforcement

representatives to detect impaired motorcyclists has been implemented nationwide through the Standard Field Sobriety Testing Curriculum.

Look to the Future

Greater effort is needed to address impaired motorcyclists. Specific components targeting impaired motorcycle riding should be incorporated into existing and new national-level impaired-driving campaigns and programs.

LICENSING

Key Issues

Most states require riders to obtain a special operator's license before driving a motorcycle on public streets and highways. There is, however, ample evidence that many motorcyclists ignore these requirements. NHTSA statistics show that, during a 10-year period ending in the mid-1990s, 42 percent of the motorcyclists involved in fatal accidents in the United States were either unlicensed or improperly licensed.

Unlicensed riders circumvent the skill and knowledge tests that are a major part of most licensing programs. Not surprisingly, they are overrepresented in fatality statistics, since their ranks include such crash-prone, high-risk riding groups as the underaged, the underexperienced, and the under suspension. As a group, unlicensed riders are 2 to 3 times more likely to be involved in a fatal crash than the typical licensed rider, and this figure rises to at least 20 times more likely among those whose licenses have been suspended.

Research Needs

Research is needed to document the size of the population of unlicensed riders. In addition, research is needed to relate testing, restrictive licensing practices, proof-of-insurance requirements, mandatory training programs, and sanctions to the size of that population.

CONSPICUITY

Background

Motorcycle crash studies provide ample evidence that motorcyclists are not easily seen by drivers of other vehicles, particularly when traffic is heavy and the visual field is complex. A common claim of motor-vehicle drivers involved in crashes is that they did not see the motorcycles and their riders at all, or did not see them in time to avoid the crash. In roughly half of the cases in which motor-vehicle drivers failed to detect a motorcycle in time to avoid a crash, other obstacles were present, either within the vehicle, as part of the landscape, or in passing traffic, that interfered with the driver's line of sight.

Countermeasures

Extensive experimental work involving both drivers and pedestrians suggests that the following measures, singly or in combination, can increase the daytime detectability of a motorcyclist by 10 to 20 percent:

- A large dipped headlamp of at least 40-watt power;
- A pair of daytime running lamps; and
- A fluorescent jacket or waistcoat.

Research Needs

Future research should address the dynamics of the automobile driver's visual display. Such research should focus on the enhancement of drivers' awareness of motorcycles, and include comparison of conspicuity influences in car-car and car-motorcycle crashes.

VEHICLE AND ROADWAY

Motorcycle

Significant numbers of motorcycles were first produced in America in the post-World War II years. The situation changed significantly in the mid-1960s when Japanese imports brought smaller, lighter, and more nimble motorcycles to the marketplace. The past 10 to 15 years has seen major innovations in aerodynamic design, liquid cooling, engine counterbalances, antilock and "linked" braking, fully adjustable suspension systems, and advanced disc braking systems. Both handling characteristics and tire technology, so crucial to the safe and efficient use of the motorcycle, have improved greatly.

Recently, manufacturers have been conducting research on new concepts, including automatic transmissions, fully enclosed rider capsules, and radical chassis designs. The latter involve such ideas as new swing-arm technologies and nontraditional front ends that use flexing technologies to overcome torsion problems. Continued experimentation with improved shaft designs and aerodynamic forms can be expected to increase rider comfort and stability. In addition, improvements of the last decade in such features as fuel injection, braking systems, and engine load mapping will continue to be introduced to a wider selection of motorcycles.

Roadway Environment

The roadway environment significantly affects motorcycle safety. Often the roadway is designed, constructed, and maintained with only automobiles and trucks in mind, and hazardous conditions for motorcyclists result. Additional attention paid to the special needs of motorcycles could greatly improve safety, especially on roadways with high motorcycle usage (e.g., scenic byways). Roadway environment issues affecting motorcycle safety that need to be considered in the next millennium include the following:

Design

- Placing rumble strips as far onto the shoulder as practical;
- Aligning grade crossings, gratings, and grooves perpendicular to the roadway;
- Avoiding protrusions on barriers and walls; and
- Avoiding wide-gap longitudinal bridge joints or marking them with warning signs.

Construction

- Providing sufficient warning of temporary shoulders and lane drop-offs, milled sections, and other hazardous areas;
- Avoiding steel plates or providing smooth edge transitions with asphalt;
- Minimizing water ponding with work zone drainage; and
- Properly securing barrels and cones to keep them off traveled areas.

Maintenance

- Removing dead animals, shredded tires, and similar obstacles from the roadway in a timely manner;

- Applying highway joint and crack sealants that do not become slippery in wet weather, are not tacky in warm weather, and do not overflow cracks;
- Using grit paint instead of smooth paint for markings such as turn arrows in the travel lane; and
- Cleaning road surfaces at toll booths and other frequent-stopping areas, which tend to become slick.

CRASH INVESTIGATIONS

There are no contemporary data on recent motorcycle crashes that could be used to validate existing countermeasures. The only major study of motorcycle crashes in the United States was sponsored by the U.S. Department of Transportation/NHTSA and completed in Los Angeles in 1981 (3). Some major findings of this multidisciplinary, on-scene, in-depth study of 900 crashes were as follows:

- Predominance of automobile-caused crashes;
- Overrepresentation of untrained and unlicensed riders;
- Effectiveness of safety helmets;
- Ineffectiveness of crash bars as leg injury countermeasures;
- High alcohol involvement in fatal crashes; and
- Important role of motorcycle conspicuity.

Since that research was published, motorcycle design has evolved. Motorcycle types—sport bikes and cruisers—that did not even exist then are now the majority of those found in traffic. Moreover, the age, gender, training, and licensing characteristics of the motorcyclists themselves have changed dramatically. Research is needed to determine how crash-involved motorcycles and riders compare with those not involved in crashes.

The *Common International Methodology for In-Depth Motorcycle Crash Investigations*, based on a methodology that originated at the University of Southern California (3), is currently being developed by the Organization for Economic Cooperation and Development (4). In the future, multidisciplinary, on-scene, in-depth investigation of motorcycle crashes utilizing the Common International Methodology should be undertaken to aid understanding of the reasons for the dramatic decline in motorcyclist fatalities during the last two decades and the characteristics of the at-risk population.

MOTORCYCLE HELMETS

Motorcycle helmets have improved greatly in comfort and convenience since the first patent for the modern protective helmet was issued in 1953. Helmet milestones include the American National Safety Standard for Motorcycle Helmets in 1966, the first full-facial-coverage helmet in 1967, Federal Motor Vehicle Safety Standard (FMVSS) No. 218 for motorcycle helmets in 1974, and increased use of energy-absorbing materials and integral eye protection beginning in the 1970s.

Motorcycle helmets in the United States are regulated by FMVSS 218, which standardizes test procedures and equipment. The current version of FMVSS 218 was issued in 1988, and a major upgrade is currently in progress (5), designed to bring the regulation closer to the international state of the art. Even with this upgrade, however, FMVSS 218 will contain no requirements for protection outside a limited zone above the ears, ignoring the important chin portion of full-facial-coverage helmets.

As the end of the 20th century approaches, 22 states have universal mandatory helmet-use laws, 25 have partial helmet-use laws, and 3 have no helmet-use requirement. Universal mandatory helmet laws result in almost 100 percent helmet use. Laws requiring helmets for certain age groups only are less effective and more difficult to enforce than those requiring universal use. In the United States, helmet laws that apply only to younger riders typically result in overall helmet use of 34 to 54 percent (1).

The effectiveness of helmets in mandatory-use states is well documented; mandatory use has been associated with at least a 30 percent reduction in fatalities (6). NHTSA estimates that helmets saved 486 motorcyclists' lives in 1997, and that 266 more could have been saved if all motorcyclists had worn helmets (1).

A disturbing trend in states with mandatory helmet-use laws is the use of "helmets" that do not comply with FMVSS 218. Although these bogus helmets are sold as novelty items, they find their way into traffic use; in California, a mandatory helmet-use state (7), they represent 10 percent of all helmets worn. These unqualified helmets do not provide adequate head protection and undermine the effectiveness of mandatory helmet-use laws.

PUBLIC EDUCATION AND AWARENESS

Current national programs address impaired riding, operator licensing, and motorcycle helmet use. These programs, which reflect the findings of focus group testing, statistical analysis, and market research, target identified high-risk segments of the riding population. Earlier national efforts focused on motorist awareness and general motorcycle safety issues.

Most state motorcycle safety programs produce educational materials focusing on awareness, impaired riding, and the use of protective gear. Additionally, states offer materials promoting motorcycling and rider education courses. These materials are distributed through motor vehicle officers; community, safety, and health fairs; rallies; and rider education courses.

In the future, public information and education campaigns focused on motorcycle safety should target all motor-vehicle operators in addition to motorcyclists. Increasing knowledge of safe motorcycle-riding practices and other motorists' awareness of motorcycles in the traffic mix are important to reducing crashes and injury. Motorcycle safety issues should be incorporated into all traffic safety campaigns. This is not the current situation at either the national or local level. Given the diminishing resources for motorcycle safety, it is becoming increasingly important to consolidate messages to reach the widest possible audience.

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