Summary

Motorcycle safety

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The present report contains updated versions of five chapters of the Handbook of Road Safety Measures about motorcycle safety. Among the most important risk factors for motorcyclists are high speed and young riders, while drunk riding is not a common problem. Other road users often fail to detect motorcycles and motorcyclists are more vulnerable to injuries than other motor vehicle occupants. Literature studies were conducted with a focus on studies that have empirically investigated relationship to and effects on crashes and injuries. Among the results are the following findings: Sports bikes have higher risk than most other motorcycles, mainly because riders of such bikes often are young and enjoy high speed. Despite the relationship between speed and crash risk, engine volume or capacity were not found to be related to crash involvement. Daytime running lights were found to reduce multi-vehicle crashes by about 40%. Motorcycles helmets reduce the risk of fatal head injuries by about 60% (also on all-terrain vehicles) while neck injuries are unchanged or reduced. Protective clothes protects mainly against minor injuries and open wounds, but has only limited effect on serious injuries and fractures. Antilock brakes for motorcycles were found to reduce injury crashes by about 30%

The present report contains updated versions of five chapters of the Handbook of Road Safety Measures (www.tsh.toi.no and Elvik et al., 2009). Each of the chapters addresses specific topics within motorcycle safety and as far as empirical studies were available also safety of all-terrain vehicles (ATV). For each chapter a literature study was conducted with the main focus on finding studies that have empirically investigated relationships to and effects on crash involvement and injuries. Some of the most important findings are summarized in the following.

Motorcycles, mopeds and ATV

Different types of motorcycles, mopeds and ATV each have specific user groups with different personal characteristics and riding styles. Among the most important risk factors for motorcyclists are high speed and young rider age. Drunk and drug riding occur and are accompanied by high crash risk, but are less common than for example among car drivers. For ATV riders, young rider age, off-road riding, drunk riding and off-road riding are the most common crash contributing factors. Roll-over is a common and one of the most injury prone crash types for ATV. Roll-over bars may reduce injury risk in roll-overs, but some studies indicate that they in some situations increase injury risk.

The crash involvement of different types of motorcycles is mainly related to rider characteristics and riding style. For example, unregistered cross motorcycles were in a Norwegian study found to be involved in a number of fatal crashes with young riders most all whom had at several of the following risk factors: Unlicensed, drunk, loaned or stolen bike, several criminal charges, riding at night (without lights) and riding with passenger (these bikes are not meant for riding with passengers). Sports bikes were in many studies found to have higher crash risk than other types of motorcycle, mainly because riders of such motorcycles enjoy speed and often are young.

Several studies indicate that passengers on motorcycles increase crash risk, especially among young riders. The severity of crashes is however reduced with passengers, most likely because speed on average is lower when riding with passenger than when riding alone.

Boxer engines on motorcycles have been found to reduce leg injuries. Improved design of fuel tanks and airbags may also reduce injury severity, but these measures have not yet been empirically investigated in real-world crashes. Reflective markings and bright colors were not found to reduce crash involvement.

Engine volume and capacity

Although high speed is a common contributing factor in motorcycle crashes, most studies failed to find a relationship between engine size or capacity and crash involvement. Relationships were only found for specific types of motorcycles or riders in some studies. For example, larger engines were in one study found to be related to involvement in crashes in curves, and sports motorcycles with large engines were in another study found to have more single vehicle crashes than sports motorcycles with smaller engines. Several studies found that motorcycles with specific classes of engine size - those most used by novice riders - are overrepresented in crashes.

Restrictions on engine size for novice riders were not found to reduce crash risk among novice riders, only the type of motorcycle used by crash involved novice riders.

Daytime running lights

Motorcycles are smaller than most other motor vehicles and other road users often fail to detect motorcycles. A major part of collisions with motorcycles are caused by other drivers who had not seen the motorcycle or underestimated its speed. Motorcycles with front lights are more likely to be detected and other road users are less likely to underestimated their speed.

Daytime running lights on motorcycles and mopeds were found to reduce involvement in multi-vehicle crashes by about 40% (refers to crash involvement of individual motorcyclists). Mandatory daytime running lights were found to reduce the total number of multi-vehicle crashes with motorcycles by about 10% (refers to crash occurrence in a motorcyclist population). Even single vehicle crashes were found to be reduced, but this may be a methodological artefact.

Alternative front light configurations may reduce crash involvement, especially collisions between a motorcycle travelling straight on and an oncoming vehicle about to turn left. However, this remains to be documented empirically.

Helmets and protective clothing

Motorcyclists and ATV occupants are more vulnerable to injuries, especially head injuries, than occupants of other types of motor vehicles.

Helmet use on motorcycles and ATV was found to reduce fatal head injuries by about 60% and brain injuries by 47%. Neck injuries are reduced or unchanged.

Full face helmets were found to provide somewhat better protection than modular helmets and far better protection that open face or half helmets. Novelty helmets do not seem to provide any protection. Unfastened or loosely fastened helmets may fall off in a crash and will then lose most of their protective effect. In general, helmet effects increase at decreasing speed and are greater on light motorcycles than on heavy motorcycles.

It was hypothesized that helmets have become more effective over time, but consistent empirical support for this hypothesis was not found. Helmet design has still some potential for improvement, especially regarding protection against brain injuries.

Protective clothes for motorcyclists were found to protect against minor injuries and open wounds, but they provide no or only minor protection against fractures and other serious injuries.

Motorcyclists wearing high-visibility clothes and helmets are more likely to be detected by other road users and the inclination to underestimates motorcycles' speed is reduced. Empirical studies found large crashes reductions among motorcyclists wearing high-visibility clothes or helmets but a part of the effects is probably due to a lack of control for rider behavior.

Rider assistance systems

Among rider assistance systems only antilock brakes have been investigated empirically. On average, antilock brakes on motorcycles were found to reduce crash involvement by about 30%. Greater effects were found on more serious crashes and on crashes on wet roads than on other crashes. Effects improve in combination with integrated braking systems.

Among other active safety systems for motorcycles and potential effects on crashes are the following: Slipper clutch prevents wheel lock-up while shifting down and may improve the effects of antilock brakes. Anti-spin is not likely to have any large effects on crash involvement. Automatic emergency brake may theoretically affect the outcome in a large proportion of motorcycle crashes, but may adversely affect motorcycle stability. Intelligent speed adaptation (ISA) may affect speed related crashes, but may also have adverse effects on motorcycle stability. Curve and intersection warning may potentially prevent crashes in curves and at intersections.