1. Purpose of this Fact Sheet

The purposes of this paper are:
- to provide an overview of the motorcycle (inclusive of all powered two-wheel vehicles) safety problem in Western Australia and elsewhere; and
- to describe some countermeasures in the context of Western Australia’s *Towards Zero* road safety framework to address motorcyclist safety.

2. What is the motorcyclist road safety problem\(^1\) in Western Australia?

While motorcycles comprise a small proportion of the vehicle fleet in Australia (approximately 4.5% of all registered vehicles and 0.9% of vehicle-kilometres travelled), motorcycle riders account for approximately 15 percent of all road deaths and an even higher proportion of serious injuries in 2007.\(^13\) In Western Australia, motorcyclists accounted for 15 percent of all road deaths in 2008, while comprising only 5.4 percent of the vehicle fleet. However, motorcycle usage is increasing: in Western Australia for example, the proportion of registered motorcycles increased from 4.2 percent of the vehicle fleet in 1998 to 5.4 percent in 2007.\(^30\) This increase is expected to lead to an increase in motorcycle-related crashes and injuries.

Analyses of the Western Australia crash data from 2000 to 2009 revealed the following contributing factors to fatal and serious injury motorcycle crashes:

- *Alcohol.* Almost one-quarter (24.2%) of fatal crashes and 4.7 percent of serious injury crashes involved riders with a Blood Alcohol Level (BAC) of 0.1g/100ml blood or more;
- *Age.* Young riders aged 34 years and below comprised 56 percent of all motorcyclist deaths, with those aged between 25 and 34 years accounting for 33.6 percent of all fatalities. Similar proportions are reported for serious injury crashes, with teenagers below licensing age involved in 3.5 percent serious injury crashes;

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\(^1\) Australian and Western Australian crash statistics rarely separate motorcycles, mopeds or scooters. However there are very few registered mopeds and scooters and the numbers of crashes thought to involve these vehicles are low. The crash data presented in this paper include motorcycles, mopeds or scooters but do not include trail bikes when ridden off-road.


• **Gender.** Overwhelmingly, males are involved in fatalities and serious injuries, compared with females (98.1% fatalities and 91.9% serious injuries);

• **Location.** Two-thirds (67.6%) of fatal crashes and 75.6 percent of serious injury crashes occurred on metropolitan roads, with the majority occurring in speed zones of 60 and 70 km/h (55% fatal and 55% serious injury crashes). The majority of crashes were at intersections and roundabouts (87% fatalities and 81% serious injuries).

Motorcyclists’ heightened involvement in fatal and serious injury crashes is readily apparent when compared to car drivers. Figures 1 and 2 show the risk of fatal and serious injury crash involvement by mode of travel per registered vehicle, comparing motorcyclists and passenger vehicles in Western Australia 2000-2009.

![Figure 1: Fatal crash rates of riders and drivers per 10,000 registered vehicles, 2000-2009.](image)

These figures show that the risk of being in a fatal or serious injury crash over the 10-year period was substantially higher for motorcyclists than for vehicle drivers (approximately 4 times for fatal crashes and 3 times for serious injury crashes).
3. Crash and injury risk factors

3.1 Rider vulnerability
Motorcyclists are vulnerable because of their relative lack of protection against impacts with other vehicles, the ground and roadside objects.\(^{19,8}\) Rider injuries are therefore often more severe than those of other road users.

3.2 Vehicle instability
The inherent instability of motorcycles makes them more prone to crashing compared with other vehicles. The problems of instability are exacerbated when braking: locking the wheel by braking increases the risk of losing control, particularly when applied in emergencies. Ouellet (2006)\(^{21}\) clearly showed that when riders collided with other road users, they frequently fell due to locked wheels before actually hitting the ‘obstacle’.

3.3 Conspicuity
Low conspicuity, or the failure of the rider to be seen by other road users, is also associated with risk of collision. Other road users can experience difficulty detecting motorcyclists due to riders’ small size, their often dark clothing and irregular contour/shape compared with passenger cars. The small numbers of motorcyclists on the roads and riders’ unusual behaviours such as high speeds\(^{5}\) and unexpected locations (such as driving between lanes) also contribute to their failure to be seen by other road users. Further, Doğan et al (2004)\(^{6}\) noted that the size of motorcyclists render them more likely to be obscured by other vehicles and objects and are hard to detect in glary conditions.

3.4 Rider behaviours
A lack of basic riding skills, failure to appreciate the inherent operating characteristics and limitations of the vehicle, failure to use special precautions while riding, failure to use defensive riding techniques, lack of specific braking and cornering skills, and failure to comply with speed limits also contribute to riders’ crash and injury risk.\(^{19}\)

Age and gender of riders are other contributing factors. Motorcyclist injuries have customarily been considered a young male phenomenon. However, in many European countries, the proportion of female riders sustaining injuries is increasing.\(^{8}\) With regard to age, there is an increasing trend in Europe, the US and Australia for ‘older’ riders (aged 50 years and above) to be over-involved in crashes.\(^{10,28}\) Some of these older riders may be new to the activity or may be returning after a long absence from riding – indicating a lack of experience or limited up-to-date-experience.

Speeding is another major contributor to crashes. Higher speed reduces a rider’s ability to control the motorcycle, to negotiate curves or other obstacles in the roadway and increases the chance of running off the road or into an on-coming vehicle. Speed also increases: the distance a motorcyclist travels while the rider reacts to a hazard, therefore reducing the time available to avoid a collision; the severity of the impact in a collision (even small increases in speed can result in a dramatic increases in the forces applied to crash victims); and unpredictability of the rider to other road users.

Adoption of other risky riding behaviours is also a consideration. In countries such as the US, Australia and Canada, the motorcycle is still reported to be mainly used for recreational purposes, even though there is an increasing number of commuter motorcyclists. Given the
combined vulnerability and excitement of motorcycle riding, it is no surprise that it attracts some individuals who are more prone to take risks than others. Riding behaviours that have been found to increase crash risk include riding too fast, alcohol, and poor observation and signalling at junctions.

4. Motorcyclist safety and the Towards Zero framework

As unprotected road users who frequently travel at high speeds, motorcyclists present a specific challenge for the Safe System approach to road safety. Moreover, the popularity of motorcycling as an alternative travel mode is increasing, suggesting an increase in the numbers of motorcycle deaths and serious injuries.

Western Australia’s Towards Zero aims to reduce the number of people killed or seriously injured on WA roads by 40% between 2008 and 2020. It is intended that this will be achieved by employing evidence-based initiatives under the four Safe Systems cornerstones:

- safe road use (20% reduction in all deaths and serious injuries);
- safe roads and roadsides (25% reduction);
- safe speeds (29% reduction); and
- safe vehicles (26% reduction).

4.1 Safe road use for motorcyclists

There are two key ways to improve road user behaviour to address motorcyclist safety.

First is the need to adopt safe riding practices. Education, information, practical training and an appropriate licensing system are essential for acquiring the attitudes, skills and knowledge necessary for safe road use. Motorcycle riding is reported to require higher levels of both vehicle control and cognitive skills than car driving, and this is not surprising, given the instability of riding on two wheels compared with four wheels. Moreover, the potential outcomes of any failure on the part of the rider, other road users or the environment threaten to be more severe. While there is no conclusive evidence suggesting that training is beneficial for motorcycle safety, hazard perception training holds some promise. While various forms of graduated licenses for riders have been implemented in Australian jurisdictions, including Western Australia, there is merit in considering more stringent graduated licensing schemes that are evidence-based and include appropriate principles of graduated licensing systems for novice drivers that apply to novice riders.

Second, there is the need to counter rider vulnerability, especially by wearing personal protective equipment. The most commonly required protective equipment required by law is a helmet. Helmets significantly reduce the probability of head and neck injuries by 53 percent and lead to a 72 percent reduction in the probability of death. Conversely, unhelmeted motorcyclists sustain substantially higher rates of facial and brain injuries compared to helmeted riders. Other items of motorcycle protective clothing, including jackets, pants, gloves and boots, are often recommended by road safety authorities. However, few if any jurisdictions legally require riders to wear this equipment. Further, survey studies show that virtually all Australian riders report wearing a jacket and helmet when riding but are less likely to report wearing protective clothing on body areas that are most often implicated in motorcycle crashes, such as their legs. Promotion of wearing helmets and other protective gear is recommended along with consideration at both jurisdictional and national levels to set guidelines and standards for minimum protective clothing required.
4.2 Safe roads and roadsides for motorcyclists

The safety of motorcyclists is compromised to a large extent by the design and operation of the road system, especially as motorcyclists differ in their use of the road compared with drivers of other motor vehicles. As an example, manoeuvring a motorcycle in curves requires a motorcyclist taking a different line than drivers, and the motorcycle is steered and balanced as a result of a complex interaction of forces rarely incorporated into the road design. At intersections, too, reduced conspicuity of motorcyclists due to poor infrastructure has been identified as a contributing factor to motorcyclist crashes.²

Intersections and roundabouts accounted for the great majority of motorcyclist fatal and serious injuries in Western Australia, emphasising the need to improve intersection design. At intersections and roundabouts, optimal conspicuity and detection of motorcyclists are essential and some suggestions for improvement are:

- The comparatively small size of a motorcycle requires that barriers, vegetation and road signs be placed so that they do not obscure a motorcycle. The design of intersections should offer a complete view of a motorcycle in the entire sight zone, while enabling the motorcyclist to have a complete view of the intersection.
- While roundabouts generally show low crash rates for most types of vehicles, motorcyclist collisions are relatively high because of specific problems of detection, approach speed and deceleration. Roundabout design that supports approach and entry angles of between 30 and 40 degrees are recommended for motorcyclists.²
- Reduced speed limits on approaches to complex intersections.

Single-vehicle run off road crashes are also a consideration for motorcyclist safety and appropriate barrier systems should be considered on road lengths where there is a high proportion of run-off-road crashes. While the debate continues regarding the types of barrier systems most protective of motorcyclists, there is the need for protection from collisions with roadside objects such as trees and poles. Current evidence points to no safety disbenefits of flexible barrier systems to motorcyclists.

Some points to consider in the design of barrier systems for motorcyclists are:

- Minimize the number of support obstacles for barrier systems and ensure no protruding, jagged or sharp edges,
- Provision of guarding on barrier support obstacles (particularly on bends),
- On bends, especially, consideration of the motorcyclist leaning behaviour needs to be incorporated in the design of barrier systems.

Other general road design features that improve motorcyclist safety include:

- Provision of good flat road surfaces free of bumps/dips at intersections, corners and bends with constant grip and skid resistant road surfaces,
- Provision of good visibility, especially at curves and intersections,
- Placement of road signs and markings at appropriate locations to ensure motorcyclists are not obscured from view of other road users,
- Provision of frangible roadside furniture.
4.3 Safer speeds for motorcyclist safety

The Safe System approach acknowledges the vital role of speed in determining overall system safety and this component is a cornerstone of the Safe System approach. If a safe system for all road users, including motorcyclists, is to be achieved in the absence of appropriate infrastructure protection, effective speed management strategies are essential to ensure that threshold impact speed values are maintained with the road network system.22

This requires comprehensive approaches to traffic management addressing all forms of speeding including illegal, excessive and recidivist speeding drivers and riders. The main approaches to managing safer speeds are setting of appropriate and credible speed limits, enhanced enforcement and supporting education for the general public. A change in the current ‘speed culture’, hence societies’ acceptance of high speeds, may arguably be vital to not only recognising the significance of the problem, but to offer a change in future speeding behaviour observed on Western Australian roads.

Suggestions for enhanced speed management strategies for motorcyclists include:

- Setting of appropriate and credible speed limits on both urban and rural road, especially popular motorcyclist routes;
- Increased use of speed limit advisory signs on popular motorcyclist routes;
- Maintenance and enhancement of widespread, highly visible and constant speed enforcement, including dual lens speed cameras to enable enforcement of speeding motorcyclists from the rear;
- Adoption of minimal tolerance levels in conjunction with speed limits based on a Safe System approach;
- For recidivist speeding riders, specific targeted deterrence is required and can include higher penalties, requirement for use of ISA technology, loss of licence.

4.4 Safe vehicles for motorcyclist safety

Safety-enhancing technologies for motorcycle safety are not as well developed as for passenger vehicles.3 Notwithstanding, there are some primary safety measures as described below:

- Enhancing stability and braking power. These technologies have highest priority as they are relevant to almost all motorcycle crash types. Advanced braking technologies such as anti-lock braking systems (ABS) reduce both the likelihood and the fear of the brakes locking in an emergency situation. Losing control of the path of the vehicle is otherwise a risk should the brakes lock, and the fear of this occurring means few riders use the maximum brake potential of their vehicle. It has been argued that ABS could be considered similar to electronic stability control on passenger cars, because they both act automatically when a critical situation is detected, address typical limitations in human performance in critical situations (e.g., difficulty controlling two systems - front and rear brakes - at once, low deceleration to avoid locked wheels and tumbling over, and lack of knowledge about and skills in optimal brake handling). There is early evidence to suggest that ABS is an effective way to reduce motorcyclist crash and injury risk.23 Furthermore, it is thought that ABS will result in a positive change in rider behaviour, as well as an actual reduction in motorcycle crashes as riders with ABS would presumably have no fear of brakes locking and use maximum brake potential in an emergency situation.
• **Crash avoidance systems.** These systems can alert the rider to potential hazards in the road environment and/or to dangerous behaviours. These include: collision warning systems, following distance warning systems, inter-vehicle communication, lane departure warning systems and lane keeping systems. While crash avoidance systems have not been widely developed for motorcycles, many have clear potential for improving motorcyclist safety. Implementation of these systems could be problematic for motorcycles unless reliable steering and braking systems were also developed. Moreover, there may be low acceptance of these technologies by those riders who perceive a lessening of riding excitement.

• **Daytime running lights (DRL).** It has been argued that the use of DRLs is beneficial for motorcyclist safety and will reduce the occurrence of multiple-vehicle collisions during the day, and that this effect can be further enhanced by other conspicuity enhancing countermeasures, such as wearing reflective clothing. This technology has been implemented in several countries and there are a number of studies that attest to the benefits of DRL, with up to an estimated 7 percent reduction in daytime crashes (cited in HUMANIST, 2006). However the conspicuity advantage of motorcycles as the only vehicles with daytime lights has now been questioned due to the growing practice among drivers of turning on their lights during the day, now authorized in most countries. Many researchers and road-safety specialists, as well as motorcyclist associations, argue that car DRLs are likely to compete with motorcycle DRLs and may have a detrimental impact on rider safety. There are also some concerns regarding the benefits of dual headlamps for motorcyclists, particularly for safety during night riding. The main concern is that motorcycles fitted with paired side by side headlamps, as viewed by other motorists, can give the illusion of it being a motor car at a much greater distance. This distance illusion has implications for collisions particularly. These are emerging issues warranting further research and identification of solutions. One solution may be to identify unique visual signatures for motorcycles that would increase their detection, such as changed ergonomics of motorcycle headlights, increased visual width and height of motorcycles and their headlights.

• **Intelligent Speed Adaptation (ISA).** While the specific design and operating characteristics of motorcycles pose a particular challenge, the adaptation of ISA technologies to motorcycles is proceeding with recent formal trials in the UK and in New South Wales.

• **Airbags.** There are demonstrated safety benefits of vehicle-mounted airbags for motorcyclists, particularly reducing the incidence of being thrown from the motorcycle in multiple-vehicle collisions. However, there are concerns about the potential for airbags to increase head and neck injury upon deployment, especially because the position of the rider is not always upright and there may be smaller distances between the rider’s face and the airbag. The presence of a pillion passenger will also affect the forward force of the rider.

5. **Summary and conclusions**

Crashes and injuries involving motorcycles and their riders and passengers are a serious and growing concern for road safety. Motorcyclist safety has long posed a major challenge to the Safe System approach, especially because they are unprotected yet travel at high speeds. In the context of Western Australia’s **Towards Zero** road safety strategy, a number of initiatives to improve the safety of motorcyclists are suggested, and include:
- Enhanced training and educational programs, especially hazard perception training and awareness of wearing protective clothing;
- Graduated licensing system for novice riders;
- Improvements to intersection and roundabout design;
- Improvements to roadside barrier systems, especially at curves;
- Improved speed management for drivers and riders, including setting of appropriate speed limits, enhanced speed detection and enforcement especially for recidivist speeding riders, and supporting public awareness campaigns;
- Technological enhancements to motorcycles, especially stability and braking systems, collision avoidance and speed adaptation systems, and airbag development.

6. References


20NSW Centre for Road Safety (2010). Results of the NSW intelligent speed adaptation trial. Effect on road safety attitudes, behaviours and speeding. NSW.


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