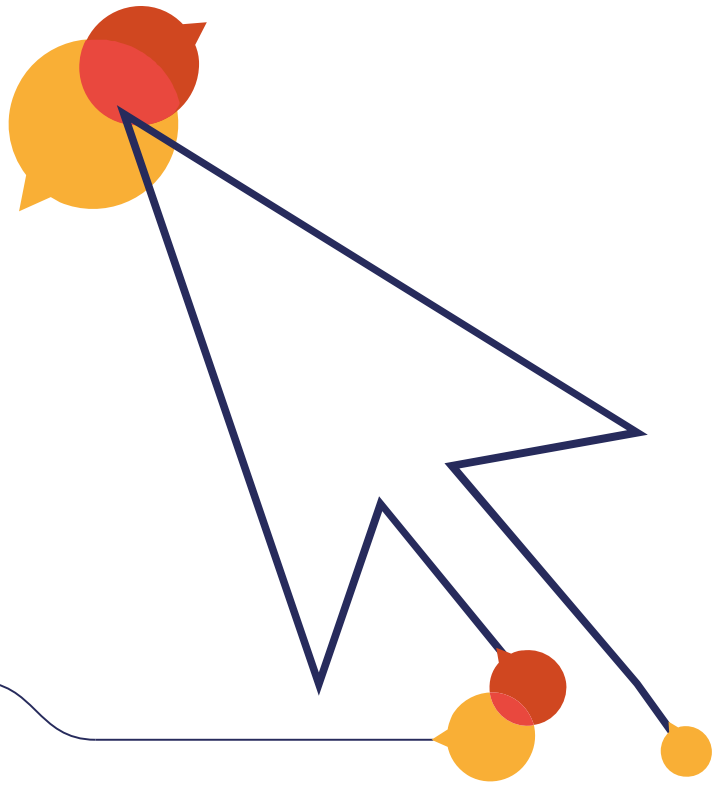
accidents don't have to happen

RoSPA Road Safety Research

Common motorcycle crash causes

April 2020



Contents

Overview of motorcycle casualties

World Health Organisation data shows that in 2013, more than 286,000 motorcyclists were killed in road traffic collisions. This represents almost a quarter of all road traffic deaths that year. Although the majority of motorcycle deaths occurred in low and middle-income countries, the safety of motorcyclists is a global concern[1].

In Great Britain, 16,818 motorcyclists were injured in reported road accidents in 2018. Of these, 354 were killed and 5,497 seriously injured[2]. This represents a decline in motorcycle casualties of 7% between 2017 and 2018. This figure has been falling since 2008, when 493 motorcyclists were killed[3]. However, research studies have shown that many non-fatal injury accidents are not reported to the police. This means that the figures reported here are likely to be lower than the actual figure of motorcyclist road casualties.

Although motorcyclists only account for 1% of total road traffic, they account for around 20% of deaths on the road[2]. Along with pedal cyclists and pedestrians, motorcyclists are vulnerable road users, as they have a higher crash and injury rate than vehicle occupants because they do not benefit from all the protective features, such as seat belts, airbags and other impact protection features.

Although the number of motorcyclists killed or seriously injured on Britain's roads has fallen substantially over the last few decades, motorcyclists are still 52 times more likely to be killed in a road traffic accident than car occupants per mile travelled, indicating that safety for motorcyclists has not improved as much as for car occupants[3]. In Great Britain in 2018, 2,039 motorcyclists were killed or seriously injured per 1 billion vehicle miles, compared to 27 car drivers killed or seriously injured per 1 billion vehicle miles[4].

Although only 29% of motorcycle accidents occurred on rural roads in 2018, 64% of fatalities occurred on these roads, indicating that these roads were particularly dangerous for motorcyclists[5].

Most accidents occur during the summer months, when most trips are made, and begin to fall in autumn. This is likely to be due to the fall in temperature and poorer weather, which could lead to fewer motorcycles on the road[6]. Motorcycle traffic decreased by 1% during 2018 to 3 billion vehicle miles[2].

Of the 16,818 motorcyclist casualties in 2018, 95% were male.

Common motorcycle accident causes

A number of in-depth accident studies have been carried out to determine the common causes of motorcycle collisions, including studies conducted by Transport Research Laboratory (TRL)[7], the Department for Transport (DfT)[8], The Association of European Motorcycle Manufacturers (ACEM) [6] and Austroads[9].

In 2001, TRL analysed a sample of 717 police reports of accidents in which a motorcyclist had been involved and where the motorcyclist or any other road users had been fatally injured. The accidents occurred between 1986 and 1995, but the majority occurred in the later years of 1992 and 1994. Almost all (87%) of those killed were motorcyclists and 11% were pedestrians. The analysis investigated the pattern of road users involved and the actions of the road user who was considered principally responsible for the accident.

The DfT conducted an in-depth accident investigation study in 2004, which included a sample of 1,790 accidents involving a motorcycle, of which 1,003 were considered in detail. Each collision was summarised on a database, recording the time and location of the accident, factors which contributed to the accident and a brief summary narrative. A 25-item questionnaire was also completed by a sample of relatively experienced motorcyclists to examine their attitudes.

In 2009, ACEM conducted an in-depth study of accidents that occurred between 1999 and 2000 in five sampling areas in Spain, Germany, France, Italy and The Netherlands. 921 accidents were investigated in detail including a full reconstruction of the accident, details of vehicle inspections, interview transcripts from witnesses and medical records of those involved (if consent had been provided). The human and environmental factors that contributed to the accident were identified and compared to 923 motorcyclists who had ridden in the crash location area, but were not involved in a collision.

More recently, Austroads collected data on motorcycle accidents between August 2012 and July 2014 in the Greater Sydney, Hunter and Illawara regions, in which a motorcyclist was seriously or fatally injured. Of these accidents, 10% involved motorcyclists who had been fatally injured. An expert multidisciplinary panel considered factors contributing to the crash and injury outcome of 102 riders (92 who had been seriously injured and 10 who had been fatally injured) and compared the data to the survey responses of 336 riders who had travelled through the crash location, but had not been involved in a crash themselves.

Overall, these in-depth motorcycle collision studies conclude that motorcycle accidents have different characteristics to collisions involving other road user groups. In particular, accidents involving motorcyclists are more likely to include right of way collisions, loss of control on bends and more frequent overtaking and passing manoeuvres by motorcyclists. The next section of this report will highlight the main causes of crashes involving motorcyclists, informing the update of 'RideSafe: Common Causes of Motorcyclist Crashes'.

Failure to negotiate bends

In 2018, 19% of killed or seriously injured motorcyclists were involved in single-vehicle accidents[10]. In over 8% of these accidents, the motorcyclist was travelling on a bend[11].

As with all other road user groups (excluding pedestrians), casualty data demonstrates that most motorcycle crashes occur when the motorcyclist is 'going ahead other'. However, in 2018, 8% of motorcycle accidents were recorded as 'going ahead on a bend', compared to 6% of cars[11]. This reflects motorcyclists' greater vulnerability when performing this manoeuvre.

This type of accident is more likely to be the fault of the rider, because he or she approaches the bend at too high a speed or misjudges the curve of the bend. Motorcyclist crashes on bends can be broadly broken down into three scenarios:

- The motorcyclist taking a left hand bend too wide and hitting an oncoming vehicle
- The motorcyclist losing control on a right hand bend and ending up colliding with a hedge or tree on the opposite side of the road and;
- Another vehicle cutting the bend and colliding with an oncoming motorcyclist, or losing control of his or her own vehicle[12].

Typically, these crashes are more likely to occur on sharp bends than gentle ones. Studies also indicate that in the UK left-hand bends are more dangerous for motorcyclists than right-hand bends, as it can be difficult for riders to perceive the curve of the bend when they are riding within it[13]. This is supported by data from Scoons and Crinson, who found 18% of motorcyclists in single-vehicle accidents were going ahead on a left-hand bend and 13% were going ahead on a right hand bend[14]. However, these kinds of crashes can be prevented by riding closer to the centre line of the bend when navigating a bend on the left, or riding closer to the left-hand side of the road when negotiating a bend on the right[15].

Road surface conditions, such as defects in the road surface, diesel spills and faulty manhole covers, are a concern often raised by motorcyclists, particularly on bends, where riders tend to lean as they go round. Slippery surfaces can also make motorcyclists particularly vulnerable[12]. Poor weather conditions creating damp, wet or icy road surfaces are also a concern for motorcyclists because as 'single track' vehicles, motorcycles are at risk of becoming unstable or 'capsizing' if a wheel loses grip on the road surface, particularly when the rider is negotiating a bend[16]. Despite this, a study by Clark et al determined that motorcycle crashes on bends were no more likely to occur when the road is damp, wet or icy. However, there is some evidence of riders encountering oil, gravel and mud on bends, particularly in rural environments[17].

Some groups of motorcyclists are overrepresented in crashes on bends:

- those who have a provisional licence, or no licence at all
- those who have a full licence, but have not held it for a long time
- those who have returned to riding a motorbike after some years

These accidents are more common amongst less experienced motorcyclists, who are just under three times more likely to be involved in a collision on a bend than experienced riders[18]. In some cases, inexperience is the only factor, as the failure to negotiate the bend did not seem to be the result of any other failure[8].

Considerable concern has also been raised about the safety of returned or 'born again' bikers, including unfamiliarity with the power, speed and handling characteristics of modern motorcycles, bearing in mind that some of these riders may have been absent from riding for fifteen years or more. During this time, weight to power ratios of motorcycles have changed considerably, meaning that some riders may be riding beyond their ability on an unfamiliar machine[12]. These riders tend to have a higher disposable income and may choose to ride higher capacity bikes, despite the fact that their riding skills may have depreciated considerably since riding in their youth[19].

For these 'born again' bikers, motorcycling might also be a leisure pursuit rather than a tool for commuting and utility purposes, meaning they may not ride as regularly as other groups of motorcyclists. Data from the in-depth motorcycle accident study indicates that accidents that occur on bends tended to peak in the afternoon or early evening, and at the weekends on a Sunday, suggesting that these accidents could be associated with recreational riding. Where the purpose of the rider's journey was known, a high number of these motorcyclists were riding for pleasure rather than for commuting, work or other purposes[18].

A survey of riders aged over 30 in Victoria, Australia, also found that while less than 10% had been involved in a crash, returned riders exhibited a pattern of behaviour that may place them at higher risk of being involved in a collision than continuing and new riders[20].

Collisions at junctions

As with all road users, junctions are a common location for motorcyclist crashes, with around 30 motorcyclists being killed or injured in collisions at junctions each day[3].

Data from the ACEM study suggested that around half of all motorcycle accidents took place at a junction[6]. UK police reported accident data supports this, with 66% of motorcycle accidents occurring at a junction in 2018[11].

The majority of these collisions occur at T-junctions, when drivers pull out into the path of an oncoming motorcyclist, especially at times of peak traffic flow in the early morning and late afternoon[8]. These accidents are three times more likely to occur at T-junctions than at other junctions, such as at crossroads or roundabouts. This finding was similar to that of a study by Hole, Tyrell and Langham, which found that the majority of motorcycle accidents at junctions occurred at uncontrolled T-junctions in urban environments[21]. A study of 100,162 motorcycle crashes found that the most commonly occurring crash type involved vehicles turning right from a junction into the path of an oncoming motorcyclist from the rider's right[22].

Another common type of motorcycle accident at junctions identified in an in-depth study was 'shunts' (a rear-end collision), which accounted for over 11% of all motorcycle accidents in the study. However, unlike other types of motorcycle collisions at junctions, in these shunt accidents, the rider was more likely than the other road user to be at fault. It was also found that riders who were young, less experienced and riding smaller machines were more likely to be involved in a shunt accident[8].

However, it must be noted that collisions at junctions are not a phenomenon restricted to urban areas at low speeds. Scoons and Crinson's study of motorcycle accidents found that motorcycles had a higher incident of crashes at all junction types compared with other road user groups[14].

As mentioned earlier, collisions at junctions, excluding shunt accidents, were more likely to be the fault of drivers, who fail to see the rider, despite them being in full view. This was reported in 36.6% of 921 accidents investigated by ACEM[6]. Similarly, in an in-depth accident investigation study, less than 20% of the accidents involved a

motorcyclist who was rated as fully or even partly to blame for the accident[8]. Finally, another study also highlighted that in multiple vehicle accidents; the driver of the other vehicle violated the motorcyclist's right of way and caused the accidents in two thirds of all accidents[23]. The main reasons that drivers were at fault were carelessness and thoughtlessness, or the failure to judge the actions of a motorcyclist. Even in collisions where the motorcyclist was riding at an excessive speed, drivers often contributed to the crash through a lack of care.

It is widely accepted that one key factor in motorcycle collisions is the difficulty other road users sometimes have in detecting an approaching motorcyclist or correctly determining their speed and position. This is supported by studies such as in-depth accident analysis conducted by ACEM, which discovered that in 60% of accidents between motorcycles and other vehicles , a traffic scanning error was detected[6]. Drivers failing to detect a motorcyclist at junctions, known as a 'looked but failed to see' accident[24] is a particular concern, even for motorists with relatively high levels of driving experience.

Helman et al (2012) [24] considered the concept of looked but failed to see accidents and identified a number of scenarios:

- Occasions where drivers simply do not look when pulling out of junctions
- Occasions where drivers do look, but not for long enough or in the correct places in the road scene
- Occasions where drivers look adequately, but fail to detect an oncoming motorcyclist
- Occasions where drivers do detect the motorcyclist, but fail to determine its 'time to collision' correctly

This highlights that in some cases, the driver may not see the rider despite the rider using daytime running lights and wearing high visibility garments. A number of theories aim to explain this phenomenon.

Mack and Rock (1998) found that drivers might be less likely to perceive an unexpected object if they are directly looking at it than if it falls outside of the centre of their visual field, a phenomenon known as inattentional blindness. This occurs when the attention of the driver is engaged in another task, event or object[25].

Other theories suggest that as there are less motorcyclists on the road, car drivers may not expect to see them[26]. Duncan's (1996) integrated competition hypothesis suggests that attention to some kinds of traffic in the road scene can be inhibited because drivers concentrate on features in the traffic scene that their experience has shown to be of critical importance[27]. Similarly, a study by Mannering and Grodsky (1995) found that motorcyclists believed that drivers tended to be inattentive with regard to motorcyclists and had conditioned themselves to look only for other cars as possible collision dangers, drawing upon their experiences of car drivers' 'sorry mate, I didn't see you' explanations for collisions[28]. As motorcyclists are physically smaller than other motor vehicles, with their face on silhouette area at around 30-40% of that of a car, they are also more likely to be obscured by other traffic[8].

Despite this, some drivers do detect a motorcyclist, but fail to determine its 'time to collision' correctly. Horswill and Helman (2001) suggested that people about to pull out from a junction tended to judge that an oncoming motorbike would reach them later than a car travelling at the same speed[29]. This is known as the 'size arrival illusion', where a motorist perceives a smaller object to be arriving later than a larger one[30].

However, evidence suggests that some interventions can improve the conspicuity of motorcyclists:

- Bright coloured clothing and daytime running lights can improve conspicuity of motorcyclists.
- Lighting that helps to accentuate the form of the motorcycle helps other motorists to determine the

arrival time of the motorcycle. This is particularly useful at night.

- However, the effectiveness of lighting does depend on background surroundings (e.g. lighting conditions) [24] and the characteristics of the driving situation (e.g. urban vs. rural)[31]. Riders should be aware of these limitations. Therefore, media campaigns aiming to increase driver awareness of motorcyclists could also aim to increase knowledge about the potential for inaccurate judgement of vehicle speeds, particularly for motorcyclists[32].

Overtaking collisions

A third common cause of motorcycle accidents is overtaking. In 2018, 15% of motorcyclists were recorded as performing an overtaking manoeuvre when they were involved in a collision, compared to 2.6% of cars[11], reflecting motorcyclists' greater vulnerability when performing this manoeuvre.

Some of these overtaking collisions occur when a rider is passing through slow moving or stationary traffic, known as filtering. An in-depth accident study found that the other road user was twice as likely to be fully or partly to blame in filtering incidents. It is thought that some of these accidents might be due to the motorcyclist 'subverting' other road users' expectations of how traffic behaves[8] because drivers can often fail to take into account that much smaller vehicles can overtake where cars and lorries are not able. This means that other road users can sometimes fail to take into account the possible approach of a motorcyclist[8].

However, some overtaking collisions occur when the rider overtakes poorly and is more likely to be at fault than the other road user. In Clarke et al's (2004) study, in 16.5% of accidents where the rider was considered partly or fully to blame, the rider was overtaking another vehicle. This may be because riders on high capacity machines can be presented with overtaking opportunities that they may find difficult to resist. This was particularly prominent amongst younger riders, with those aged under 25 having approximately a third more overtaking accidents in which they were at fault than those aged over 25[8]. In contrast, in a study of police reports of fatal accidents involving motorcyclists suggested that overtaking was a common factor involving riders of 201-650cc machines, possibly because they were seeking to emulate the behaviour of riders of more powerful machines[7].

Loss of control

Around 20% of motorcycle accidents are caused by the rider losing control, without any other road user being involved. These collisions were often associated with rider error, occurred on rural roads and were linked to excessive speed, alcohol, other impairments and reckless or careless behaviour[7]. However, less commonly, motorcyclists were involved in these accidents because they lost control while attempting to avoid impact with another vehicle, or lost control due to another vehicle's movement[9].

Research highlights that new riders had relatively more single vehicle crashes than continuing or returning riders[20]. Similarly, a study conducted found that for built up roads, the average age of a rider involved in a collision where the main contributory factor was loss of control was 26 years, compared to 31 years for other contributory factors. This suggests that loss of control accidents are more common amongst riders with less experience[7].

There were a number of causes of loss of control accidents amongst younger or less experienced riders. The Austroads in-depth crash study discovered that young riders were more likely to report that they were to blame for their crash, stating that they were not able to handle their motorcycle well enough, not knowing what to do in the situation, being unfamiliar with the location, travelling too fast and not braking fast enough[9].

Another factor that sometimes contributes to loss of control accidents is difficulties with loose gravel and slippery surfaces. The TRL in-depth accident study highlighted that in virtually all road accidents where poor road surface was a contributory factor, the factor was assigned to the rider rather than any other road user. This reflects the lack of stability of two-wheeled motor vehicles, making them more vulnerable than four-wheeled vehicles on poor road surfaces[7]. Motorcyclists are more likely to skid on both wet and dry road surfaces, and in particular are put at greater risk by mud or oil on the road. Snow and ice seem to affect car drivers as much as motorcyclists although it is likely that motorcycle use falls significantly when ice and snow make riding very difficult and unpleasant.

Speed

Excessive and inappropriate speed is the leading cause of road trauma in many countries globally. The higher the speed at which the vehicle travels, the longer the vehicle takes to stop. Although most motorcycle accidents occur at lower speeds, fatal and serious injuries are more likely to be suffered at higher speeds. As those riding a motorbike are not offered as the same level of crash protection as those in motor vehicles, they are particularly vulnerable to serious or fatal injuries associated with excessive speed[1].

'Exceeding the speed limit' was the most commonly attributed crash causation factor for motorcyclists riding bikes with an engine size over 500cc, reported in 29 of 39 collisions in Smith et al (2012)'s study. Motorcyclists riding smaller bikes (engine size less than 500cc) had a combination of commonly reported contributory factors in their collisions, including 'exceeding the speed limit', 'careless, reckless or in a hurry' and 'learner or inexperienced rider'. Other research also highlighted the prevalence of speed in motorcycle accidents. In one study, over a third (38%) of the motorcyclists involved in a fatal collision were considered to have been speeding before the collision[26]. Another study also highlighted that speed (travelling slower or faster than other traffic) contributed to 8% of collisions for riders in contrast to 4.8% for drivers[6].

Speed is a contributory factor in certain types of crashes, such as when a motorcyclist is negotiating a bend. Clarke et al's (2004) study identified misjudging the speed to negotiate a bend as the most common cause of single vehicle crashes. Inappropriate speed (both exceeding the speed limit and riding within the limit but too fast for the conditions) was a contributory factor in 9.2% of motorcycle accidents studied. Over half (58%) of experienced motorcyclists who responded to the questionnaire also admitted to always or frequently breaking the speed limit, but only when they felt it was safe to do so. However, over two-thirds of these experienced motorcyclists also admitted to sometimes miscalculating the appropriate speed for negotiating a bend [8].

Some motorcyclists may be more likely to engage in riding at inappropriate speed than others. Age has proven an important indicator of the intention to engage in risky speed related behaviours when riding a motorcycle. In common with research on car drivers, young riders were more likely to intend to speed. This is supported by Huang and Preston's literature review, which suggested that motorcyclists sometimes displayed risky or aggressive behaviour by choosing higher speeds, overtaking more often than other road users and pulling into smaller gaps in the traffic. Young male riders were particularly likely to display these kinds of risky behaviour[33]. However, this was not the only predictor of engaging in risky behaviour. A number of other factors came into play such as experience, the types of riding a rider engages in and the size of their engine[18].

It is also important to note that although excessive speed is often noted as a contributory factor in accidents involving motorcyclists, this area could be open to misinterpretation[34].

Alcohol

Alcohol reduces the ability to concentrate, reduces reaction times, creates over-confidence and increases the risk of being involved in an accident. It remains in the body for several hours after it has been consumed and may still affect the rider the morning after consuming it. A 2004 paper suggested that alcohol impairment was found to a have a prominent role in fatal and serious motorcycle accidents for which motorcyclists were found to be responsible[18].

In a study by ACEM, alcohol was present in 39% of 921 accidents. A motorcyclist was 2.7 times more likely to be involved in an accident when under the influence of alcohol than a car driver[6].

However, this does not imply that motorcyclists are more willing than other road users to drink and drive. In fact, motorcyclists were less likely to fail breath tests than drivers and coroners' data show that rider fatalities present similar or slightly lower blood alcohol levels than driver fatalities. It instead suggests that any level of alcohol places a rider at a greater risk of being involved in an accident[18]. Mannering and Grodsky (1995) claim that this is because motorcycle operation can be a more complex task than car driving, requiring excellent motor skills, physical coordination and balance. As a result, any impairment would more greatly affect a motorcyclist's risk of an accident when compared with a similar level of impairment while driving[35]. This suggests that any level of alcohol places two wheeled motor vehicle riders at a greater risk (relative to their normal elevated level) of being involved in an accident than car drivers. The instability of these vehicles could mean that a seemingly minor error can easily have serious consequences when compared to a 4-wheeled vehicle[7].

Impairment by illegal or medical drugs could also be a cause for concern. In 2018, impairment by drugs (illegal or medicinal) was recorded as a contributory factor in 80 fatal accidents and 404 that resulted in serious injury[36]. Research in 2001 found that six bodies of dead drivers (18%) and 16% of motorcyclists were found to have illegal drugs in their body in a sample of 1,000 drivers who were killed in road crashes. Around 6% of dead drivers and motorcyclists had taken drugs that could have affected their driving or riding[37].

Conclusions

In Great Britain, 16,818 motorcyclists were injured in reported road accidents in 2018. Of these, 354 were killed and 5,912 seriously injured[2]. This figure has been falling since 2008, when 493 motorcyclists were killed[3]. However, research studies have shown that many non-fatal injury accidents are not reported to the police. This means that the figures reported here are likely to be lower than the actual figure of motorcyclist road casualties.

Although motorcyclists only account for 1% of total road traffic, they account for around 20% of deaths on the road[2]. Along with pedal cyclists and pedestrians, motorcyclists are vulnerable road users, as they have a higher crash and injury rate than vehicle occupants because they do not benefit from all the protective features, such as seat belts, airbags and other impact protection features.

Failure to negotiate bends

In 2018, 8% of motorcycle accidents reported to the police occurred when the motorcyclist was negotiating a bend[11]. This type of accident was more likely to be the fault of the rider, because he or she approaches the bend at too high a speed or misjudges the curve of the bend.

Those who have a provisional licence, or no licence at all, those who have a full licence, but have not held it for a long time and those who have returned to riding a motorbike after some years are overrepresented in crashes on bends.

Collisions at junctions

Junctions are a common location for motorcyclist crashes. The majority of these collisions happen at T-junctions, when drivers pull into the path of an oncoming motorcyclist, particularly at times of peak traffic flow[8]. However, these accidents are not restricted to T-junctions in urban areas. Motorcyclists are involved in more crashes at all junction types compared to other road users [14]. These accidents are more likely to be the fault of drivers, who fail to see the rider, despite them being in full view.

Overtaking collisions

In 2018, 15% of motorcyclists involved in collisions were completing an overtaking manoeuvre at the time of the accident[11]. Some of these collisions occur when a rider is passing through slow moving or stationary traffic, known as filtering, where the other road user was twice as likely to be fully or partly to blame for the collision. Other collisions take place when the rider overtakes poorly, meaning they were more likely to be at fault than the other road user.

Loss of control

Around 20% of motorcycle accidents are caused by the rider losing control, without any other road user being involved. These collisions were often associated with rider error, occurred on rural roads and were linked to excessive speed, alcohol, other impairments and reckless or careless behaviour[7]. However, less commonly, motorcyclists were involved in these accidents because they lost control while attempting to avoid impact with another vehicle, or lost control due to another vehicle's movement[9]. Research suggested that new riders had more single vehicle crashes than experienced or returned riders[20].

Speed

Excessive and inappropriate speed is the leading cause of road trauma in many countries globally. The higher the speed at which the vehicle travels, the longer the vehicle takes to stop. Although most motorcycle accidents occur at lower speeds, fatal and serious injuries are more likely to be suffered at higher speeds. As those riding a motorbike are not offered as the same level of crash protection as those in motor vehicles, they are particularly vulnerable to serious or fatal injuries associated with excessive speed[1].

Alcohol

A motorcyclist was 2.7 times as likely to be involved in an accident when under the influence of alcohol than a driver[6]. This does not mean that motorcyclists were more likely to drink and drive, but rather that alcohol places a rider at greater risk of being involved in an accident.

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