

Synthesis title: Motorcycles

Observatory main category: Riders

Other relevant topics:

- Rural roads (Drivers/Riders)
- Urban roads (Drivers/Riders)
- Speed (Drivers/Riders)
- Training (Drivers)

Keywords: Motorcyclists, casualties, accidents, road safety.

Key Facts

- Motorcycle users are the road user group with the highest rate of casualties and fatalities per mile travelled. Compared to car occupants, motorcycle users in 2014 were:
 - Approximately 24 times more likely to be injured in a road traffic accident (per mile ridden).
 - Over 60 times more likely to be killed in a reported road traffic accident (per mile ridden).

- There were a total of 1,792 fatalities in road accidents in 2016. Of these, 319 (18 per cent) were motorcycle fatalities. This represents a decrease of 3 per cent in motorcycle fatalities from 2015.

- In 2016, men make up around 91 per cent of all motorcycle user casualties.

- A significant number (28 per cent) of non-fatal motorcyclist casualties are younger riders (aged up to 25 years old) on smaller engine motorcycles (up to 125 cc). However, the peak age of motorcyclist fatalities are older riders (aged between 31 and 55) on large motorcycles with engine sizes over 125 cc (accounting for 43 per cent of all fatalities).

- Over two-thirds of motorcycle fatalities in 2016 occurred in rural areas, compared with under half for serious motorcycle casualties and a third for slight motorcycle casualties.

- Of all the motorcycles involved in reported accidents in 2016, 66 per cent were at a junction.

(RRCGB, DfT, 2017)

Summary

- Motorcycle users are the road user group with the highest rate of casualties and fatalities per mile travelled. Compared to car occupants, motorcycle users in 2014 were:
 - Approximately 24 times more likely to be injured in a road traffic accident (per mile ridden).
 - Over 60 times more likely to be killed in a reported road traffic accident (per mile ridden).
- There were a total of 1,792 fatalities in road accidents in 2016. Of these, 319 (18 per cent) were motorcycle fatalities. This represents a decrease of 3 per cent in motorcycle fatalities from 2015, and is the lowest number of motorcycle user deaths recorded. (RRCGB, DfT, 2017).
- The fatality rate for motorcycle riders was 122 deaths per billion miles in 2014. This compares to a fatality rate of 1.8 deaths per billion miles for car drivers.
- In 2015, men made up around 90 per cent of all motorcycle user casualties. (RRCGB, DfT, 2017).
- A significant number (28 per cent) of non-fatal motorcyclist casualties are younger riders (aged up to 25 years old) on smaller engine motorcycles (up to 125 cc). However, the peak age of motorcyclist fatalities are older riders (aged between 31 and 55) on large motorcycles with engine sizes over 125 cc (accounting for 39 per cent of all fatalities). (RRCGB, DfT, 2017).
- Over two-thirds of motorcycle fatalities in 2016 occurred in rural areas, compared with under half for serious motorcycle casualties and a third for slight motorcycle casualties. Of all the motorcycles involved in reported accidents in 2016, 66 per cent were at a junction. (RRCGB, DfT, 2017)
- Analysis of accident data shows that motorcycle accidents have somewhat different characteristics to accidents involving other classes of road user: in particular they include junction accidents (including 'looked but failed to see' accidents), accidents involving loss of control on bends, and accidents attributed to motorcyclists more frequent overtaking/passing opportunities.

- A systematic review examining the effectiveness of motorcycle helmets in reducing injury found that motorcycle helmets reduced the risk of death and head injury in motorcyclists who crashed. Helmets were estimated:
 - To reduce the risk of death by 42 per cent.
 - To reduce the risk of head injury by 69 per cent.

(Liu et al, 2008)

- Motorcycle protective clothing has been associated with a significantly reduced risk of injury in crashes, particularly when body armour was fitted. Compared to those wearing non-motorcycle clothing, motorcyclists wearing motorcycle protective clothing fitted with body armour were significantly less likely to sustain injuries to the protected areas. The risk of any foot or ankle injuries was reduced by 53 per cent by non-motorcycle boots when compared to shoes or trainers, a risk reduction similar to motorcycle boots.

(de Rome et al, 2011)

Methodology

A detailed description of the methodology used to produce this review is provided in the Methodology section of the Observatory website at <http://www.roadsafetyobservatory.com/Introduction/Methods> .

This synthesis was compiled during July 2011, and updated in January 2017.

Note

In December 2017, statistics from Reported Road Casualties Great Britain were updated to [Reported Road Casualties Great Britain 2016](#).

Searches were carried out on the pre-defined sources identified in the methodology section.

Search terms used to identify relevant papers included: motorcyclists, motorcycling, motorcycles, road safety, collisions, casualties, effectiveness. 29 articles (research, statistical report or policy document) have been included in this review.

Key Statistics

Trends in motorcycle traffic and casualties over time

- Motorcycle traffic decreased 16.5 per cent between 2005 and 2015 to 2.8 billion vehicle miles. Compared to 2014, there was no change in motorcycle traffic volume in 2015. In comparison, the traffic volumes for cars increased between 2014 and 2015 by 1.1%.
- In 2015, 5,413 motorcycle users were killed or seriously injured (KSI) in reported road accidents. There were 365 motorcycle fatalities in 2015, 8 per cent more than in 2014 (and 28 per cent less than the 2006-10 average).
- The number of motorcycle users seriously injured fell by 5 per cent between 2014 and 2015 (from 5,289 to 5,048) and the total number of casualties fell by 2 per cent between the two years (from 20,366 to 19,927).
- The fatality rate for motorcycle riders was 121 deaths per billion miles in 2014. This compares to a fatality rate of 1.8 deaths per billion miles for car drivers.

(Annual Road Traffic Estimates: Great Britain 2015, 2016; Reported Road Casualties in Great Britain: 2015 Annual Report, 2016)

- Motorcycle users remain the road user group with the highest rate of accidents and casualties per mile travelled.
- Motorcycle riders, per mile ridden, are over 60 times more likely to be killed in a road traffic accident than car occupants. Motorcyclists are approximately 24 times more likely to be injured in a reported road accident than a car occupant.

(Reported Road Casualties in Great Britain: Main Results 2015, 2016)

Note

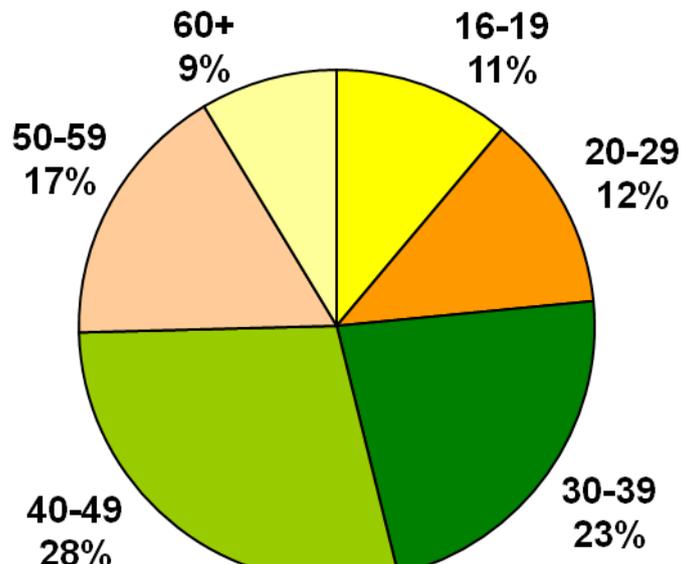
In December 2017, statistics from Reported Road Casualties Great Britain were updated to [Reported Road Casualties Great Britain 2016](#).

Motorcycle ownership and use

- In 2012, 2.6 per cent of households in Great Britain owned one or more motorcycles. There has been substantial growth in stock numbers over the last decade: since 1994, the number of licensed motorcycles in Great Britain has increased by 70 per cent.
- In 2012, people who recorded at least 1 motorcycle trip made an average of 8 trips per week by motorcycle, spent 3.5 hours travelling, and covered 85 miles each week.
- The age distribution of motorcyclists in 2002/12 is shown in the chart below. The majority of the sample were male (93 per cent).

(National Travel Survey: 2012, 2013; Vehicle Licensing Statistics: 2012, 2013)

Motorcyclists by age: Great Britain, 2002/12



[Source: National Travel Survey, Table NTS0610¹]

¹ Accessed 04/02/14: <https://www.gov.uk/government/statistical-data-sets/nts06-age-genderand-modal-breakdown>

Where accidents occur and in what circumstances

- Detailed analysis of reported road accidents in 2015 showed that:
 - 52 per cent of motorcycle KSI casualties occurred as a result of a *multi-vehicle accident* (mostly involving a motorcycle and a car) *at a junction*. The motorcyclist was 'going ahead' in over two-thirds of such cases. Another vehicle was turning in the majority of cases.
 - 24 per cent of KSI casualties occurred in *single vehicle accidents*. Over 35 per cent of these occurred when the motorcyclist was travelling around a bend.
 - 24 per cent of KSIs occurred in *multi-vehicle accidents away from junctions*. Of these KSIs, 21 per cent occurred when the motorcyclist was overtaking.(Reported Road Casualties in Great Britain: 2015 Annual Report, 2016)
- Over two-thirds of motorcycle fatalities in 2015 occurred in rural areas, compared with under half for serious motorcycle casualties and under a third for slight motorcycle casualties.
- Of all the motorcycles involved in reported accidents in 2015, 68 per cent were at a junction.
(Reported Road Casualties in Great Britain: 2015 Annual Report, 2016)

When accidents occur

- Detailed analysis of reported road accidents in 2015 showed that:
 - Most motorcycle KSI casualties in reported junction accidents occurred during the week (77 per cent), particularly at peak times.
 - In contrast, 38 per cent of KSI casualties in single vehicle accidents happened at weekends. Overall, a slightly greater proportion of fatalities happened at weekends (38 per cent, compared with 30 per cent of KSIs).
 - Most motorcyclist KSI casualties happened between April and October (68 per cent), reflecting an increase in motorcycling when the weather is better.(Reported Road Casualties in Great Britain: 2015 Annual Report, 2016)
- In 2015, there were higher absolute numbers of motorcycle KSI casualties during the months of March to October.
(Reported Road Casualties in Great Britain: 2015 Annual Report (RAS30): Table 30020, 2016)

Reported casualties by age, size of motorcycle and sex

- A significant number (around 30 per cent) of non-fatal motorcyclist casualties are younger riders (aged up to 25 years old) on smaller engine motorcycles (up to 125 cc). However, the peak age of motorcyclist fatalities are older riders (aged between 31 and 55) on large motorcycles with engine sizes over 125 cc (accounting for around 45 per cent of all fatalities).
- There were 3,189 motorcycle casualties of all severities in the 16-19 age band in 2015, and 29 fatalities. This compares with 2,992 casualties among those in their 40s, and 79 fatalities. Overall there were 19,927 motorcyclist casualties and 365 fatalities in 2015.
- Approximately 77 per cent of the fatal motorcycle casualties in 2015 involved motorcycles with an engine size over 125 cc.
- Motorcycle casualties are predominantly male; only 9 per cent of all rider casualties in 2015 were female.
- In 2015, 23 per cent of riders of motorcycles 50cc and under involved in personal injury road accidents were aged 16 years. A further 13 per cent were 17 years old. This is in contrast to motorcycles greater than 50cc, where 34 per cent of riders involved in injury road accidents were aged 30-49 years.

(Reported Road Casualties in Great Britain: 2015 Annual Report, 2016)

Speeding

- Analysis of data from 2012 showed that:
 - Compared to 2002, the percentage of vehicles exceeding the limit on 30mph roads had fallen for every vehicle type, excluding motorcycles which increased by 3 per cent.
 - Motorcycles had the highest average free flow speeds across all road types except motorways (for which cars and LGVs were the highest at 69mph, whereas the average free flow speed for motorcycles was 68mph on motorways).
 - The percentage of motorcycles exceeding the speed limit on motorways has decreased by 9 percentage points over the last 10 years to 48 per cent.
 - Motorcycles had the highest proportion travelling at least 10mph above the speed limit on motorways (18 per cent) and dual carriageways (19 per cent).

(Free Flow Vehicle Speed Statistics: Great Britain 2012, 2013)

Contributory factors

- Police attending the scene of a road accident can record up to 6 factors which in their opinion contributed to the accident. In 2015, the most commonly reported contributory factors attributed to motorcycles were 'Loss of control' and 'Failed to look properly', which were both attributed to 14 and 17 per cent of motorcycles involved in accidents respectively.
- In 2015, 'Exceeding the speed limit' and 'Travelling too fast for conditions' were both attributed to 5 per cent of motorcycles in reported accidents (as compared with 3 and 4 per cent of all vehicles respectively). 'Learner or inexperienced driver/rider' was attributed to a higher proportion of motorcycles in 2015 than all vehicles (7 per cent as compared to 2 per cent for all vehicles).
(Reported Road Casualties in Great Britain: 2015 Annual Report, 2016)
- In 2015, 'Loss of control' was the most common contributory factor attributed to single vehicle motorcycle accidents.
(Reported Road Casualties in Great Britain: 2015 Annual Report, 2016)

International comparators

EU statistics for motorcycle (including moped) fatalities show that:

- In 2010, the fatality rate for motorcycle riders per million inhabitants in the UK was well below the average for 21 EU countries for which data were available (6.8 as compared to 12.9 per million). The highest rate was in Greece (35.6) and the lowest was in Luxembourg (2.0).
- Motorcycle and moped fatalities made up 15 per cent of the total number of road accident fatalities in 2010 in the EU-24 countries for which EU data are available.
- In 2010, 4,368 riders (drivers and passengers) of *motorcycles* were killed in the EU-19 countries in traffic accidents. This is 12 per cent less than the number reported in 2009 for the same countries. The annual total of motorcycle fatalities decreased by 17 per cent during the decade (between 2001 and 2010) for these countries.
- In 2010, 1,094 riders (drivers and passengers) of *mopeds* were killed in the EU-19 countries in traffic accidents. This is 11 per cent less than the number reported in 2009 in the same countries. The annual total of moped fatalities decreased by more than 51 per cent during the decade (between 2001 and 2010) for these countries.

- The large majority of motorcycle and moped fatalities were male – only 11 per cent of moped rider fatalities and 6 per cent of motorcycle rider fatalities were female.
- In 2010, approximately 39 per cent of EU moped rider fatalities were aged between 15-24 years old. The number of EU motorcycle rider fatalities aged 40-65 years old increased by 38 per cent between 2001 and 2010.

(Yannis et al, 2012)

Australian Government statistics published in 2008 showed that:

- Motorcycle usage continued to grow in Australia; vehicle kilometres saw an annual growth rate of 5.7 per cent from 2002. By contrast, motorcycle usage in the UK peaked in 2003 and has flattened off since then.
- A large proportion of fatal crashes in Australia are associated with leisure riding rather than commuting. In GB, fatalities are more evenly spread between weekdays and weekends (i.e. across commuting and leisure times).

(Johnston et al, 2008)

Research findings

Summaries of key findings from research reports are given below. Further details of the studies reviewed, including methodology and findings, and links to the reports, are given in the References section.

Motorcycle accident characteristics

Analysis of accident data shows that motorcycle accidents have somewhat different characteristics to accidents involving other classes of road user: in particular they include junction accidents (including 'looked but failed to see' accidents), accidents involving loss of control on bends, and accidents attributed to motorcyclists more frequent overtaking/passing opportunities.

In-depth analysis of motorcycling accidents that occurred in the Midlands between 1997 and 2002 showed that:

- The majority of accidents could be classified into Right of Way Violations (ROWVs; 38 per cent), loss of control on a bend (15 per cent), overtaking accidents (17 per cent) and filtering accidents (5 per cent).
- There is a particular problem surrounding other road users' perception of motorcycles, particularly at junctions. The majority (approximately 80 per cent) of the motorcycle ROWV accidents were found to be primarily the fault of other motorists.
- Over 65 per cent of ROWV accidents where the motorcyclist is not regarded as to blame involve a driver who fails to see the motorcyclist who should be in clear view (and is often in view to witnesses or other road users in the area).
- Motorcyclists themselves tend to be more at fault with other types of accident, such as those on bends, while for overtaking or filtering accidents either party may be more at fault.

(Clark et al, 2004)

A recent review has further considered the concept of 'looked but failed to see' accidents, and identified that this term can encompass a range of situations, including:

- Occasions when drivers simply do not look at all when pulling out of a junction.
- Occasions when drivers look, but they do not do so for long enough or in the correct places within the scene.
- Occasions when drivers look adequately, but they still fail to detect an oncoming motorcyclist.
- Occasions when drivers look and detect an oncoming motorcyclist, but fail to assess its 'time to collision' correctly.

(Helman et al, 2012)

- Rider fatigue has been identified as a factor in a relatively small proportion of motorcycle accidents.

(Horberry et al, 2008)

Rider characteristics

Motorcycle riders, like all road users, comprise a number of different types, each of which needs to be considered separately in designing safety and training initiatives and communications.

- Seven segments have been identified, ranging from 'performance disciples' through 'riding hobbyists' to 'car aspirants' and 'look-at-me enthusiasts'. These various types of rider tend to differ in the way they think about and manage risk. For example, 'Riding disciples' are highly conscious of potential risk in riding, and take active steps to manage it by responsible riding behaviour and use of gear. By contrast, 'Look-at-me enthusiasts' display blasé confidence, recognising the risks of riding in general, but seeing themselves as relatively safe, and exhibiting a strong tendency to see risk as part of what makes riding fun, and to engage in risky behaviours.

(Christmas et al, 2009)

Research conducted in 2005 (Jamson et al, 2005) found that the older motorcyclist made up a large proportion of riders. There had also been a shift towards leisure riding in the period up to 2002, and a reduction in the amount of time it takes for the average rider to upgrade to a larger machine. This research is now several years old and riding patterns may have changed over the last few years. This is particularly true of the shift towards leisure riding, as since this research was carried out, there has been a growth in commuter riding.

Car drivers' attitudes and skills

Approximately three quarters of all motorcycle accidents resulting in serious injury or death involve another vehicle (Reported Road Casualties Great Britain 2012 Annual Report, 2013). Police accident records suggest that the other driver is at fault in many cases, with the contributory factor 'Failed to look properly' being most common (see Key Statistics section).

Research has explored what car driver attitudes and perceptions underlie this problem, and what might be done about it. Findings are:

- All drivers are more cautious in the presence of motorcycles than cars, but car drivers who are also motorcycle riders – dual drivers - are even more cautious than others.
- Dual drivers typically look at approaching motorcycles for longer than other experienced drivers at junctions and when changing lanes. This suggests that experienced drivers may not realise that they are looking at a motorcycle, and provides some experimental evidence of the phenomenon of 'look but fail to see'.
- While holding some promise for the future, the training interventions developed to deal with car driver behaviour have so far failed to produce the desired results.

(Crundall et al, 2011)

Focus group discussions between motorcyclists and non-motorcyclists explored risk taking on the roads, relationships between different road users and potential road safety interventions. It found:

- Motorcyclists themselves tend to note that the vulnerability of being on a bike creates the danger, which is largely overcome by experience and skill of the rider, while losing none of the thrill.
- Motorcyclists tend to view safety in terms of being able to handle the bike, knowing its limitations and capabilities, whereas car drivers are less likely to view this as skill and could view this instead as resulting in reckless behaviour.
- Those who classify themselves as calculated risk takers on the road (on any mode) show more empathy and understanding to motorcycle riders.
- Female car drivers were far more negative towards motorcyclists. They were far more likely to view motorcyclist behaviour as not just dangerous but also discourteous and law-breaking.
- Motorcycle riding identity is strongly linked with the need to ride safely. However, the perception of what is safe riding varies between motorcyclists.
- Motorcycling has a strong social identity and affiliation that means social norms are easily transmitted amongst the groups, meaning training amongst groups could be easily assembled.
- There is a strong belief that car drivers are as much to blame for motorcycle accidents, particularly through failing to look properly. However, some riders may feel that the responsibility for safety lies in the hands of the car drivers, rather than themselves. This creates a further divide between road users.
- In line with previous research, more empathy and indeed positive attitudes are shown towards motorcyclists by those who are motorcyclists, or have previously ridden a motorcycle or have motorcyclists in their immediate family or circle of friends.

(Musselwhite et al, 2012)

Training and testing

Research recently conducted to support a review of the motorcycle test compared test performance data from an off-road test site with an on-road test. Key findings included:

- Learners committed more faults on-road than for an equivalent module 1 test at an off-road test centre.
- Examiners and learners reported greater feelings of risk and vulnerability when carrying out the test manoeuvres on-road rather than for the module 1 off-road test.

(Tong et al, 2013)

Research on training needs in the context of introducing an updated motorcycle test in 2009 concluded that:

- Trainers agreed to varying degrees that the 2009 test would standardise testing conditions for manoeuvres, deliver an improved standard of riding and ensure that riders with minimal amounts of training were less likely to pass.
- Problems of accessing off-road sites for training might be overcome if DSA could provide test candidates with the option of a practice session at a DSA site.

(Tong, 2009)

Research in 2005 concluded that the following changes to current training programmes were worth consideration:

- Improvements to pre and post-test training content and delivery.
- Changes to the testing requirements to induce better training.
- Extending the span of Compulsory Basic Training (CBT) beyond one day.
- Making compulsory some aspects of post-CBT and/or post-test training
 - Encouraging longer training periods for Direct Access Scheme trainees, perhaps by introducing a log-book.
- Changes to the licensing system.

(Sexton and Elliot, 2009)

As detailed above, research has shown that car driver failures to give way at T-junctions are one of the three main causes of accidents involving motorcycles in the UK. Research has concentrated on the car-driver's perspective of these collisions but there has been little focus on the rider's perspective. A simulator study aimed to demonstrate whether riders of differing experience and training approached side roads differently. The study found:

- The Advanced riders (those had undertaken advanced training) mainly adopted a strategy which most riding instructors would consider to reflect safe practice when approaching junctions, riding closer to the central line than Novices (post CBT and preparing for DSA motorcycle test or had passed in previous 12 months).
- The Experienced riders (more than three years' experience) chose faster speeds, especially when approaching open junctions or when the junction apparently did not contain another vehicle. The Experienced riders collided most often with the hazard vehicle.
- The study concluded that it could be possible to train motorcyclists to approach side junctions in a manner that may reduce their crash liability.

(Crundall et al., 2013)

Equipment

A study of the use of helmets undertaken for COST (European Co-operation in Science and Technology) indicated that:

- There are differences in practice between southern and northern European countries, largely as a result of climactic differences.
- Older riders and those with larger bikes wear their helmets more often, and have helmets which are in better condition. Riders with little experience have more damaged helmets than those with more experience
- Riders of motorcycles over 400cc are twice as likely to be involved in an accident as riders of bikes of under 400cc.
- Various other classes of rider are at above average risk of involvement in accidents, including riders who do not wear their helmets properly, riders using helmets with stickers, those with dark visors, and riders who have flipped their retractable chin bar.

(Otte et al, 2009)

Traffic management and road characteristics

A pilot trial in London assessed the effects of motorcycles being permitted access to bus lanes. It is worth noting that despite some safety concerns, the trial has been extended to see if the problems raised can be addressed through increased publicity and enforcement.

- Permitting motorcycles access to bus lanes can result in an increase in motorcycle speeds and in the percentage exceeding the speed limit, and an increase in collisions involving motorcycles. This increase generally involved cars turning left into and out of side roads.
- There appeared to be no changes in the safety of cyclists and pedestrians that were directly attributable to motorcycles being permitted access to bus lanes.

(York et al, 2010)

The EuroRAP Motorcycle Safety Review conducted a review of crash barriers and concludes that there is a lack of attention to safe road infrastructure for motorcyclists. The review found:

- Hitting a crash barrier is a factor in 8-16 per cent of rider deaths
- In collisions with crash barriers, riders are 15 times more likely to be killed than a car occupant.
- Motorcycle-friendly systems have been shown to halve fatalities and offer high rates of return.
- That the quality of crash data and the research base surrounding how motorcyclists are killed and injured in crashes involving infrastructure needs to improve substantially.

- The decision in July 2008 to develop a new European testing standard for crash barriers that incorporates the needs of dismounted riders is commended – but concerns remain that testing should take place for riders striking the barrier whilst mounted and for protective equipment added to existing barriers.
- Every road safety engineering department should have a motorcycle champion to introduce a cultural change to the way in which risk is viewed by a road authority.

(EuroRAP, 2008)

How effective?

Training

An analysis of the effect of motorcycle training on road traffic collisions, undertaken for the Cochrane Collaboration (an international not-for-profit body focussed on delivering high quality evidence for health care) in 2010, found that:

- Most studies suffered from serious methodological weaknesses. Most were non-randomised and controlled poorly for confounders. Most also suffered from detection bias due to the poor use of outcome measurement tools. Small sample sizes and short follow-up time after training were also common.
- Due to the poor quality of studies identified, the authors were unable to draw any conclusions about the effectiveness of rider training on crash, injury, or offence rates.

(Kardamanidis et al, 2010)

Equipment and clothing

A systematic review examining the effectiveness of motorcycle helmets in reducing injury found that:

- Motorcycle helmets reduced the risk of death and head injury in motorcyclists who crashed. Helmets were estimated:
 - To reduce the risk of death by 42%
 - To reduce the risk of head injury by 69%

(Liu et al, 2008)

Protective clothing is thought to offer the greatest injury reduction in low impact crashes. A cohort study of motorcycle crashes conducted in Australia found that:

- Motorcycle protective clothing was associated with a significantly reduced risk of injury in crashes, particularly when body armour was fitted. Compared to those wearing non-motorcycle clothing, motorcyclists wearing motorcycle protective clothing fitted with body armour were significantly less likely to sustain injuries to the protected areas (there was a 23 per cent lower risk of injury associated with motorcycle jackets, 45 per cent with motorcycle gloves and 45 per cent with motorcycle boots).
- The risk of any foot or ankle injuries was reduced by 53 per cent by non-motorcycle boots when compared to shoes or trainers, a risk reduction similar to motorcycle boots.

(de Rome et al, 2011)

A recent review regarding interventions to increase motorcyclists' conspicuity and visibility found that:

- There is evidence demonstrating that bright clothing and daytime running lights can improve conspicuity.
- Lighting that accentuates the form of the motorcycle helps observers to determine the time to arrival of the approaching bike (especially at night).
- The evidence indicates that colour can improve the effectiveness of interventions e.g. coloured motorcycle lights improve visibility against surrounding vehicles with white lights.
- Effectiveness can depend on the background surroundings (higher contrast with background improves visibility and conspicuity) and riders should be aware of these limitations.

(Helman et al, 2012)

A study examined judgements of approach speeds for motorcyclists and how low light compounded perceptual limitations. Research has found that perception of vehicle speed could be affected by vehicle speed, with smaller vehicles appearing to travel more slowly and thus reaching the observation point at a later time than larger vehicles. This can be exacerbated at night when the contours of the rider and vehicle can no longer be depicted. A study examined how individuals judge the speed of motorcycles and cars over a number of different light level conditions. It found:

- The accuracy of judgement remained constant for cars across all lighting levels.
- Participant estimations of motorcycles with a solo headlight were significantly less accurate as lighting levels degraded.
- The addition of a tri-headlight formation considerably reduced the degradation in speed judgements under lower light conditions. However, judgements were still poorer than the car.
- Whilst this is less than optimal, the introduction of the tri-headlight formation could reduce the likelihood of right of way violation collisions occurring.
- It was also suggested that media campaigns aiming to raise driver awareness could also aim to increase knowledge about the potential for inaccurate judgements of vehicle speeds, particularly for motorcyclists.

(Gould et al, 2012)

A recent European project ('2 BE SAFE'), co-funded by the European Commission, undertook a range of behavioural and ergonomics research with the aim of developing countermeasures to improve the safety of motorcyclist and moped riders. Key findings from a summary of the experimental studies on conspicuity include:

- The traffic environment, including cars with daytime running lights, potentially reduces drivers' ability to perceive powered-two-wheelers (PTWs).
- Varying riders' clothing (bright clothes, reflective warning vests, and dark clothes) can enhance riders' conspicuity in certain situations but the effects are strongly mediated by the background conditions (e.g. lighting conditions) and by the characteristics of the driving situation (e.g. urban vs. rural traffic environment).
- Variations of specific frontal light configurations were found as promising solutions to enhance PTWs conspicuity i.e. providing a unique visual signature/signal pattern for PTWs to other road users would facilitate recognition and identification processes.
- Variation of the light colour (yellow headlights), additional helmet lights ('Alternating Blinking Light System') and specific frontal light arrangements with additional lights installed on the front of the PTW (e.g. T-shaped, V-shaped, FACE design) were considered as possible approaches to implement such a visual signature. Results revealed advantages in terms of a better detection and faster identification for yellow coloured headlights, ABLs and additional lights on the fork and handlebars for motorcycles (T-shaped light configuration).
- The experiments revealed a beneficial effect of 'priming' car drivers to actively look for PTWs in the traffic scene.

(Weare and Parkes, 2013)

Motorcycle design

A study carried out on behalf of the European Commission looked at the potential impact of technical changes in connection with proposed European type approval requirements. This indicated that, within the EU:

- Mandating *advanced braking systems* (ABS) for all bikes showed that for injury mitigation there is a benefit cost ratio (BCR) in the longer term of 2.3 to 3.0 as against doing nothing i.e. no change from the current situation. Mandating a combination of ABS for larger bikes and combined braking systems (CBS) for bikes under 125cc also showed a benefit in the longer term (BCR 2.0 to 2.6).
- The study also looked at the relationship between maximum power and accident risk but was not able to establish a direct link.

(Robinson et al, 2009)

Campaigns

In the UK, national road safety motorcycling campaigns are conducted through the Department for Transport's THINK! campaign. The THINK! BIKER 'Named Rider' campaign first ran in March 2010 (last running from March to May 2013). The campaign aims to humanise motorcyclists and build empathy between drivers and motorcyclists.

A post-campaign evaluation conducted in April 2010 found that:

- 69 per cent of respondents had seen advertising about motorcyclist road safety in at least one of the sources used in the 'Named Rider' campaign e.g. TV, radio, poster hoarding.
- 17 per cent of respondents spontaneously described aspects of a campaign that could be directly attributed to 'Named Rider' e.g. recall of an ad with signs above motorcyclists.
- 56 per cent of respondents recognised the 'Named Rider' TV ad, and 21 per cent recognised the radio ad.
- 58 per cent agreed that when they see a motorcycle, they think about the person riding it (a significant increase from the 51 per cent at prestage).

(Angle et al, 2010)

References

(References are listed by order presented in synthesis.)

Title:	Annual Road Traffic Estimates: Great Britain 2015
Published:	Department for Transport, May 2016
Link:	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/524261/annual-road-traffic-estimates-2015.pdf
Objectives :	Statistical release presenting road traffic estimates for Great Britain in 2015.
Methodology:	<p>Annual estimates are mainly based on around 8,000 manual counts where trained enumerators count traffic by vehicle type over a 12 hour period. Traffic data are also collected continuously from a national network of around 270 Automatic Traffic Counters (ATCs). In addition to counting traffic, the ATCs record some of the physical properties of passing vehicles which are used to classify traffic by type.</p> <p>These two data sources are combined with road lengths statistics to produce the number of vehicle miles travelled each year by vehicle type, road category and region.</p>
Key Findings:	<ul style="list-style-type: none"> ➤ In 2015, the overall motor vehicle traffic volume in GB was 316.7 billion vehicle miles, almost 1% more than the previous high in 2007. ➤ In 2015, traffic volumes for cars and motorcycles were broadly similar when compared to 2014, while HGVs and LGV's showed increases of 4% each, and buses and coaches showed decreases of 5%. ➤ In the last 10 years, traffic volumes for cars and LGV's have increased (2% and 22% respectively) and has decreased for HGV's (-7%) Motorcycles (-17%) and buses and coaches (-15%).
Keywords:	Traffic, volume, vehicle miles.
Comments	National statistics.

Title:	Reported Road Casualties in Great Britain: 2015 Annual Report
Published:	Department for Transport, September 2016
Link:	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/556396/rrcgb2015-01.pdf
Objectives:	Presents detailed statistics regarding the circumstances of personal injury road accidents, including the types of vehicles involved, the resulting casualties, and factors which may contribute to the accidents.
Methodology:	Majority of the statistics in the report are based on information about accidents reported to the police. Coroners and Procurators Fiscal provide data on alcohol levels of road user fatalities.
Key Findings:	<p>In 2015 in Great Britain:</p> <ul style="list-style-type: none"> • A total of 1,730 people were killed and 22,144 seriously injured on Britain's roads. • 365 motorcycle users were killed in reported road accidents, an 8% increase from 2014. • 5,042 motorcycle users were seriously injured in reported road accidents, a 5% decrease from 2014 • Motorcycle fatalities were 4% higher than their 2010-14 average, but serious injuries were the same. • Over two thirds of motorcycle fatalities occurred in rural areas, compared with under half for serious motorcycle casualties and about a third for all motorcycle casualties. • Over 90% of motorcycle user casualties were male. • Around 30 per cent of non-fatal motorcyclist casualties are younger riders (aged up to 25 years old) on smaller engine motorcycles (up to 125 cc).
Keywords:	Accidents, casualties, killed or seriously injured.
Comments:	National statistics.

Title:	Vehicle Licensing Statistics: 2012
Published:	Department for Transport, April 2013
Link:	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/198753/vls-2012.pdf
Objectives:	Presents information on motor vehicles that were licensed, or were subject to a Statutory Off-Road Notification (SORN), in Great Britain during 2012.
Methodology:	The statistics are derived from data held by the Driver and Vehicle Licensing Agency (DVLA), which administers vehicle registration and licensing records in Great Britain.
Key findings:	<ul style="list-style-type: none"> ➤ At the end of 2012 there were 34.5 million vehicles licensed for use on the roads in Great Britain, of which 28.7 million (83 per cent) were cars. ➤ Between 2011 and 2012 the total vehicle stock increased by 0.9 per cent. ➤ Since 1994, the number of licensed cars in Great Britain has increased by 35 per cent from 21.2 million. Over the same period the number of light vans (light good vehicles / LGVs) and motorcycles have increased by 53 per cent and 70 per cent respectively. ➤ The number of private cars with a female registered keeper has increased by 70 per cent since 1994.
Keywords:	Vehicles, licensing, stock.
Comments:	National statistics.

Title:	Free Flow Vehicle Speed Statistics: Great Britain 2012
Published:	Department for Transport, 2013
Link:	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209104/free-flow-vehicle-speeds-2012.pdf
Objectives:	Statistical release presenting estimates on the speed of traffic in free flowing conditions on roads in Great Britain during 2012.
Methodology:	Estimates are based on traffic speed data collected from a sample of 92 Automatic Traffic Counters (ATCs) from a national network of around 270 ATCs. This sample was deliberately chosen to exclude ATCs located where external factors are present which might restrict driver behaviour e.g. junctions, hills, sharp bends, safety cameras.
Key Findings:	<ul style="list-style-type: none"> ➤ Compared to 2002, the percentage of vehicles exceeding the limit on 30 mph roads has fallen for every vehicle type, excluding motorcycles which has increased by 3 percentage points. ➤ On motorways, 48 per cent of cars exceeded the 70 mph speed limit in 2012, a decrease of 1 percentage point from 2011. ➤ In 2012, motorcycles had the highest average free flow speeds across all road types except motorways for which cars and light goods vehicles were the highest at 69 mph. Motorcycles had the highest proportion travelling at least 10 mph above the speed limit on motorways (18 per cent) and dual carriageways (19 per cent).
Keywords:	Free flow speeds, motorcycles, casualties, killed or seriously injured.
Comments:	National statistics. These statistics provide insight into the speeds at which drivers choose to travel and their compliance with speed limits, but should not be taken as estimates of actual average speed across the road network.

Title:	Basic Fact Sheet "Motorcycles and Mopeds"
Published:	Yannis G. et al (2012) Deliverable D3.9 of the EC FP7 project DaCoTA.
Link:	http://ec.europa.eu/transport/road_safety/pdf/statistics/dacota/bfs2012-dacota-ntua-motomoped.pdf
Objectives:	Series of Road Safety fact sheets produced for the European Road Safety Observatory.
Methodology:	Accident and casualty statistical information from a range of European countries analysed and compared.
Key Findings:	<ul style="list-style-type: none"> ➤ In 2010, the fatality rate for motorcycle riders per million inhabitants in the UK was well below the average for 21 EU countries for which data were available (6.8 as compared to 12.9 per million). The highest rate was in Greece (35.6) and the lowest was in Luxembourg (2.0). ➤ Motorcycle and moped fatalities made up 15 per cent of the total number of road accident fatalities in 2010 in the EU-24 countries for which EU data are available ➤ In 2010, 4,368 riders (drivers and passengers) of <i>motorcycles</i> were killed in the EU-19 countries in traffic accidents. This is 12 per cent less than the number reported in 2009 for the same countries. The annual total of motorcycle fatalities decreased by 17 per cent during the decade (between 2001 and 2010) for these countries. ➤ In 2010, 1,094 riders (drivers and passengers) of <i>mopeds</i> were killed in the EU-19 countries in traffic accidents. This is 11 per cent less than the number reported in 2009 in the same countries. The annual total of moped fatalities decreased by more than 51 per cent during the decade (between 2001 and 2010) for these countries. ➤ The large majority of motorcycle and moped fatalities were male – only 11 per cent of moped rider fatalities and 6 per cent of motorcycle rider fatalities were female. ➤ In 2010, approximately 39 per cent of EU moped rider fatalities were aged between 15-24 years old. The number of EU motorcycle rider fatalities aged 40-65 years old increased by 38 per cent between 2001 and 2010.
Keywords:	Motorcycle, moped, fatalities, EU.
Comments:	

Title:	Fatal and serious road crashes involving motorcyclists
Published:	P. Johnston, C. Brooks, and H. Savage (2008) Department of Infrastructure, Transport, Regional Development and Local Government
Link:	http://s3.amazonaws.com/zanran_storage/www.ipwea.org.au/ContentPages/909745141.pdf
Objectives:	To analyse data on fatal and serious motorcycle crashes in Australia.
Methodology:	Time trends are shown and comparisons made across road user groups, crash type and national and international jurisdictions. Analysis of the crashes includes road-type, weather, and main contributory factors. Analysis of rider characteristics include age, and helmet use.
Key Findings:	<ul style="list-style-type: none"> ➤ Motorcycles account for 4.5 per cent of all Australian passenger vehicle registrations and 0.9 per cent of vehicle-kilometres travelled. However, motorcycle riders account for approximately 15 per cent of all road crash deaths and an even higher proportion of serious injuries. Per distance travelled, the Australian rate of motorcyclist deaths is approximately 30 times the rate for car occupants. The corresponding rate for a serious injury is approximately 41 times higher. Similar elevated rates are also found in other developed countries. ➤ Motorcycle usage has increased each year since 2002. For motorcycle registrations there has been an average growth rate of 6.8 per cent per year. Vehicle kilometres travelled have grown at 5.7 per cent per year. Usage of other passenger vehicles has also increased, but at a lower rate than for motorcycles. ➤ Over the last five years numbers of motorcyclist deaths have increased at an average annual growth rate of 3.6 per cent. Car driver deaths have increased at an annual rate of 0.4 per cent. Over the last ten years, counts of single vehicle crashes involving a motorcyclist death have grown at around 4.9 per cent per year. For fatal multiple vehicle motorcycle crashes, annual growth has been 2.4 per cent. ➤ Over the last ten years, the total decrease in risk in terms of deaths per vehicle-kilometre (VKT) for car occupants has been approximately 20 per cent (4.3 deaths per billion VKT in 1998 and 3.9 in 2007). For motorcyclists, no improvement in safety has been observed (116.4 deaths per billion VKT in 1998 and 116.9 in 2007). ➤ An analysis of the age distribution of motorcyclists killed shows that over the last ten years, riders aged over 44 years accounted for most of the annual increase in deaths. ➤ A large proportion of fatal motorcycle crashes occur during weekends. Also, on any day of the week, most fatal

	<p>crashes occur during the middle to late afternoon period (2.00 pm to 6.00 pm). These facts suggest that a significant proportion of fatal motorcycle crashes are associated with recreational riding rather than commuting.</p> <p>➤ Approximately 20 per cent of motorcyclists killed do not have a valid motorcycle licence. Of all riders killed, 10 per cent were not wearing a helmet and 20 per cent were wearing an incorrectly fitted helmet.</p>
Keywords:	Motorcycles, fatalities.
Comments:	Australian statistics.

Title:	In-depth Study of Motorcycle Accidents
Published:	D. Clarke, P. Ward, C. Bartle and W. Truman (2004) Road Safety Research Report No. 54, Department for Transport
Link:	http://webarchive.nationalarchives.gov.uk/20110509101621/http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme5/indepthstudyofmotorcycleacc.pdf
Objectives:	To explore the factors behind motorcycle road accidents
Methodology:	A sample of 1,790 accident cases were examined from Midland police forces, involving motorcyclists of all ages, and covering the years 1997–2002 inclusive. The main objective features of each case (e.g. time and place) were explored alongside a summary narrative, a sketch plan and a list of explanatory factors. In addition, a 25 item questionnaire was completed by a sample of relatively experienced motorcyclists recruited through the Motorcycle Action Group (MAG).
Key Findings:	<p>Significant differences were found in the sample with respect to the types of accidents involving motorcyclists and their blameworthiness.</p> <ul style="list-style-type: none"> ➤ Junction collisions – 38 per cent of collisions in the study - where the collision is primarily the fault of other motorists. ➤ Losing control on bends - over 15 per cent of cases - primarily the fault of the motorcyclist, more associated with leisure riding and three times as likely to involve inexperienced riders. ➤ Overtaking accidents, where the rider is often judged fully or partly to blame, tend to involve younger riders, and on higher capacity machines, than others in the sample. ➤ Filtering through traffic, where other drivers are more than twice as likely to be at fault, though there is evidence of an increased proportion of combined fault accidents. ➤ Rear end shunts, 11 per cent of all motorcycle accidents, where riders are more likely to be at fault than in other accident types and tend to be younger, more inexperienced riders on smaller capacity machines, especially in wet conditions.
Keywords:	Motorcycles, accidents, blameworthiness.
Comments:	Report covers data between 1997-2002, and only from Midland police forces.

Title:	Literature review of interventions to improve the conspicuity of motorcyclists and help avoid 'looked but failed to see' accidents
Published:	S. Helman, A. Weare, M. Palmer, and K. Fernandez-Medina (2012) TRL report PPR638, Transport Research Laboratory
Link:	https://trl.co.uk/reports/PPR638
Objectives:	To review the international literature addressing the effectiveness of interventions that are designed to increase motorcyclist conspicuity and visibility.
Methodology:	Systematic review including 27 papers/articles.
Key Findings:	<ul style="list-style-type: none"> ➤ There is evidence demonstrating that bright clothing and daytime running lights can improve conspicuity. ➤ Lighting that accentuates the form of the motorcycle helps observers to determine the time to arrival of the approaching bike (especially at night). ➤ The evidence indicates that colour can improve the effectiveness of interventions e.g. coloured motorcycle lights improve visibility against surrounding vehicles with white lights. ➤ Effectiveness can depend on the background surroundings (higher contrast with background improves visibility and conspicuity) and riders should be aware of these limitations.
Keywords:	Motorcyclists, conspicuity, visibility.
Comments:	Systematic review.

Title:	Judgements of approach speed for motorcycles across different lighting levels and the effect of an improved tri-headlight configuration
Published:	M. Gould, D.R. Poulter, S. Helman, J.P. Wann (2012) Accident Analysis and Prevention 48 (2012) 341-345
Link:	https://www.ncbi.nlm.nih.gov/pubmed/22664699
Objectives:	To conduct a study examining how accurately individuals are able to judge the speed of motorcycles and cars across a number of different ambient light level conditions.
Methodology:	A simulator study of 14 participants recording perceived vehicle speed in different lighting conditions.
Key Findings:	<p>The accuracy of judgement remained constant for cars across all lighting levels.</p> <p>Participant estimations of motorcycles with a solo headlight were significantly less accurate as lighting levels degraded.</p> <p>The addition of a tri-headlight formation considerably reduced the degradation in speed judgements under lower light conditions. However, judgements were still poorer than the car.</p> <p>Whilst this is less than optimal, the introduction of the tri-headlight formation could reduce the likelihood of right of way violation collisions occurring.</p> <p>It was also suggested that media campaigns aiming to raise driver awareness could also aim to increase knowledge about the potential for inaccurate judgements of vehicle speeds, particularly for motorcyclists.</p>
Keywords:	Perception, vision, looming, motorcycle, conspicuity
Comments:	Systematic review.

Title:	Motorcycle Rider Fatigue: A Review
Published:	T. Horberry, R. Hutchins and R. Tong (2008) Road Safety Research Report No. 78, Department for Transport
Link:	http://webarchive.nationalarchives.gov.uk/20090417002224/http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme2/riderfatigue.pdf
Objectives:	The review aimed to investigate the incidence of fatiguerelated accidents among riders and the causes, symptoms and effects of fatigue on riders; to assess the impact of fatigue in riders on accident causation; and to explore possible countermeasures to combat the effects of fatigue.
Methodology:	Literature review
Key Findings:	<ul style="list-style-type: none"> ➤ The available literature and accident data provide very little scientific information specifically on the subject of rider fatigue. ➤ Fatigue is identified as a factor in a relatively small proportion of the motorcycle accidents in the accident databases, and there is insufficient evidence to draw conclusions about any associations with other factors (time of day, etc.). ➤ Causes of rider fatigue identified in the literature survey were insufficient breaks, long riding hours, monotonous roads, heat stress, stress from cold, noise or vibration, posture/discomfort stress and night-time riding. ➤ Remedial measures identified affecting rider behaviour were formal fatigue management programmes; taking regular breaks; ingesting caffeine; setting realistic targets for the journey; and taking 'power naps'. Measures identified to reduce the physical and mental demands of riding included: having a windshield on the motorbike; correct configuration of the motorcycle; and using hearing protection. However, hard evidence of the effectiveness of these measures is lacking.
Keywords:	Rider, fatigue, remedial measures.
Comments:	

Title:	Passion, performance, practicality: motorcyclists' motivations and attitudes to road safety – motorcycle safety research project
Published:	S Christmas, D Young, R Cookson and R Cuerden (2009) TRL report PPR442, Transport Research Laboratory
Link:	https://trl.co.uk/reports/PPR442
Objectives:	To gain an understanding of motorcyclists' attitudes to safety, and the reasons behind the decisions that impact on their safety.
Methodology:	Qualitative research was undertaken to explore the motivations behind the decisions that impact on road safety. The insights gained were then validated by a quantitative study of 1019 riders, using structured questionnaires.
Key Findings:	<p>Patterns emerged in the ways different types of rider thought about and managed risk, which the report summarises under 7 segments as follows:</p> <ul style="list-style-type: none"> • <i>Performance disciples: precautionary fatalism</i>: see risk as unavoidable negative of riding but tend not to think about it all the time – emphasis on personal skill and armour as responses to risk. • <i>Performance hobbyists: cautious attraction</i>: see risk as part of what makes riding fun, but very circumspect about own abilities to deal with risks, leading to caution in behaviour. • <i>Riding disciples: active management of risks</i>: highly conscious of potential risk in riding, take active steps to manage it by responsible riding behaviour and use of gear. • <i>Riding hobbyists: personal responsibility for avoiding risk</i>: highly conscious of risk, tendency to avoid potentially risky situations altogether, and to emphasise rider's responsibility for risks. • <i>Car rejecters: high awareness and high unhappiness</i>: very sensitive to the risks of riding, and see this as a strong argument against riding. • <i>Car aspirants: low awareness but high educability</i>: tend not to think about the risks of riding and as a result may not take steps to manage them; but signs that they will take steps when the risks are pointed out to them. • <i>Look-at-me enthusiasts: blasé confidence</i>: recognise risks of riding in general, but see themselves as relatively safe; plus strong tendency to see risk as part of what makes riding fun, and to engage in risky behaviours.
Keywords:	Motorcyclist, attitudes, road safety, segment/segmentation.

Title:	The Older Motorcyclist
Published:	S. Jamson, K. Chorlton and M. Conner (2005) Road Safety Research Report No. 55, Department for Transport
Link:	http://webarchive.nationalarchives.gov.uk/20110509101621/http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme2/theoldermotorcyclistno55.pdf
Objectives:	The project aimed to provide a broad picture of the older motorcyclist in terms of experience, vehicle characteristics, riding history and attitudes to risk.
Methodology:	The study involved (i) a literature review, (ii) a survey examining ownership characteristics completed by 1009 riders, (iii) a survey examining psychological determinants of risky riding behaviours completed by 4929 riders and (iv) a simple accident analysis using STATS19 data.
Key Findings:	<ul style="list-style-type: none"> • The older motorcyclist makes up a large proportion of current riders. • The average age at which motorcyclists gain their first licence has increased by 13 years since the 1970s. • Motorcyclists are moving on from small to larger capacity machines more quickly than their predecessors. • 30 per cent of motorcyclists engage solely in leisure trips while 85 per cent engage partly in leisure trips. This represents a shift in behaviour to leisure cycling. Leisure riders tend to consist of long-term and returning riders. • Past behaviour emerged as the most significant predictor of risky riding with attitudes and behavioural beliefs also emerging as consistent predictors. After taking account of these variables, age was not found to be a significant predictor of risky behaviour.
Keywords:	Older motorcyclist, attitudes, behaviour.
Comments:	

Title:	Car Drivers' Attitudes and Visual Skills in Relation to Motorcycles
Published:	D. Crundall, D. Clarke and A. Shahar (2011), Road Safety Research Report No. 121, Department for Transport
Link:	http://webarchive.nationalarchives.gov.uk/20120606181145/http://assets.dft.gov.uk/publications/rsrr-theme1motorcyclists/rsrr121mainreport.pdf
Objectives:	A common cause of motorcycle accidents is car drivers who fail to give way to an approaching motorcycle at a T-junction. Car drivers often claim that they looked but failed to see the motorcycle. This study explores whether such 'look but fail to see' accidents occur, and what factors contribute to them.
Methodology:	3 studies were involved. (i) With a view to increasing their empathy for motorcyclists, exposing a sample of car drivers to hazard perception clips filmed from a motorcycle, combined with a pre- and post-intervention questionnaire survey of their attitudes towards motorcyclists; (ii) Using multiple screen video clips, testing the reactions of drivers moving through a series of T-junctions and change-lane manoeuvres. Eye movements and response times were monitored; (iii) Empirical testing of 3 possible training interventions, involving (a) explicit instruction on where to look when approaching junctions etc; (b) training to reduce the processing threshold for motorcycle information; and (c) using the hazard perception clips to increase awareness of the vulnerability of motorcycles.
Key Findings:	<ul style="list-style-type: none"> • The presentation of hazardous video clips from a motorcyclist's perspective resulted in an improvement in their self-reported attitudes to motorcyclists; • There were differences in the reactions and responses of dual drivers (who both drive a car and ride a motorcycle), novice drivers and experienced drivers when presented with two scenarios involving car-motorcycle interactions; • All drivers were more cautious in the presence of motorcycles than cars. Dual drivers were the most cautious. • There were no differences between groups in how they visually searched a T-junction, or when changing lanes. However, dual drivers typically gave more attention to approaching motorcycles than cars, while experienced drivers looked at motorcycles for less time than cars. This suggests that experienced drivers do not realise that they are looking at a motorcycle, providing the first experimental evidence that drivers might truly look at an approaching motorcycle but 'fail to see it'. • While holding some promise for the future, the training interventions failed to produce the desired results.
Keywords:	Motorcyclists, hazard perception, training.

Title:	Public attitudes towards motorcyclists' safety: A qualitative study from the United Kingdom
Published:	C. Musselwhite, E. Avineri, Y. Susilo, D. Bhattachary (2012) Accident Analysis and Prevention 49 (2012) 105-113
Link:	http://dx.doi.org/10.1016/j.aap.2011.06.005
Objectives:	To examine the perceptions of road user safety amongst different road users and examine the link between attitudes, empathy and skill in motorcycle safety behaviour.
Methodology:	A qualitative study of 228 participants, recruited in groups of ten. Participants took part in three re-convened workshops, each in turn exploring views on risk, the relationships between different road users; and policy interventions to promote road safety. The participants were recruited from four locations in the UK: London, Bradford, Glasgow and North-West Wales. Participants belonged to one of the following groups: Group 1: Young male drivers (17-21 years) Group 2: Those who drive for work (aged 21-54) Group 3: Those with children under the age of 16 (aged 21-54) Group 4: Older people (both drivers and non-drivers aged 55+) Group 5: Younger working people with no children yet (21-34) Group 6: Individuals with different attitudes to risk Each group was comprised of a mix of car drivers, motorcycle riders, cyclists and non drivers.
Key Findings:	<ul style="list-style-type: none"> ➤ Motorcyclists themselves tend to note that the vulnerability of being on a bike creates the danger, which is largely overcome by experience and skill of the rider, while losing none of the thrill. ➤ Motorcyclists tend to view safety in terms of being able to handle the bike, knowing its limitations and capabilities, whereas car drivers are less likely to view this as skill and could view this instead as resulting in reckless behaviour. ➤ Those who classify themselves as calculated risk takers on the road (on any mode) show more empathy and understanding to motorcycle riders. ➤ Female car drivers were far more negative towards motorcyclists. They were far more likely to view motorcyclist behaviour as not just dangerous but also discourteous and law-breaking. ➤ Motorcycle riding identity is strongly linked with the need to ride safely. However, the perception of what is safe riding varies between motorcyclists. ➤ Motorcycling has a strong social identity and affiliation that means social norms are easily transmitted amongst the groups, meaning training amongst groups could be easily assembled. ➤ There is a strong belief that car drivers are as much to blame for motorcycle accidents, particularly through failing to look properly. However, some riders may feel that the responsibility for safety lies in the hands of the car drivers, rather than

	<p>themselves. This creates a further divide between road users.</p> <ul style="list-style-type: none"> ➤ In line with previous research, more empathy and indeed positive attitudes are shown towards motorcyclists by those who are motorcyclists, or have previously ridden a motorcycle or have motorcyclists in their immediate family or circle of friends.
Keywords:	Attitudes, Risk, Motorcycle, Qualitative, Empathy

Title:	Motorcycle manoeuvres review - phase 2 and phase 3 report
Published:	S. Tong, S. Helman, C. Fowler, E. Delmonte, and R. Hutchins (2013) , TRL report PPR659
Link:	https://trl.co.uk/reports/PPR659
Objectives:	Following a review of the motorcycle test, Phase 1 tested a revised set of motorcycle test manoeuvres by inviting 'test ready' learners to ride through the manoeuvres on an off-road area mocked up with the carriageway dimensions of a real road. Phases 2 and 3 of the research trialled the revised manoeuvres on-road with experienced riders and test-ready learners respectively.
Methodology:	Phase 2 piloted the revised manoeuvres on-road with a small sample of 10 experienced riders. Phase 3 trialled 151 testready learners, all of whom completed the revised manoeuvres on-road and the module 1 manoeuvres at a test centre, in a pseudo-randomised design.
Key Findings:	<ul style="list-style-type: none"> ➤ Phase 2 data indicated that it would be possible to find a small number of on-road sites on which to trial the revised manoeuvres with test-ready learner riders. ➤ The Phase 3 test performance data showed that learners committed significantly more faults on-road than for the equivalent module 1 test. The significantly higher fault rate was primarily attributed to learners committing four times as many 'serious' faults on-road than in module 1 (any serious fault precludes a test pass being issued to a candidate). ➤ Data and comments from examiners and learners indicated significantly greater feelings of risk and vulnerability when carrying out manoeuvres on-road rather than for module 1. ➤ A wide range of incidents occurred during on-road trials, of which the vast majority were near-misses or non-injury incidents. The risk assessment identified that these incidents, which were across a range of the manoeuvres, often had the potential for more serious outcomes. ➤ The findings indicate there was a difference in the competences and assessment standards for the on-road test when compared with the current module 1 test.
Keywords:	Motorcycle, test, manoeuvres, test review.
Comments:	Follows on from a Phase 1 study which assessed the feasibility and safety of carrying out a revised set of manoeuvres for the motorcycle test.

Title:	Updating the Motorcycle test for 2009: exploring the training requirements for the off-road manoeuvres
Published:	S. Tong (2009) TRL Report PPR316, Transport Research Laboratory
Link:	https://trl.co.uk/reports/PPR316
Objectives:	To explore the training requirements for the 2009 Motorcycle Test, and the relationship between the training undertaken and subsequent performance on the off-road manoeuvring course.
Methodology:	Interviews with training instructors and assessment of how 50 candidates performed in on off-road manoeuvres in a mock test situation.
Key Findings:	<ul style="list-style-type: none"> • Trainers agreed to varying degrees that the 2009 test would standardise testing conditions for manoeuvres, deliver an improved standard of riding and ensure that riders with minimal amounts of training were less likely to pass. • Problems of accessing off-road sites for training might be overcome if DSA could provide test candidates with the option of a practice session at a DA site.
Keywords:	Motorcycle test, trainers, training.

Title:	A Review of Motorcycle Training
Published:	B Sexton and M Elliott (2009) TRL Report PPR306, Transport Research Laboratory
Link:	https://trl.co.uk/reports/PPR306
Objectives:	To explore the views of training organisations and umbrella bodies on the core training and skills required by motorcyclists and to investigate what was considered best training practice.
Methodology:	In-depth interviews and a postal survey of training organisations; an observational study following the training of new riders; discussions with umbrella bodies.
Key Findings:	<p>The report identified the following areas for consideration in improving motorcycle safety:</p> <ul style="list-style-type: none"> • Improvements to pre and post-test training content and delivery • Changes to the testing requirements to induce better training • Extending the span of Compulsory Basic Training (CBT) beyond one day • Making compulsory some aspects of post-CBT and/or posttest training • Encouraging longer training periods for Direct Access Scheme trainees, perhaps by introducing a log-book. □ Changes to the licensing system
Keywords:	Motorcycle training, road safety, testing.

Title:	A simulator study investigating how motorcyclists approach side-road hazards
Published:	E. Crundall, A.W. Stedmon, R. Saikayasit, D. Crundall (2013) Accident Analysis and Prevention 51 (2013) 42-50
Link:	http://dx.doi.org/10.1016/j.aap.2012.10.017
Objectives:	To demonstrate whether riders of differing experience and training approach side roads differently, and whether this can be identified in a motorcycle simulator.
Methodology:	Sixty-one participants, comprising 20 Novice riders, 21 Experienced riders and 20 Advanced riders were recruited to undertake a simulator test of a virtual route. Side roads were present on the virtual route, with car hazards emerging from some side roads. Participants were asked to ride the route as they would in the real world and lateral position from the centre of the road and speed were recorded.
Key Findings:	<ul style="list-style-type: none"> ➤ The Advanced riders (those had undertaken advanced training) mainly adopted a strategy which most riding instructors would consider to reflect safe practice when approaching junctions, riding closer to the central line than Novices (post CBT and preparing for DSA motorcycle test or had passed in previous 12 months). ➤ The Experienced riders (more than three years' experience) chose faster speeds, especially when approaching open junctions or when the junction apparently did not contain another vehicle. The Experienced riders collided most often with the hazard vehicle. ➤ The study concluded that it could be possible to train motorcyclists to approach side junctions in a manner that may reduce their crash liability.
Keywords:	Simulator, Motorcycle, Hazard, Junction, Driving

Title:	A European Perspective of In-Depth Data Sampling on Cognitive Aspects of Motorcycle Helmets within COST 357
Published:	D. Otte, M. Jäensch, J. Chliaoutakis, M.D. Gilchrist, T. Lajunen, A. Morandi, T. Ozkan, J. Pereira, A. Stendardo, G. Tzamalouka (2009) COST Action 357
Link:	http://bast.opus.hbz-nrw.de/volltexte/2012/490/pdf/A_European_Perspective_of_In_Depth_Data_Sampling_on_Cognitive.pdf COST Action 357 Final Report: http://e-collection.library.ethz.ch/eserv/eth:1202/eth-120201.pdf
Objectives:	To analyse motorcycle accident events and to identify motorcycle design issues which affect motorcycle riders while wearing a helmet.
Methodology:	Consideration of accident data across 6 different countries (Germany, Greece, Italy, Ireland, Portugal and Turkey) recorded in the course of in-depth investigations at the site of accidents in combination with field studies of motorcyclists participating in traffic, but not involved in accidents.
Key Findings:	<ul style="list-style-type: none"> • There are differences in practice between southern and northern countries, largely as a result of climactic differences. • The age of the helmets motorcyclists worn by cyclists varied: typically 2.8 years old in Ireland and 5.1 years old in Portugal. • Older riders and those with larger bikes wear their helmets more often, and have helmets which are in better condition. Riders with little experience have more damaged helmets than those with more experience • Riders of motorcycles over 400cc are twice as likely to be involved in an accident as riders of bikes of under 400cc. <ul style="list-style-type: none"> ➤ Various other classes of rider are at above average risk of involvement accidents, including riders who don't wear their helmets properly, riders using helmets with stickers, those with dark visors, and riders who have flipped their retractable chin bar.
Keywords:	Motorcycle, rider, accidents, helmets.
Comments:	

Title:	Assessment of TfL's experimental scheme to allow motorcycles onto with-flow bus lanes on the TLRN
Published:	I. York, S. Ball, O. Anjum, and D. Webster (2010) TRL Report PPR495, Transport Research Laboratory
Link:	https://www.tfl.gov.uk/cdn/static/cms/documents/motorcyclesin-bus-lanes-full-report.pdf
Objectives:	To assess the impact on all traffic, in particular cyclists, of allowing motorcyclists to use bus lanes.
Methodology:	On-street before and after surveys on 60 sites in London, involving video surveys and automatic traffic counters.
Key Findings:	<ul style="list-style-type: none"> • There was an increase in motorcycle speeds after they were permitted access to bus lanes, an increase in the percentage exceeding the speed limit, and an increase in collisions involving motorcycles. This increase generally involved cars turning left into and out of side roads. • There were no changes in the safety of cyclists and pedestrians that could be directly attributed to motorcycles being permitted access to bus lanes.
Keywords:	Motorcycles, with-flow bus lanes, surveys, safety.
Comments:	Pilot trial in London – would benefit from repeating systematically across a wider area, with a more representative sample size.

Title:	Barriers to change: designing safe roads for motorcyclists. Position paper on motorcycles and crash barriers
Published:	EuroRAP (2008)
Link:	https://www.iamroadsmart.com/docs/default-source/research-reports/iam-eurorap-motorcycle-crash-barrier-report-2008.pdf
Objectives:	To review the evidence and research base on crash barriers and their impact on Powered Two-Wheelers
Methodology:	A panel of European experts in the field of motorcycle safety, including representatives from motoring clubs, manufacturers, riders' organisations, practitioners, transport specialists in research institutions and professional associations, and national and regional road authorities.
Key Findings:	<ul style="list-style-type: none"> ➤ Hitting a crash barrier is a factor in 8-16 per cent of rider deaths ➤ In collisions with crash barriers, riders are 15 times more likely to be killed than a car occupant. ➤ Motorcycle-friendly systems have been shown to halve fatalities and offer high rates of return. ➤ That the quality of crash data and the research base surrounding how motorcyclists are killed and injured in crashes involving infrastructure needs to improve substantially. ➤ The decision in July 2008 to develop a new European testing standard for crash barriers that incorporates the needs of dismounted riders is commended – but concerns remain that testing should take place for riders striking the barrier whilst mounted and for protective equipment added to existing barriers. ➤ Every road safety engineering department should have a motorcycle champion to introduce a cultural change to the way in which risk is viewed by a road authority.
Keywords:	Motorcycles, Crash barriers, Risk

Title:	Motorcycle rider training for the prevention of road traffic crashes (Review)
Published:	K. Kardamanidis, A. Martiniuk, R.Q. Ivers, M.R. Stevenson and K. Thistlethwaite (2010) Cochrane Database of Systematic Reviews
Link:	http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD005240.pub2/abstract;jsessionid=3EC48A2230F9CB5E4E12E65D2B7076F5.f01t01
Objectives:	To quantify the effectiveness of pre- and post-licence motorcycle rider training on the reduction of traffic offences, traffic crash involvement, injuries and deaths of motorcycle riders.
Methodology:	23 studies were analysed in terms of data about the study population, study design and methods, interventions and outcome measures & data quality from each included study.
Key Findings:	<ul style="list-style-type: none"> • Most studies suffered from serious methodological weaknesses. Most were non-randomised and controlled poorly for confounders. Most also suffered from detection bias due to the poor use of outcome measurement tools. Small sample sizes and short follow-up time after training were also common. • Due to the poor quality of studies identified, the authors were unable to draw any conclusions about the effectiveness of rider training on crash, injury, or offence rates.
Keywords:	Motorcycle training, effectiveness.
Title:	Helmets for preventing injury in motorcycle riders
Published:	B.C. Liu, R. Ivers, R. Norton, S. Boufous, S. Blows, S.K. Lo (2008) Cochrane Database of Systematic Reviews
Link:	http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD004333.pub3/full
Objectives:	To assess the effects of wearing a motorcycle helmet in reducing mortality and head and neck injury following motorcycle crashes.
Methodology:	Systematic review, with defined selection criteria. All studies included compared an intervention and control group.
Key Findings:	<ul style="list-style-type: none"> ➤ Motorcycle helmets reduced the risk of death and head injury in motorcyclists who crashed. Helmets were estimated: <ul style="list-style-type: none"> ➤ To reduce the risk of death by 42% ➤ To reduce the risk of head injury by 69% ➤ The evidence was not sufficient to compare the effectiveness of different types of helmet. ➤ There was weak evidence for helmets protecting against facial injury, but the evidence was not conclusive.
Keywords:	Motorcycle, helmets, effectiveness.

Title:	Motorcycle protective clothing: Protection from injury or just the weather?
Published:	L. de Rome, R. Ivers, M. Fitzharris, W. Du, N. Haworth, S. Heritier, and D. Richardson (2011) Accident Analysis and Prevention, 43, 1893-1900
Link:	http://www.sciencedirect.com/science/article/pii/S0001457511001163
Objectives:	To examine the association between use of motorcycle protective clothing and risk of injury in crashes.
Methodology:	A 12 month prospective cohort study of motorcycle crashes was conducted from June 2008. Participants were n=212 riders/passengers, aged 17-70 years, involved in motorcycle crashes. The study was conducted in Australia. Participants completed a face-to-face interview approximately 2 weeks after the crash, and self-reported injury data was used for the analysis.
Key Findings:	<ul style="list-style-type: none"> • Almost all participants wore helmets (98.6 per cent), motorcycle jackets (82.5 per cent) and motorcycle gloves (87.3 per cent). Less than half wore motorcycle pants (34.9 per cent) and motorcycle boots (38.2 per cent), and approximately a quarter wore other heavy boots (25.9 per cent). • The most common injuries were cuts, abrasions and bruises followed by sprains, mostly to the upper torso. Hospital records showed a close correspondence with injury reports obtained at interview. • Overall, riders were significantly less likely to be admitted to hospital if they crashed while wearing a motorcycle jacket, motorcycle pants, or motorcycle gloves. The effect of motorcycle boots on hospitalization was not significant. • Motorcyclists wearing motorcycle protective clothing fitted with body armour were significantly less likely to sustain injuries to the protected areas compared to those wearing non-motorcycle clothing (23 per cent lower risk of injury associated with motorcycle jackets, 45 per cent for motorcycle gloves and 45 per cent for motorcycle boots. • The risk of any foot or ankle injuries was reduced by 53 per cent by non-motorcycle boots when compared to shoes or trainers, a risk reduction similar to motorcycle boots. • There was a significant reduction in the risk of any soft tissue injuries (including bruises, abrasions, cuts and lacerations) associated with all forms of motorcycle clothing fitted with body armour.
Keywords:	Motorcycle, rider, passenger, protective clothing, injury, relative risk.
Comments:	Study conducted in Australia.

Title:	EC project '2 BE SAFE' briefing note for Deliverable 18: Experimental studies on powered two-wheeler visual conspicuity
Published:	A. Weare and A. Parkes (2013) TRL report PPR600, Transport Research Laboratory
Link:	https://trl.co.uk/reports/PPR600 Project deliverables can be downloaded from: http://www.2besafe.eu/deliverables
Objectives:	2 BE SAFE is a European project which aimed to examine the behavioural and ergonomic factors contributing to motorcycle crashes by studying rider behaviour and the interactions between motorcycle riders and car drivers. This briefing note summarises the findings from experimental studies examining conspicuity of motorcyclists.
Methodology:	Summary of a range of experimental studies (studies detailed in deliverable 18).
Key Findings:	<ul style="list-style-type: none"> ➤ Results show that the complexity of the traffic situation impairs the detection of PTWs (as expected). The detection rate of Powered Two Wheelers in inter-urban road environments was significantly higher than the rates obtained in urban scenarios with a more crowded traffic environment. ➤ Results indicate that detection rate of PTWs is substantially lower under dusk time conditions compared to during daytime time conditions, especially when participants were not explicitly instructed to look for PTWs. ➤ The results suggest that the traffic environment, including cars with daytime running lights, potentially reduces drivers' ability to perceive PTWs. ➤ Varying riders' clothing (bright clothes, reflective warning vests, and dark clothes) can enhance riders' conspicuity in certain situations but the effects are strongly mediated by the background conditions (e.g. lighting conditions) and by the characteristics of the driving situation (e.g. urban vs. rural traffic environment). ➤ Variations of specific frontal light configurations were found as promising solutions to enhance PTWs conspicuity. Due to the distinctive features of such a frontal light configuration, it is proposed to provide a unique visual signature/signal pattern for PTWs to other road users, and thus, to facilitate recognition and identification processes. ➤ Variation of the light colour (yellow headlights), additional helmet lights ('Alternating Blinking Light System' or ABLs) and specific frontal light arrangements with additional lights installed on the front of the PTW (as T shaped, V shaped, FACE design) were considered as possible approaches to implement such a visual signature.

	<ul style="list-style-type: none"> ➤ Results reveal advantages in terms of a better detection and faster identification for yellow coloured headlights, ABLs and additional lights on the fork and handlebars for motorcycles (T Light configuration). ➤ The experiments revealed a beneficial effect of 'priming' car drivers to actively look for PTWs in the traffic scene.
Keywords:	Motorcycles, conspicuity, visibility, rider behaviour.
Comments:	

Title:	Evaluating the impact of possible new measures concerning category L vehicles
Published:	T. L. Robinson, M. McCarthy, M. Pitcher, T. Gibson and C. Visvikis (2009) TRL Report CPR383, Transport Research Laboratory
Link:	http://ec.europa.eu/enterprise/sectors/automotive/files/projects/report_new_measures_l_category_en.pdf
Objectives:	To investigate the potential social, economic and environmental impact of various technical changes proposed for type approval for motorcycles and other category L vehicles under Directive 2002/24/EC. This was in the context of consideration of wider changes to the legislative context for category L vehicles.
Methodology:	Review of published studies and discussions with stakeholders.
Key Findings:	<p>Within the EU:</p> <ul style="list-style-type: none"> • Mandating advanced braking systems (ABS) for all bikes showed that for injury mitigation there is a benefit cost ratio in the longer term of 3.6 to 4.6 as against doing nothing. Mandating a combination of ABS for larger bikes and combined braking systems (CBS) for bikes under 125cc also showed a benefit in the longer term (BCR 3.0 to 4.0). • The study also looked at the relationship between maximum power and accident risk but was not able to establish a direct link.
Keywords:	Motorcycles, advanced braking systems, benefit-cost ratio.
Comments:	

Title:	THINK! Road Safety Campaign Evaluation Post Stage: 'Named Rider' motorcycle campaign
Published:	H. Angle, S. Bone, E. Goddard and E. Johns (2010) TNS-BMRB for Department for Transport, 2010
Link:	http://webarchive.nationalarchives.gov.uk/20120606112243/http://assets.dft.gov.uk/publications/thinkresearch/motorcycles-report.pdf
Objectives:	<ul style="list-style-type: none"> • To measure changes in attitudes towards motorcyclist road safety, including where the responsibility for reducing road accidents with motorcyclists lies. • To gauge driver awareness of motorcyclists while driving and to understand how motorcycles and their riders are seen from the drivers perspective. • To determine what is perceived as the most common causes of motorcycle accidents and the precautions taken to avoid accidents with motorcyclists
Methodology:	2,075 interviews were conducted with those aged 15+ in Great Britain. Interviews were conducted in-home using CAPI (Computer Assisted Personal Interviewing).
Key Findings:	<ul style="list-style-type: none"> ➤ Two thirds of all respondents (66%) recalled seeing or hearing advertising about road safety in relation to motorcyclists recently, a significant increase from half at the pre-stage (46%). ➤ Two thirds had seen advertising about motorcyclist road safety in at least one of the sources used in the 'Named Rider' campaign (69%). Six in ten had seen a TV advert (62%), one in ten a radio advert (8%), poster hoarding (8%). ➤ Two thirds recognised any of the campaign ads (66%). Over half recognised the TV ad (56%), and two in ten had heard a radio ad (21%). ➤ Four in ten (37%) spontaneously reported the main message of the 'Named Rider' TV ad to be, 'look out for motorcyclists', with 16% saying the message is to think about the person on the bike. One in ten picked up on the message that motorcyclists are human/ people (11%). ➤ Nearly six in ten drivers (58%) agreed that when they see a motorcycle, they think about the person riding it, a significant increase from the pre-stage (51%). ➤ Over six in ten respondents indicated that they felt car drivers and motorcyclists are equally responsible for reducing motorcycle accidents (64%), stable from the prestage.
Keywords:	Campaign, motorcyclists, awareness, attitudes.
Comments:	